Terraprobe
Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

GEOTECHNICAL INVESTIGATION
MOUNTAINSIDE POOL REVITALIZATION
2205 MOUNT FOREST DRIVE
BURLINGTON, ONTARIO

Prepared For: City of Burlington
Capital Works Department
426 Brant Street, P.O. Box 5013
Burlington, Ontario, L7R 3Z6

Attention: Ms. Jennifer Johnson
Senior Project Manager

File No. 7-21-0014-01
April 1, 2021

Distribution:

1 copy (pdf): The City of Hamilton
1 copy (pdf): Architects Tillmann Ruth Robinson
1 copy: Terraprobe Inc., Stoney Creek

Terraprobe Inc.

Greater Toronto
11 Indell Lane
Brampton, Ontario L6T 3Y3
(905) 796-2650 Fax: 796-2250

Hamilton – Niagara
903 Barton Street, Unit 22
Stoney Creek, Ontario L8E 5P5
(905) 643-7560 Fax: 643-7559

Central Ontario
220 Bayview Drive, Unit 25
Barrie, Ontario L4N 4Y8
(705) 739-8355 Fax: 739-8369

Northern Ontario
1012 Kelly Lake Rd., Unit 1
Sudbury, Ontario P3E 5P4
(705) 670-0460 Fax: 670-0558

www.terraprobe.ca

TABLE OF CONTENTS

1.0 INTRODUCTION

Terraprobe Inc. was retained by the City of Burlington to carry out a geotechnical investigation at a property located at 2205 Mount Forest Drive in Burlington, Ontario. The property is located on the north side of Mount Forest Drive. A site location plan is provided as Figure 1. A proposal and cost estimate to carry out the investigation were provided in our proposal of February 3, 2021. Authorization to proceed with the work was provided by the City of Burlington on February 17, 2021 via email, and purchase order number 62005887 was provided on March 17, 2021.

The purpose of the work was to investigate and report on the subsurface soil and ground water conditions in a series of boreholes drilled at the site. Based on this information, advice is provided with respect to the geotechnical aspects of the proposed development, including the design of foundations, retaining walls, floor slabs-on-grade and pavements. The anticipated construction conditions pertaining to excavation, backfill and temporary ground water control are discussed also, but only with regard to how these might influence the design.

2.0 SITE AND PROJECT DESCRIPTION

2.1 Existing Site Conditions

The entire property addressed 2205 Mount Forest Drive consists of an approximately 10.4 ha (25.7 acre) park “Mountainside Park”. The park consists of baseball diamonds on the eastern portion of the property, a forested area on the central portion of the property, and an outdoor swimming pool and recreation centre on the southern portion of the property. The property has frontage along the north side of Mount Forest Drive of approximately 90 m. The property is bound to the north and east by the forested area of Mountainside Park, to the south by Mount Forest Drive, and to the west by a residential subdivision.

The property is currently developed with a one-storey community use building which includes a public arena and change rooms, an outdoor public swimming pool and deck, and associated driveways and parking areas.

2.2 Site Geology

Based on published geological information for the general area of the site, the near surface overburden soil at and in the vicinity of the subject property consists of Pleistocene Age Late Wisconsinan Halton Till: clay and silt till.[1] The Halton Till is underlain by bedrock of the Queenston Formation.[2] The Queenston Formation consists of reddish brown shale, interbedded with limestone and calcareous

1 *Quaternary Geology of the Hamilton Area, Southern Ontario*; Ontario Division of Mines; Map No. 2605; 1983.
2 *Paleozoic Geology, Hamilton Area, Southern Ontario*; Ontario Division of Mines; Map No. 2336; 1976.

sandstone. The geological mapping and regional well records indicated that the bedrock beneath the site is about 3 to 11 metres below existing grade.[3]

2.3 Proposed Re-development

It is understood the re-development will consist of the construction of a new community pool with associated slide structure, shade structures, retaining walls, concrete deck slab and asphalt pathway. The location and features of the re-development are shown on the Proposed Site Re-development Plan, Figure 3, as derived from a Site Plan drawing prepared by Architects Tillmann Ruth Robinson.

3.0 PROCEDURE

The field work for this investigation was carried out on March 9 and 10, 2021 during which time seven (7) boreholes were drilled to depths of about 4.3 to 9.2 metres below the existing ground surface (m BGS). The locations of the boreholes are shown on the Borehole Location Plan, Figure 2. The results of the boreholes are shown on the Log of Borehole sheets presented in Appendix A.

The boreholes were drilled using track mounted power auger equipment supplied and operated by a specialist drilling contractor. The boreholes were advanced using conventional solid stem continuous flight augers. The samples of the strata were obtained using the Split-Barrel Method (ASTM D1586). After the drilling, sampling, and logging was completed, the boreholes were backfilled with auger cuttings and bentonite sealant, in accordance with Ontario Regulation 903.

The field work was observed throughout by a member of our engineering staff who located the boreholes, arranged for the underground utility locates at the borehole locations and cared for the samples obtained. The ground surface elevations at the borehole locations were inferred from a topographical drawing prepared by Mackay, Mackay & Peters Limited, dated March 6, 2021, and was understood to have been referred to the geodetic datum.

Ground water observations were made in each borehole during and upon completion of drilling and sampling. No provision was made for long-term ground water monitoring at the site.

All of the samples recovered in the course of the investigation were brought to our Stoney Creek laboratory for further examination. Geotechnical laboratory testing consisted of moisture content tests on all recovered samples in accordance with ASTM Standards. The test results are shown on the individual borehole logs presented in Appendix A. Two (2) soil samples obtained from the boreholes were submitted to AGAT Laboratories Limited for corrosivity testing. The Certificate of Analysis for the corrosivity testing is included in Appendix B and the results of the testing are discussed in Section 5.0 of this report.

3 *Bedrock Topography of the Hamilton Area, Southern Ontario*; Ontario Department of Mines; Map No. 2034; 1964.

4.0 SUBSURFACE CONDITIONS

The subsurface soil, rock and ground water conditions encountered in the boreholes, and the results of the field and laboratory testing, are shown on the Log of Borehole sheets in Appendix A. A list of abbreviations and symbols are provided to assist in the interpretation of the borehole logs. It should be noted that the boundaries between the strata have been inferred from drilling observations and non-continuous samples. The boundaries generally represent a transition from one soil type to another and should not be inferred to represent exact planes of geological change. Further, conditions will vary between and beyond the locations investigated.

4.1 Soil Conditions

The following discussion has been simplified in terms of the major soil strata for the purposes of geotechnical design. In general, the boreholes drilled at the site penetrated existing concrete pavement, topsoil and fill overlying clayey silt till, silt and weathered shale bedrock.

4.1.1 Concrete Pavement

Boreholes 1, 2 and 5 were drilled within the existing pool deck and penetrated approximately 140 to 185 mm of concrete pavement at the ground surface. The concrete was underlain by about 500 to 1500 mm of sand and gravel fill.

4.1.2 Topsoil

A layer of topsoil ranging from 75 to 300 mm in thickness was encountered at the ground surface in boreholes 3, 4, 6 and 7.

4.1.3 Fill

Fill consisting predominantly of clayey silt with intermixed rootlets and gravel was encountered immediately beneath the topsoil in boreholes 3, 4, and 6 and extended to a depth of about 0.8 to 1.5 m BGS. Borehole 7 encountered sand and gravel fill beneath the topsoil to a depth of about 1.5 m BGS. The N values, as determined in the Standard Penetration testing carried out within the fill, ranged from 7 to 13 blows per 0.3 m, inferring a loose to compact state of packing. The in-situ water content of the samples of fill recovered from the standard penetration testing ranged from about 10 to 22 percent.

4.1.4 Clayey Silt Till

All boreholes encountered a stratum of clayey silt till beneath the topsoil and fill extending to depths of 4.3 to 7.6 m BGS. The N values determined within the clayey silt till were in the range of 14 to greater than 100 blows per 0.3 m and had an average N value of 47 blows per 0.3 m, inferring a hard consistency. The natural water content of the clayey silt till varied from 12 to 22 percent.

4.1.5 Silt

Boreholes 2 and 6 encountered a stratum of silt with trace gravel and shale fragments beneath the clayey silt till stratum to 9.2 and 7.5 m BGS, respectively. The N values determined within the silt greater than 100 blows per 0.3 m, inferring a very dense relative density. The natural water content of the silt varied from 10 to 14 percent.

4.1.6 Weathered Shale (Queenston Formation)

The augering and interval sampling method used to explore the overburden at the site is conventionally accepted investigative practice. However, this method does not define the bedrock surface with precision, particularly as in this instance where the overlying soil consists of a hard glacial till possibly containing cobbles and boulders, and where the surficial zone of the bedrock formation is often found to be weathered. Detailed exploration of the bedrock was not carried out as part of this assignment; however the bedrock beneath the site is known to consist of the Queenston Formation which is comprised of predominantly thinly bedded reddish brown shale of Ordovician age. The shale typically contains interbeds of green calcareous shale, limestone, sandstone and siltstone. As best could be practically determined, the surface of the bedrock was encountered in borehole 6 at a depth of 7.6 m BGS or at elevation 115.7 m.

Borehole 6 was terminated in reddish brown weathered shale of the Queenston Formation. A single N value of greater than 100 blows per 0.3 m was determined in the weathered shale. The natural water content of the sample of weathered shale recovered from the standard penetration testing was about 9 percent.

4.2 Ground Water

All boreholes remained dry during and upon completion of drilling. These conditions may not necessarily represent stabilized conditions. Fluctuation in the ground water levels will also occur due to seasonal variations and precipitation conditions.

5.0 CORROSIVITY TESTING

To assess the aggressiveness of the subsurface environment to underground plant, a suite of parameters including pH, Resistivity, Electrical Conductivity, Redox (oxygen reduction potential), Sulphate, Sulphide and Chloride were carried out on two (2) subgrade samples (BH3 SA4 and BH7 SA5), recovered from depths approximately corresponding to the expected invert elevations. A copy of the Certificate of Analysis for the testing is provided in Appendix B.

The soil resistivity, in combination with other parameters and environmental factors, provides an indication of the potential for corrosion of buried metal pipe. Application of the AWWA soil evaluation criteria to the results of the testing indicated ratings of 2 for both samples BH3 SA4 and BH7 SA5. A rating of greater than 10 is considered to represent a potentially corrosive environment. A more recent study suggested that soil with a resistivity of less than about 2000 ohm-cm should be considered aggressive. Soil resistivity values of about 3950 and 5380 ohm-cm were reported for the samples tested, suggesting that the risk for corrosion of buried metal pipe would be minimal.

