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REPORT ON

Geotechnical Investigation
Proposed Residential Development
Riverside South Lands
River Road and Spratt Road
Ottawa, Ontario

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REPORT

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1.0 INTRODUCTION

This report presents the results of a geotechnical investigation carried out for a proposed residential development to be located on the Riverside South Lands (east of River Road and west of Spratt Road) in Ottawa, Ontario.

The purpose of this geotechnical investigation was to determine the general soil, groundwater, and bedrock conditions across the site by means of 35 boreholes. Based on an interpretation of the factual information obtained, engineering guidelines are provided on the geotechnical design aspects of the project, including construction considerations which could affect design decisions.

The results of the environmental sampling and testing program are provided separately in the Phase II Environmental Site Assessment report for this project.

The reader is referred to the “Important Information and Limitations of This Report” which follows the text but forms an integral part of this document.

2.0 DESCRIPTION OF PROJECT AND SITE

Plans are being prepared to develop a proposed residential development within the Riverside South Lands which is located east of River Road and west of Spratt Road in Ottawa, Ontario (see Key Plan inset, Figure 1).

The following is known about the project and site.

- The western boundary of the site is located east of River Road, approximately 400 metres north of the intersection with Rideau Road. The eastern boundary of the site is located west of Spratt Road, approximately 845 metres north of the intersection with Rideau Road.
- The site is irregular in shape, with the southwestern portion adjacent to River Road measuring approximately 390 metres by 420 metres and the northern portion measuring about 200 metres by 1,110 metres.
- The site topography is relatively flat with a gentle downward slope from east to west (i.e., towards the Rideau River).
- The majority of the site is currently undeveloped and predominately consists of agricultural land with localized vegetation and trees.
- It is understood that the proposed development will include conventional residential dwellings (single family homes and townhouses) as well as access roads and services within the subdivision. A park and institutional development are also proposed for the site.

Golder Associates has completed several geotechnical investigations within or in the vicinity of this site, including an investigation that was carried out in 2007 for the City of Ottawa for the overall planning of the Riverside South Community.

Based on a review of those previous studies and published geological mapping, the subsurface conditions on the site likely consist of a thick deposit of sensitive and compressible silty clay; the silty clay is expected to thin towards the northeast portion of the site, adjacent to Spratt Road, where glacial till and potentially bedrock is expected at shallow depths. The bedrock surface is expected to be at depths ranging from about 5 to 15 metres, sloping down from the east to the west across the site. Based on published geological mapping, the bedrock on the site should consist of March Formation sandstone and Oxford Formation dolostone on the northeast and southwest parts of the site, respectively. The bedrock formations are divided by the Hazeldean Fault, which crosses the site on a northwest to southeast trend.

3.0 PROCEDURE

The fieldwork for this investigation was carried out between January 5 and 26, 2017. At that time, 35 boreholes (numbered 17-1 to 17-35, inclusive) were put down at the approximate locations shown on the Site Plan, Figure 1.

The boreholes were advanced to sampled depths ranging from about 2.1 to 8.2 metres below the existing ground surface. Upon reaching practical refusal to augering in boreholes 17-2, 17-23, and 17-27, boreholes 17-2A, 17-23A, and 17-27A were advanced adjacent to boreholes 17-2, 17-23, and 17-27 for dynamic cone penetration testing to depths of about 7.9, 4.3, and 3.4 metres, respectively. Upon reaching practical refusal to augering in boreholes 17-22 and 17-28, the boreholes were then advanced to depths of about 6.4 and 3.2 metres, respectively, using dynamic cone penetration testing.

Upon reaching practical refusal to augering at a depth of about 3.3 metres below the existing ground surface, borehole 17-27 was advanced an additional 3.3 metres into the bedrock using rotary diamond drilling techniques while retrieving NQ sized bedrock core.

The boreholes were advanced using a track-mounted continuous flight hollow-stem auger drill rig, supplied and operated by CCC Geotechnical and Environmental Drilling of Ottawa, Ontario.

Standard Penetration Tests (SPT) were carried out in the boreholes at regular intervals of depth and samples of the soils encountered were recovered using drive open sampling equipment. In situ vane testing was carried out where possible in the cohesive deposits to determine the undrained shear strength of these soils. In addition, boreholes 17-10A, 17-12A, 17-14A, 17-17A, 17-18A, and 17-24A were advanced adjacent to boreholes 17-10, 17-12, 17-14, 17-17, 17-18, and 17-24 to retrieve relatively undisturbed 73 millimetre diameter thin walled Shelby tube samples of the silty clay using a fixed piston sampler.

Standpipe piezometers or monitoring wells were sealed into boreholes 17-1, 17-3, 17-9, 17-14A, 17-18A, 17-21, 17-24A, 17-27, 17-28, 17-29, 17-30, and 17-31 to allow subsequent measurement of the groundwater level across the site as well as groundwater sampling and analytical testing to support the Phase II Environmental Site Assessment. The groundwater levels in these standpipe piezometers were measured on January 30, 2017.

The fieldwork was supervised by an experienced technician from our staff who located the boreholes, directed the drilling operations and in situ testing, logged the boreholes, and took custody of the soil samples retrieved.

Upon completion of the drilling operations, samples of the soils and bedrock encountered in the boreholes were transported to our laboratory for further examination by the project engineer and for laboratory testing. The laboratory testing included natural water content determinations, Atterberg limit tests, grain size distribution tests, and oedometer consolidation testing.

Soil samples from boreholes 17-9 and 17-20 were submitted to Eurofins Environment Testing for basic chemical analysis related to potential sulphate attack on buried concrete elements and corrosion of buried ferrous elements.

The borehole locations were selected, picketed, and surveyed in the field by Golder Associates Ltd. The borehole locations and elevations were surveyed using a Trimble R8 Global Positioning System (GPS) unit. The elevations are referenced to Geodetic datum.

4.0 SUBSURFACE CONDITIONS

4.1 General

Information on the subsurface conditions is provided as follows:

- The Record of Borehole and Drillhole Sheets are provided in Appendix A.
- The results of the basic chemical analysis carried out on soil samples from boreholes 17-9 and 17-20 are provided in Appendix B.
- Oedometer consolidation test results are provided on Figures 3 to 5.
- Grain size distribution testing results are provided on Figures 2, 6, and 7.

In general, the subsurface conditions across this site consist of surficial layers of topsoil, fill, and silty sand. The surficial soils across the majority of the site are underlain by a deposit of weathered silty clay, clayey silt, and silty sand, which is underlain by unweathered silty clay and/or glacial till. Shallow bedrock (i.e. at a depth of about 3 metres depth) was encountered at the east end of the site, adjacent to Spratt Road.

The following sections present a more detailed overview of the subsurface conditions encountered in the boreholes at the site.

4.2 Topsoil and Fill

Topsoil exists at the ground surface, or buried beneath the surficial fill, at most of the borehole locations, and typically ranges from about 60 to 300 millimetres in thickness. Fill (some of which is topsoil) exists at boreholes 17-7, 17-8, 17-29, 17-30, 17-31, 17-32, 17-33, and 17-35. The fill layers extend to depths of between about 0.1 to 1.1 metres below the existing ground surface. The fill consists of topsoil, asphaltic concrete, sand, sandy gravel, silty sand, silty clay, and/or sand and gravel.

4.3 Upper Sands and Silts

A deposit of sandy silt, sand, or silty sand with varying amounts of gravel exists below the topsoil and/or fill in boreholes 17-2, 17-8, 17-9, 17-10, 17-12 to 17-16, 17-20, 17-21, 17-29, and 17-35. The deposit generally extends to depths ranging from about 0.4 to 1.3 metres below the existing ground surface, with the exception of borehole 17-21 where it extends to a depth of about 3.5 metre below the existing ground surface.

The results of standard penetration tests measured within the deposit gave SPT ‘N’ values ranging from 7 to greater than 50 blows per 0.3 metres of penetration, indicating a loose to very dense state of packing.

The measured natural water content of three samples of the deposit were about 6, 11, and 23 percent.

The results of grain size distribution testing carried out on one sample of the silty sand are provided on Figure 2.

4.4 Layered Silt, Clayey Silt, and Silty Sand

A deposit of layered silt, clayey silt, and silty sand exists below the topsoil in boreholes 17-3, 17-4, and 17-5. The layered deposit generally extends to depths ranging from about 1.4 to 2.0 metres below the existing ground surface.

The results of standard penetration tests measured within this layered deposit gave SPT ‘N’ values ranging from about 3 to 6 blows per 0.3 metres of penetration, indicating a very loose to loose state of packing.

The measured natural water content of one sample of this deposit was about 25 percent.

4.5 Weathered Silty Clay, Clayey Silt, and Silty Sand

Deposits of silty clay to clay and/or layered silty clay, clayey silt, and silty sand exists in all of the boreholes, with the exception of boreholes 17-20 and 17-21. These deposits have been weathered to a grey brown colour. These weathered deposits extend to depths of about 1.8 to 5.8 metres below the existing ground surface.

The results of standard penetration tests within these deposits measured SPT ‘N’ values ranging from 1 to 8 blows per 0.3 metres of penetration. The results of in situ vane testing in these deposits measured undrained shear strength values generally ranging from about 77 to greater than 96 kilopascals. The results of the in situ testing indicates these deposits to have a stiff to very stiff consistency.

The results of Atterberg limit testing carried out on three samples from the weathered deposits gave plasticity index values of about 29, 39, and 57 percent and liquid limit values of about 49, 59, and 77 percent, indicating a soil of intermediate to high plasticity. The measured natural water content measured on samples from these deposits ranged from about 28 to 65 percent.

4.6 Unweathered Silty Clay to Clay

The silty clay deposit below the depth of weathering in boreholes 17-5, 17-6, 17-8 to 17-19, 17-23, 17-24, and 17-26 is unweathered and grey in colour. The unweathered silty clay was fully penetrated to depth of about 3.8 to 6.3 metres below the existing ground surface at borehole 17-5, 17-6, 17-11, 17-19, 17-23, 17-24, and 17-26, where the thickness of the deposit ranges from about 0.3 to 3.2 metre. The unweathered silty clay was not fully penetrated in the remaining boreholes but was proven to depths ranging from about 5.8 to 7.9 metres below the existing ground surface.

The results of in situ vane testing in the deposit measured undrained shear strength values generally ranging from about 31 to 90 kilopascals, indicating a firm to stiff consistency

The results of Atterberg limit tests carried out on three sample of the unweathered deposit gave plasticity index values of about 24, 28, and 36 percent and liquid limit values ranging from 42, 47, and 57 percent, indicating a soil of intermediate to high plasticity. The measured natural water content measured in the unweathered silty clay ranges from about 33 to 63 percent.

Oedometer consolidation testing was carried out on three Shelby tube samples of the unweathered clay from boreholes 17-12A, 17-18A, and 17-24A. The results of this testing are provided on Figures 3 to 5, and are also summarized below.

Borehole/Sample Number	**Sample Depth/Elevation (m)**	**σ_o' (kPa)**	**σ_P' (kPa)**	**C_c**	**C_r**	**e_o**	**OCR**
17-12A / 1	4.8 / 85.0	60	150	0.97	0.008	1.47	2.5
17-18A / 1	4.1 / 86.6	35	155	0.39	0.006	1.01	4.4
17-24A / 1	3.4 / 89.2	35	180	1.03	0.004	1.46	5.1

Notes:
σ_o' - Initial effective stress
C_c - Compression index
e_o - Initial void ratio
σ_P' - Apparent preconsolidation pressure
C_r - Recompression index
OCR - Overconsolidation Ratio

4.7 Lower Sand to Gravelly Silty Sand

A deposit of sand to gravelly silty sand exists below the weathered silty clay in boreholes 17-26, 17-27, and 17-28. This deposit was proven/inferred to depths of about 5.5 and 3.2 metres below the existing ground surface, at boreholes 17-26 and 17-28, respectively, and fully penetrated to a depth of about 3.3 metres below the existing ground surface at borehole 17-27. The deposit also contains cobbles and boulders.

The results of standard penetration tests measured within this deposit gave SPT ‘N’ values ranging from 8 to greater than 50 blows per 0.3 metres of penetration, indicating a loose to very dense state of packing. However, the higher ‘N’ values likely reflect the presence of cobbles and boulders within the deposit, rather than the actual state of packing of the soil matrix.

The measured natural water content of two samples from this deposit were about 21 and 30 percent. The results of grain size distribution testing carried out on one sample of the gravelly silty sand are provided on Figure 6.

