Terraprobe

Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

GEOTECHNICAL INVESTIGATION
PART OF EAST HALF OF LOT 22, CONCESSION 4, WEST OF HURONTARIO STREET (ALTON) CALEDON, ONTARIO

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TABLE OF CONTENTS

1.0 INTRODUCTION

Terraprobe Inc. was retained by Normaple Development Ltd. and Seaton Foxbridege Corporation to carry out a geotechnical investigation for a property located at Part of East Half of Lot 22, Concession 4, West of Hurontario Street in the Township of Caledon, Ontario. A site location plan is provided as Figure 1. A proposal and cost estimate to carry out the investigation were provided in our letter of November 21, 2018. Authorization to proceed with the work was provided by Polocorp Inc. on December 19, 2018.

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, floor slabs on grade, pavements and a SWM pond. 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 subject property is situated south of Queen Street West between Agnes Street and Emeline Street in the Village of Alton. The site is an irregular shaped parcel of land covering approximately 4.04 ha (10 acres). The site was primarily used for agricultural operations. Tree lines exist at portions of the southeastern property lines at the rear of the agricultural lands. The surrounding land has primarily been developed for residential use. The topography varies across the site. There is a fall of about 3.5 m in elevation across the 266 m traverse of the site from the north to the south. From the west to the east there is a fall in elevation of about 4.2 m across the 158 m traverse of the site.

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 sandy silt till.[1] The sandy silt till is underlain by the Amabel Formation. The Amabel Formation consists of grey or blue-grey dolostone.[2]

[1] Quaternary Geology, Orangeville Area, Southern Ontario; Ontario Division of Mines; Map P.848; 1973
[2] Reynolds, J.K., Bernier, L.; Paleozoic Geology, Orangeville Area; Ontario Division of Mines; Map P.947; 1974

2.3 Proposed Development

The general arrangement of the site and the proposed development features are shown on Figure 3, as derived from a drawing prepared by Van Harten Surveying Inc. In this design, it is proposed to construct a residential subdivision. The development will be provided with municipal water services, private sewage systems and will have roads meeting the standards of the Town of Caledon.

3.0 PROCEDURE

The field work for this investigation was carried out on February 7 and 8, 2019, during which time eight (8) boreholes were drilled to depths of about 2.5 to 6.7 metres below the existing ground surface (mBGS). The locations of the boreholes are shown on the Borehole Location Plan, Figure 2. The detailed results of the boreholes are shown on the accompanying Borehole Logs in Appendix A.

The borehole drilling and sampling was carried out using a track mounted drill rig supplied and operated by a specialist drill contractor. The boreholes were advanced using conventional interval augering and sampling techniques and soil samples were recovered at regular intervals of depth by split barrel sampling in accordance with ASTM Standard D1586. After the drilling, sampling, and logging was completed, the boreholes were backfilled with auger cuttings and bentonite sealant.

The field work was observed throughout by a member of our engineering staff who also arranged for underground services locates in advance of the work, logged the boreholes and cared for the samples recovered. The boreholes were located in the field with respect to the existing site features. The ground surface elevations at the borehole locations were inferred from spot elevations on a topographical plan of the site provided by Van Harten Surveying Inc. The ground surface elevations at the boreholes were referred to the geodetic datum.

Ground water observations were made in each borehole during and upon completion of drilling and sampling. In addition, monitoring wells were installed in three (3) boreholes namely BH2, BH5 and BH8. The monitoring wells were extended to depths of 4.6 to 6.7 metres below ground surface (m BGS). The monitoring wells were constructed of 50 mm diameter schedule 40 PVC screen and riser with a silica sand pack, and bentonite seal. The screen length used was 1.5 metres and silica sand pack was placed at the tip of the monitoring well and extended at least 0.6 m above the screen. Details of monitoring well construction are also presented on the attached borehole logs in Appendix A. Water levels were measured following drilling on March 4, 2019.

Boreholes that were not equipped with a monitoring well were decommissioned and sealed with bentonite pellets in accordance with Ontario Regulation 903.

Geotechnical laboratory testing consisted of moisture content tests on all recovered samples and grain size distribution analyses on two (2) select samples in accordance with ASTM Standards. The results of the grain size analysis are presented in Appendix A.

Chemical analyses of the soils at this site were not included in the scope of this investigation.

4.0 SUBSURFACE INVESTIGATION

The subsurface soil 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. These boundaries generally represent a transition from one soil type to another and should not be inferred to represent exact planes of geological change. The 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 topsoil and fill, overlying silty fine sand and silty sand and gravel.

4.1.1 Topsoil

A layer of topsoil was encountered at the ground surface at most borehole locations and generally varied in thickness between about 150 and 600 mm.

4.1.2 Fill

Fill consisting predominantly of silty fine sand with trace gravel and topsoil was encountered immediately beneath the ground cover in boreholes 2, 5, 6, 7, and 8. The fill extended to a depth generally varying from 0.8 to 2.1 m BGS. The N values, as determined in the Standard Penetration testing carried out within the fill or disturbed/weathered native soil, ranged from 3 to 37 blows per 0.3m, inferring a very loose to dense consistency. The higher N values of the fill determined in borehole 6 are due to the presence of large particles and gravel. The in-situ water content of the samples of fill recovered from the standard penetration testing ranged from about 5 to 36 percent.

4.1.3 Silty Fine Sand

Boreholes 1, 5 and 6 penetrated a stratum of silty fine sand to depths ranging from 2.1 to 4.0 m BGS. The N values within the silty fine sand determined from the standard penetration testing ranged from 5 to 27 blows per 0.3 m, inferring a loose to compact relative density. The natural water content of the silty fine sand samples ranged from about 4 to 11 percent.

4.1.4 Silty Sand and Gravel

A deposit of silty sand and gravel with cobbles and boulders was encountered in all boreholes beneath the fill and silty fine sand to depths of about 2.5 to 6.7 m BGS. The N values determined in the silty sand and gravel ranged from 16 to greater than 100 blows per 0.3 m, generally inferring a compact to very dense relative density. The natural water content of samples of the silty sand and gravel recovered from the penetration testing were in the range of about 4 to 13 percent.

4.2 Ground Water Conditions

The ground water conditions were observed in each of the boreholes during and upon completion of drilling, and 50 mm diameter monitoring wells were constructed in Boreholes 2, 5 and 8. A nested well was installed in borehole 2. The water levels were measured in the three monitoring wells on March 4, 2019 and are shown below:

Borehole No.	Depth of Well (m)	Strata Captured by Well Screen	March 4, 2019	
			Depth to Ground Water (m)	Elevation of Ground Water (m)
2	(Nested Well) 3.0 and 6.7	Silty Sand & Gravel	2.3 and 2.4	413.6 and 413.4
5	6.4	Silty Sand & Gravel	6.3	415.6
8	6.6	Silty Sand & Gravel	2.2	411.7

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 GEOTECHNICAL DESIGN CONSIDERATIONS

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.

The comments provided in the following sections are to be considered preliminary since details regarding the proposed development and the final design grades are not known at this time. For this reason, the geotechnical aspects of this project should be reviewed by this office at the final design stage. It is possible that additional subsurface exploration may be required at that time.

5.1 Site Preparation Works

The preliminary site development information indicates that some cutting and filling will be required. Any fill that will be required in areas to be developed for floor slabs on grade must be constructed as an engineered fill. A specification for the creation of an Engineered Fill is provided as Appendix B. It is expected that the site restoration and filling will be carried out in advance of construction.

It is noted that the surficial vegetative cover and topsoil varies in thickness between 150 mm and 600 mm as observed within all boreholes drilled during the geotechnical investigation. Contractors bidding on the work should undertake test pits to better assess topsoil stripping requirements.

Topsoil within the limits of the project shall be salvaged prior to beginning excavating, fill or hauling, operations by excavating topsoil and stockpiling the material at designated locations on drawings or as designated by the owner in a manner that will facilitate measurement, minimize sediment damage, and not obstruct natural drainage. All stockpiles (topsoil and/or earth fill) shall be protected from sediment transport by surface roughening and perimeter silt fencing.

The subgrade soils exposed after the removal of the surficial topsoil will consist of existing earth fill or disturbed/weathered native soil. Care will be required during excavation to separate any materials that appears to contain significant topsoil from the clean earth fill. Prior to backfilling or site grading activities, the exposed subgrade soils should be visually inspected, compacted if required, and proof rolled using large axially loaded equipment. Any soft, organic, or unacceptable areas should be removed as directed by the Geotechnical Engineer and replaced with suitable fill materials compacted to a minimum of 98 percent standard Proctor maximum dry density (SPMDD). If the fill used to raise site grades in the building areas is to support foundations, then it will be necessary to remove all existing fill to competent native soils prior to filling. Clean earth fill used to raise grades in the proposed building and pavement areas should be placed in thin layers (150 mm thick or less) and compacted by a heavy sheep-foot type roller to 98 percent of SPMDD. For optimal performance, the placement water content of the fill should be maintained within about 2 percent of the laboratory optimum water content for compaction. Benches should be cut into the existing slopes at a maximum 600 mm height to allow placement of new fill in a horizontal manner.