The laboratory values reported for the corrosivity related parameters suggest that the subsurface environment is not aggressive to gray or ductile iron pipe and the minimum requirements for corrosion protection may therefore be considered appropriate. Irrespective of the laboratory test results, if a high incidence of corrosion related failure has been reported in this area, additional measures may be prudent.

The tests revealed that the sulphate concentrations in the soil samples were between 27 and 87µg/g or between 0.0027 and 0.0087%. Based on this, ordinary Type 10 Portland Cement could be used for the design of the concrete mix as far as soil exposure to sulphate attack is concerned. In general, the results of sulphate ion content analysis indicate the soil samples contain low levels of sulphate ion that are below the class of exposure levels outlined in CSA A23.1-04. No additional precautions are required to provide protection against sulphate attack such as special cements or mixtures.

6.0 DISCUSSION

The following discussion is based on our interpretation of the factual data obtained during this investigation and is intended for the use of the design engineer only. Comments made regarding the construction aspects are provided only in as much as they may impact on design considerations. Contractors bidding on or undertaking any work at the site should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction and make their own interpretation of the factual data as it affects their proposed construction techniques, schedule, equipment capabilities, costs, sequencing and the like.

It is understood the re-development will consist of the construction of a new community pool with associated slide structure, shade structures, retaining walls, concrete deck slab and asphalt pathway. The location and features of the re-development are shown on the Proposed Site Re-development Plan, Figure 3, as derived from a Site Plan drawing prepared by Architects Tillmann Ruth Robinson.

6.1 Foundations

Boreholes 1 to 7 were located within the approximate areas that will be re-developed as new shade structures, slide structure and new community pool. The boreholes penetrated fill to depths of about 0.8 to 1.5 m BGS, overlying clayey silt till, silt and weathered shale bedrock. The existing fill is unsuitable for the support of foundations. Based on the results of the boreholes it is considered feasible to support foundations on conventionally designed spread or strip footings established within the undisturbed clayey silt till stratum.

6.1.1 Spread Footing Foundations

Conventional spread footings must be founded at least 0.3 m into the undisturbed clayey silt till stratum. The following table summarizes the bearing resistance at serviceability limit states (SLS) and factored geotechnical resistance at ultimate limit states (ULS) for design purposes possible for conventional spread footing foundations by borehole location at the highest permissible elevations.

Bearing Pressure Possible for Spread Footing Foundations

Borehole No.	Minimum Depth below existing grade (m)	Geodetic Elevation m	Allowable Bearing Pressure SLS (kPa)	Factored Bearing Capacity at ULS (kPa)	Bearing Stratum
BH 1	0.9	123.7	200	300	Clayey Silt Till
BH 2	0.8	123.9	200	300	Clayey Silt Till
BH 3	1.8	122.9	200	300	Clayey Silt Till
BH 4	1.1	122.2	200	300	Clayey Silt Till
BH 5	1.8	122.9	200	300	Clayey Silt Till
BH 6	1.1	122.2	200	300	Clayey Silt Till
BH 7	1.8	122.8	200	300	Clayey Silt Till

A minimum footing width of 450 mm is recommended for strip footings and a minimum footing width of 900 mm should be considered for spread footings. The total and differential settlement (short term and long term) of spread footings established on the competent clayey silt till stratum at the above design bearing pressures is expected to be less than 20 mm.

Some variability in the consistency and depth of the clayey silt till stratum is expected. Deeper excavations may be required locally and for this reason, it is important that all of the foundation excavations be inspected by Terraprobe to confirm that the fill has been fully penetrated and to identify any preparatory work required prior to placing the footing concrete. Where deeper excavations are required, the footings should be lowered in a series of steps with maximum vertical increments of 0.6 m and with a rise to run ratio of 1:2.

All spread footing foundations exposed to freezing temperatures must be provided with a minimum of 1.2 metres of earth cover for frost protection or alternative equivalent insulation. If construction proceeds during freezing weather conditions, adequate temporary frost protection for the footing bases and concrete must be provided.

6.2 Earthquake Design Parameters

Under Ontario Regulation 88/19, the ministry amended Ontario's Building Code (O. Reg 332/12) to further harmonize Ontario's Building Code with the 2015 National Codes. These changes are intended to help reduce red tape for businesses and remove barriers to interprovincial trade throughout the country. The amendments are based on code change proposals the ministry consulted in 2016 and 2017. The majority of the amendments came into effect on January 1, 2020, which includes structural sufficiency of buildings to withstand external forces and improve resilience.

Seismic hazard is defined in the 2012 Ontario Building Code (OBC 2012) by uniform hazard spectra (UHS) at spectral coordinates of 0.2 s, 0.5 s, 1.0 s and 2.0 s and a probability of exceedance of 2% in 50 years. The OBC method uses a site classification system defined by the average soil/bedrock properties (e.g. shear wave velocity (vs), Standard Penetration Test (SPT) resistance, and undrained shear strength (su)) in the top 30 meters of the site stratigraphy below the foundation level, as set out in Table 4.1.8.4A of the Ontario Building Code (2012). There are 6 site classes from A to F, decreasing in ground stiffness from A, hard rock, to E, soft soil; with site class F used to denote problematic soils (e.g. sites underlain by thick peat deposits and/or liquefiable soils). The site class is then used to obtain peak ground acceleration (PGA), peak ground velocity (PGV) site coefficients Fa and Fv, respectively, used to modify the UHS to account for the effects of site-specific soil conditions.

Based on the above noted information, it is recommended that the site designation for seismic analysis be 'Site Class C', as per Table 4.1.8.4.A of the Ontario Building Code (2012).

The values of the site coefficient for design spectral acceleration at period T, F(T), and of similar coefficients F(PGA) and F(PGV) shall conform to Tables 4.1.8.4.B. to 4.1.8.4.I of the OBC 2012, as amended January 1, 2020, using linear interpolation for intermediate values of PGA.

6.3 Earth Pressure Design Considerations

The parameters used in the determination of earth pressures acting on retaining walls are defined below.

Parameter	Definition	Units
φ	internal angle of friction	degrees
γ	bulk unit weight of soil	kN / m^3
K_a	active earth pressure coefficient (Rankin)	dimensionless
K_o	at-rest earth pressure coefficient (Rankin)	dimensionless
K_p	passive earth pressure coefficient (Rankin)	dimensionless

The appropriate values for use in the design of structures subject to unbalanced earth pressures at this site are tabulated as follows:

Stratum/Parameter	φ	γ	Ka	Ko	Kp
Compact Granular Fill Granular 'B' (OPSS 1010)	32	21.0	0.31	0.47	3.25
Clayey Silt Till or Similar Fill	30	19.0	0.33	0.50	3.00

Walls subject to unbalanced earth pressures must be designed to resist a pressure that can be calculated based on the following equation:

$$P = K\,[\gamma\,(h-h_w) + \gamma' h_w + q] + \gamma_w h_w$$

where,
- **P** = the horizontal pressure at depth, **h** (m)
- **K** = the earth pressure coefficient,
- h_w = the depth below the ground water level (m)
- **γ** = the bulk unit weight of soil, (kN/m^3)
- **γ'** = the submerged unit weight of the exterior soil, (γ - 9.8 kN/m^3)
- **q** = the complete surcharge loading (kPa)

Where the wall backfill can be drained effectively to eliminate hydrostatic pressures on the wall, acting in conjunction with the earth pressure, this equation can be simplified to:

$$P = K[\gamma h + q]$$

The factored geotechnical resistance to sliding of earth retaining structures is developed by friction between the base of the footing and the soil. This friction **(R)** depends on the normal load on the soil contact (**N**) and the frictional resistance of the soil **(tan φ)** expressed as: **R = N tan φ**. This is an unfactored resistance. The factored resistance at ULS is $R_f = 0.8\ N \tan \varphi$. The K value to be used for the design will depend on the rigidity of the wall.

6.4 Retaining Wall Design Considerations

Specific design details of the wall were not available at the time of report preparation. It is expected that the proposed wall will have an overall height of about 1.5 to 2.0 m. For preliminary design consideration, it is expected that the proposed retaining wall would be about 800 mm deep and will be provided with a minimum of 10 vertical to 1 horizontal face batter (approximately 5 percent). The wall will be provided with a minimum of 0.6 m thick free draining granular backfill (150 to 300 mm clear crushed stone, OPSS Form 1001, 1004) and a geotextile (Terrafix 270R or equivalent) separating the granular fill and the retained soil. Further, the wall will be provided with a minimum of 300 mm depth of embedment and be supported on a minimum of 300 mm thick granular pad comprising of Granular A (OPSS Form 1010) placed in maximum 150 mm thick lifts and compacted to 98 percent of standard Proctor maximum dry density.

6.4.1 Retaining Wall Foundations

Based on the results of boreholes, it is expected that the base of the replacement retaining wall would be founded on clayey silt till. Foundations supported on this material may be designed using a factored geotechnical resistance at Ultimate Limit States (ULS) of 225 kPa and a bearing resistance of 150 kPa at Serviceability Limit States (SLS).

6.4.2 Drainage

A perforated sub-drain pipe (minimum 100 mm diameter) should be installed within the backfill immediately behind the wall. The sub-drain should outlet through the wall at intervals of about 3.5 m or to an outlet meeting local plumbing codes. The outlet of the drainage system should be protected against freezing to ensure proper functioning of the system during the winter season.

6.4.3 General Design Constraints

The following general constraints are recommended:

- The retaining walls must be designed by a professional engineer and in accordance with the assumptions made by Terraprobe;

- The performance of the completed works will be highly dependent on the quality and uniformity of the construction. To this end, a regular program of geotechnical inspection and testing should be carried out during construction to verify that the intent of the design and compliance with the specifications has been achieved; and

- The timing of the major grading works on the site is critical to the performance of the work. It may not be feasible to carry out fill operations during wet or freezing conditions. The schedule must provide adequate time to complete the work, allowing for delays due to adverse weather.

6.5 Concrete Slab on Grade Design Parameters

The subsurface conditions within the investigated area are expected to comprise of existing fill materials and topsoil. Based on the findings of the investigation, the existing fill is not considered suitable for construction of a slab-on-grade structure and should be sub-excavated and replaced with suitably compacted engineered fill. Test pits may be required in the slab on grade area to determine the existing fill thickness and to assess the sub-excavation requirements. Also, some localized weak zones of native or suitable fill soils may be encountered at the design subgrade for the slab that should be sub-excavated and removed prior to backfilling for construction and replaced with suitable fill materials compacted to a minimum of 98 percent of SPMDD.