4.8 Glacial Till

A deposit of glacial till exists below the silty clay in boreholes 17-1, 17-3 to 17-7, 17-11, 17-19, 17-22, 17-24, and 17-25, and below the silty sand in boreholes 17-20 and 17-21. Glacial till was also inferred in borehole 17-2A below the silty clay and in borehole 17-22 below the upper portion of the glacial till based on the results of the dynamic cone penetration testing. The glacial till generally consists of a heterogeneous mixture of gravel, cobbles, and boulders in a matrix of silty sand to sandy silt. The glacial till was encountered at depths ranging from about 0.9 to 6.3 metres below the existing ground surface, and proven to extend to depths ranging from about 4.2 to 8.2 metres below the existing ground surface.

The results of standard penetration tests measured within the glacial till gave SPT ‘N’ values ranging from 3 to greater than 50 blows per 0.3 metres of penetration, but more generally ranging from 10 to 30 blows, indicating a compact state of packing. In addition, the higher ‘N’ values likely reflect the presence of cobbles and boulders within the glacial till, rather than the actual state of packing of the soil matrix.

The measured natural water content of samples obtained from this deposit ranged from about 6 to 15 percent. The results of grain size distribution testing carried out on two samples from the deposit of the glacial till are shown on Figure 7.

4.9 Silty Sand and Gravel

A layer deposit of silty sand and gravel was encountered below the glacial till in boreholes 17-20 and 17-21. This layered deposit was not fully penetrated at the borehole locations, but was proven to depths of about 6.1 and 7.9 metres, respectively, below the existing ground surface.

The results of two standard penetration tests measured within this layered deposit gave SPT ‘N’ values of 15 blows per 0.3 metres of penetration, indicating a compact state of packing.

The measured natural water content of one sample of the silty sand and gravel deposit was about 18 percent.

4.10 Refusal and Bedrock

Practical refusal to auger advancement was encountered at boreholes 17-1, 17-2, 17-4, 17-23, 17-24, 17-25, and 17-26 at depths ranging from about 3.8 to 6.7 metres below the existing ground surface. Refusal to dynamic cone penetration test advancement was encountered in boreholes 17-23A, 17-27A, and 17-28 at depths between about 3.2 and 4.3 metres below the existing ground surface. Refusal could indicate the bedrock surface or may reflect the presence of cobbles and boulders in the glacial till deposit.

In borehole 17-27, the bedrock was encountered below the overburden soils at a depth of about 3.3 metres below the existing ground surface, where it was cored for a depth of about 3.3 metres (i.e., to a total depth of about 6.6 metres below the existing ground surface).

The bedrock encountered consists of fresh, thinly to medium bedded, grey, fine grained limestone. The Rock Quality Designation (RQD) values measured on the recovered bedrock core were 62 and 100 percent, indicating fair to excellent quality rock.

4.11 Groundwater

The groundwater levels within the groundwater monitoring devices installed in boreholes 17-1, 17-3, 17-9, 17-14A, 17-18A, 17-21, 17-24A, 17-27, 17-28, 17-29, 17-30, and 17-31 were measured on January 30, 2017. The observed groundwater levels are summarized in the table below:

Borehole Number	Soil Strata	Ground Surface Elevation (m)	Water Level Depth (m)	Water Level Elevation (m)
17-1	Glacial Till	90.0	0.4	89.6
17-3	Glacial Till	91.1	1.3	89.8
17-9	Silty Clay	90.3	0.2	90.1
17-14A	Silty Clay	90.5	0.7	89.8
17-18A	Silty Clay	90.7	0.3	90.4
17-21	Silty Sand	94.7	2.5	92.2
17-24A	Silty Clay	92.6	0.8	91.8
17-27	Bedrock	93.9	0.8	93.1
17-28	Gravelly Silty Sand	94.0	0.3	93.7
17-29	Silty Clay	90.2	0.7	89.5
17-30	Silty Clay	90.0	0.6	89.4
17-31	Silty Clay	90.1	0.7	89.4

It should be noted that groundwater levels are expected to fluctuate seasonally. Higher groundwater levels are expected during wet periods of the year, such as spring.

5.0 DISCUSSION

5.1 General

This section of the report provides engineering guidelines on the geotechnical design aspects of this project based on our interpretation of the borehole information as well as the project requirements, and is subject to the limitations in the "Important Information and Limitations of This Report" which follows the text of this report.

5.2 Site Grading

Based on the subsurface conditions encountered and the soil strengths determined within the boreholes, the site has been divided into two "assessment areas", Area A and Area B. The boundaries of the assessment areas are shown on the Site Plan, Figure 1.

The subsurface conditions in Assessment Area A generally consist of topsoil/fill underlain low compressibility layered silt, silty clay, clayey silt, and silty sand overlying glacial till or topsoil underlain by silty sand and glacial till. The subsurface conditions in Assessment Area B generally consist of topsoil/fill underlain weathered silty clay, clayey silt, and silty sand, overlying a deposit of unweathered and potentially compressible silty clay to clay underlain by glacial till.

For Area A, there is no practical limitation on the amount of grade raise fill which can be placed in this area from a geotechnical point of view.

The "softer" unweathered silty clay in Area B has limited capacity to accept additional load from the weight of grade raise fill and from the foundations of houses without undergoing consolidation settlements. Therefore, for this area, to leave sufficient remaining capacity for the silty clay to support house foundations, with reasonable footing sizes, the thicknesses of grade raise fill will need to be limited.

The following table provides the maximum grade raises which are permitted for each of the assessment areas indicated on Figure 1. These grade raise limitations have been assessed based on leaving sufficient remaining capacity in the silty clay deposit such that strip footings up to 0.6 metres in size can be designed using an allowable bearing pressure of at least 75 kilopascals, consistent with design in accordance with Part 9 of the Ontario Building Code.

Assessment Area	**Maximum Permissible Grade Raise (metres)**
A*	No Limitation
B	2.4

Note: * There are no practical grade raise restrictions in Area A, however, grade raises of more than 4 metres would require additional review.

It should also be noted that the maximum permissible grade raise in Area B was calculated assuming that any fill required for site grading (above the original grade) and the backfill within the garages and porches would have a unit weight of no more than 19.5 kilonewtons per cubic metre. Silty clay, clayey silt, and silty sand (such as present on this site), as well as crushed clear stone and uniform fine sand (for the garage and porch backfill) may be suitable for this purpose. Silty sand and gravel, gravelly silty sand, glacial till, and crushed stone typically have a higher unit weight and, if these materials are to be used, the maximum permissible grade raises would be reduced and would need to be re-evaluated. However, there are no restrictions with regards to the unit weight for site grading and garage backfill materials in Area A (i.e., silty sand and gravel, gravelly silty sand, glacial till and crushed stone would be acceptable in this area).

If the grading restrictions given above cannot be accommodated, then further recommendations from Golder Associates could be provided, if and when they are required.

In addition, with regards to site grading, the surficial sand and silt deposits which were encountered across the site are relatively permeable and the measured groundwater levels are relatively shallow (i.e., about 0.2 metres below the ground surface). Excavations for basement construction which extend below the groundwater level could therefore encounter groundwater inflows. Limiting the required depth of excavation into these materials could be advantageous as it would reduce the groundwater management requirements (and costs).

As a general guideline regarding the site grading, the preparation for filling of the site should include stripping the topsoil and fill for predictable performance of structures and services. The topsoil is not suitable as engineered fill and should be stockpiled separately for re-use in landscaping applications only. In areas with no proposed structures, services, or roadways, the topsoil may be left in place provided some settlement of the ground surface following filling can be tolerated.

5.3 Foundations

It is considered that the proposed residences may be supported on spread footings founded at conventional depth on or within the native overburden materials.

As discussed in the preceding section, the silty clay deposits have limited capacity to accept the combined load from site grading fill and foundation loads. The allowable bearing pressures for spread footing foundations in Area B are therefore based on limiting the stress increases on the firm, compressible, grey silty clay at depth to an acceptable level so that foundation settlements do not become excessive. Four important parameters in calculating the stress increase on the grey silty clay are:

- The thickness of soil below the underside of the footings and above the unweathered silty clay;
- The size (dimensions) of the footings;
- The amount of surcharge in the vicinity of the foundations due to landscape fill, underslab fill, floor loads, etc., as described in Section 5.2; and,
- The effects of groundwater lowering caused by this or other construction.

Provided that the grade raises are restricted to those indicated in Section 5.2, strip footing foundations up to 0.6 metres in width and pad footings up to 2.0 metres square can be designed using a maximum allowable bearing pressure of 75 kilopascals. As such, the house footings may be sized in accordance with Part 9 of the Ontario Building Code (OBC).

This same maximum allowable bearing pressure can be used for houses in Area A, but without restrictions on footing sizes.

The post construction total and differential settlements of footings sized using the above maximum allowable bearing pressure should be less than about 25 and 15 millimetres, respectively, provided that the subgrade at or below founding level is not disturbed during construction.

The tolerance of the house foundations to accept those settlements could be increased by providing nominal levels of reinforcing steel in the top and bottom of the foundation walls.

Further, the provided maximum allowable bearing pressure for footings founded within the silty clay correspond to settlement resulting from consolidation of these deposits. Consolidation of the silty clay is a process which takes months or longer and, as such, results from sustained loading. Therefore, the foundation loads to be used in conjunction with the allowable bearing pressure should be the full dead load plus sustained live load.

If any existing ditches are found to underlie future houses, these ditches will need to be filled. The ditches should be dry and cleaned of all organic or disturbed soil prior to filling. The ditches should be lined with a Class II non-woven geotextile with a Filtration Opening Size (FOS) not exceeding 100 microns, in accordance with Ontario Provincial Standard Specification (OPSS) 1860. Filling to the underside of footing elevation should be carried out using engineered fill consisting of OPSS Granular B Type II (or similar approved material), placed in maximum 300-millimetre thick lifts, and compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable vibratory compaction equipment. The engineered fill should extend out and down from the outside edge of the footings at a slope not steeper than 1 horizontal to 1 vertical. Footings founded on or within properly placed engineered fill (as described above) can also be designed using a maximum allowable bearing pressure of 75 kilopascals.

If the proposed grading results in some of the footing levels being above the surface of the native inorganic subgrade soil (following removal of the topsoil and any surficial fill materials), the engineered fill guidelines provided above should similarly be followed.

There may be portions of the site where the surficial sand and silt deposits will be exposed at footing/subgrade level. Prior to construction of footings or the placement of engineered fill within these areas, the surface of the native sandy material should be proof-rolled to provide surficial densification of any loose or disturbed material (which may require pre-drainage of these thin surficial layers).

The glacial till contains boulders which may be encountered when excavating to founding level. If those boulders extend below founding level and are dislodged by the excavator, the soils around the boulders will have become disturbed. In that case, the boulders will need to be fully removed (and not pushed back in place) and the void filled with concrete. Otherwise, recompression of the disturbed soils could lead to larger than expected post-construction settlements.

5.4 Frost Protection

All exterior perimeter foundation elements or foundation elements in unheated areas should be provided with a minimum of 1.5 metres of earth cover for frost protection purposes. Isolated and/or unheated exterior footings adjacent to surfaces which are cleared of snow cover during winter months should be provided with a minimum of 1.8 metres of earth cover.

Insulating the bearing surface with high density insulation could be considered as an alternative to earth cover for frost protection. Further details could be provide if required.

5.5 Seismic Design

The seismic design provisions of the 2012 OBC depend, in part, on the shear wave velocity of the upper 30 metres of soil and/or bedrock below founding level. The OBC also permits the Site Class to be specified based solely on the stratigraphy and in situ testing data, rather than from direct measurement of the shear wave velocity. Based on this methodology, it is considered that for the design of low-rise structures, a Site Class of D would be applicable for the development, with the exception of the houses in the area of borehole 17-12 where a Site Class E would be applicable (using the available information). Geophysical measurement of the shear wave velocity for the upper 30 metres of soil and/or bedrock below founding level in the area of borehole 17-12 would allow for a more accurate seismic Site Class to be specified, and to help assess whether a more favourable Site Class value could be assigned to this area.

It should be noted that the seismic Site Class is not directly applicable to structures designed in accordance with Part 9 of the OBC (i.e., conventional housing), however this assessment is provided to address City of Ottawa requirements that relate to housing on Site Class E sites.

5.6 Basement Excavations

Excavations for basements will be through the topsoil, fill, sands, silts and clays, as well as the underlying glacial till (where the till surface is shallow). No unusual problems are anticipated with excavating the overburden soils using conventional hydraulic excavating equipment.

Side slopes in the clayey overburden materials should be stable in the short term at 1 horizontal to 1 vertical in accordance with the Occupational Health and Safety Act (OHSA) of Ontario for Type 3 soils. However, if the water table is encountered within the excavations, the sandy and silty layers would be considered as Type 4 soils and side slopes of 3 horizontal to 1 vertical will be required.