The quality of imported soil should be consistent with the applicable property use standards of the MECP's document entitled, '*Soil, Ground Water and Sediment Standards for Use Under Part XV. I of the Environmental Protection Act*', dated April 15, 2011.

All aspects of the engineered fill construction should be verified by the geotechnical engineer including the final excavation, compacting of the native subgrade, and placement and compaction of the engineered fill. In-situ density testing should be carried out during construction to confirm that each lift has been compacted to the specified degree. Source acceptance testing of materials imported for use as engineered fill must be carried out prior to the importation to the site.

5.2 Foundation Design Parameters

5.2.1 Conventional Spread Footings

The boreholes penetrated fill materials overlying silty fine sand and silty sand and gravel strata. The existing fill and the disturbed/weathered native soil are not suitable for the support of foundations. Based on the results of the boreholes, it is considered feasible to support the building foundations on the undisturbed silty fine sand, silty sand and gravel or engineered fill.

Conventional spread footings must be founded at least 0.3 m into the undisturbed clayey silt. 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	0.8	417.4	150	225	Silty Fine Sand
BH 2	1.1	414.7	150	225	Silty Sand & Gravel
BH 3	0.8	417.2	150	225	Silty Sand & Gravel
BH 4	0.8	414.5	150	225	Silty Sand & Gravel
BH 5	1.8	420.1	150	225	Silty Fine Sand
BH 6	2.4	412.3	150	225	Silty Fine Sand
BH 7	1.8	415.2	150	225	Silty Sand & Gravel
BH 8	1.7	412.2	150	225	Silty Sand & Gravel

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 silty fine sand or silty sand and gravel strata at the above design bearing pressures is expected to be less than 25 mm.

Some variability in the consistency and depth of the native undisturbed strata is expected. For this reason, it is important that all of the foundation excavations be inspected by Terraprobe to confirm that the soft surficial strata have 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 footings in unheated areas must be provided with at least 1.2 metres of earth cover for frost protection or equivalent insulation. If construction proceeds during freezing weather conditions, adequate temporary frost protection for the footing bases and concrete must be provided.

5.2.2 Foundations on Engineered Fill

Based on the existing site grades, it is likely that some portions of the site will undergo some filling. Recommendations for the construction of engineered fill are provided in Section 5.1 of this report. A maximum net allowable bearing pressure of up to 150 kPa for SLS design and 225 kPa for a factored ULS design can be used for foundations placed within the engineered fill area.

Prior to placing engineered fill it will be necessary to remove all surficial fill in proposed footing areas to the top of the native soil stratum. The exposed subgrade surfaces should be visually inspected and proof rolled by an experienced geotechnical engineer to confirm the presence of competent native soils. The excavation for the engineered fill should extend beyond the footprint area of the proposed structure equal to the depth of fill beneath the proposed footing plus 0.5 m. The engineered fill should be placed in 150 mm thick layers and compacted to 98 percent of SPMDD. Foundations constructed on engineered fill must be provided with steel reinforcement designed to minimize the effects of post construction differential settlement.

5.3 Earthquake Design Parameters

The Ontario Building Code (2012) stipulates the methodology for earthquake design analysis, as set out in Subsection 4.1.8.7. The determination of the type of analysis is predicated on the importance of the structure, the spectral response acceleration and the site classification. The parameters for determination of Site Classification for Seismic Site Response are set out in Table 4.1.8.4A of the Ontario Building Code (2012). The classification is based on the determination of the average shear wave velocity in the top 30 meters of the site stratigraphy, where shear wave velocity (v_s) measurements have been taken. Alternatively, the classification is estimated on the basis of rational analysis of undrained shear strength (s_u) or penetration resistance (N-values).

$$\upsilon_{s-avg} = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{\upsilon_{si}}} \qquad S_{u-avg} = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{s_{ui}}} \qquad N_{avg} = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{N_i}}$$

Shear wave velocity **Undrained shear strength** **SPT N-values**

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). Tables 4.1.8.4.B and 4.1.8.4.C. of the same code provide the applicable acceleration and velocity based site coefficients.

Site Class	Values of F_a				
	$S_a(0.2) \leq 0.25$	$S_a(0.2) = 0.50$	$S_a(0.2) = 0.75$	$S_a(0.2) = 1.00$	$S_a(0.2) \geq 1.25$
C	1.0	1.0	1.0	1.0	1.0
Site Class	Values of F_v				
	$S_a(1.0) \leq 0.1$	$S_a(1.0) = 0.20$	$S_a(1.0) = 0.30$	$S_a(1.0) = 0.40$	$S_a(1.0) \geq 0.50$
C	1.0	1.0	1.0	1.0	1.0

It should be noted that the seismic site designation above is estimated on the basis of rational analysis of penetration resistance (N-Values) observed in the boreholes (assuming the consistency for the deeper soil stratigraphy beyond the investigation depth was similar to that of the lowest soil strata penetrated within the investigation depth).

5.4 Floor Slabs on Grade

The subsurface conditions within the investigated area are expected to be comprised of existing fill and/or the disturbed/weathered native soil materials. Based on the findings of the investigation, the upper portion the earth fill layer is not considered suitable for construction of a slab-on-grade structure and should be sub-excavated to an appropriate depth equivalent to a minimum of one half of the existing fill thickness 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 subexcavation 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 standard Proctor maximum dry density. For a slab on grade founded on clayey silt soils, engineered fill, or approved existing fill, 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
- Engineered fill: 25,000 kPa/m
- Silty Sand & Gravel 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.

5.5 Earth Pressure Design Considerations

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
Silty Sand 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:

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

where,
P = the horizontal pressure at depth, **h** (m)
K = the earth pressure coefficient,
$\mathbf{h_w}$ = 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, ($\gamma - 9.8\ kN/m^3$)
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:

$$\mathbf{P = K[\gamma h + q]}$$

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 ϕ**. The K value to be used for the design will depend on the rigidity of the wall.

Heavy compaction equipment should not be used immediately behind the walls, as this may cause deflection or damage to the wall.

5.6 Basement Drainage

To assist in maintaining basements dry from seepage, it is recommended that exterior grades around the buildings be sloped away at a 2 percent gradient or more, for a distance of at least 1.2 m. As well, perimeter foundation drains should be provided, consisting of perforated pipe surrounded by a granular filter (minimum 150 mm thick). The granular filter should consist of OPSS HL 8 Coarse Aggregate.

The basement wall must be provided with damp-proofing provisions in conformance to the Section 9.13.2 of the Ontario Building Code (2012). The basement wall backfill for a minimum lateral distance of 0.6 m out from the wall should consist of free-draining granular material (OPSS 1010 Granular 'B'), or provided with a suitable alternative drainage cellular media.

Apart from the above recommended perimeter drainage, the provision of a sub-floor drainage system installed beneath the basement floor is also recommended. The sub-floor drainage system may consist of perforated pipes located at a distance of about 3 m centre to centre. The size of the sump pit should be adequate to accommodate the water seepage. The perimeter and sub-floor drain installation and outlet provisions must conform to the plumbing code requirements. Further, the sub-floor drainage system should be adequately designed to prevent the possibility of back-flow.

5.7 Pavement Design

5.7.1 Subgrade Preparation

Earth fills or disturbed soil strata, consisting predominantly of silty fine sand, were encountered immediately beneath the ground cover in most of the boreholes. The fill and the silty fine sand materials were occasionally observed to contain organics, and rootlets. These soil conditions may be suitable to support pavements for the potential roadway and parking areas provided the exposed subgrade is proofrolled, recompacted, and inspected as per Section 5.1 and provided the fill is free of all loose and deleterious materials.

Where there is existing fill on the site, caution needs to be exercised in the preparation of the subgrade on this material because there is no evidence to suggest it has been compacted appropriately. It is recommended that any subgrade comprising of existing fill be inspected for obvious soft/loose areas and presence of deleterious materials. Should such areas be found, Terraprobe can provide appropriate advice for replacement of the material and addressing local weak areas at that time.

If new fill is required to raise the grade, selected on-site fill could be used, provided it is free of any topsoil and other deleterious material. The fill should be placed in large areas where it can be compacted by a heavy smooth drum type roller. The fill should be placed in large areas where it can be uniformly compacted in 300 mm thick lifts with each lift uniformly compacted to at least 95 percent of standard Proctor maximum dry density. The upper 1 m of backfill beneath areas to be developed as pavements should be compacted to 98 percent of SPMDD.