Final construction beneath slabs on grade should consist of 200 mm of uniformly compacted Granular A uniformly compacted to 98 percent of SPMDD. The moduli of subgrade reaction appropriate for slab on grade design on the aforementioned soils are as follows:

- Proof-rolled Earth Fill: 18,000 kPa/m
- Clayey Silt Till: 30,000 kPa/m

If moisture sensitive floor finishes are proposed, a capillary moisture barrier will be required beneath the slab. The capillary moisture barrier may consist of a layer of suitably graded clear crushed stone rather than the Granular A as outlined above. If a clear stone capillary moisture barrier is selected for the underfloor design, this material has poor stability under wheel loading and can be an impediment to other site activities such as steel and mechanical erection. If this is the case, substitution of the upper 50 mm with compacted Granular A to provide a travel surface, constitutes no technical compromise to the capillary barrier effect intended. The placement of a polyethylene vapour barrier is to be at the discretion of the design engineer and architect, as this may have implications on slab curing and certain floor finishes are more sensitive to moisture diffusion through the slab than others.

All slabs on grade should be structurally separate from foundation walls and columns. Saw cut control joints should be incorporated into the slabs along column lines and at regular intervals. Interior load bearing walls should not be founded on the slab but on spread footings as outlined above.

The soil at this site is susceptible to frost effects which would have the potential to deform hard landscaping adjacent to the building. At locations where buildings are expected to have flush entrances, care must be taken in detailing the exterior slabs / sidewalks, providing insulation / drainage / non-frost susceptible backfill to maintain the flush threshold during freezing weather conditions.

6.6 Underground Services

It is expected that the excavations for underground services will penetrate fill and terminate in the glacial till stratum. It is anticipated that the relatively shallow cuts required for the underground services can be carried out using conventional open-cut techniques as discussed in Section 7.1 of this report.

Bedding for underground services should consist of well graded free draining granular material such as Granular A (OPSS 1010), which is compatible with the size and type of plant and consistent with City of Burlington standards. Care will be required to ensure that all fill, and any softened, loosened or disturbed soil is removed prior to placing pipe bedding.

The excavated soil will generally consist of fill, and clayey silt till. The in-situ water content of the fill was generally wet of the estimated laboratory optimum water content for compaction; however the natural water content of the underlying glacial till was within a range where effective mechanical compaction can be achieved. It is considered feasible to re-use selectively excavated glacial till for backfill. Any excavated fill or topsoil should be treated as surplus material or selectively used for the final lift of backfill in areas that will support turf.

Service trench backfill in areas where hard surfacing is proposed or where post construction settlement is of more concern (i.e. beneath slabs on grade or asphalt surfacing) must consist of Granular A or Granular B (OPSS 1010, Type I) materials.

The general trench backfill should be placed in 300 mm thick lifts with each lift uniformly compacted to at least 95 percent of standard Proctor maximum dry density (SPMDD). The upper 1 m of trench backfill beneath pavements or within the limits of buildings or hard surfaces must be uniformly compacted to at least 98 percent of SPMDD.

6.7 Asphalt Walkway

A new asphalt surfaced pathway is proposed for the site. It is assumed that the pathway will be used as a service road as well as a pedestrian access. The vehicular traffic will typically consist of landscaping equipment and 1 ton pickup trucks.

The subgrade in the area of the new pavement will generally consist of poor quality fill. Areas to be developed as pavement (includes pathways) must be cleared of all topsoil and highly organic soils, cut neat and inspected by the geotechnical engineer. Depending on the condition of the exposed subgrade, there may be a need for additional excavation and/or other remedial work. The nature of and limits of the remedial work can best be assessed by the geotechnical engineer during construction. The final subgrade surface must be free of depressions and shaped and graded to promote drainage.

Drainage of the granular base and subbase materials should be achieved by means of continuous perforated sub-drains or by swales. Sub-drains should also be provided at all catch-basin locations.

The following minimum pavement component thicknesses are recommended for the vehicular pavement proposed and for a properly prepared subgrade as outlined above.

Pavement Layer	Compaction Requirements	Minimum Component Thickness
Surface Course Asphaltic Concrete HL3 (OPSS 1150)	92% MRD	40 mm
Base Course Asphaltic Concrete HL8 (OPSS 1150)	92% MRD	50 mm
Base Course: Granular A (OPSS 1010)	98% standard Proctor Maximum Dry Density (ASTM-D1557)	100 mm
Subbase Course: Granular B Type II (OPSS 1010)	98% standard Proctor Maximum Dry Density (ASTM-D1557)	300 mm

Some adjustment to the thickness of the granular subbase material may be required depending on the condition of the subgrade at the time of the pavement construction. The need for such adjustments can be best assessed by the geotechnical engineer during construction. Equivalent Superpave mixes can be used in lieu of the Marshall Mix Designations given above.

7.0 DESIGN CONSIDERATIONS FOR CONSTRUCTABILITY

7.1 Excavations

Excavations must be carried out in accordance with the Occupational Health and Safety Act, Ontario Regulation 213/91 (as amended), Construction Projects, Part III – Excavations, Sections 222 through 242. These regulations designate four (4) broad classifications of soils to stipulate appropriate measures for excavation safety. For practical purposes at this site, the fill strata at the site should generally be regarded as "Type 3 Soil", and the undisturbed clayey silt till stratum should generally be regarded as “Type 2 Soil” provided that effective ground water control is achieved where required and surface water is directed away from open excavations.

Where workers must enter a trench or excavation the soil must be suitably sloped and/or braced in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. The regulation stipulates safe slopes of excavation by soil type as follows:

Soil Type	Base of Slope	Steepest Slope Inclination
1	within 1.2 metres of bottom of trench	1 horizontal to 1 vertical
2	within 1.2 metres of bottom of trench	1 horizontal to 1 vertical
3	from bottom of trench	1 horizontal to 1 vertical
4	from bottom of trench	3 horizontal to 1 vertical

Minimum support system requirements for steeper excavations are stipulated in Sections 235 through 238 and 241 of the Act and Regulations and include provisions for timbering, shoring and moveable trench boxes.

Although significant ground water was not encountered in the boreholes, depending on the actual ground water conditions at the time of construction, seepage from surface drainage and seepage from any preferentially permeable features in the soil should be expected. For the range in excavation depths expected, the volume of water anticipated is such that temporary pumping from properly filtered sumps located as required in the excavations should suffice to control ground water.

7.2 Depth of Frost Penetration

The design frost penetration depth for the general area is 1.2 m. Therefore, a permanent soil cover of 1.2m or its thermal equivalent insulation is required for frost protection of foundations. All exterior footings, footings beneath unheated areas and foundations exposed to freezing temperatures should have at least such earth cover or equivalent synthetic insulation for frost protection. During winter construction exposed surfaces to support foundations must be protected against freezing by means of loose straw and tarpaulins, heating, etc.

For buried utility lines, variations from the above noted depth of frost penetration might be considered, depending on various factors such as the type of backfilling materials or the temperature and moisture exposure of the area (prevailing winds, drifting snow, etc.). However, these variations do not generally represent a concern unless special equipment and/or buried utilities have specific requirements regarding the subsurface temperature and moisture regime (i.e., water lines or sensitive electrical utilities etc.). In such special situations further tests and analysis should be conducted on a case-by-case basis.

The depth of frost penetration is also defined as the zone of active weathering where sizeable variations in the moisture content accompany the yearly temperature fluctuations. Therefore, the foundation grades should be established at or below this depth. For light poles and other light structures that are to be installed on a single footing, if some frost heave (25 mm to 50 mm) cannot be tolerated, the foundation elements should also be provided with the above noted minimum depth of soil cover or equivalent exterior-grade insulation.

7.3 Site Work

The soil at this site is fine-grained and will become weakened when subjected to traffic when wet. If there is site work carried out during periods of wet weather, then it can be expected that the subgrade will be disturbed unless an adequate granular working surface is provided to protect the integrity of the subgrade soils from construction traffic. Subgrade preparation works cannot be adequately accomplished during wet weather and the project must be scheduled accordingly. The disturbance caused by the traffic can result in the removal of disturbed soil and use of fill material for site restoration or underfloor fill that is not intrinsic to the project requirements. Attempting to build slabs and pavements at this site during wet weather could significantly increase earthworks and pavement costs.

The most severe loading conditions on the subgrade may occur during construction. Consequently, special provisions such as end dumping and forward spreading of earth and aggregate fills, restricted construction lanes, and half-loads during paving and other work are required, especially if construction is carried out during unfavourable weather.

If construction proceeds during freezing weather conditions, adequate temporary frost protection for the founding subgrade and concrete must be provided. The soil at this site is highly susceptible to frost damage. Consideration must be given to frost effects, such as heave or softening, on exposed soil surfaces in the context of this particular project development.

7.4 Quality Control

The foundation installations must be field reviewed by Terraprobe as they are constructed to ensure that the founding soil exposed is consistent with the design bearing intended by the geotechnical engineer. The on-site review of the condition of the foundation soil as the foundations are constructed is an integral part of the geotechnical design function and is required by Section 4.2.2.2 of the Ontario Building Code 2012.

The long term performance of the pavement structure and any slab-on-grade structures are 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 as much as practically possible. The design advice in this report is based on an assessment of the subgrade support capabilities as indicated by the boreholes. These conditions may vary across the site depending on the final design grades and therefore, the preparation of the subgrade and the compaction of all fill should be monitored by the geotechnical engineer at the time of construction to confirm material quality, thickness, and to ensure adequate compaction.

The requirements for fill placement on this project have been stipulated relative to standard Proctor Maximum Dry Density. In situ determinations of density during fill and asphaltic placement on site are required to demonstrate that the specified placement density is achieved. Concrete must be specified in accordance with the requirements of CAN3 - CSA A23.1-14.

8.0 LIMITATIONS AND USE OF REPORT

8.1 Procedures

This investigation has been carried out using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by Terraprobe and other engineering practitioners, working under similar conditions and subject to the time, financial and physical constraints applicable to this project. The discussions and recommendations that have been presented are based on the factual data obtained from this investigation.

The drilling work was carried out by a specialist drilling contractor. The boreholes were made by a continuous flight power auger machine. A Terraprobe technician logged the boreholes and examined all of the recovered samples. The samples obtained were sealed in clean, air-tight containers and transferred to Terraprobe's Stoney Creek laboratory, where they were reviewed for consistency of description by a geotechnical engineer. Ground water observations were made in the borehole as drilling proceeded.

The samples of the strata penetrated were obtained using the Split-Barrel Method technique (ASTM D1586). The samples were taken at regular intervals of depth. The sampling procedure used for this investigation does not recover continuous samples of soil. Consequently there is some interpolation of the borehole layering between samples and indications of changes in stratigraphy as shown on the borehole logs are approximate.