Based on *present* groundwater levels, excavations deeper than about 0.2 metres may, in some areas, extend below the groundwater level. Where this is the case and the excavation encounters the relatively more permeable sandy soils, the excavation subgrade will be subject to time dependent disturbance caused by the upward flow of groundwater, resulting in possible disturbance of the excavation subgrade and potential instability of the excavation side slopes. However, considering the limited thickness of these deposits, it is considered that, for conventional excavation depths for basement construction, it should generally be possible to handle the groundwater inflow by pumping from well filtered sumps in the floor of the excavations. Where the subgrade is found to be wet and sensitive to disturbance, consideration should be given to placing a 150 millimetre thick layer of OPSS Granular A (following inspection and approval by geotechnical personnel) underlain by a non-woven geotextile or a mud slab of lean concrete, to protect the subgrade from construction traffic.

In these areas (of excavation below the groundwater level in sandy soils), some pre-drainage of the site using ditching or one or more shallow wells to lower the groundwater level to at least 0.5 metres below the floor of the excavation would assist in avoiding subgrade disturbance.

5.7 Basement and Garage Floor Slabs

In preparation for the construction of the basement floor slabs, all loose, wet, and disturbed materials should be removed from beneath the floor slabs. Provision should be made for at least 200 millimetres of 19 millimetre crushed clear stone to form the base of the basement floor slabs.

To prevent hydrostatic pressure build up beneath the basement floor slabs, it is suggested that the granular base material be positively drained. This could be achieved by providing a hydraulic link between the underslab fill material and the exterior drainage system.

The general groundwater level at this site is within about 0.2 metres of the existing ground surface (at least on portions of the site). The surficial sandy soils at this site are permeable and therefore, if/where the groundwater level is encountered above basement subgrade level in these soil conditions, a geotextile could be required between the clear stone underslab fill and the sandy subgrade soils, to avoid loss of fine soil particles from the subgrade soil into the voids in the clear stone and ultimately into the drainage system. In the extreme case, loss of fines into the clear stone could cause ground loss beneath the slab and plugging of the drainage system. Where a geotextile is required, it should consist of a Class II non-woven geotextile with a FOS not exceeding 100 microns, in accordance with OPSS 1860.

The backfill material inside the garages and porches in Area B should have a unit weight of no greater than 19.5 kilonewtons per cubic metre (i.e., uniform fine sand or clear crushed stone). Note: there is no restriction on the unit weight of the backfill materials in Area A. The garage backfill should be placed in maximum 300 millimetre thick lifts and be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable compaction equipment. The granular base for the garage floor slab should consist of at least 150 millimetres of OPSS Granular A compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable compaction equipment.

5.8 Basement Wall and Foundation Wall Backfill

The soils at this site are frost susceptible and should not be used as backfill directly against exterior, unheated, or well insulated foundation elements. To avoid problems with frost adhesion and heaving, a bond break such as Platon system sheeting should be placed against the foundation walls.

Drainage of the wall backfill should be provided by means of a perforated pipe subdrain in a surround of 19 millimetre clear stone, fully wrapped in geotextile, which leads by gravity drainage to an adjacent storm sewer or sump pit. Conventional damp proofing of the basement walls is appropriate with the above design approach.

Should the foundations be designed in accordance with Part 4 of the Ontario Building Code, further guidelines on the foundation wall design will need to be provided.

5.9 Site Servicing

Excavations for the installation of site services will be made through the topsoil, fill, layered sands, silts and clays, as well as the glacial till, and possibly into the underlying bedrock (particularly in the eastern portion of the site adjacent to Spratt Road). No unusual problems are anticipated with excavating the overburden using conventional hydraulic excavating equipment. However, it should be expected that boulders will be encountered within the glacial till and gravelly silty sand deposits. Boulders larger than 0.3 metres in size should be removed from the excavation side slopes for worker safety.

Bedrock removal could be accomplished using mechanical methods (such as hoe ramming) for shallow excavation depths. However, deeper excavations will likely require drill and blast procedures, as hoe ramming would be slow and inefficient.

In accordance with the OHSA of Ontario, the overburden soils above the water table would generally be classified as Type 3 soils, and side slopes in the overburden in the short term may be sloped at 1 horizontal to 1 vertical. Excavation side slopes below the groundwater level in the sandier overburden soils would need to be cut back at 3 horizontal to 1 vertical (i.e., Type 4 soils). Alternatively, excavations within the overburden could also be carried out within a fully braced steel trench box, which would minimize the width of the excavation.

Stockpiling of soil beside the excavations made in the silty clay should be avoided; the weight of the stock piled soil could lead to basal instability of braced excavations or slope instability for unsupported excavations.

Near-vertical excavation side slopes in the bedrock should be feasible, at least for shallow depths of excavation (e.g., less than about 3 metres depth). The stability of deeper excavations would need further assessment.

Blasting should be controlled to limit the peak particle velocities at all adjacent structures or services (such as may be created by the development phasing) such that blast induced damage will be avoided. Blast designs should be prepared by a specialist in this field.

A pre-blast survey should be carried out of all the surrounding structures and utilities.

The contractor should be required to submit a complete and detailed blasting design and monitoring proposal prepared by a blasting/vibrations specialist prior to commencing blasting. This submission would have to be reviewed and accepted in relation to the requirements of the blasting specifications.

The contractor should be limited to only small controlled shots. The following frequency dependent peak vibration limits at the nearest structures and services are suggested.

Frequency Range (Hz)	**Vibration Limits (mm/sec)**
< 10	5
10 to 40	5 to 50 (sliding scale)
> 40	50

It is recommended that the monitoring of ground vibration intensities (peak ground vibrations and accelerations) from the blasting operations be carried out both in the ground adjacent to the closest structures/utilities and within the structures/utilities themselves.

Some groundwater inflow into the excavations should be expected. However, it should generally be possible to handle the groundwater inflow by pumping from well filtered sumps in the excavations provided suitably sized pumps are used. Somewhat higher rates of groundwater inflow could be expected where the excavation extends into/through deep sandy layers such as were encountered at boreholes 17-21, 17-26, 17-27, and 17-28 on the eastern portion of the site. In these areas, active dewatering of the sandy layers in advance of excavation could be necessary, such as by pumping from shallow wells. However, the need for such measures will depend on the design invert levels of the sewers. This issue should be reviewed further once the design sewer levels are known. Consideration should also be given to carrying out a test excavation at the bidding stage so that the contractors can directly view the groundwater flow conditions.

The hydraulic conductivity of the bedrock is also not known, but trenches in the bedrock could also potentially encounter significant groundwater inflow. The bedrock formations which are mapped to underlie this site are known to often have a very high hydraulic conductivity. A significant fault is also mapped to cross this site. If trenches into the bedrock will be required, further investigation to evaluate the bedrock hydraulic conductivity should be considered.

The actual rate of groundwater inflow to the trenches will depend on many factors including the contractor's schedule and rate of excavation, the size of the excavation, and the time of year at which the excavation is made. There also may be instances where significant volumes of precipitation and/or groundwater collects in an open excavation, and must be pumped out. According to Ontario Regulation 63/16 and Ontario Regulation 387/04, a Permit to Take Water (PTTW) is required from the Ministry of the Environment and Climate Change (MOECC) if a volume of water greater than 400,000 Litres/day is pumped from the excavations. If the volume of water to be pumped will be less than 400,000 Litres/day, but more than 50,000 Litres/day, the water taking will not require a PTTW, but will need to be registered in the Environmental Activity and Sector Registry (EASR) as a prescribed activity. The anticipated dewatering rate should be confirmed once more details about the site servicing are known to determine if either a PTTW or EASR is required for this site.

At least 150 millimetres of OPSS Granular A should be used as pipe bedding for sewer and water pipes (or 300 millimetres where the trench is in bedrock). Where unavoidable disturbance to the subgrade surface does occur, it may be necessary to place a sub-bedding layer consisting of compacted OPSS Granular B Type II beneath the Granular A or to thicken the Granular A bedding. Where the sewers will likely be installed directly in the unweathered silty clay, it is likely that additional bedding thickness (e.g., 300 millimetres) will be required. The bedding material should, in all cases, extend to the spring line of the pipe and should be compacted to at least 95 percent of the material’s standard Proctor maximum dry density. The use of crushed clear stone as a bedding layer should not be permitted anywhere on this project since fine particles from the sandy backfill materials or sandy soils on the trench walls could potentially migrate into the voids in the clear crushed stone and cause loss of lateral pipe support.

Cover material, from spring line of the pipe to at least 300 millimetres above the top of pipe, should consist of OPSS Granular A or Granular B Type I with a maximum particle size of 25 millimetres. The cover material should be compacted to at least 95 percent of the material’s standard Proctor maximum dry density.

It should generally be possible to re-use the drier silty clay, clayey silt, sandy silt, silty sand, and glacial till as trench backfill. Boulders larger than 300 millimetres in diameter should be removed from the overburden materials.

However, the high moisture content of the unweathered clayey and silty soils makes these soils difficult to handle and compact. If these materials are excavated during installation of the site services, they should be wasted or should only be used as backfill in the lower portion of the trenches to limit the amount of long term settlement of the roadway surface. If the unweathered silty and clayey materials are used in trenches under roadways, long term settlement of the pavement surface should be expected. Some significant padding of the roadways may be required prior to final paving. In that case, it would also be prudent to delay final paving for as long as practical.

Well fractured or well broken bedrock will be acceptable as backfill for the lower portion of the service trenches in areas where the excavation is in rock. The rock fill, however, should only be placed from at least 300 millimetres above the pipes to minimize damage due to impact or point load. The rock fill should be limited to a maximum of 300 millimetres in size.

Where the trench will be covered with hard surfaced areas, the type of native material placed in the frost zone (between subgrade level and 1.8 metres depth) should match the soil exposed on the trench walls for frost heave compatibility. Trench backfill should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the material’s standard Proctor maximum dry density using suitable compaction equipment.

Impervious dykes or cut-offs should be constructed at 100 metre intervals in the service trenches to reduce groundwater lowering at the site due to the “french drain” effect of the granular bedding and surround for the service pipes. It is important that these barriers extend from trench wall to trench wall and that they fully penetrate the granular materials to the trench bottom. The dykes should be at least 1.5 metres wide and could be constructed using relatively dry (i.e., compactable) grey brown silty clay from the weathered zone.

5.10 Pavement Design

In preparation for pavement construction, all topsoil, fill, disturbed, or otherwise deleterious materials (i.e., those materials containing organic material) should be removed from the roadway areas.

Pavement areas requiring grade raising to proposed subgrade level should be filled using acceptable OPSS Select Subgrade Material (SSM). The SSM should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable compaction equipment.

The surface of the pavement subgrade should be crowned to promote drainage of the roadway granular structure. Perforated pipe sub-drains should be provided at subgrade level extending from the catch basins for a distance of at least 3 metres longitudinally, parallel to the curb in two directions.

The pavement structure for local roads without bus or truck traffic should consist of:

Pavement Component	Thickness (millimetres)
Asphaltic Concrete	90
OPSS Granular A Base	150
OPSS Granular B Type II Subbase	375

The pavement structure for collector roadways which will include bus and truck traffic should consist of:

Pavement Component	Thickness (millimetres)
Asphaltic Concrete	90
OPSS Granular A Base	150
OPSS Granular B Type II Subbase	450

For arterial roadways, the subbase thickness should be increased to 600 millimetres.

The granular base and subbase materials should be uniformly compacted as per OPSS 501, Method A. The asphaltic concrete should be compacted in accordance with the procedures outlined in OPSS 310

The composition of the asphaltic concrete pavement should be as follows:

■ Superpave 12.5 mm Surface Course	40 millimetres
■ Superpave 19 mm Base Course	50 millimetres

The asphaltic cement should consist of PG 58-34 and the design of the mixes should be based on a Traffic Category B for local roads and Category D for collector roads.

The above pavement designs are based on the assumption that the pavement subgrade has been acceptably prepared (i.e., where the trench backfill and grade raise fill have been adequately compacted to the required density and the subgrade surface not disturbed by construction operations or precipitation). Depending on the actual conditions of the pavement subgrade at the time of construction, it could be necessary to increase the thickness of the subbase and/or to place a woven geotextile beneath the granular materials.

5.11 Pools, Decks and Additions

The following guidelines are provided to address some typical requirements of the City of Ottawa.

5.11.1 Above Ground and In Ground Pools

There are no restrictions for above ground pools in Area A.