The most severe loading conditions on pavement areas and the subgrade may occur during construction. Consequently, special provisions such as end dumping and forward spreading of sub-base fills, restricted construction lanes, and half-loads during paving may be required, especially if construction is carried out during wet weather conditions.

Control of surface water is a significant factor in achieving good pavement life. Grading of adjacent pavement areas must be designed so that water is not allowed to pond adjacent to the outside edges of the pavement or curb. The existing earth fill and native soils have anywhere from a moderate to severe frost susceptibility to frost heave, and pavement on these materials must be designed accordingly. The subgrade must be free of depressions and sloped (preferably at a minimum grade of two percent) to provide effective drainage toward subgrade drains or side ditches.

5.7.2 Asphaltic Concrete Pavement Design

The industry pavement design methods are based on a design life of 15 to 20 years for typical weather conditions and for the design traffic loadings. On this basis, the following pavement component thicknesses are recommended for flexible pavements which will be subjected to “heavy duty” use (ie main site accesses and service accesses) and “light duty” use (ie car parking) constructed on a properly prepared clayey silt subgrade.

Minimum Asphaltic Concrete Pavement Structure

Pavement Layer	Compaction Requirements	Light Duty Minimum Component Thickness	Heavy Duty Minimum Component Thickness
Surface Course Asphaltic Concrete HL3 (OPSS 1150)	92-96.5% MRD	40 mm	45 mm
Base Course Asphaltic Concrete HL8 (OPSS 1150)	92-96.5% MRD	50 mm	60 mm

Pavement Layer	Compaction Requirements	Light Duty Minimum Component Thickness	Heavy Duty Minimum Component Thickness
Base Course: Granular A (OPSS 1010) or 19mm Crusher Run Limestone	98% standard Proctor Maximum Dry Density (ASTM-D1557)	150 mm	150 mm
Subbase Course: Granular B Type II (OPSS 1010) or 50mm Crusher Run Limestone	98% standard Proctor Maximum Dry Density (ASTM-D1557)	300 mm	350 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.

The granular materials should be placed in lifts 150 mm thick or less, and compacted to a minimum of 100 percent SPMDD for granular base and granular sub-base. Asphalt materials should be rolled and compacted as per OPSS 310. The granular and asphalt pavement materials and their placement should conform to OPSS Forms 310, 501, 1010, 1101 and 1150 and pertinent Town of Caledon specifications.

It is recommended that the placement of the wearing surface be delayed for at least one year after construction of the binder course to minimize the effects of post construction settlement of subgrade fill. Prior to placing the wearing surface, the binder course should be evaluated and remedial work carried out as required in preparation for final construction.

5.8 SWM Pond

A SWM pond is proposed at the northeast corner of the property boundary as shown on the Proposed Development plan, Figure 3. Information regarding the details of the SWM Pond, inverts and the like are not known at this present time. Therefore, recommendations made in this section should be viewed as preliminary in nature and should be reviewed by Terraprobe once information as become available.

Prior to excavating for the pond, all topsoil and any otherwise deleterious material should be stripped and carefully stockpiled to minimize contamination of the underlying subgrade materials which may be reused for general site regrading, for the construction of berms, embankments, and other features.

Cut slopes within the silty fine sand strata with depths approaching about 5 m would be considered stable at inclinations approaching about 3 horizontal to 1 vertical, however operational standards for such facilities usually dictate somewhat flatter inclinations as required for public safety. Side slopes below the permanent water table should be 4 horizontal to 1 vertical or flatter.

Any containment berms must be keyed into the underlying undisturbed subgrade to a depth of at least 0.6m. It is not considered feasible to construct the containment berms using the excavated silty fine sand and gravel from the SWM pond excavation. A liner or silty clay material would need to be used instead. Care should be taken to exclude from the silty clay any topsoil, excessively wet, frozen, or otherwise deleterious material (ie. cobbles, boulders, etc…). The fill for the berms should be placed in nominal lift thicknesses of 200 mm and each lift must be uniformly compacted to at least 98 percent of SPMDD. Post construction settlement of structural elements or utilities founded within the berm should be expected.

It should be noted that the fine grained soils which are predominant to the site and will be encountered during construction, are susceptible to erosion. All cut and filled slopes must be provided with adequate vegetation cover. Measures will be required to control surface runoff and the off-site migration of soil during the construction phase and until the vegetation cover has become established. Areas which will be exposed to stormwater flow should be provided with more durable erosion protection. Preference should be given to erosion protection which is free draining, flexible and incorporates adequate filter protection. Such protection could be achieved by blanketing the slope with a suitable filter fabric and a shell of granular material, such as OPSS 1010 Granular A. The filter fabric could consist of Terrafix 270R or equivalent.

Section SG 6 of the Supplementary Guidelines for the Ontario Building Code 1997 (August 2003 update), provides guidance for the selection of a percolation rate on the basis of soil type as outlined in the Unified Soil Classification System. Based on the results of sieve and hydrometer analyses and Atterberg limits, the order of magnitude of soil permeability to be used for any surficial stormwater infiltration system is estimated to be between 10^{-3} to 10^{-5} m/sec which is in medium to low range of soil permeability values. Further analyses will be completed as part of a Hydrogeological Assessment being conducted at the site.

6.0 DESIGN CONSIDERATIONS FOR CONSTRUCTABILITY

6.1 Excavations

All excavations must be carried out in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. In this context, the near surface soil strata at the site, primarily consisting of fill, 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 the excavation.

Where workmen must enter a trench or excavation carried deeper than 1.2 metres the trench or excavation must be suitably sloped and/or braced in accordance with the regulation requirements. Minimum support system requirements for steeper excavations are stipulated in Sections 235 thru 238 and 241 of the Act and Regulations and include provisions for timbering and shoring.

Ground water was encountered in the monitoring wells installed at the site. 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.

6.2 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 the 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.

6.3 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.

6.4 Quality Control

The foundation construction must be field reviewed by the geotechnical engineer to ensure that the founding soil exposed is consistent with the design bearing intended. 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 pavements and any slabs-on-grade 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 Terraprobe 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.

7.0 LIMITATIONS AND USE OF REPORT

7.1 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 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.

7.2 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.

7.3 Use of Report

This report is prepared for the express use of Normaple Development Ltd. & Seaton Foxbridge Corporation 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 local building authority, in their capacity as the planning authority under Provincial statues, will make use of and rely upon this report, cognizant of the limitations thereof, both as are expressed and implied.

Terraprobe Inc.