It must be recognized that there are special risks whenever engineering or related disciplines are applied to identify subsurface conditions. A comprehensive sampling and testing programme implemented in accordance with the most stringent level of care may fail to detect certain conditions. Terraprobe has assumed for the purposes of providing design parameters and advice, that the conditions that exist between sampling points are similar to those found at the sample locations.

It may not be possible to drill a sufficient number of boreholes and/or sample and report them in a way that would provide all the subsurface information and geotechnical advice to completely identify all aspects of the site and works that could affect construction costs, techniques, equipment and scheduling. Contractors bidding on or undertaking work on the project must be directed to draw their own conclusions as to how the subsurface conditions may affect them, based on their own investigations and their own interpretations of the factual investigation results, and their approach to the construction works, cognizant of the risks implicit in the subsurface investigation activities.

8.2 Changes in Site and Scope

The subsurface conditions may potentially be altered with passage of time, natural occurrences, and direct or indirect human intervention at or near the site. Caution should be exercised in the consideration of contractual responsibilities as they relate to control of seepage, disturbance of soils, and frost protection.

The design parameters provided and the engineering advice offered in this report are based on the factual data obtained from this investigation made at the site by Terraprobe and are intended for use by the owner and its retained design consultants in the design phase of the project. If there are changes to the project scope and development features, the interpretations made of the subsurface information, the geotechnical design parameters, advice and comments relating to constructability issues and quality control may not be relevant or complete for the project. Terraprobe should be retained to review the implications of such changes with respect to the contents of this report.

8.3 Use of Report

This report is prepared for the express use of the City of Burlington and their retained design consultants, and is not intended for use by others. This report is copyright of Terraprobe Inc., and no part of this report may be reproduced by any means, in any form, without the prior written permission of Terraprobe. It is recognized that the City of Burlington, in their capacity as the planning and building authority under Provincial statues, will make use of and rely upon this report, cognizant of the limitations thereof, both as are expressed and implied.

We trust the foregoing information is sufficient for your present requirements. If you have any questions, or if we can be of further assistance, please do not hesitate to contact us.

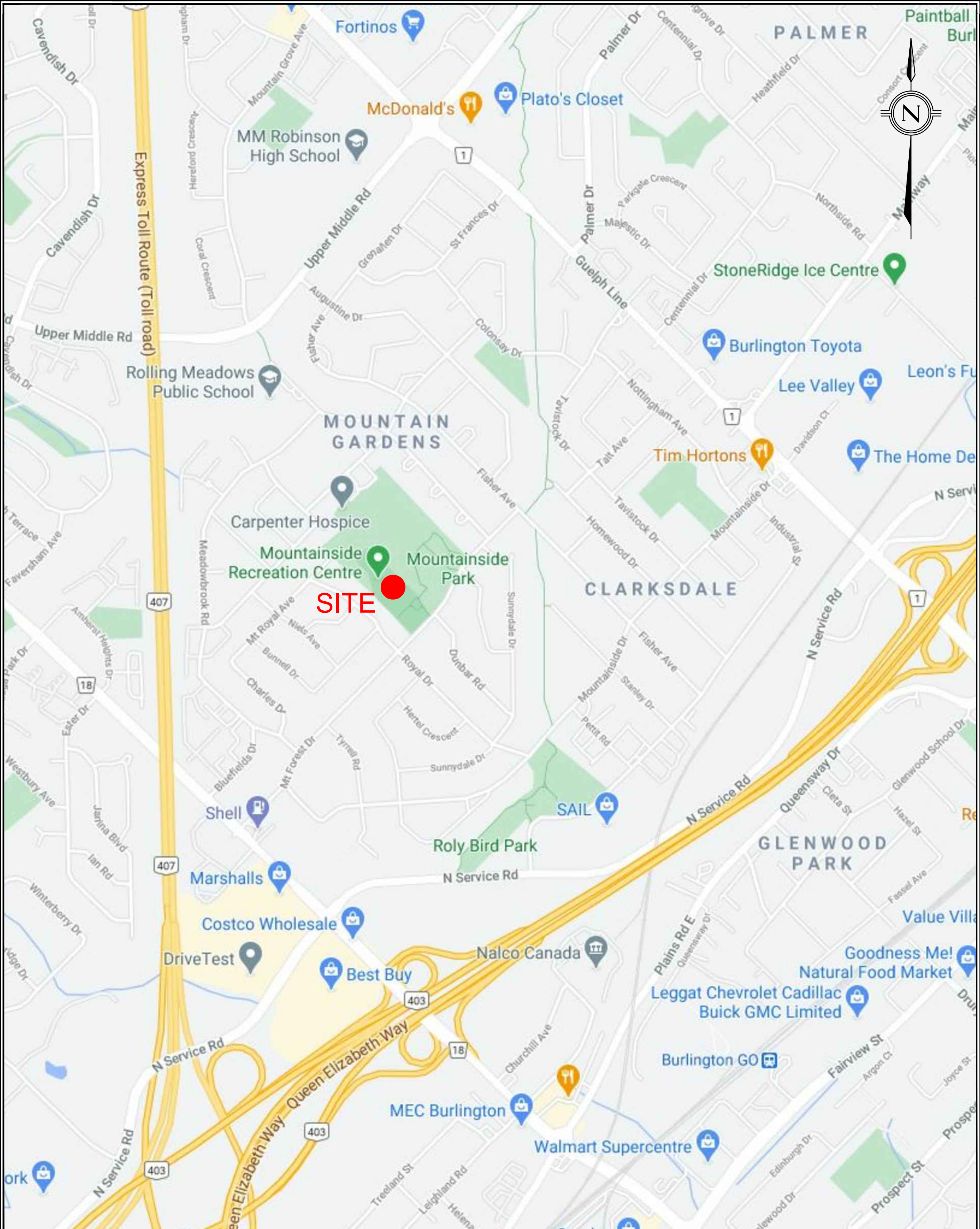
Terraprobe Inc.

Anthony Felice, P. Eng.
Project Manager, Geotechnical

Patrick Cannon, P. Eng.
Principal, Branch Manager

FIGURES

Terraprobe Inc.

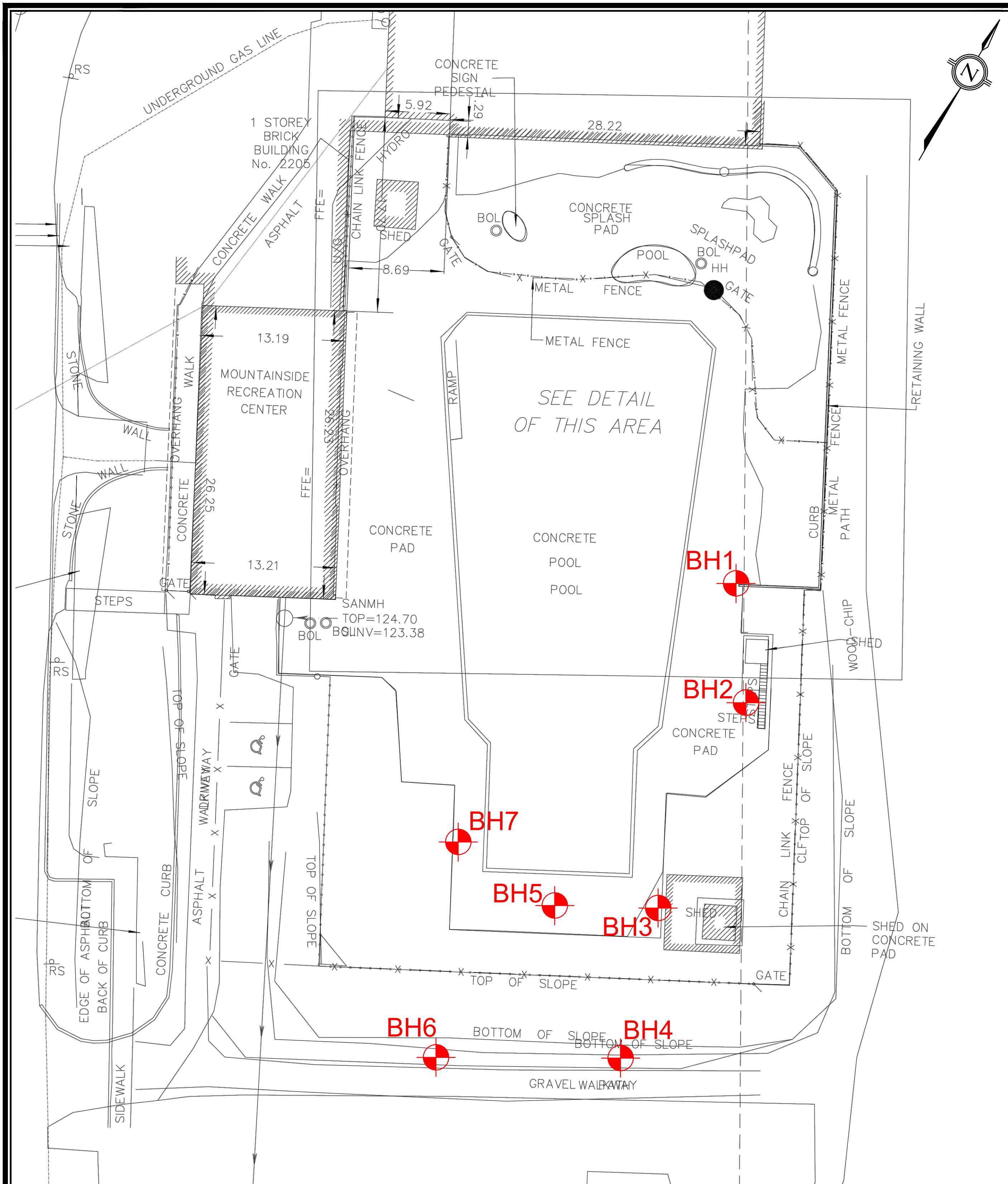


Terraprobe
903 Barton Street - Unit 22, Stoney Creek, Ontario, L8E 5R7
Tel: (905) 643-7560, Fax: (905) 643-7559