For Area B, no special geotechnical considerations are necessary for the installation of in-ground pools, provided that the pool (including piping) does not extend deeper than the house footing level. A geotechnical assessment will be required if the pool extends deeper than the house foundations.

For Area B, due to the additional loads that would be imposed by the construction of *above-ground pools*, these should be located no closer than 2 metres from the outside wall of the house. In addition, the installation of an above-ground pool should not be permitted to alter the existing grades within 2 metres of the house. Provided these restrictions are adhered to, no further geotechnical assessment should be required for above-ground pools.

5.11.2 Decks

For Area A, no special geotechnical considerations area necessary for decks.

For Area B, a geotechnical evaluation/assessment will be necessary for future decks that:

- are attached to the house;
- require changes to the existing grades; or,
- are heavily loaded and require spread footing or drilled pier foundations.

The geotechnical evaluation must consider the proposed grading, foundation types and sizes, depths of foundations, and design bearing pressures. Written approval from a geotechnical engineer should be required by the City of Ottawa prior to a building permit being issued.

5.11.3 Additions

For both Areas A and B, any proposed addition to a house (regardless of size) will require a geotechnical assessment. The geotechnical assessment must consider the proposed grading, foundation types and sizes, depths of foundations, and design bearing pressures. Written approval from a geotechnical engineer should be required by the City of Ottawa prior to the building permit being issued.

5.12 Corrosion and Cement Type

Samples of soil from boreholes 17-9 and 17-20 were submitted to Eurofin Environment Testing for basic chemical analysis related to potential corrosion of buried steel elements and potential sulphate attack on buried concrete elements. The results of this testing are provided in Appendix B. The results indicate that concrete made with Type GU Portland cement should be acceptable for substructures. The results also indicate a potential for corrosion of exposed ferrous metal, which should be considered in the design of substructures.

5.13 Trees

The clay soils on this site are potentially sensitive to water depletion by trees of high water demand during periods of dry weather. When trees draw water from clay soil, the clay undergoes shrinkage which can result in settlement of adjacent structures. Some restrictions could therefore need to be imposed on the planting of trees of higher water demand in close proximity to the foundations of houses or other structures founded at shallow depth. The required set-backs can be evaluated once further details are available on the site grading design.

6.0 ADDITIONAL CONSIDERATIONS

The soils at this site are sensitive to disturbance from ponded water, construction traffic, and frost.

All footing and subgrade areas should be inspected by experienced geotechnical personnel prior to filling or concreting to ensure that soil having adequate bearing capacity has been reached and that the bearing surfaces have been properly prepared. The placing and compaction of any engineered fill as well as sewer bedding and backfill should be inspected to ensure that the materials used conform to the specifications from both a grading and compaction point of view.

At the time of the writing of this report, only preliminary details for the proposed subdivision were available. Golder Associates should be retained to review the guidelines provided in this report once additional details are known.

Depending on the required sewer excavation depths, additional hydrogeological investigation could be required in order to evaluate the hydraulic conductivity of (and potential inflow from) the deep gravelly silty sand layers and/or the bedrock in order to support a EASR or PTTW application. It should also be confirmed that the boreholes drilled as part of this investigation extend below the required excavation depths for the sewers (since the invert levels are not currently known.

For any higher/heavier structures (e.g., schools, commercial buildings etc.) proposed for the site that will be designed in accordance with Part 4 of the OBC, further investigation will be required to support the site plan and building permit applications and additional geotechnical guidelines will need to be provided for detailed design.

The soil and groundwater quality was tested in areas where issues of potential environmental concern were identified during the Phase I Environmental Site Assessment. The reader is referred to the Phase II ESA report for this project, which is provided under separate cover.

The groundwater level monitoring devices (i.e., standpipe piezometers or wells) installed at the site will require decommissioning at the time of construction in accordance with Ontario Regulation 128/03. However, it is expected that most of the wells will either be destroyed during construction or can be more economically abandoned as part of the construction contract. If that is not the case or is not considered feasible, abandonment of the monitoring wells can be carried out separately.

7.0 CLOSURE

We trust this report satisfies your current requirements. If you have any questions regarding this report, please contact the undersigned.

GOLDER ASSOCIATES LTD.

S Trickey

LICENSED PROFESSIONAL ENGINEER
S. A. TRICKEY
100104579
PROVINCE OF ONTARIO

Troy

Susan Trickey, P.Eng.
Geotechnical Engineer

Troy Skinner, P.Eng.
Associate, Senior Geotechnical Engineer

WAM/SAT/TMS/mvrd
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IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client, Claridge Homes Corporation. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder can not be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then the client may authorize the use of this report for such purpose by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process, provided this report is not noted to be a draft or preliminary report, and is specifically relevant to the project for which the application is being made. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client can not rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT (cont'd)

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. **The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report.** The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

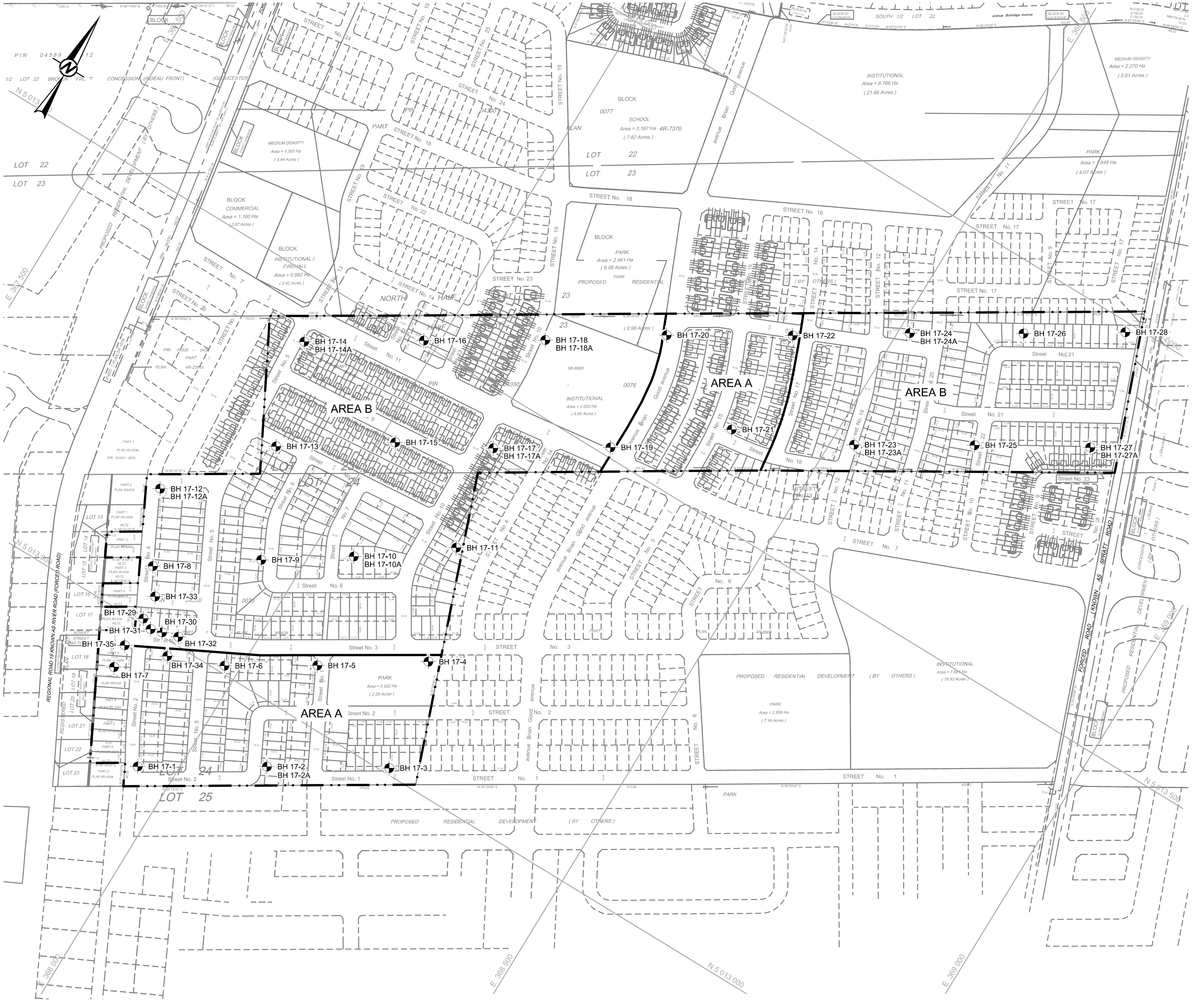
Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.



KEY MAP

SCALE 1:50,000

LEGEND

⊕ APPROXIMATE BOREHOLE LOCATION

— · — APPROXIMATE SITE LIMITS

NOTES

1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. REPORT No. 1658448

REFERENCE

1. BASE PLAN SUPPLIED BY ANNIS O'SULLIVAN VOLLEBEKK LTD., RECEIVED NOV. 1, 2016, FILE NO. client 15739-15 Claridge Pt Lts 23 24 BF RF GL SK S D5.dwg
2. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: MTM ZONE 9, VERTICAL DATUM: CGVD28

0 100 200

1:5,000 METRES

CLIENT

CLARIDGE HOMES CORPORATION

PROJECT

GEOTECHNICAL INVESTIGATION
RIVERSIDE SOUTH LANDS - RIVER ROAD AND SPRATT ROAD
OTTAWA, ONTARIO

TITLE

SITE PLAN

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	----
PREPARED	JM
REVIEWED	SAT
APPROVED	TMS

PROJECT NO.	PHASE	REV.	FIGURE
1658448	1000	A	1

Path: \\golder.gds\gal\ottawa\Active\Spatial_IM\ClaridgeHomes\RiversideLands\ACAD\99_PROJ\1658448\40_PROD\Phase1000_Geotech\ | File Name: 1658448-1000-BG-0001.dwg | Last Edited By: jmckenzie Date: 2017-07-31 Time:4:30:22 PM | Printed By: jmcconnell Date: 2017-10-10 Time:10:02:33 AM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25 mm

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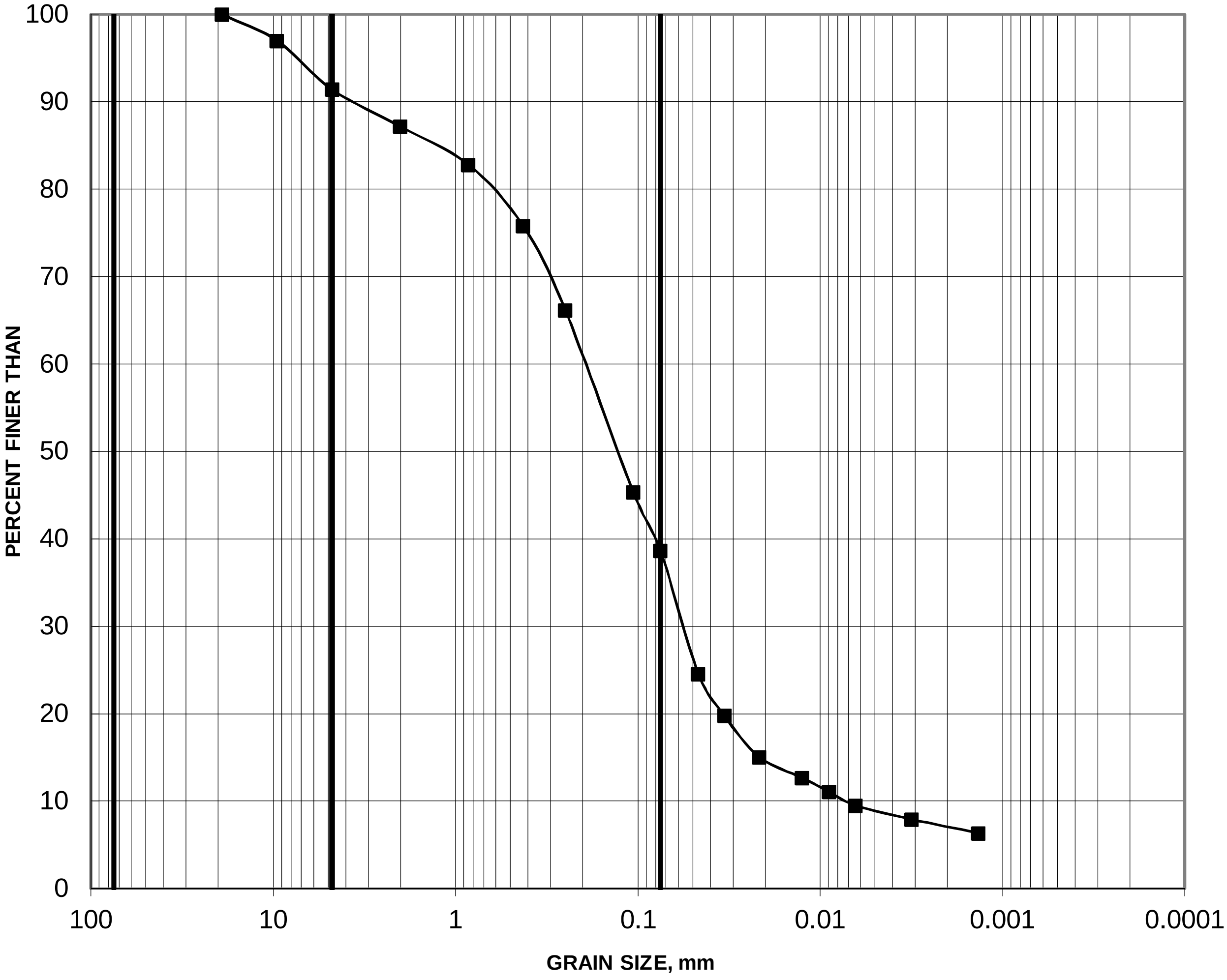
GRAIN SIZE DISTRIBUTION