LICENSED PROFESSIONAL ENGINEER
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PROVINCE OF ONTARIO

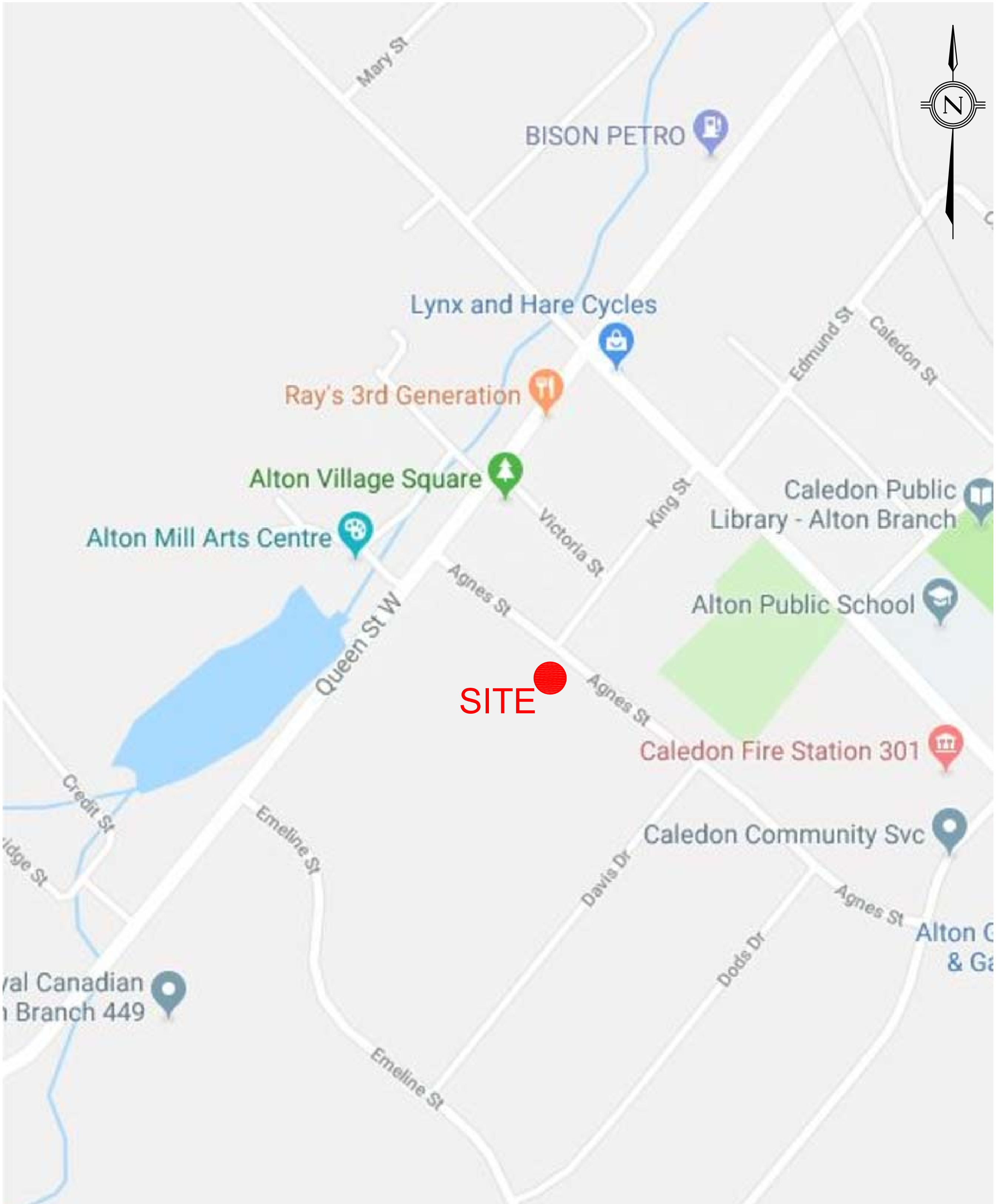
LICENSED PROFESSIONAL ENGINEER
P. T. CANNON
PROVINCE OF ONTARIO

Anthony Felice, P. Eng.
Project Manager, Geotechnical

Patrick Cannon, P. Eng.
Principal

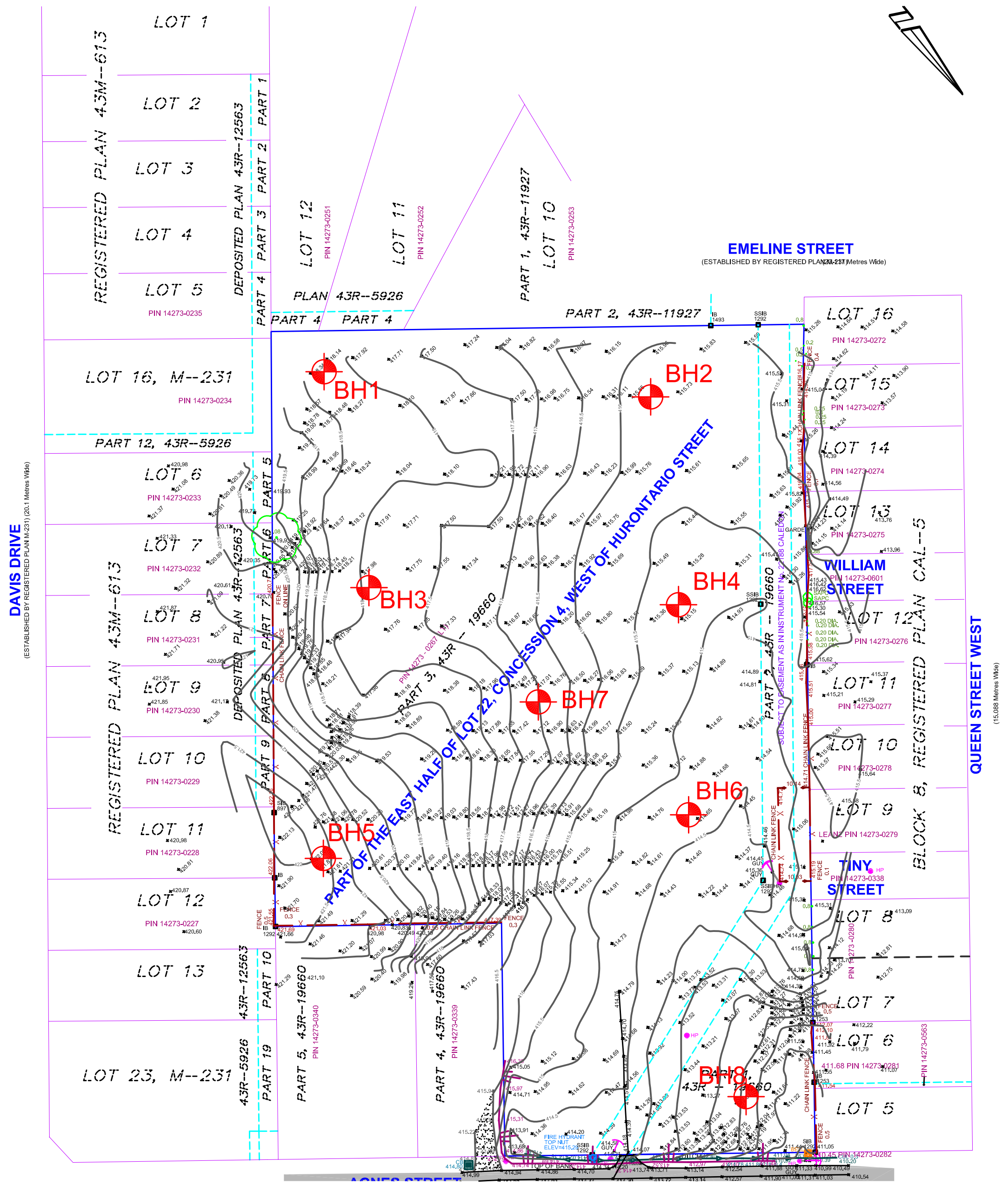
FIGURES

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	FIGURE : 1
File No. 7-18-0158-01	



Source:

REVISION SCHEDULE			
No.	DATE	BY	COMMENTS
1	7/25/18	S.J.	INITIAL SUBMISSION

Van Harten
SURVEYING INC.
LAND SURVEYORS and ENGINEERS

Kitchener	Guelph	Orangeville
Ph: 519-742-8371	Ph: 519-821-2763	Ph: 519-940-4110

www.vanharten.com info@vanharten.com

DRAWN BY: S.J. | CHECKED BY: ML | PROJECT No. 25228-17

LEGEND

BH1 Borehole Location

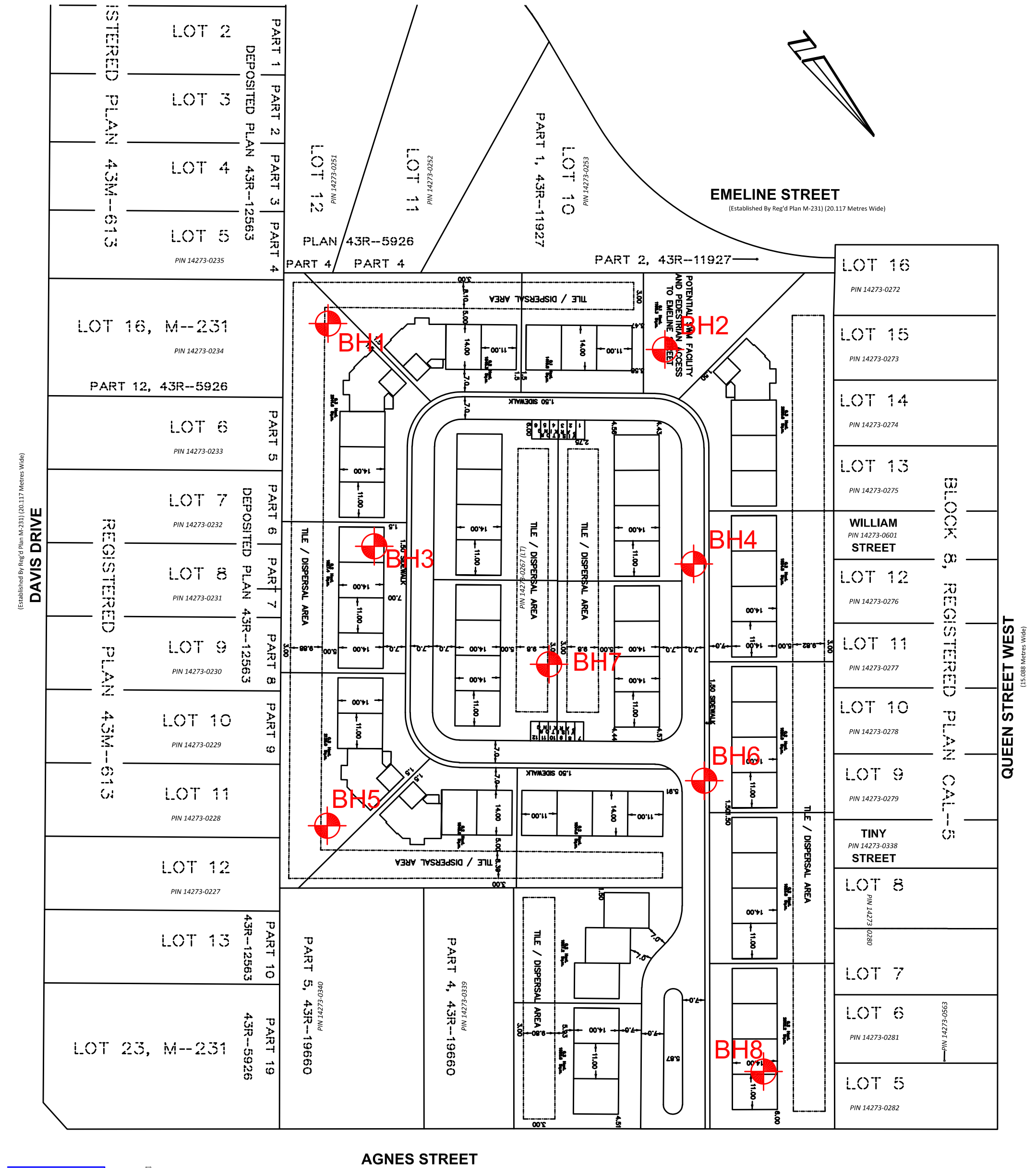
Terraprobe

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

Title: BOREHOLE LOCATION PLAN

File No. 7-18-0158-01

FIGURE : 2



Source:

Van Harten
SURVEYING INC.
LAND SURVEYORS and ENGINEERS

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DRAWN BY: JML | CHECKED BY: JML | PROJECT No. 25228-17

Jan 29,2019-10:02am
G:\CALEDON\CON4WHS\AGNES ST DEVELPOMENT\ACAD\TOWNHOUSE CONCEPT JAN 2019.dwg

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 DEVELOPMENT PLAN

File No. 7-18-0158-01

FIGURE : 3

LOGS OF BOREHOLES

APPENDIX A

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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

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www.terraprobe.ca

Terraprobe

LOG OF BOREHOLE 1

Project No. : 7-18-0158-01	Client : Normaple Development Ltd. and Seaton Foxbridege Corporation	Originated by : JM
Date started : February 7, 2019	Project : Part of East Half of Lot 22, Concession 4, West of Hurontario St	Compiled by : AF
Sheet No. : 1 of 1	Location : Caledon, Ontario	Checked by : PC

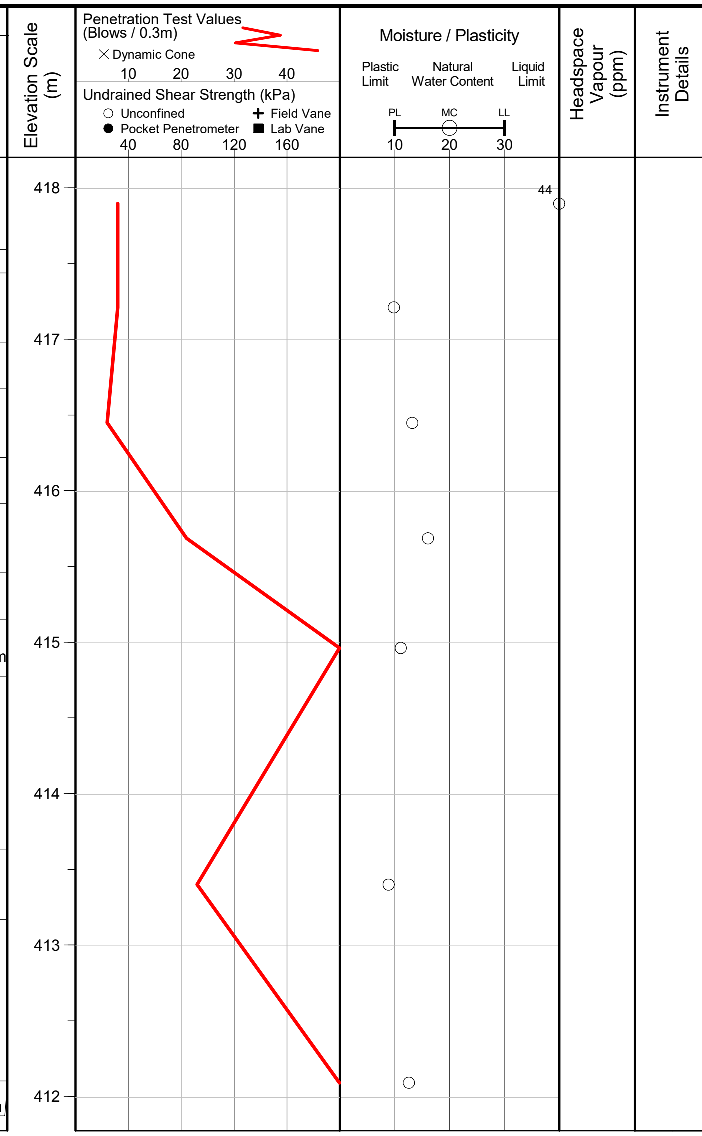
Position : E: 574695, N: 4856275 (UTM 17T)	Elevation Datum : Geodetic
Rig type : D50, track-mounted	Drilling Method : Hollow stem augers

SOIL PROFILE

Elev / Depth (m)	Description
418.2	**GROUND SURFACE**
	500mm **TOPSOIL**
417.7 / 0.5	**SILTY FINE SAND**, trace gravel, loose, brown
416.1 / 2.1	**SILTY SAND and GRAVEL**, with occasional cobbles and boulders, compact to very dense, brown
411.8 / 6.4	**END OF BOREHOLE**

SAMPLES

Number	Type	SPT 'N' Value
1	SS	8
2	SS	8
3	SS	6
4	SS	21
5	SS	62 / 225mm
6	SS	23
7	SS	50 / 25mm



Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

GR	SA	SI	CL
2	86	4	8

END OF BOREHOLE
Refusal (obstruction in the hole)

Possible cobble or bedrock obstruction in hole.

Unstabilized water level measured at 4.3 m below ground surface; borehole was open upon completion of drilling.

LOG OF BOREHOLE 2

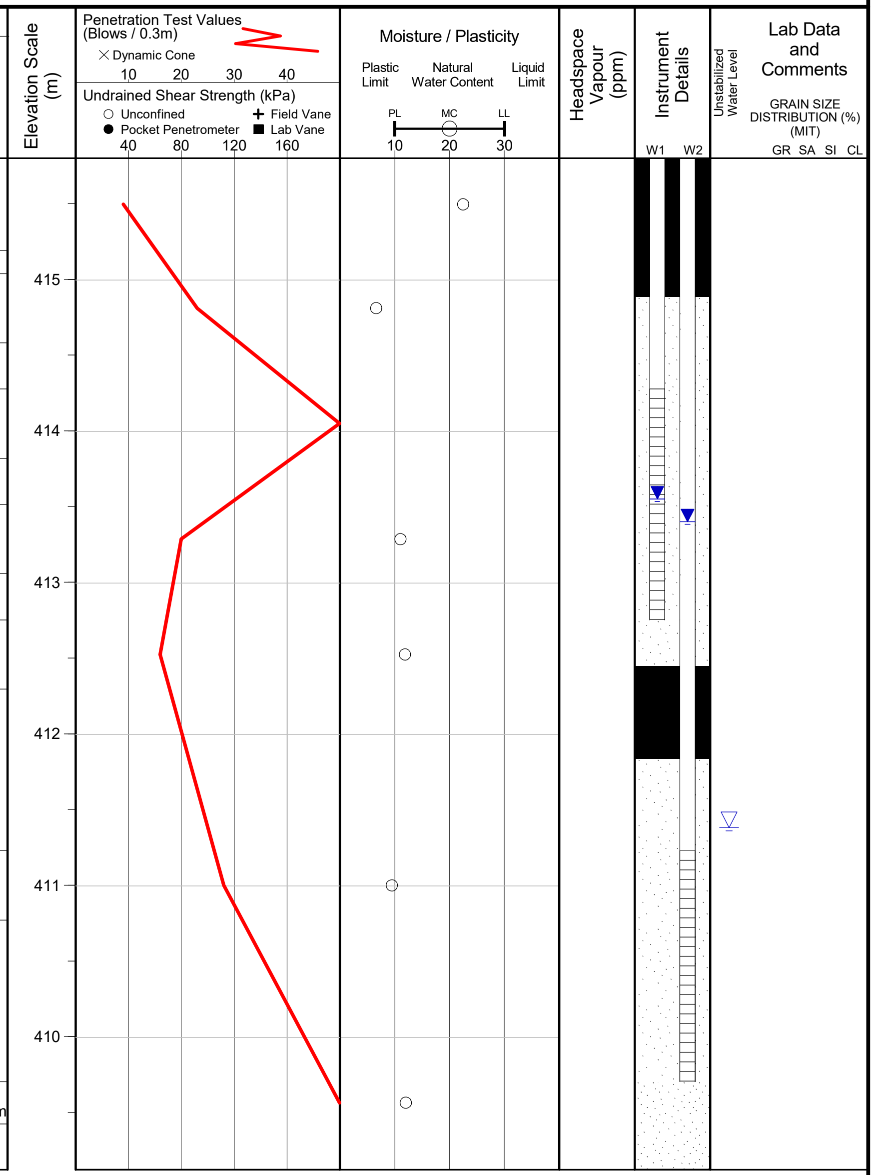
Terraprobe

Project No. : 7-18-0158-01	Client : Normaple Development Ltd. and Seaton Foxbridege Corporation	Originated by : JM
Date started : February 7, 2019	Project : Part of East Half of Lot 22, Concession 4, West of Hurontario St	Compiled by : AF
Sheet No. : 1 of 1	Location : Caledon, Ontario	Checked by : PC