Title: SITE LOCATION PLAN

File No. 7-21-0014-01

FIGURE: 1



LEGEND

BH1 Borehole Location

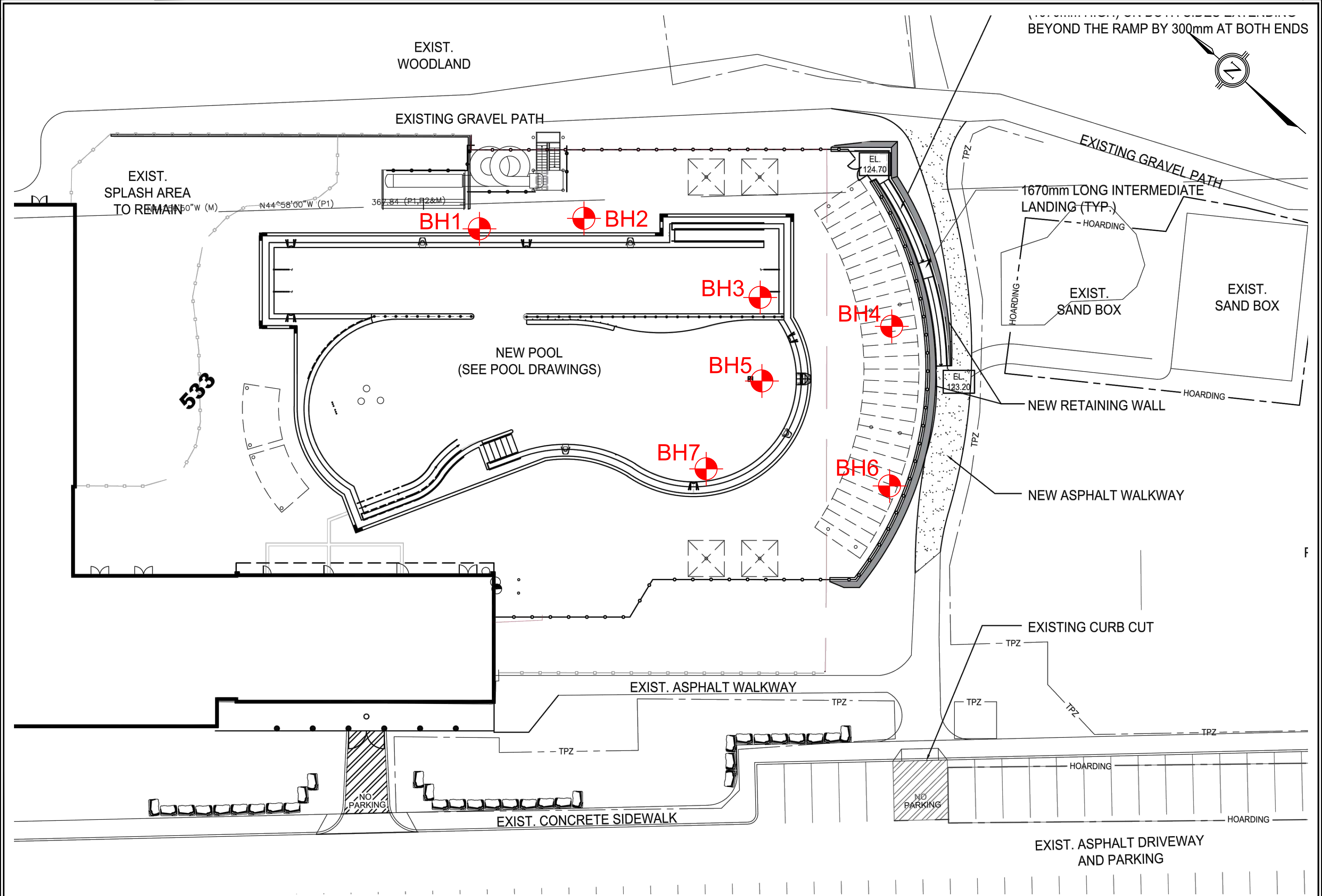
Terraprobe

903 Barton Street - Unit 22, Stoney Creek, Ontario, L8E 5R7
Tel: (905) 643-7560, Fax: (905) 643-7559

Title: BOREHOLE LOCATION PLAN

File No. 7-21-0014-01

FIGURE : 2



LEGEND

BH1 Borehole Location

Terraprobe

903 Barton Street - Unit 22, Stoney Creek, Ontario, L8E 5R7
Tel: (905) 643-7560, Fax: (905) 643-7559

Title: PROPOSED SITE RE-DEVELOPMENT PLAN

File No. 7-21-0014-01

FIGURE : 3

LOGS OF BOREHOLES

APPENDIX A

Terraprobe Inc.

SAMPLING METHODS

AS	auger sample
CORE	cored sample
DP	direct push
FV	field vane
GS	grab sample
SS	split spoon
ST	shelby tube
WS	wash sample

PENETRATION RESISTANCE

Standard Penetration Test (SPT) resistance ('N' values) is defined as the number of blows by a hammer weighing 63.6 kg (140 lb.) falling freely for a distance of 0.76 m (30 in.) required to advance a standard 50 mm (2 in.) diameter split spoon sampler for a distance of 0.3 m (12 in.).

Dynamic Cone Test (DCT) resistance is defined as the number of blows by a hammer weighing 63.6 kg (140 lb.) falling freely for a distance of 0.76 m (30 in.) required to advance a conical steel point of 50 mm (2 in.) diameter and with 60° sides on 'A' size drill rods for a distance of 0.3 m (12 in.)."

COHESIONLESS SOILS

Compactness	'N' value
very loose	< 4
loose	4 – 10
compact	10 – 30
dense	30 – 50
very dense	> 50

COHESIVE SOILS

Consistency	'N' value	Undrained Shear Strength (kPa)
very soft	< 2	< 12
soft	2 – 4	12 – 25
firm	4 – 8	25 – 50
stiff	8 – 15	50 – 100
very stiff	15 – 30	100 – 200
hard	> 30	> 200

COMPOSITION

Term (e.g)	% by weight
trace silt	< 10
some silt	10 – 20
silty	20 – 35
sand *and* silt	> 35

TESTS AND SYMBOLS

MH	mechanical sieve and hydrometer analysis
w, w_c	water content
w_L, LL	liquid limit
w_P, PL	plastic limit
I_P, PI	plasticity index
k	coefficient of permeability
γ	soil unit weight, bulk
φ'	internal friction angle
c'	effective cohesion
c_u	undrained shear strength

▽	Unstabilized water level
▼	1st water level measurement
▼	2nd water level measurement
▼	Most recent water level measurement
3.0 +	Undrained shear strength from field vane (with sensitivity)
C_c	compression index
c_v	coefficient of consolidation
m_v	coefficient of compressibility
e	void ratio

FIELD MOISTURE DESCRIPTIONS

Damp refers to a soil sample that does not exhibit any observable pore water from field/hand inspection.

Moist refers to a soil sample that exhibits evidence of existing pore water (e.g. sample feels cool, cohesive soil is at plastic limit) but does not have visible pore water

Wet refers to a soil sample that has visible pore water

Terraprobe

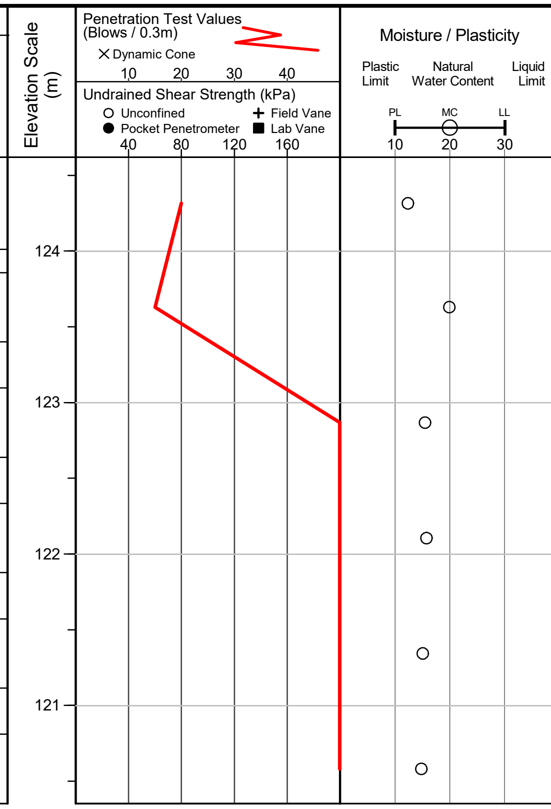
LOG OF BOREHOLE 1

Project No. : 7-21-0014-01	Client : City of Burlington	Originated by : KG
Date started : March 10, 2021	Project : 2205 Mount Forest Drive	Compiled by : AF
Sheet No. : 1 of 1	Location : Burlington, Ontario	Checked by : AF

Position : E: 595397, N: 4800644 (UTM 17T) — Elevation Datum : Geodetic

Rig type : Mini Mole, track-mounted — Drilling Method : Solid stem augers

Elev (m)	Depth (m)	Description	Sample Number	Type	SPT 'N' Value
124.6	0	**GROUND SURFACE**			
124.4	0.2	185mm Concrete			
		FILL, sand and gravel, compact, brown	1	SS	20
124.0	0.6	**CLAYEY SILT**, with embedded sand and gravel, very stiff to hard, brown (GLACIAL TILL)	2	SS	15
			3	SS	55
			4	SS	53
			5	SS	57
			6	SS	61
120.3	4.3	**END OF BOREHOLE**			



Headspace Vapour (ppm) | Instrument Details | Unstabilized Water Level | Lab Data and Comments — GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL

Borehole was dry and open upon completion of drilling.

file: 7-21-0014-01 - mountainside pool.gpj

Terraprobe

LOG OF BOREHOLE 2

Project No. : 7-21-0014-01
Client : City of Burlington
Originated by : KG
Date started : March 10, 2021
Project : 2205 Mount Forest Drive
Compiled by : AF
Sheet No. : 1 of 1
Location : Burlington, Ontario
Checked by : AF

Position : E: 595406, N: 4800640 (UTM 17T)
Elevation Datum : Geodetic
Rig type : Mini Mole, track-mounted
Drilling Method : Solid stem augers