FIGURE 2

Upper SILTY SAND



Cobble	coarse	fine	coarse	medium	fine	SILT AND CLAY
Size	GRAVEL SIZE		SAND SIZE			

Borehole	Sample	Depth (m)
■ 17-21	5	2.90-3.51

Project: 1658448

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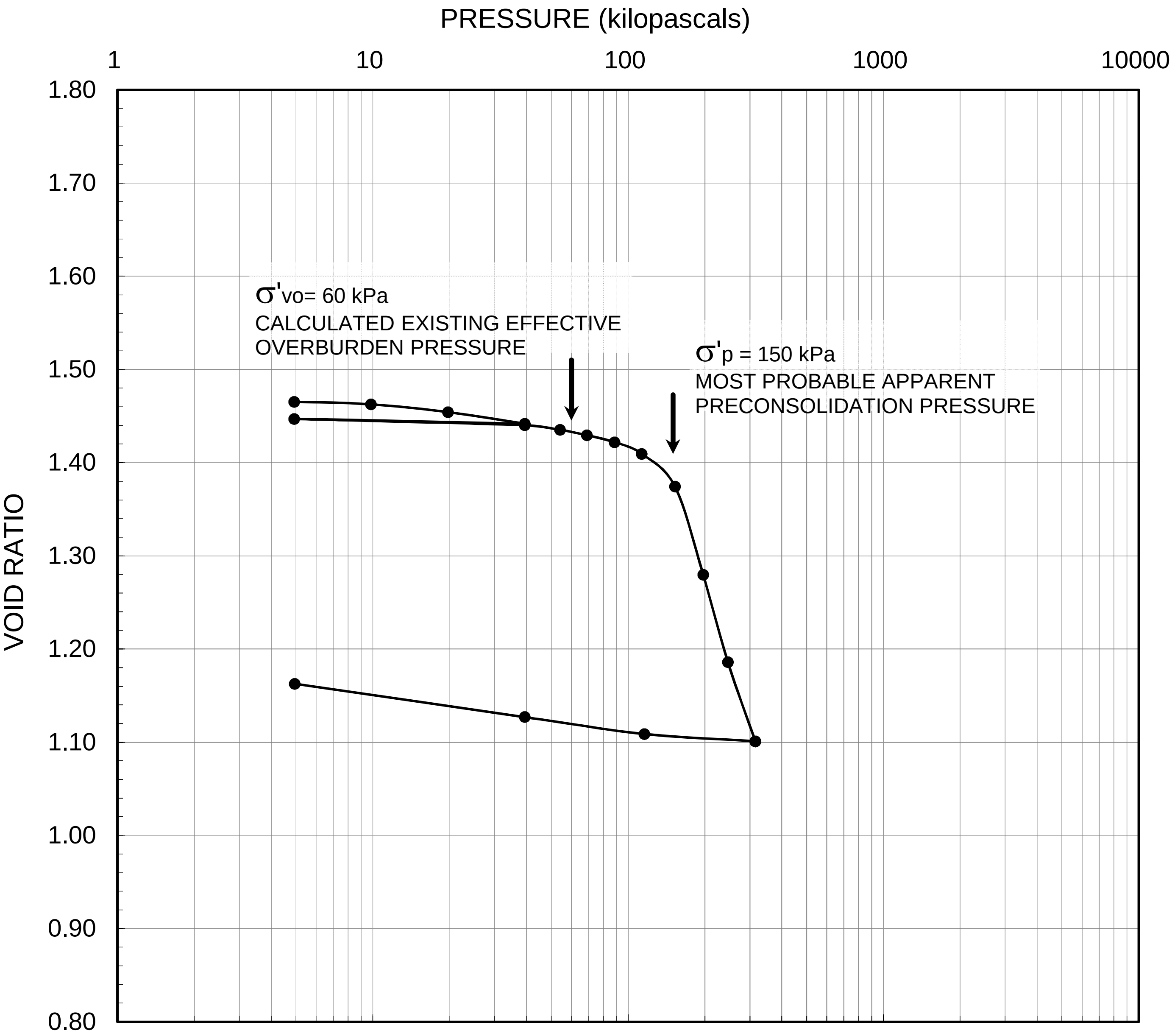
Created by: MI
Checked by: CNM



LEGEND

Borehole: 17-12A
Sample: 1
Depth (m): 4.8
Elevation (m): 85.0

w_i = 54%
w_f = 43%
w_l = 42%
w_p = 18%

S_o = 100%
e_o = 1.47
C_c = 0.97
C_r = 0.008

γ = 16.7 kN/m³
G_s = 2.74

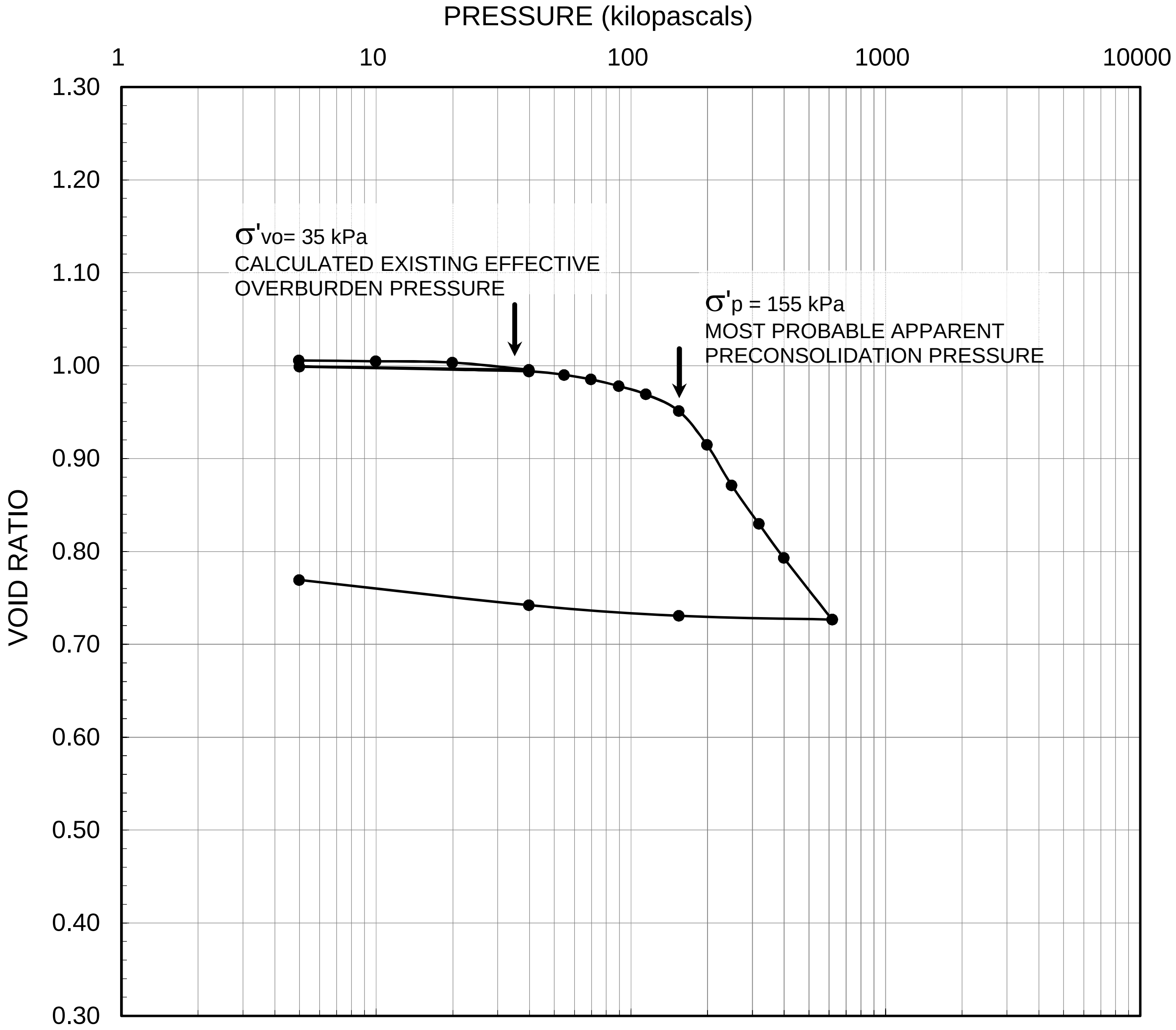
SCALE AS SHOWN
DATE 07/20/17
CADD N/A
ENTERED MI
CHECK CNM
REVIEW SAT

FILE No. Consolidation summary
PROJECT No. 1658448 REV. 1

TITLE

CONSOLIDATION TEST RESULTS

FIGURE **3**



LEGEND

Borehole:	17-18A	w_i	= 37%	S_o	= 100%	γ	= 18.4 kN/m³
Sample:	1	w_f	= 29%	e_o	= 1.01	G_s	= 2.75
Depth (m):	4.1	w_l	= 57%	C_c	= 0.39		
Elevation (m):	86.6	w_p	= 21%	C_r	= 0.006		

Golder Associates

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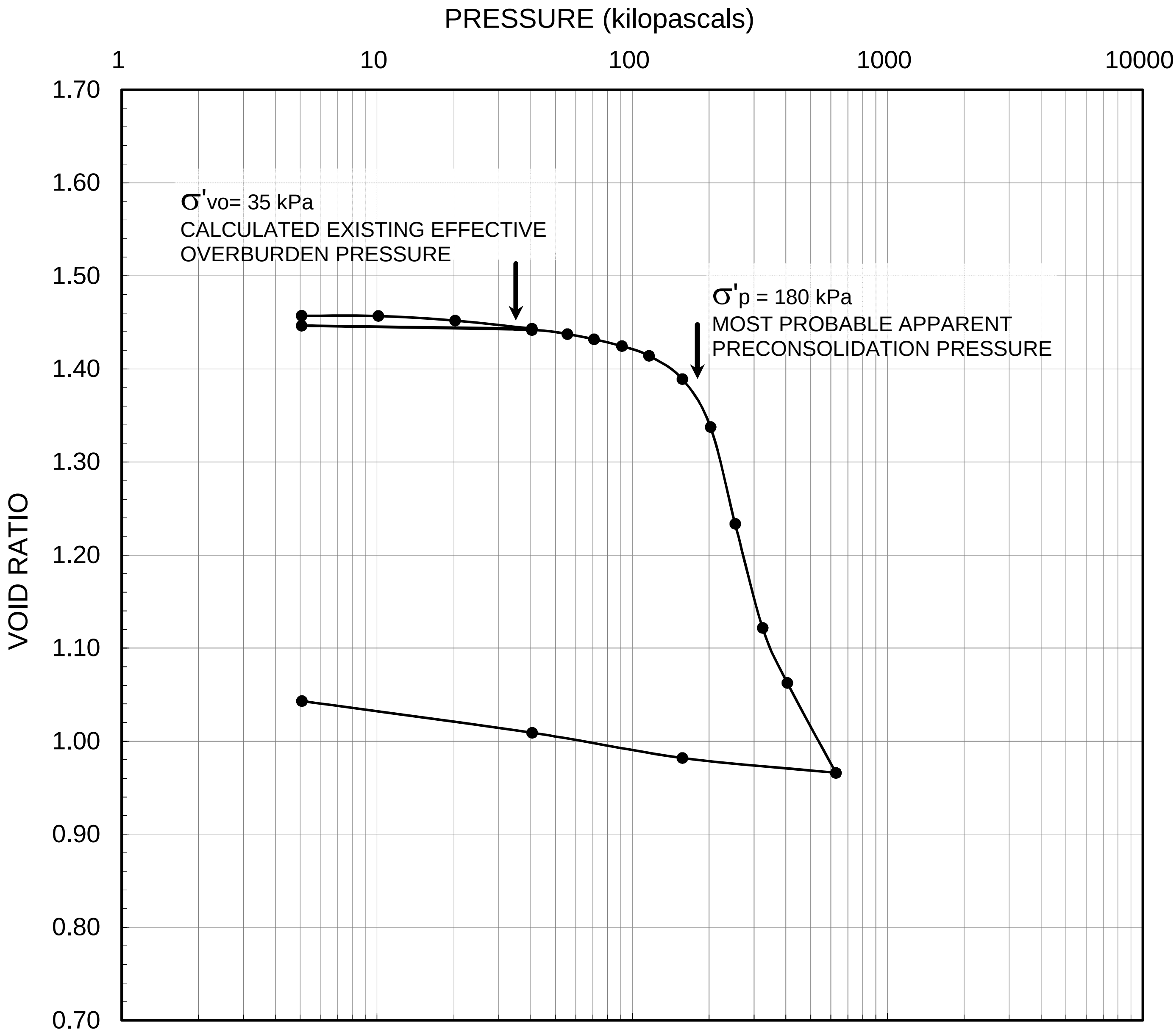
FILE No. Consolidation summary
PROJECT No. 1658448 REV. 1