Position : E: 574614, N: 4856342 (UTM 17T) Elevation Datum : Geodetic

Rig type : D50, track-mounted Drilling Method : Hollow stem augers

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	Number	Type	SPT 'N' Value
0	415.8	GROUND SURFACE			
		300mm **TOPSOIL**			
	415.5 0.3	**FILL**, silty fine sand, trace gravel, loose, brown	1	SS	9
	415.0 0.8	**SILTY SAND and GRAVEL**, with occasional cobbles and boulders, compact to very dense, brown			
1			2	SS	23
			3	SS	56
2			4	SS	20
3			5	SS	16
5			6	SS	28
6			7	SS	50 / 125mm
	409.1 6.7				



END OF BOREHOLE
Refusal (obstruction in the hole)

Possible cobble or bedrock obstruction in hole.

Unstabilized water level measured at 4.4 m below ground surface; borehole was open upon completion of drilling.

W1: 50 mm dia. monitoring well installed.
W2: 50 mm dia. monitoring well installed.

W1 WATER LEVELS

Date	Water Depth (m)	Elevation (m)
Mar 4, 2019	2.3	413.6

W2 WATER LEVELS

Date	Water Depth (m)	Elevation (m)
Mar 4, 2019	2.4	413.4

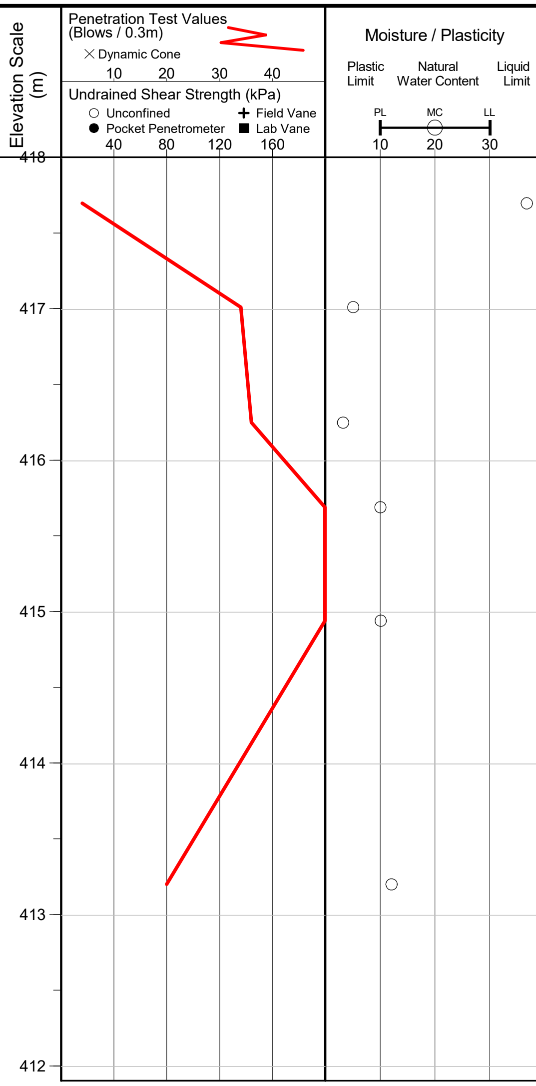
Terraprobe

LOG OF BOREHOLE 3

Project No. : 7-18-0158-01
Client : Normaple Development Ltd. and Seaton Foxbridege Corporation
Originated by : JM
Date started : February 7, 2019
Project : Part of East Half of Lot 22, Concession 4, West of Hurontario St
Compiled by : AF
Sheet No. : 1 of 1
Location : Caledon, Ontario
Checked by : PC

Position : E: 574728, N: 4856325 (UTM 17T)
Elevation Datum : Geodetic
Rig type : D50, track-mounted
Drilling Method : Hollow stem augers

Elev (m)	Depth (m)	Description	Sample Number	Type	SPT 'N' Value
418.0	0	GROUND SURFACE			
		150mm **TOPSOIL**	1	SS	4
417.5	0.5	**SILTY SAND and GRAVEL**, with occasional cobbles and boulders, compact to dense, brown	2	SS	34
			3	SS	36
			4	SS	50 / 50mm
			5	SS	50 / 25mm
			6	SS	20
411.9	6.1				



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

END OF BOREHOLE
Refusal (obstruction in the hole)

Possible cobble or bedrock obstruction in hole.

Borehole was dry and open upon completion of drilling.

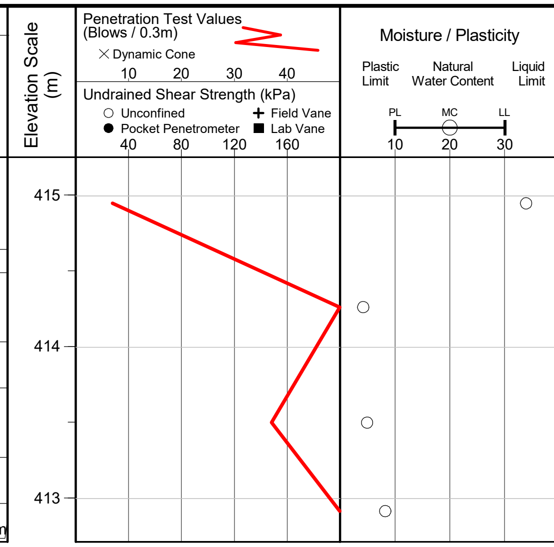
LOG OF BOREHOLE 4

Terraprobe

Project No.	: 7-18-0158-01	Client	: Normaple Development Ltd. and Seaton Foxbridege Corporation	Originated by	: JM
Date started	: February 7, 2019	Project	: Part of East Half of Lot 22, Concession 4, West of Hurontario St	Compiled by	: AF
Sheet No.	: 1 of 1	Location	: Caledon, Ontario	Checked by	: PC

Position : E: 574646, N: 4856389 (UTM 17T)
Elevation Datum : Geodetic
Rig type : D50, track-mounted
Drilling Method : Hollow stem augers

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	Graphic Log	SAMPLES Number	Type	SPT 'N' Value	Elevation Scale (m)	Headspace Vapour (ppm)	Instrument Details	Unstabilized Water Level	Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL
0	415.3	GROUND SURFACE									
	414.8 / 0.5	450mm **TOPSOIL**		1	SS	7	415				
1		**SILTY SAND and GRAVEL**, with occasional cobbles and boulders, dense to very dense, brown		2	SS	58	414				
2				3	SS	37	413				
	412.8 / 2.5			4	SS	50 / 100mm					



END OF BOREHOLE
Refusal (obstruction in the hole)

Possible cobble or bedrock obstruction in hole.

Borehole was dry and open upon completion of drilling.

file: 7-18-0158-01 - anges st.gpj

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LOG OF BOREHOLE 5

Project No. : 7-18-0158-01 | Client : Normaple Development Ltd. and Seaton Foxbridege Corporation | Originated by : JM

Date started : February 7, 2019 | Project : Part of East Half of Lot 22, Concession 4, West of Hurontario St | Compiled by : AF

Sheet No. : 1 of 1 | Location : Caledon, Ontario | Checked by : PC

Position : E: 574776, N: 4856396 (UTM 17T) | Elevation Datum : Geodetic

Rig type : D50, track-mounted | Drilling Method : Hollow stem augers

Elev / Depth (m)	Description	Sample Number	Type	SPT 'N' Value
421.9	GROUND SURFACE			
	450mm **TOPSOIL**	1	SS	6
421.4 / 0.5	**FILL**, silty sand, trace gravel, very loose, brown	2	SS	3
420.4 / 1.5	**SILTY FINE SAND**, trace gravel, compact, brown	3	SS	26
		4	SS	14
		5	SS	27
417.9 / 4.0	**SILTY SAND and GRAVEL**, with occasional cobbles and boulders, compact to very dense, brown	6	SS	24
		7	SS	50 / 25mm
415.5 / 6.4				

END OF BOREHOLE
Refusal (obstruction in the hole)

Possible cobble or bedrock obstruction in hole.