SOIL PROFILE

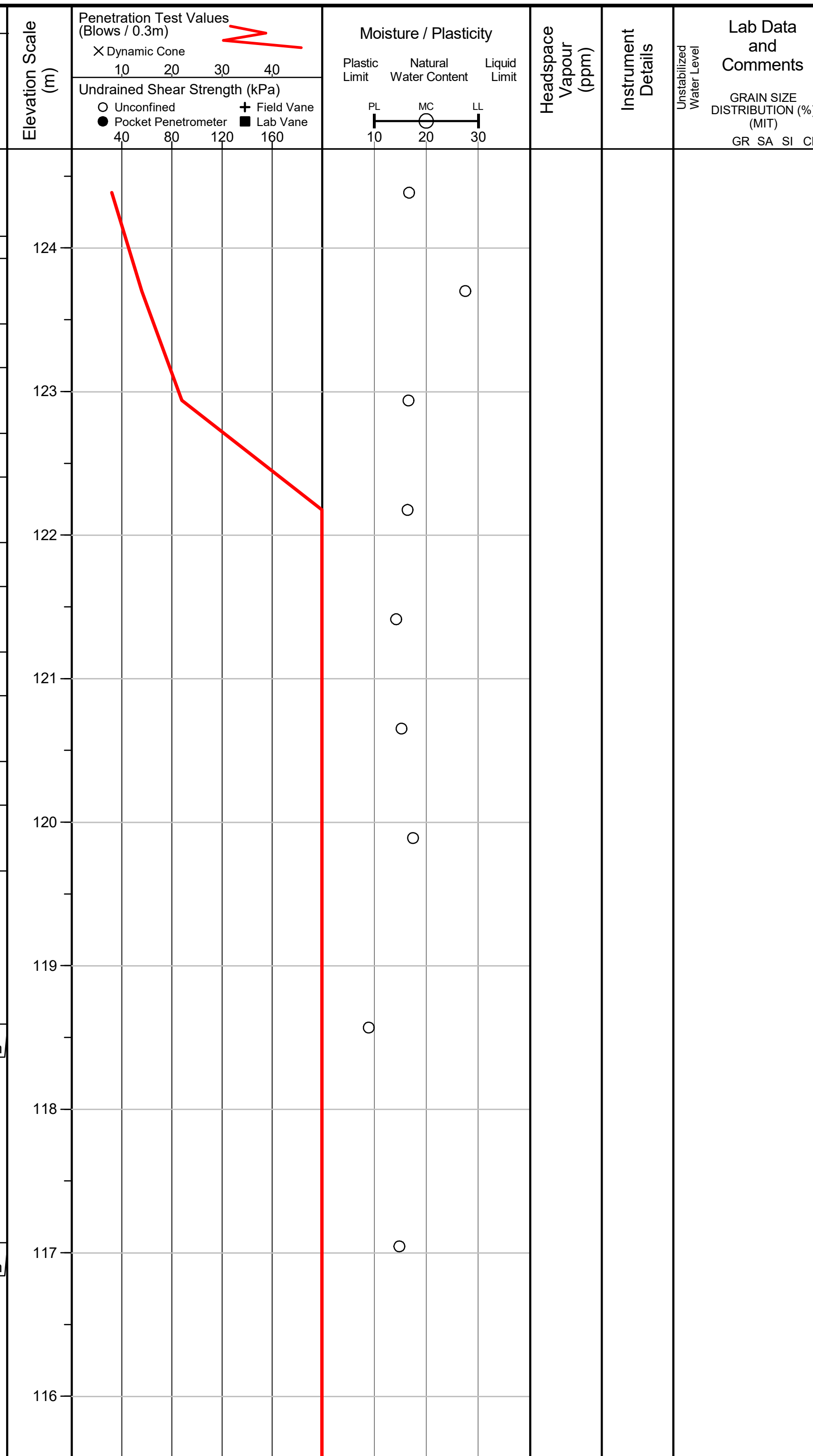
Elev / Depth (m)	Description
124.7	**GROUND SURFACE**
124.5 / 0.2	165mm Concrete
124.2 / 0.5	**FILL**, sand and gravel, loose, brown
117.1 / 7.6	**CLAYEY SILT**, with embedded sand and gravel, stiff to hard, brown (GLACIAL TILL)
115.5 / 9.2	**SILT**, trace gravel, trace shale fragments, very dense, brownish grey ...becoming reddish brown at 9.1m depth

END OF BOREHOLE
Auger refusal

Borehole was dry and open upon completion of drilling.

SAMPLES

Number	Type	SPT 'N' Value
1	SS	8
2	SS	14
3	SS	22
4	SS	54
5	SS	66
6	SS	76
7	SS	51
8	SS	50 / 50mm
9	SS	50 / 50mm
10	SS	50 / 25mm



Depth Scale (m): 0–9

file: 7-21-0014-01 - mountainside pool.gpj

LOG OF BOREHOLE 3

Terraprobe

Project No. : 7-21-0014-01 | Client : City of Burlington | Originated by : KG

Date started : March 10, 2021 | Project : 2205 Mount Forest Drive | Compiled by : AF

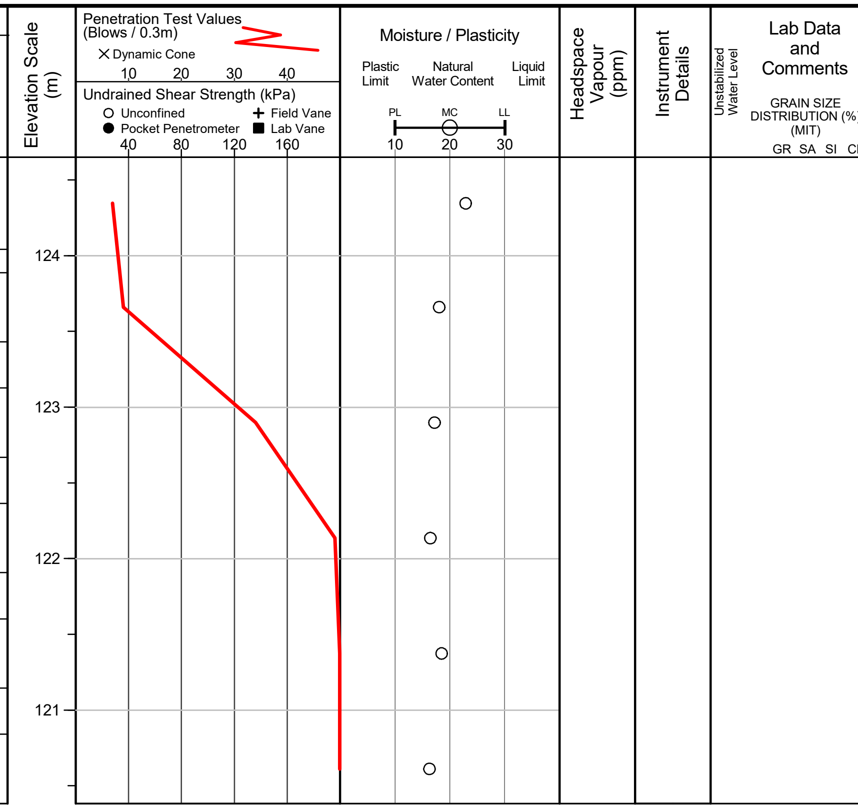
Sheet No. : 1 of 1 | Location : Burlington, Ontario | Checked by : AF

Position : E: 595423, N: 4800625 (UTM 17T) | Elevation Datum : Geodetic

Rig type : Mini Mole, track-mounted | Drilling Method : Solid stem augers

SOIL PROFILE / SAMPLES

Elev (m)	Depth (m)	Description	Sample Number	Type	SPT 'N' Value
124.7	0	GROUND SURFACE			
124.4	0.3	250mm **TOPSOIL**			
		FILL, clayey silt, trace rootlets, gravel, sand, loose, brown	1	SS	7
			2	SS	9
123.2	1.5	**CLAYEY SILT**, with embedded sand and gravel, hard, brown (GLACIAL TILL)	3	SS	34
			4	SS	49
			5	SS	52
120.4	4.3		6	SS	65



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

file: 7-21-0014-01 - mountainside pool.gpj

Terraprobe

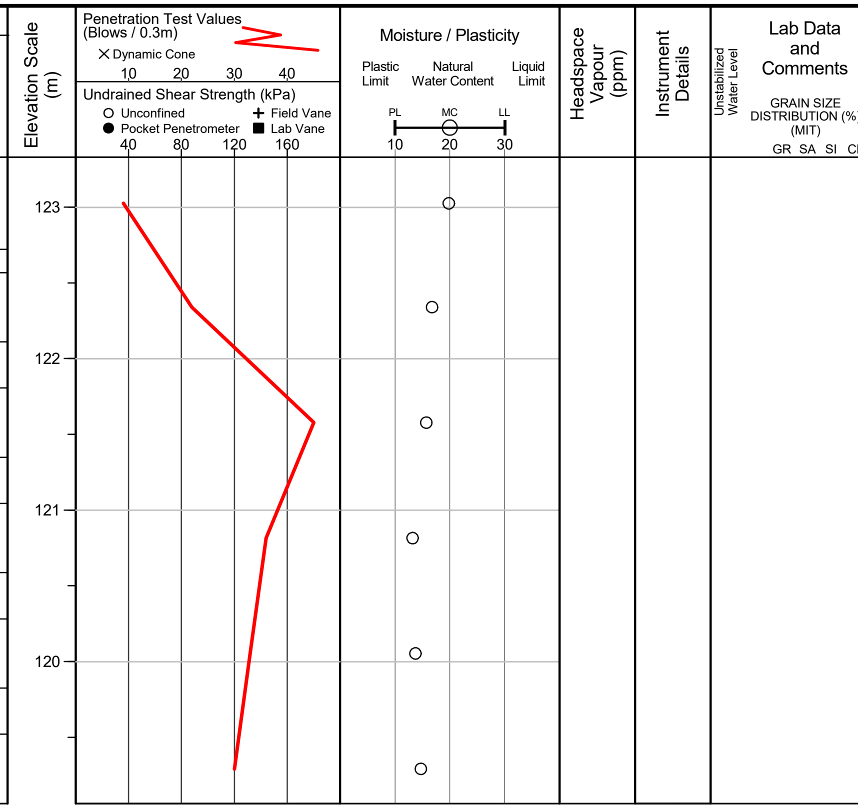
LOG OF BOREHOLE 4

Project No. : 7-21-0014-01	Client : City of Burlington	Originated by : KG
Date started : March 9, 2021	Project : 2205 Mount Forest Drive	Compiled by : AF
Sheet No. : 1 of 1	Location : Burlington, Ontario	Checked by : AF

Position : E: 595428, N: 4800616 (UTM 17T) | Elevation Datum : Geodetic

Rig type : Mini Mole, track-mounted | Drilling Method : Solid stem augers

Elev / Depth (m)	Description (SOIL PROFILE)	Sample Number	Type	SPT 'N' Value
123.3	**GROUND SURFACE**			
123.0 / 0.3	300mm **TOPSOIL**			
122.5 / 0.8	**FILL**, clayey silt, trace rootlets, gravel, loose, brown	1	SS	9
	CLAYEY SILT, with embedded sand and gravel, very stiff to hard, brown (GLACIAL TILL)	2	SS	22
		3	SS	45
		4	SS	36
		5	SS	33
119.0 / 4.3		6	SS	30