TITLE

CONSOLIDATION TEST RESULTS

FIGURE **4**



σ'vo= 35 kPa
CALCULATED EXISTING EFFECTIVE
OVERBURDEN PRESSURE

σ'p = 180 kPa
MOST PROBABLE APPARENT
PRECONSOLIDATION PRESSURE

LEGEND

Borehole: 17-24A	w_i = 53%	S_o = 100%	γ = 16.8 kN/m³
Sample: 1	w_f = 39%	e_o = 1.46	G_s = 2.75
Depth (m): 3.4	w_l = 46%	C_c = 1.03	
Elevation (m): 89.2	w_p = 18%	C_r = 0.004	

SCALE AS SHOWN
DATE 07/26/17
CADD N/A
ENTERED MI
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REVIEW SAT

FILE No. Consolidation summary
PROJECT No. 1658448 REV. 2

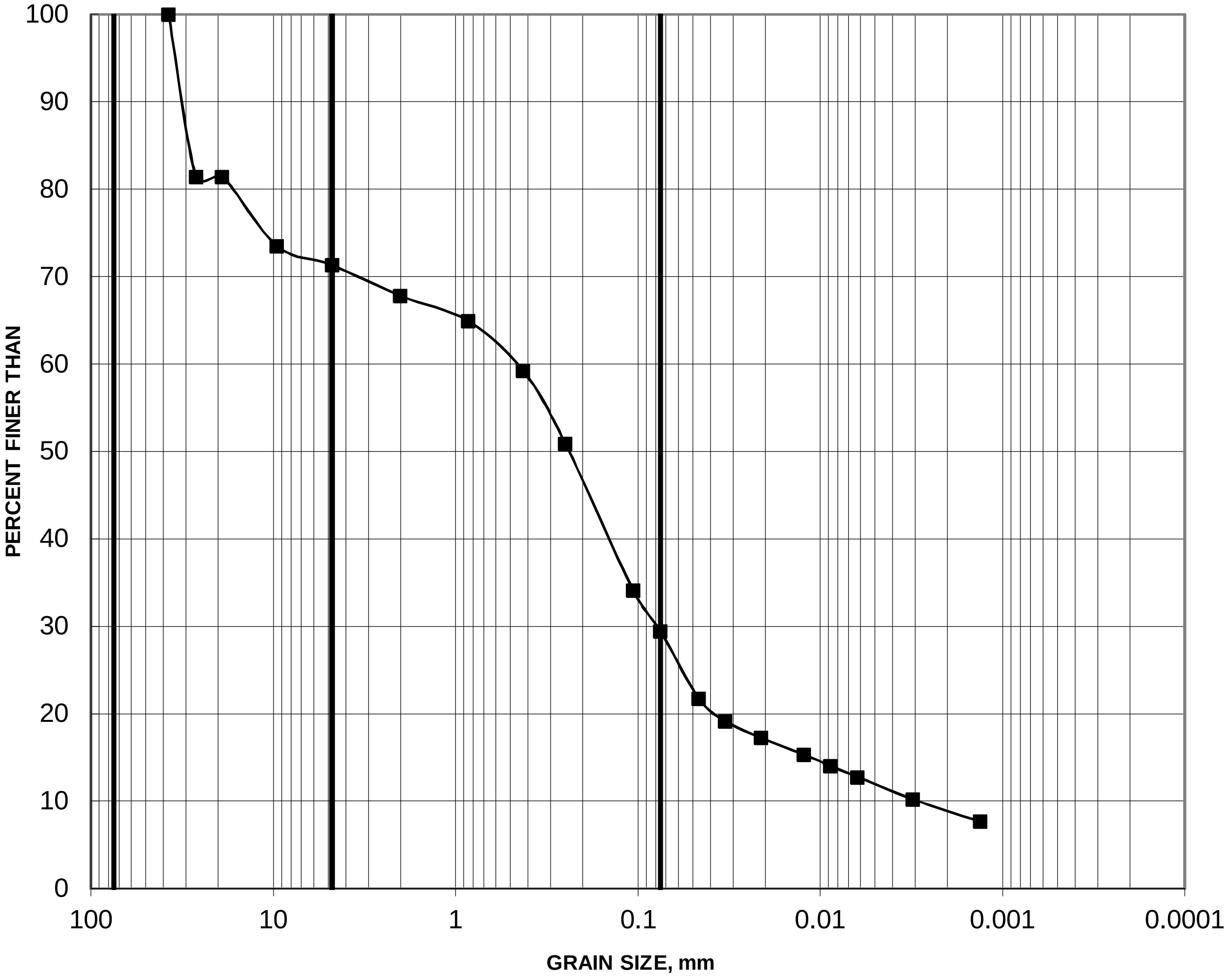
TITLE

CONSOLIDATION TEST RESULTS

FIGURE 5

GRAIN SIZE DISTRIBUTION	FIGURE 6

Lower gravelly SILTY SAND



Cobble	coarse	fine	coarse	medium	fine	SILT AND CLAY
Size	GRAVEL SIZE		SAND SIZE			

Borehole	Sample	Depth (m)
■ 17-27	3	2.13-2.65

Project: 1658448

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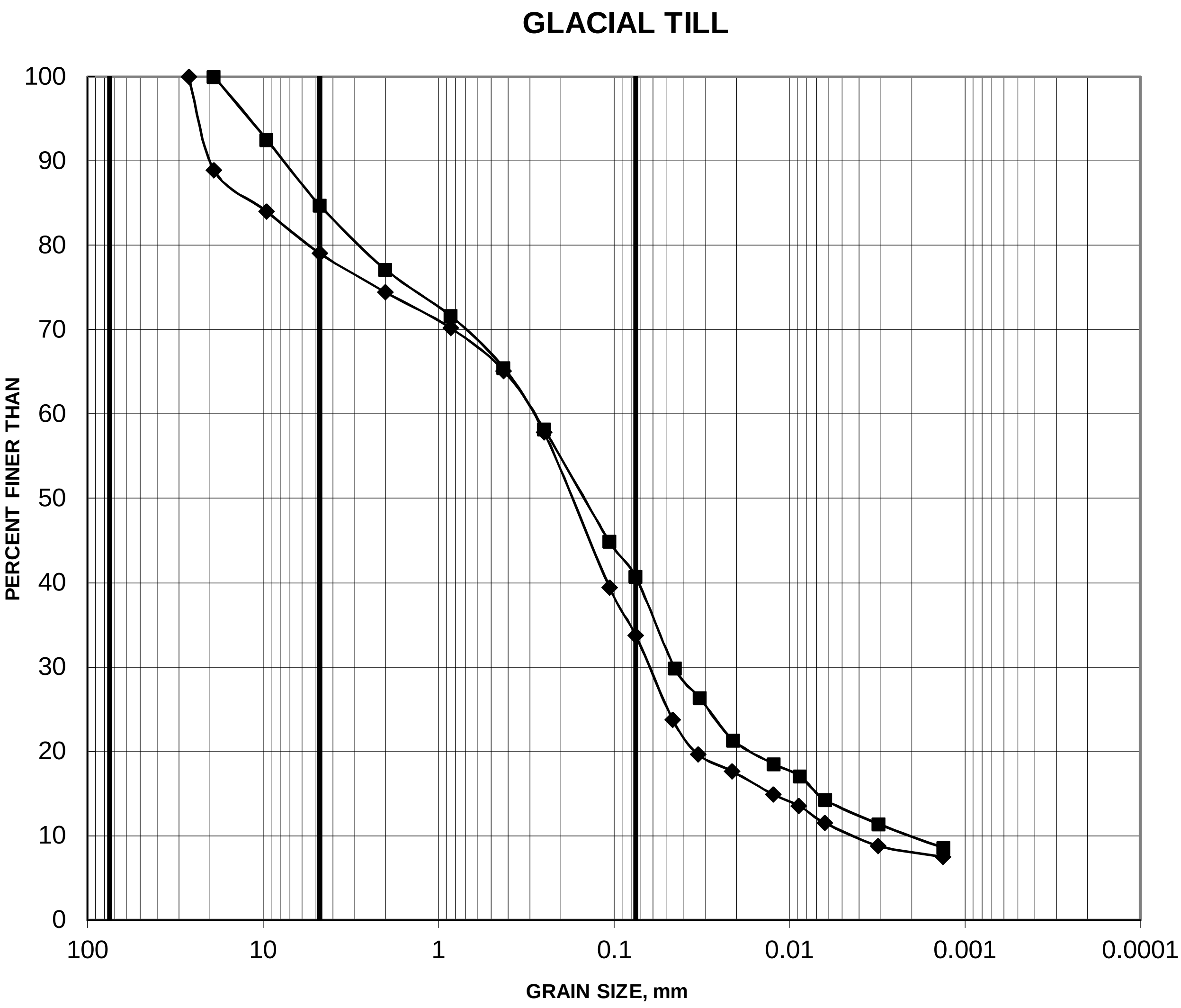
Checked by: CNM

GRAIN SIZE DISTRIBUTION

FIGURE 7



Cobble	coarse	fine	coarse	medium	fine	SILT AND CLAY
Size	GRAVEL SIZE		SAND SIZE			

Borehole	Sample	Depth (m)
■ 17-6	6	5.49-6.10
◆ 17-21	8	5.18-5.79

Created by: MI
Checked by: CNM

Project: 1658448

Golder Associates

APPENDIX A

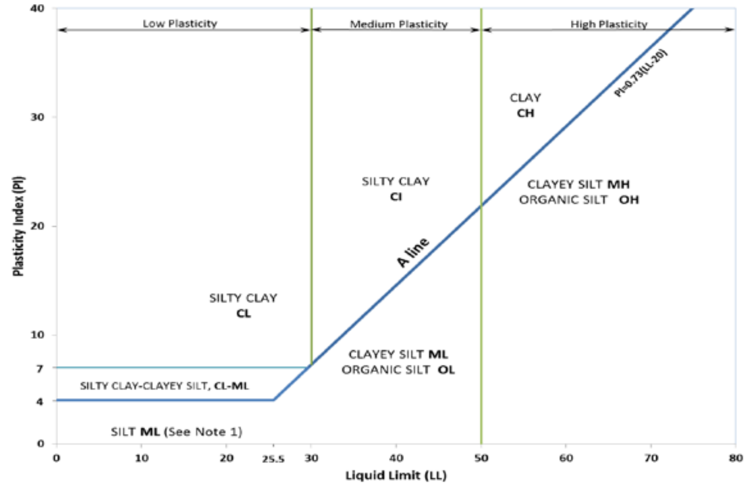
Method of Soil Classification
Abbreviations and Terms Used on Records of Boreholes
List of Symbols
Lithological and Geotechnical Rock Description Terminology
Record of Borehole and Drillhole Sheets

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
				Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
				Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
				Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
			Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
				None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% **(see Note 2)**	CL	SILTY CLAY
			Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
			Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures							30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat							75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.

Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.

For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.

For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.

A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL, SAND and CLAY)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.).