Borehole was dry and open upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Mar 4, 2019	6.3	415.6

file: 7-18-0158-01 - anges st.gpj

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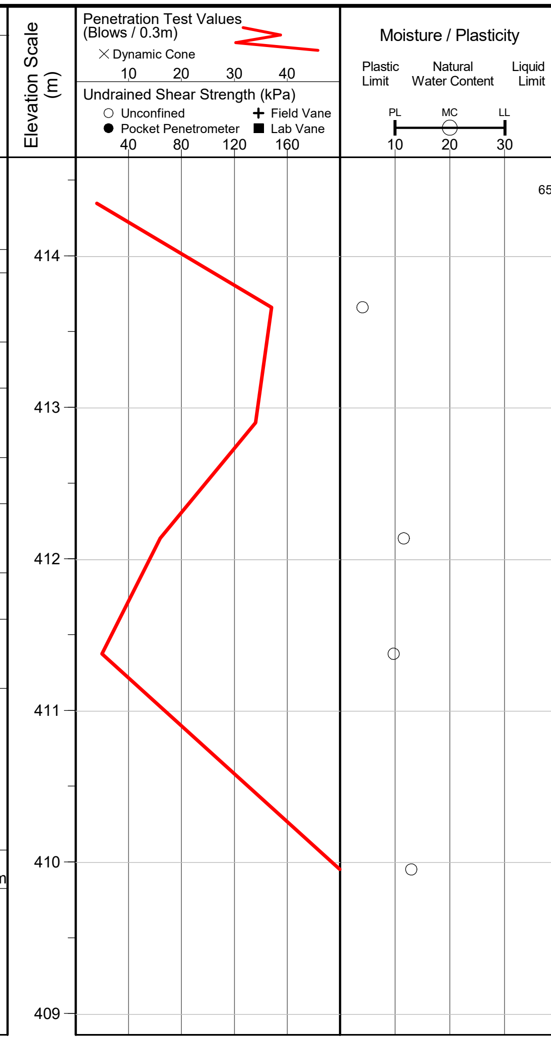
LOG OF BOREHOLE 6

Project No. : 7-18-0158-01	Client : Normaple Development Ltd. and Seaton Foxbridege Corporation	Originated by : JM
Date started : February 8, 2019	Project : Part of East Half of Lot 22, Concession 4, West of Hurontario St	Compiled by : AF
Sheet No. : 1 of 1	Location : Caledon, Ontario	Checked by : PC

Position : E: 574690, N: 4856454 (UTM 17T)
Elevation Datum : Geodetic
Rig type : D50, track-mounted
Drilling Method : Hollow stem augers

Depth Scale (m)	Elev Depth (m)	Description	Sample Number	Type	SPT 'N' Value	Unstabilized Water Level
0	414.7	**GROUND SURFACE**				
		600mm **TOPSOIL**	1	SS	4	
	414.1 / 0.6	**FILL**, sand and gravel, trace topsoil, dense, brown	2	SS	37	
			3	SS	34	
	412.6 / 2.1	**SILTY FINE SAND**, trace gravel, compact, brown	4	SS	16	∇ (2.3 m)
			5	SS	5	
	410.9 / 3.8	**SILTY SAND and GRAVEL**, with occasional cobbles and boulders, very dense, brown	6	SS	50 / 100mm	
	408.9 / 5.8	**END OF BOREHOLE**				



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

END OF BOREHOLE
Refusal (obstruction in the hole)

Possible cobble or bedrock obstruction in hole.

Unstabilized water level measured at 2.3 m below ground surface; borehole was open upon completion of drilling.

file: 7-18-0158-01 - anges st.gpj

Terraprobe

LOG OF BOREHOLE 7

Project No. : 7-18-0158-01 | Client : Normaple Development Ltd. and Seaton Foxbridege Corporation | Originated by : JM

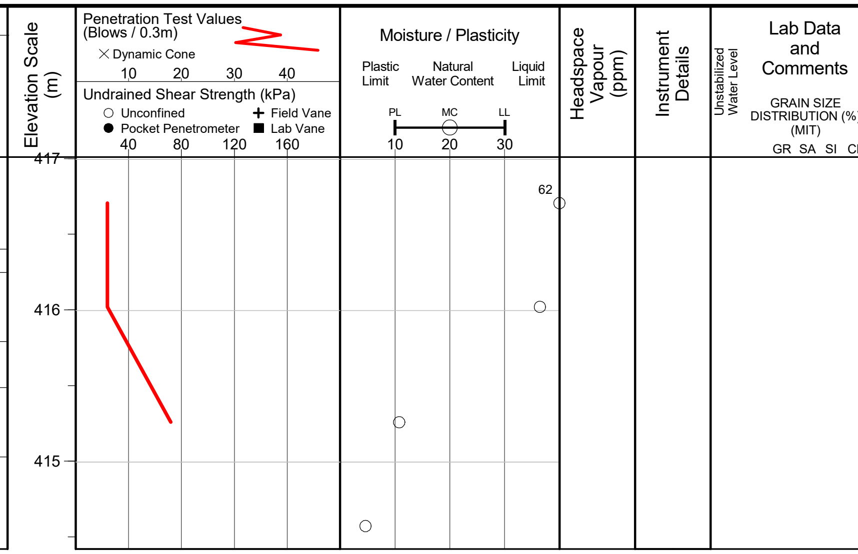
Date started : February 8, 2019 | Project : Part of East Half of Lot 22, Concession 4, West of Hurontario St | Compiled by : AF

Sheet No. : 1 of 1 | Location : Caledon, Ontario | Checked by : PC

Position : E: 574703, N: 4856377 (UTM 17T) | Elevation Datum : Geodetic

Rig type : D50, track-mounted | Drilling Method : Hollow stem augers

Elev / Depth (m)	Description	Sample Number	Type	SPT 'N' Value
417.0	GROUND SURFACE			
	600mm **TOPSOIL**	1	SS	6
416.4 / 0.6	**FILL**, silty fine sand, trace rootlets, topsoil, loose, brown	2	SS	6
415.5 / 1.5	**SILTY SAND and GRAVEL**, with occasional cobbles and boulders, compact to very dense, brown	3	SS	18
		4	AS	
414.4 / 2.6	**END OF BOREHOLE**			



END OF BOREHOLE
Refusal (obstruction in the hole)

Possible cobble or bedrock obstruction in hole.

Borehole was dry and open upon completion of drilling.

file: 7-18-0158-01 - anges st.gpj

Terraprobe

LOG OF BOREHOLE 8

Project No. : 7-18-0158-01	Client : Normaple Development Ltd. and Seaton Foxbridege Corporation	Originated by : JM
Date started : February 8, 2019	Project : Part of East Half of Lot 22, Concession 4, West of Hurontario St	Compiled by : AF
Sheet No. : 1 of 1	Location : Caledon, Ontario	Checked by : PC

Position : E: 574738, N: 4856521 (UTM 17T) — Elevation Datum : Geodetic

Rig type : D50, track-mounted — Drilling Method : Hollow stem augers

Elev (m)	Depth (m)	Description	Sample Number	Type	SPT 'N' Value	Natural Water Content (%)	Lab Data and Comments (GR SA SI CL)
413.9	0	GROUND SURFACE					
		450mm **TOPSOIL**	1	SS	8	45	
413.4	0.5	**FILL**, silty fine sand, trace gravel, compact, brown	2	SS	16		
412.5	1.4	**SILTY SAND and GRAVEL**, with occasional cobbles and boulders, compact to very dense, brown	3	SS	16		27 41 23 9
			4	SS	26		
			5	SS	39		
409.3	4.6		6	SS	50 / 25mm		

END OF BOREHOLE
Refusal (obstruction in the hole)

Possible cobble or bedrock obstruction in hole.

Unstabilized water level measured at 3.2 m below ground surface; borehole was open upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Mar 4, 2019	2.2	411.7

file: 7-18-0158-01 - anges st.gpj

**“DRAFT” ENGINEERED FILL
EARTHWORKS SPECIFICATIONS**

APPENDIX B

Terraprobe Inc.

ENGINEERED FILL
EARTHWORKS SPECIFICATIONS

PART 1 GENERAL

1.01 Description

Engineered fill refers to earth fill (earthworks) designed and constructed with engineering inspection and testing, so as to be capable of supporting building foundations without excessive settlement. Concrete foundation walls must be provided with nominal reinforcing steel to provide stiffening of the foundation walls and to protect against excessive crack formation within the foundation walls.

Engineered fill is a suitable and economical method to support building foundations in areas of deep filling or large grade changes. The building foundations can consist of conventional shallow spread footings constructed on engineered fill which extends down to competent and stable native soil capable of supporting the engineered fill and foundation loads without excessive settlement.