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

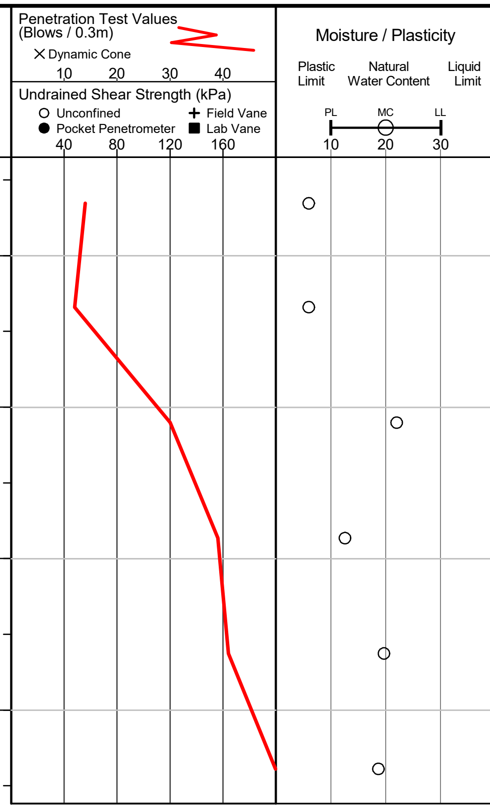
LOG OF BOREHOLE 5

Terraprobe

Project No. : 7-21-0014-01	Client : City of Burlington	Originated by : KG
Date started : March 9, 2021	Project : 2205 Mount Forest Drive	Compiled by : AF
Sheet No. : 1 of 1	Location : Burlington, Ontario	Checked by : AF

Position : E: 595409, N: 4800618 (UTM 17T)
Elevation Datum : Geodetic
Rig type : Mini Mole, track-mounted
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Sample Number	Type	SPT 'N' Value	Elevation Scale (m)
0	124.7	**GROUND SURFACE**				
		140mm Concrete				
		FILL, sand and gravel, compact, brown	1	SS	14	124
1			2	SS	12	
	123.2 1.5	**CLAYEY SILT**, with embedded sand and gravel, very stiff to hard, brown (GLACIAL TILL)	3	SS	30	123
2			4	SS	39	122
3			5	SS	41	121
4	120.4 4.3		6	SS	59	



Headspace Vapour (ppm) | Instrument Details | Unstabilized Water Level | Lab Data and Comments — GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

file: 7-21-0014-01 - mountainside pool.gpj

LOG OF BOREHOLE 6

Terraprobe

Project No. : 7-21-0014-01	Client : City of Burlington	Originated by : KG
Date started : March 9, 2021	Project : 2205 Mount Forest Drive	Compiled by : AF
Sheet No. : 1 of 1	Location : Burlington, Ontario	Checked by : AF

Position : E: 595412, N: 4800600 (UTM 17T) — Elevation Datum : Geodetic

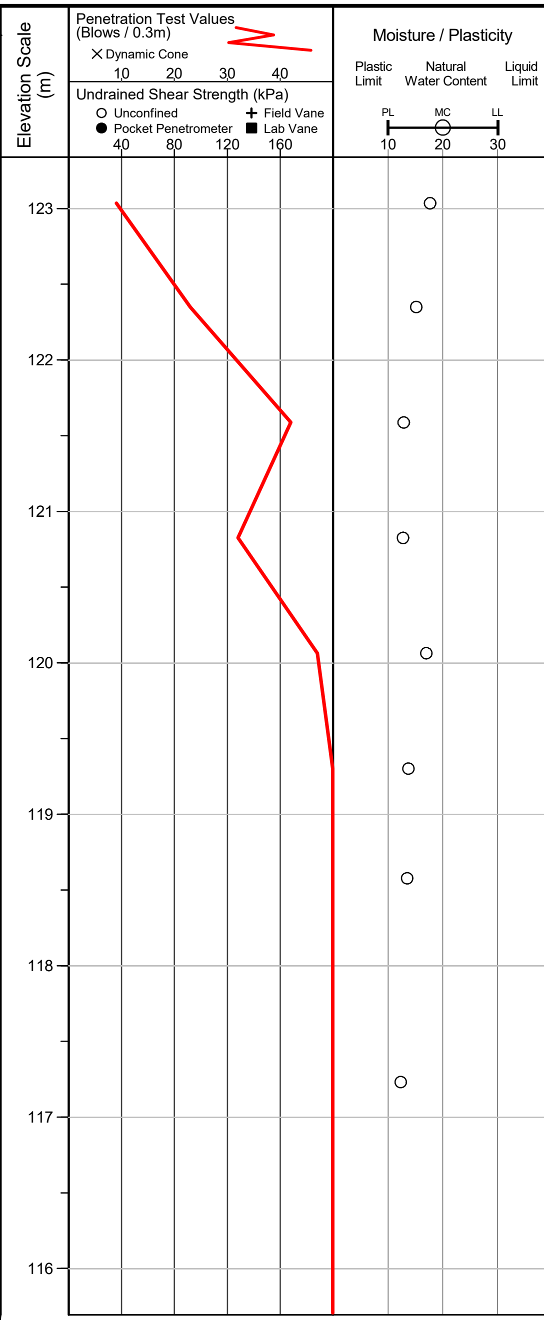
Rig type : Mini Mole, track-mounted — Drilling Method : Solid stem augers

SOIL PROFILE

Elev (m)	Depth (m)	Description
123.3		**GROUND SURFACE**
123.1	0.2	200mm **TOPSOIL**
122.5	0.8	**FILL**, clayey silt, trace rootlets, gravel, loose, brown
117.2	6.1	**CLAYEY SILT**, with embedded sand and gravel, very stiff to hard, brown (GLACIAL TILL)
115.7	7.6	**SILT**, trace shale fragments, very dense, brownish grey
115.7	7.6	**WEATHERED SHALE**, hard, reddish brown

SAMPLES

Number	Type	SPT 'N' Value
1	SS	9
2	SS	23
3	SS	42
4	SS	32
5	SS	47
6	SS	58
7	SS	72 / 225mm
8	SS	50 / 25mm
9	SS	50 / 25mm



Headspace Vapour (ppm) | Instrument Details | Unstabilized Water Level | Lab Data and Comments — GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL

END OF BOREHOLE
Auger refusal on inferred bedrock

Borehole was dry and open upon completion of drilling.

file: 7-21-0014-01 - mountainside pool.gpj

LOG OF BOREHOLE 7

Terraprobe

Project No.	: 7-21-0014-01	Client	: City of Burlington	Originated by	: KG
Date started	: March 9, 2021	Project	: 2205 Mount Forest Drive	Compiled by	: AF
Sheet No.	: 1 of 1	Location	: Burlington, Ontario	Checked by	: AF

Position : E: 595389, N: 4800616 (UTM 17T)   Elevation Datum : Geodetic

Rig type : Mini Mole, track-mounted   Drilling Method : Solid stem augers

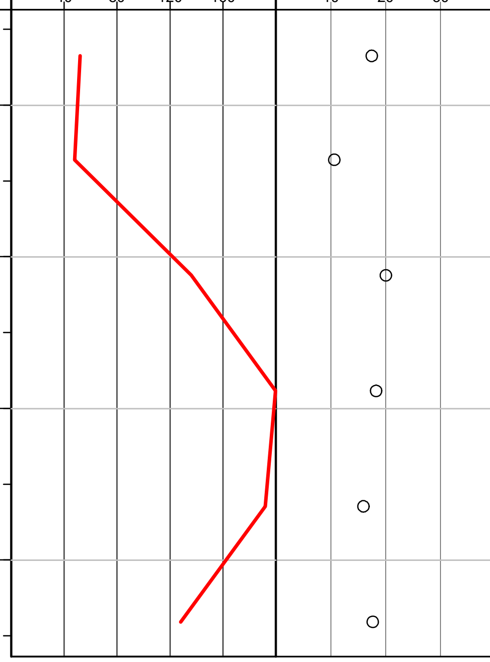
Depth Scale (m)	Elev / Depth (m)	SOIL PROFILE – Description	Graphic Log	SAMPLES – Number	Type	SPT 'N' Value	Elevation Scale (m)
0	124.6	GROUND SURFACE					
		75mm **TOPSOIL**					
		FILL, sand and gravel, compact, brown		1	SS	13	124
1				2	SS	12	
	123.1 / 1.5	**CLAYEY SILT**, with embedded sand and gravel, hard, brown (GLACIAL TILL)		3	SS	34	123
2				4	SS	83	122
3				5	SS	48	121
4	120.3 / 4.3			6	SS	32	

Penetration Test Values (Blows / 0.3m): X Dynamic Cone; 10, 20, 30, 40

Undrained Shear Strength (kPa): O Unconfined, + Field Vane, ● Pocket Penetrometer, ■ Lab Vane; 40, 80, 120, 160

Moisture / Plasticity: Plastic Limit (PL), Natural Water Content (MC), Liquid Limit (LL); 10, 20, 30

Headspace Vapour (ppm) | Instrument Details | Unstabilized Water Level | Lab Data and Comments – GRAIN SIZE DISTRIBUTION (%) (MIT): GR SA SI CL



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

file: 7-21-0014-01 - mountainside pool.gpj

CERTIFICATES OF ANALYSES - CORROSIVITY

APPENDIX B

Terraprobe Inc.