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH:	Sampler advanced by hydraulic pressure
PM:	Sampler advanced by manual pressure
WH:	Sampler advanced by static weight of hammer
WR:	Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
FS	Foil sample
GS	Grab Sample
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size
TP	Thin-walled, piston – note size
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 - 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects.
2. Definition of compactness descriptions based on SPT 'N' ranges from Terzaghi and Peck (1967) and correspond to typical average N_{60} values.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1,2] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\,\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index $= (w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index $= (w - w_p) / I_p$
I_C	consistency index $= (w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index $= (e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio $= \sigma'_p / \sigma'_{vo}$

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction $= \tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of rock material weathering.

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, as measured along the centerline axis of the core, relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid segments.

DISCONTINUITY DATA

Fracture Index

A count of the number of naturally occuring discontinuities (physical separations) in the rock core. Mechanically induced breaks caused by drilling are not included.

Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90^{o} angle is horizontal.

Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

JN	Joint	PL	Planar
FLT	Fault	CU	Curved
SH	Shear	UN	Undulating
VN	Vein	IR	Irregular
FR	Fracture	K	Slickensided
SY	Stylolite	PO	Polished
BD	Bedding	SM	Smooth
FO	Foliation	SR	Slightly Rough
CO	Contact	RO	Rough
AXJ	Axial Joint	VR	Very Rough
KV	Karstic Void		
MB	Mechanical Break		

PROJECT: 1658448

RECORD OF BOREHOLE: 17-1

SHEET 1 OF 1

LOCATION: N 5012839.8 ;E 367953.0

BORING DATE: January 13, 2017

DATUM: Geodetic

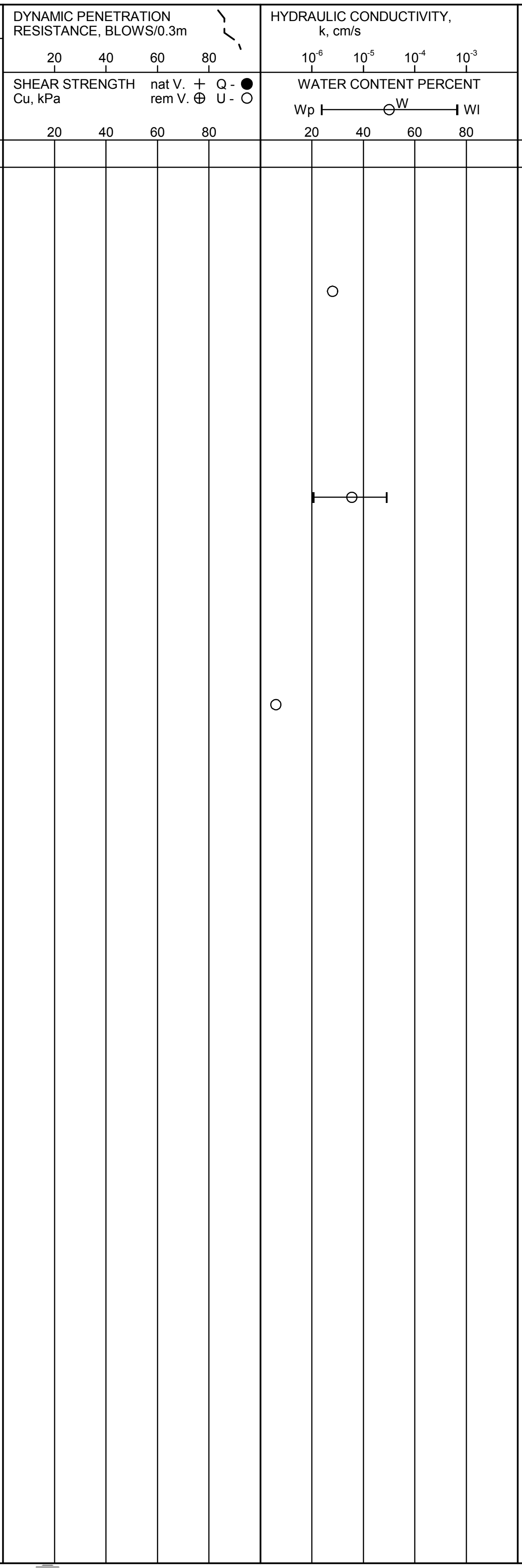
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

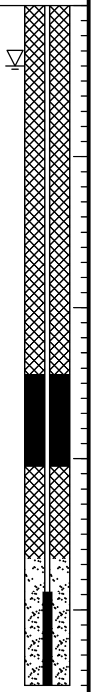
BORING METHOD: Power Auger, 200 mm Diam. (Hollow Stem)

SOIL PROFILE: DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	89.98
TOPSOIL - (ML) sandy SILT; dark brown; non-cohesive	0.06
(CI/CH-ML and SM) SILTY CLAY, CLAYEY SILT and SILTY SAND; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff	
(CI/CH) SILTY CLAY to CLAY; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff	87.85 2.13
(ML-SM) gravelly sandy SILT to SILTY SAND; grey brown, contains cobbles and boulders (GLACIAL TILL); non-cohesive, wet, compact	86.78 3.20
End of Borehole Auger Refusal	85.48 4.50

SAMPLES NUMBER	TYPE	BLOWS/0.30m
1	SS	5
2	SS	4
3	SS	5
4	SS	8
5	SS	26



PIEZOMETER OR STANDPIPE INSTALLATION



Native Backfill

Bentonite Seal

Native Backfill

Silica Sand

Standpipe

WL in Standpipe at Elev. 89.58 m on Jan. 30, 2017

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: PAH
CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-2

SHEET 1 OF 1

LOCATION: N 5012927.0 ;E 368096.0

BORING DATE: January 16, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl : 20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m
		GROUND SURFACE	90.52			
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) SILTY SAND, fine; dark brown; non-cohesive	0.00			
		(SM) SILTY SAND, fine; brown; non-cohesive, moist	90.27 0.25			
1		(CI/CH) SILTY CLAY to CLAY; grey brown, contains silty fine sand seams, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff	90.00 0.52	1	SS	7
		(CI/CH-ML and SM) SILTY CLAY, CLAYEY SILT and SILTY SAND; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff	89.15 1.37	2	SS	3
2		(CI/CH) SILTY CLAY to CLAY; grey brown, fissured (WEATHRED CRUST); cohesive, w>PL, very stiff	88.39 2.13	3	SS	4
3				4	SS	8
4		End of Borehole Auger Refusal	86.71 3.81			
5						
6						
7						
8						
9						
10						

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-2A

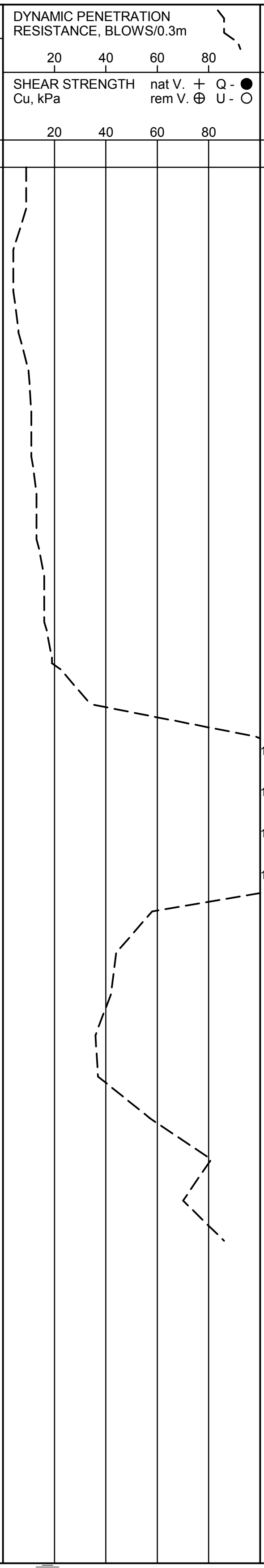
SHEET 1 OF 1

LOCATION: N 5012927.0 ;E 368096.0

BORING DATE: January 16, 2017

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		90.52					
0	DCPT Open Hole	Probable Silty Clay to Clay	▨	0.00					
4	DCPT Open Hole	Probable Glacial Till		86.62 3.90					
8		End of DCPT		82.60 7.92					



HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl; 20 40 60 80

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-3

SHEET 1 OF 1

LOCATION: N 5013008.0 ;E 368232.2

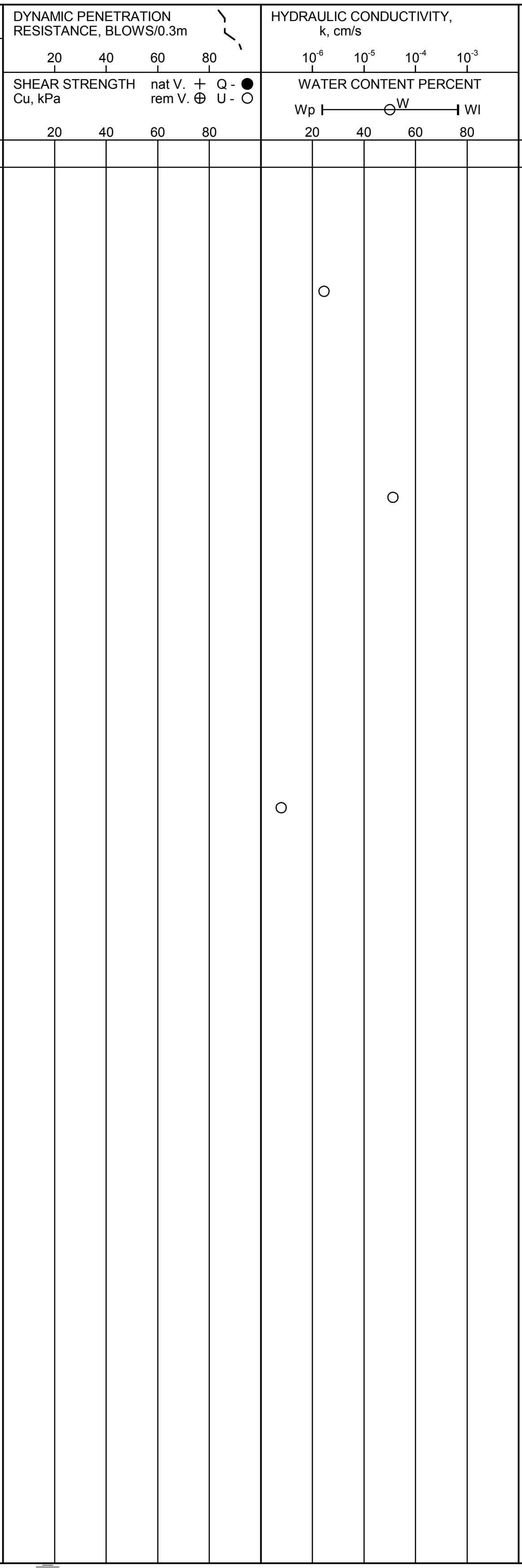
BORING DATE: January 10, 2017

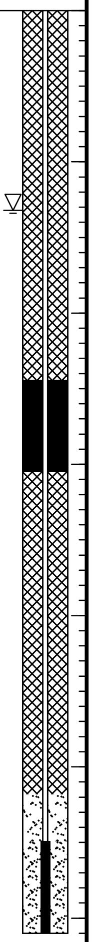
DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	PIEZOMETER OR STANDPIPE INSTALLATION
	GROUND SURFACE	91.08				
Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML) CLAYEY SILT; brown; non-cohesive	0.00				
	(ML and SM) SILT, CLAYEY SILT and SILTY SAND; grey brown; non-cohesive, wet, very loose to loose	90.78 0.30				
			1	SS	5	Native Backfill
			2	SS	3	
	(CI/CH) SILTY CLAY to CLAY; grey brown, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff	89.25 1.83				
			3	SS	4	Bentonite Seal
	(SM) gravelly SILTY SAND; grey brown, contains cobbles and boulders (GLACIAL TILL); non-cohesive, wet, compact to dense	88.09 2.99	4	SS	10	
			5	SS	34	Native Backfill
			6	SS	28	
						Silica Sand
			7	SS	32	Standpipe
	End of Borehole	84.98 6.10				WL in Standpipe at Elev. 89.76 m on Jan. 30, 2017





DEPTH SCALE

1 : 50

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-4

SHEET 1 OF 1

LOCATION: N 5013152.1 ;E 368203.6

BORING DATE: January 10, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | SAMPLES | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 | SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80 | HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} | WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80 | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION

BORING METHOD: Power Auger, 200 mm Diam. (Hollow Stem) (0 to 6.74 m)

DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)
GROUND SURFACE		91.01
TOPSOIL - (ML) CLAYEY SILT; dark brown; non-cohesive		0.00
(ML and SM) SILT, CLAYEY SILT and SILTY SAND; grey brown; non-cohesive, wet, very loose to loose		90.71 0.30
(CI/CH) SILTY CLAY to CLAY; grey brown, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff		89.03 1.98
(SM) gravelly SILTY SAND; grey brown, contains cobbles and boulders (GLACIAL TILL); non-cohesive, wet, compact to very dense		87.73 3.28
End of Borehole Auger Refusal		84.27 6.74