Preparation for engineered fill should only be conducted under full time inspection and testing by the Geotechnical Engineer, in order to ensure adequate compaction and fill quality.

The work covered by this section includes the furnishing of all labour, materials, equipment and incidentals for the construction of engineered fill, as shown on the Design Drawings prepared by the Design Civil Engineer and as described by these specifications. The work included in this section consists of, but is not limited to, the following:

a) Stripping of the topsoil layer from the ground surface below all areas to be covered with engineered fill,

b) Excavation of Test Holes into the subgrade to investigate the suitability of subsurface conditions for support of the Engineered fill and determine if any prior existing fill materials are present,

c) Proof-rolling of the subgrade (with a heavy rubber-tired equipment such as a grader or loaded dump truck) below areas to be covered with Engineered fill, to detect the presence and extent of unstable ground conditions,

d) Excavation and removal of unstable subgrade materials or other approved stabilization measures, if required prior to the placement of engineered fill,

e) Surveying of ground elevations prior to placing engineered fill,

f) Supply, placement, and compaction of approved clean earth as specified herein, with full time inspection and testing,

g) Surveying of ground elevations on completion of engineered fill placement,

h) Providing and maintaining survey lay out of areas to receive engineered fill, and monitoring of ground elevations throughout the construction of engineered fill.

1.02 The Contractor

A) The term Contractor shall refer to the individual or firm who will be carrying out the earthworks related to preparation and construction of engineered fill.

B) The Contractor must have the necessary experience for the project and have successfully completed projects of similar scope and size.

1.03 The Geotechnical Engineer

A) The term Geotechnical Engineer shall refer to the individual or firm who will be carrying out the full time inspection and testing of the earthworks related to preparation and construction of engineered fill.

B) The Geotechnical Engineer must have the necessary experience for the project and have successfully completed projects of similar scope and size.

1.04 The Design Civil Engineer

A) The term Design Civil Engineer shall refer to the individual or firm who will be carrying out the site grading design (pre-grading), the determination of design foundation grades for the buildings on the site, and the choice of lots and site areas to receive Engineered fill.

B) The Design Civil Engineer must have the necessary experience for the project and have successfully completed projects of similar scope and size.

PART 2 MATERIALS

2.01 Definitions

A) Topsoil Layer is the surface layer of naturally organic soil typically found at the ground surface and commonly with thickness on the order of 200 to 400 mm thick.

B) Earth fill is soil material which has been placed by man-made effort and has not been deposited by nature over a long period of time.

C) Subgrade soil is the “in situ” (in place) natural or native soil beneath any earth fill and/or topsoil layer(s).

D) Engineered fill soils should consist of clean earth materials (not excessively wet), free of organics and topsoil, free of deleterious materials such as building rubble, wood, plant materials, placed in thin lifts not exceeding 200 mm in thickness. Cohesionless soils such as sand or gravel, are the easiest to handle and compact.

E) All values stated in metric units shall be considered as accurate.

PART 3 ENGINEERED FILL DESIGN

3.01 Design Standard

A) The Geotechnical Engineer is responsible for providing a design that shall consider the external stability, internal stability, and local stability, including global stability, total and differential settlement.

B) Engineered fill can be expected to experience post-construction settlement on the order of 1 percent of the depth of the Engineered fill. The time period over which this settlement typically occurs, depends on the composition of the engineered fill as follows;

a) sand or gravel soil;	several days
b) silt soil;	several weeks
c) clay or clayey soil;	several months.

The placement of engineered fill might also result in post-construction settlement of the underlying natural soil.

The timing of foundation construction must take into account the post-construction settlement of the engineered fill and the foundation soil.

3.02 Design Foundation Pressure

A) Unless otherwise stated, the engineered fill is to be placed over the entire lot area or site area.

B) The engineered fill is to extend up to at least 1 m above the highest level of required foundation support. Typically this can be within 1 m of the design final grades. Additional common fill can be placed over the engineered fill to provide protection against environmental factors such as wind, frost, precipitation, and the like.

C) An allowable design foundation pressure of 150 kPa is typically recommended for the engineered fill. Foundations shall have minimum widths of 600 mm for continuous strip footings, and minimum dimensions of 900 mm for column footings.

D) At the foundation level, sufficient engineered fill shall be constructed to ensure that it extends at least 1.0 m laterally beyond the edge of any foundations, and that it extends outward within an area defined by a 1 to 1 line downward to the base of the engineered fill.

E) Foundations placed on the engineered fill must be provided with nominal reinforcing steel for stiffening of strip footing foundations and for protection against excessive minor cracking of the concrete strip footing foundations. The reinforcing steel must consist of 2-15M bars continuous at the top of the foundation wall, and 2-15M bars continuous at the bottom of the foundation walls.

F) At the time of foundation construction, foundation excavations must be reviewed by the Geotechnical Engineer to confirm suitable bearing capacity of the engineered fill. The Geotechnical Engineer must inspect the foundation subgrade immediately after excavation, and must inspect the foundation subgrade immediately prior to placement of concrete for footings. The Geotechnical Engineer must also inspect the placement of reinforcing steel in the foundation walls. Written approval must be obtained from the Geotechnical Engineer prior to,
   a) placement of footing concrete, and
   b) placement of foundation wall concrete.

PART 4 CONSTRUCTION

4.01 Survey Layout

A) The survey layout shall be carried out and maintained throughout the construction of engineered fill activities. A suitable layout stake shall be placed the corners of the start and finish of every block or work area to receive engineered fill.

B) At least two temporary survey elevation benchmarks shall be provided for every work area to receive engineered fill, to assist in monitoring the level of the engineered fill as it is constructed.

C) The ground elevations of the subgrade approved for receiving engineered fill shall be surveyed and recorded on a regular grid pattern. Engineered fill shall not be placed on any work area without the written approval of the Geotechnical Engineer.

D) The ground elevations of the engineered fill on each work area shall be surveyed and recorded on a regular grid pattern at the end of each day during the placement of engineered fill.

E) On completion of engineered fill construction, the final ground elevations shall be surveyed and recorded on a regular grid pattern.

4.02 Topsoil Stripping

A) The Geotechnical Engineer must observe the stripping of topsoil from the areas proposed for engineered fill, from start to finish.

B) Topsoil must be stripped from the entire building site area. The Geotechnical Engineer must photograph the work areas which have been suitably stripped.

4.03 Test Holes Into Subgrade

A) After topsoil has been stripped, the exposed subgrade must be investigated for the presence of old buried fill or deleterious material, which may be unsuitable for the support of engineered fill.

B) Exploratory test holes must be dug using a small backhoe, on a suitable pattern to obtain a representative indication of the entire site area.

C) The Geotechnical Engineer must observe the digging and backfilling of the test holes; must log the test hole stratigraphy; must obtain soil samples at maximum depth intervals of 0.3m; and must photograph each dug test hole.

D) If the test holes discover any old buried fill or deleterious materials, it must be excavated and removed from the lot area down to undisturbed, stable native soil.

E) All test holes must be properly backfilled and compacted in thin lifts (max. 150mm thickness) to at least 98 percent Standard Proctor Maximum Dry Density (SPMDD), at the optimum water content plus or minus 2 percent. The Geotechnical Engineer must observe the backfilling and compaction of the test holes.

4.04 Subgrade Proof-rolling

A) Prior to placing any engineered fill, the exposed subgrade must be proof-rolled using a heavy rubber-tired vehicle such as a loaded grader or dump truck. The Geotechnical Engineer must observe the proof-rolling.

B) If unstable subgrade conditions are encountered, the unstable subgrade must be sub-excavated. If wet site conditions exist during filling, stabilization with granular materials may be required.

4.05 Engineered fill Placement

A) Engineered fill must not be placed without the approval of the Geotechnical Engineer. Prior to placing any engineered fill, the topsoil must be stripped, the subgrade must be investigated for old buried fill or deleterious material, the subgrade must be proof-rolled, and the subgrade elevations must be surveyed.

B) Prior to the placement of engineered fill, the source or borrow area for the engineered fill must be evaluated for its suitability. Samples of the proposed fill material must be obtained by the Geotechnical Engineer and tested in the geotechnical laboratory for Standard Proctor Maximum Dry Density, prior to approval of the material for use as engineered fill. The engineered fill must consist of clean earth, free of organics and other deleterious material (wood, building debris, rubble, cobbles, boulders, and the like).

C) The engineered fill must be placed in maximum loose lift thicknesses of 200 mm. Each lift of engineered fill must be compacted with a heavy roller, to at least 98 percent Standard Proctor Maximum Dry Density (SPMDD), at the optimum water content plus or minus 2 percent.

D) Field density tests must be taken by the Geotechnical Engineer, on each lift of engineered fill, on each lot area. Any engineered fill which is tested and found to not meet the specifications, shall be either removed or reworked and retested.