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: TERRAPROBE INC
903 Barton Street
Stoney Creek, ON L8E5P5
(905) 643-7560

ATTENTION TO: Anthony Felice

PROJECT: 7-21-0014-01

AGAT WORK ORDER: 21H722696

SOIL ANALYSIS REVIEWED BY: Nivine Basily, Inorganics Report Writer

DATE REPORTED: Mar 23, 2021

PAGES (INCLUDING COVER): 5

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*Notes

Disclaimer:

- *All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.*
- *All samples will be disposed of within 30 days following analysis, unless expressly agreed otherwise in writing. Please contact your Client Project Manager if you require additional sample storage time.*
- *AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.*
- *This Certificate shall not be reproduced except in full, without the written approval of the laboratory.*
- *The test results reported herewith relate only to the samples as received by the laboratory.*
- *Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, or non-infringement. AGAT assumes no responsibility for any errors or omissions in the guidelines contained in this document.*
- *All reportable information as specified by ISO/IEC 17025:2017 is available from AGAT Laboratories upon request.*

Certificate of Analysis

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

AGAT WORK ORDER: 21H722696

PROJECT: 7-21-0014-01

CLIENT NAME: TERRAPROBE INC | **ATTENTION TO: Anthony Felice**

SAMPLING SITE: | **SAMPLED BY:K. Greenman**

Corrosivity Package

DATE RECEIVED: 2021-03-17 | **DATE REPORTED: 2021-03-23**

			SAMPLE DESCRIPTION:	BH3 SA4	BH7 SA5
			SAMPLE TYPE:	Soil	Soil
			DATE SAMPLED:	2021-03-09	2021-03-09
Parameter	**Unit**	**G / S**	**RDL**	**2230958**	**2230959**
Chloride (2:1)	µg/g		2	7	12
Sulphate (2:1)	µg/g		2	87	27
pH (2:1)	pH Units		NA	8.26	8.24
Electrical Conductivity (2:1)	mS/cm		0.005	0.253	0.186
Resistivity (2:1) (Calculated)	ohm.cm		1	3950	5380
Redox Potential 1	mV		NA	281	312
Redox Potential 2	mV		NA	282	326
Redox Potential 3	mV		NA	283	327

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

2230958-2230959 EC, pH, Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). Resistivity is a calculated parameter.
Redox potential measured on as received sample. Due to the potential for rapid change in sample equilibrium chemistry with exposure to oxidative/reduction conditions laboratory results may differ from field measured results.
Redox potential measurement in soil is quite variable and non reproducible due in part, to the general heterogeneity of a given soil. It is also related to the introduction of increased oxygen into the sample after extraction. The interpretation of soil redox potential should be considered in terms of its general range rather than as an absolute measurement.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO CHARTERED NIVINE BASILY CHEMIST

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: TERRAPROBE INC | **AGAT WORK ORDER: 21H722696**
PROJECT: 7-21-0014-01 | **ATTENTION TO: Anthony Felice**
SAMPLING SITE: | **SAMPLED BY:K. Greenman**

Soil Analysis

RPT Date: Mar 23, 2021			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Corrosivity Package															
Chloride (2:1)	2230958	2230958	7	7	NA	< 2	91%	70%	130%	105%	80%	120%	105%	70%	130%
Sulphate (2:1)	2230958	2230958	87	86	1.2%	< 2	92%	70%	130%	103%	80%	120%	103%	70%	130%
pH (2:1)	2223670		8.47	8.53	0.7%	NA	99%	90%	110%						
Electrical Conductivity (2:1)	2230958	2230958	0.253	0.251	0.8%	< 0.005	107%	80%	120%						
Redox Potential 1	1						100%	90%	110%						

Comments: NA signifies Not Applicable.
pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Duplicate NA: results are under 5X the RDL and will not be calculated.

Certified By:

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: TERRAPROBE INC | **AGAT WORK ORDER: 21H722696**
PROJECT: 7-21-0014-01 | **ATTENTION TO: Anthony Felice**
SAMPLING SITE: | **SAMPLED BY:K. Greenman**

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Chloride (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	modified from MSA PART 3, CH 14 and SM 2510 B	EC METER
Resistivity (2:1) (Calculated)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION
Redox Potential 1	INOR-93-6066	modified G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 2	INOR-93-6066	modified G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 3	INOR-93-6066	modified G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE

AGAT Laboratories

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Laboratory Use Only

Work Order #: 21H722696.

Cooler Quantity: MD COOLER

Arrival Temperatures: 7.7 | 8.0 | 8.2 / 9.6 | 9.8 | 9.6

Custody Seal Intact: ☐Yes ☐No ☐N/A

Notes: MD COOLER ICE PACK

Report Information:

Company: Terraprobe
Contact: Anthony Felice
Address: 903 Barton St, Stoney Creek L8E 5P5
Phone: 905 643 7560 Fax:
Reports to be sent to:
1. Email: afelice@terraprobe.ca
2. Email:

Regulatory Requirements:

(Please check all applicable boxes)

- ☐ Regulation 153/04 — Table ___ *Indicate One* — ☐Ind/Com ☐Res/Park ☐Agriculture
- Soil Texture *(Check One)* ☐Coarse ☐Fine
- ☐ Excess Soils R406 — Table ___ *Indicate One*
- ☐ Regulation 558
- ☐ CCME
- ☐ Sewer Use — ☐Sanitary ☐Storm — ___ *Region*
- ☐ Prov. Water Quality Objectives (PWQO)
- ☐ Other ___ *Indicate One*

Is this submission for a **Record of Site Condition?** ☐ Yes ☒ No

Report Guideline on *Certificate of Analysis* ☒ Yes ☐ No

Turnaround Time (TAT) Required:

Regular TAT ☒ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply)

☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT
**TAT is exclusive of weekends and statutory holidays*

For 'Same Day' analysis, please contact your AGAT CPM

Project Information:

Project: 7-21-0014-C1
Site Location:
Sampled By: K. Greenman
AGAT Quote #: PO:
Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:

Bill To Same: Yes ☒ No ☐
Company:
Contact: Lorena Rossi
Address:
Email: lrossi@terraprobe.ca

Sample Matrix Legend

- **B** Biota
- **GW** Ground Water
- **O** Oil
- **P** Paint
- **S** Soil
- **SD** Sediment
- **SW** Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI, DOC (Y/N)	O. Reg 153: Metals & Inorganics	O. Reg 153: Metals - ☐ CrVI, ☐ Hg, ☐ HWSB	O. Reg 153: BTEX, F1-F4 PHCs	Analyze F4G if required ☐ Yes ☐ No	PAHs	PCBs	VOC	O. Reg 558: Landfill Disposal Characterization TCLP: TCLP: ☐ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs	O. Reg 406: Excess Soils SPLP Rainwater Leach SPLP: ☐ Metals ☐ VOCs ☐ SVOCs	O. Reg 406: Excess Soils Characterization Package pH, ICPMS Metals, BTEX, F1-F4	Salt - EC/SAR	Corrosivity Package							Potentially Hazardous or High Concentration (Y/N)
BH3 SA4	Mar 9/21	AM PM	1	S														X							
BH7 SA5	Mar 9/21	AM PM	1	S														X							
		AM PM																							
		AM PM																							
		AM PM																							
		AM PM																							
		AM PM																							
		AM PM																							
		AM PM																							
		AM PM																							
		AM PM																							

Samples Relinquished By (Print Name and Sign)	Date	Time	Samples Received By (Print Name and Sign)	Date	Time
K. Greenman [signature]	Mar 17/21	14:30	DTAIC [signature]	MAR 17/21	2:35pm
DTAIC [signature]	MAR-17/21	3pm	John Chyepha	Mar 17	5:00
[signature]			John Chyepha	Mar 17	6:30

Page 1 of 1

Nº: 111390

5623 McADAM ROAD
MISSISSAUGA, ONTARIO
CANADA L4Z 1N9
TEL (905)501-9998
FAX (905)501-0589
http://www.agatlabs.com

CLIENT NAME: TERRAPROBE INC
903 Barton Street
Stoney Creek, ON L8E5P5
(905) 643-7560

ATTENTION TO: Anthony Felice

PROJECT: 21H722696

AGAT WORK ORDER: 21T725052

SOLID ANALYSIS REVIEWED BY: Sherin Moussa, Senior Technician

DATE REPORTED: Mar 31, 2021

PAGES (INCLUDING COVER): 5

Should you require any information regarding this analysis please contact your client services representative at (905) 501-9998

*NOTES

All samples are stored at no charge for 90 days. Please contact the lab if you require additional sample storage time.

Certificate of Analysis

AGAT WORK ORDER: 21T725052
PROJECT: 21H722696

5623 McADAM ROAD
MISSISSAUGA, ONTARIO
CANADA L4Z 1N9
TEL (905)501-9998
FAX (905)501-0589
http://www.agatlabs.com

CLIENT NAME: TERRAPROBE INC

ATTENTION TO: Anthony Felice

(201-042) Sulfide

DATE SAMPLED: Mar 22, 2021 | DATE RECEIVED: Mar 23, 2021 | DATE REPORTED: Mar 31, 2021 | SAMPLE TYPE: Other

	Analyte:	Sulfide
	Unit:	%
Sample ID (AGAT ID)	RDL:	0.05
BH3 SA4-2230958 (2252199)		<0.05
BH3 SA4-2230958-DUP (2252200)		<0.05
BH7 SA5-2230959 (2252201)		<0.05

Comments: RDL - Reported Detection Limit
Analysis performed at AGAT 5623 McAdam Rd., Mississauga, ON (unless marked by *)

Certified By: Sherin Moussa

AGAT Laboratories
5623 McADAM ROAD
MISSISSAUGA, ONTARIO
CANADA L4Z 1N9
TEL (905)501-9998
FAX (905)501-0589
http://www.agatlabs.com

CLIENT NAME: TERRAPROBE INC

ATTENTION TO: Anthony Felice

(201-042) Sulfide

	REPLICATE #1				REPLICATE #2				REPLICATE #3							
Parameter	Sample ID	Original	Replicate	RPD	Sample ID	Original	Replicate	RPD	Sample ID	Original	Replicate	RPD				
S	2252199	0.017	0.017	0.0%	2252200	0.018	0.018	0.0%	2252201	0.012	0.013	8.0%				
Sulfate	2252199	< 0.01	< 0.01	0.0%	2252200	< 0.01	< 0.01	0.0%	2252201	< 0.01	< 0.01	0.0%				
Sulfide	2252199	< 0.05	< 0.05	0.0%	2252200	< 0.05	< 0.05	0.0%	2252201	< 0.05	< 0.05	0.0%				

5623 McADAM ROAD
MISSISSAUGA, ONTARIO
CANADA L4Z 1N9
TEL (905)501-9998
FAX (905)501-0589
http://www.agatlabs.com

CLIENT NAME: TERRAPROBE INC

ATTENTION TO: Anthony Felice

(201-042) Sulfide

	CRM #1				CRM #2				CRM #3							
Parameter	Expect	Actual	Recovery	Limits	Expect	Actual	Recovery	Limits	Expect	Actual	Recovery	Limits				
S	0.80	0.81	101%	90% - 110%	0.80	0.80	100%	90% - 110%	0.80	0.80	100%	90% - 110%				
Sulfate	0.01	0.01	100%	90% - 110%	0.01	0.01	100%	90% - 110%	0.01	0.01	100%	90% - 110%				
Sulfide	0.80	0.80	100%	90% - 110%	0.80	0.79	98%	90% - 110%	0.80	0.79	98%	90% - 110%				

AGAT Laboratories
5623 McADAM ROAD
MISSISSAUGA, ONTARIO
CANADA L4Z 1N9
TEL (905)501-9998
FAX (905)501-0589
http://www.agatlabs.com

Method Summary

CLIENT NAME: TERRAPROBE INC
AGAT WORK ORDER: 21T725052
PROJECT: 21H722696
ATTENTION TO: Anthony Felice
SAMPLING SITE:
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Solid Analysis			
Sulfide	MIN-200-12037		LECO