NUMBER	TYPE	BLOWS/0.30m
1	SS	6
2	SS	3
3	SS	4
4	SS	3
5	SS	21
6	SS	>50
7	SS	25
8	SS	19

∇

WL in open borehole at 1.10 m depth below ground surface upon completion of drilling

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-5

SHEET 1 OF 1

LOCATION: N 5013072.9 ;E 368083.3

BORING DATE: January 10, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	90.40							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML) CLAYEY SILT; brown; non-cohesive	0.00	1	GRAB	-				
		(ML and SM) SILT, CLAYEY SILT and SILTY SAND; grey brown; non-cohesive, wet, very loose to loose	90.15 0.25	2	SS	4				∇
1		(CI/CH) SILTY CLAY to CLAY; grey brown, fissured, contains clayey silt layers (WEATHERED CRUST); cohesive, w>PL, very stiff	89.03 1.37	3	SS	4				
2		(CI/CH-ML and SM) SILTY CLAY, CLAYEY SILT and SILTY SAND; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff	88.27 2.13	4	SS	3				
3		(CI/CH) SILTY CLAY to CLAY; grey brown, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff	87.50 2.90	5	SS	2				
4							>96 + >96 +			
5				6	SS	2				
							>96 + >96 +			
		(CI/CH) SILTY CLAY to CLAY; grey, contains clayey silt seams; cohesive, w>PL, very stiff	84.76 5.64	7	SS	4				
6		(ML) sandy SILT, some gravel; grey (GLACIAL TILL); non-cohesive, wet, very loose to loose	84.46 5.94							
		End of Borehole	84.15 6.25							WL in open borehole at 0.80 m depth below ground surface upon completion of drilling
7										
8										
9										
10										

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-6

SHEET 1 OF 1

LOCATION: N 5013009.8 ;E 367980.8

BORING DATE: January 9, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		90.26							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML) CLAYEY SILT; dark brown; non-cohesive		0.00							
		(CI/CH-ML and SM) SILTY CLAY, CLAYEY SILT and SILTY SAND; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff		0.15							
1					1	SS	3				∇
					2	SS	2				
2					3	SS	2		○		
3		(CI/CH) SILTY CLAY to CLAY; grey brown, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff		87.21 3.05	4	SS	3				
								>96 +			
4								>96 +			
		(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, stiff		85.99 4.27							
					5	SS	2		○		
5		(SM) gravelly SILTY SAND, some gravel; grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, wet, compact		85.08 5.18							
					6	SS	16		○	MH	
6		End of Borehole		84.16 6.10							WL in open borehole at 1.22 m depth below ground surface upon completion of drilling
7											
8											
9											
10											

MIS-BHS 001 1658448.GPJ GAL-MIS.GDT 10/10/17 JM

DEPTH SCALE

1 : 50

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-7

SHEET 1 OF 1

LOCATION: N 5012933.6 ;E 367859.5

BORING DATE: January 5, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	90.24							
0	Power Auger 200 mm Diam. (Hollow Stem)	FILL/TOPSOIL - (SM) SILTY SAND; dark brown; moist	0.00							
		FILL - (SP-CL/CI) Mixture of SAND and SILTY CLAY; brown to grey brown; non-cohesive, moist, loose to very loose	89.94 0.30	1	GRAB	-				
1		(CI/CH) SILTY CLAY to CLAY, some sand; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff	89.18 1.06	2	SS	4				
2				3	SS	6				
3				4	SS	2				
				5	SS	3				
4							>96 +			
5				6	SS	4				
				7	SS	2				
6		(SM) SILTY SAND, some gravel; grey, contains clayey silt seams, cobbles and boulders (GLACIAL TILL); non-cohesive, wet, compact	84.45 5.79	8	SS	24				
7				9	SS	10				
8				10	SS	11				
		End of Borehole	82.02 8.22							
9										
10										

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-8

SHEET 1 OF 1

LOCATION: N 5013071.6 ;E 367834.3

BORING DATE: January 23, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger 200 mm Diam. (Hollow Stem)

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m
	GROUND SURFACE		89.77			
0	FILL - (SP/GP) SAND and GRAVEL; dark grey to black, contains asphaltic concrete fragments; non-cohesive, moist	▩	0.00	1	GRAB	-
	(SM) SILTY SAND; brown; non-cohesive, moist		89.36 0.41	2	GRAB	-
	(CI/CH) SILTY CLAY to CLAY; red brown to grey brown, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff	▨	89.16 0.61	3	SS	5
1						
	(CI/CH-ML and SM) SILTY CLAY, CLAYEY SILT and SILTY SAND; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff		88.40 1.37	4	SS	5
2				5	SS	2
3	(CI/CH) SILTY CLAY to CLAY; grey brown, contains silty fine sand seams (WEATHERED CRUST); cohesive, w>PL, very stiff	▨	86.87 2.90	6	SS	2
4	(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, stiff	▨	85.81 3.96			
5				7	SS	WH
6	End of Borehole		83.83 5.94			
7						
8						
9						
10						

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

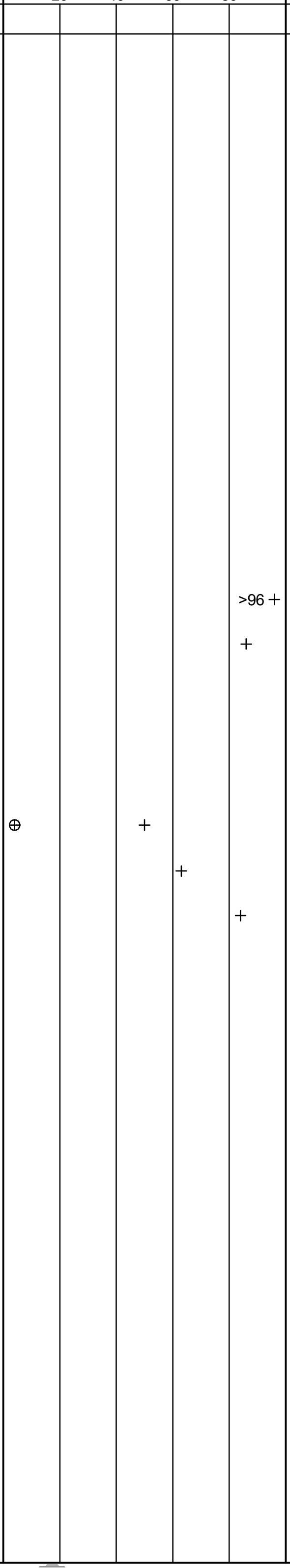
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl : 20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-9

SHEET 1 OF 1

LOCATION: N 5013151.7 ;E 367949.8

BORING DATE: January 16, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, 200 mm Diam. (Hollow Stem)

SOIL PROFILE – DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	90.26
TOPSOIL - (SM) SILTY SAND; dark brown; non-cohesive	0.00
(SM) SILTY SAND; grey brown; non-cohesive, wet	0.15
(CI/CH) SILTY CLAY to CLAY; grey brown, contains silty fine sand seams, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff	89.85 0.41
(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, stiff	86.30 3.96
End of Borehole	82.34 7.92

SAMPLES NUMBER	TYPE	BLOWS/0.30m
1	GRAB	-
2	SS	5
3	SS	5
4	SS	2
5	SS	3
6	SS	WH
7	SS	WH
8	SS	WH

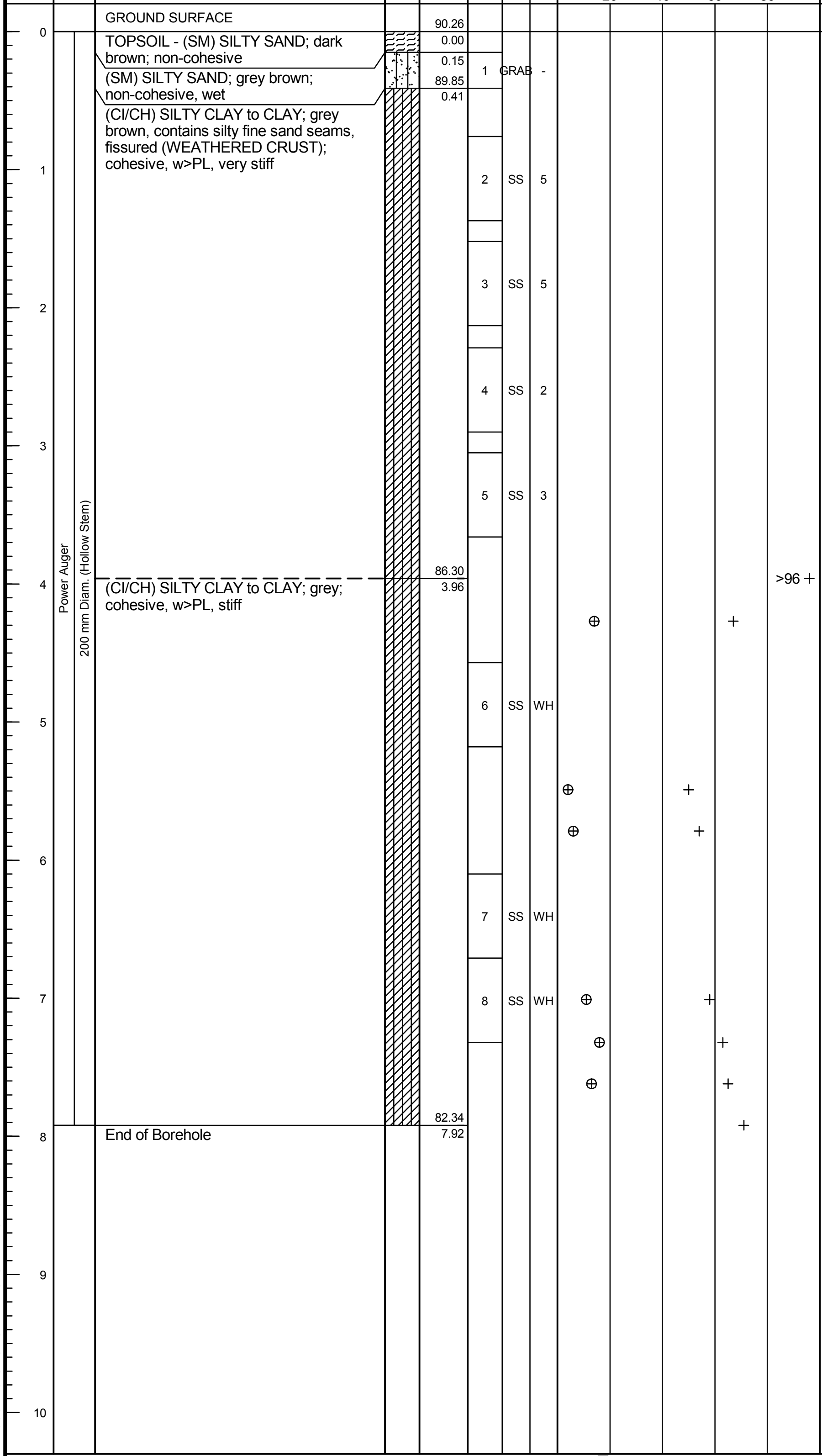
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m — 20 40 60 80

SHEAR STRENGTH Cu, kPa — nat V. + Q - ● rem V. ⊕ U - ○ — 20 40 60 80

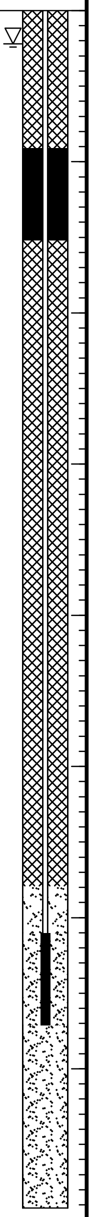
HYDRAULIC CONDUCTIVITY, k, cm/s — 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT — Wp ⊢—○W—⊣ Wl — 20 40 60 80

ADDITIONAL LAB. TESTING



PIEZOMETER OR STANDPIPE INSTALLATION



Native Backfill

Bentonite Seal

Native Backfill

Silica Sand

Standpipe

Silica Sand

WL in Standpipe at Elev. 90.04 m on Jan. 30, 2017

DEPTH SCALE
1 : 50

LOGGED: PAH
CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-10

SHEET 1 OF 1

LOCATION: N 5013218.5 ;E 368049.9

BORING DATE: January 16, 2017

DATUM: Geodetic

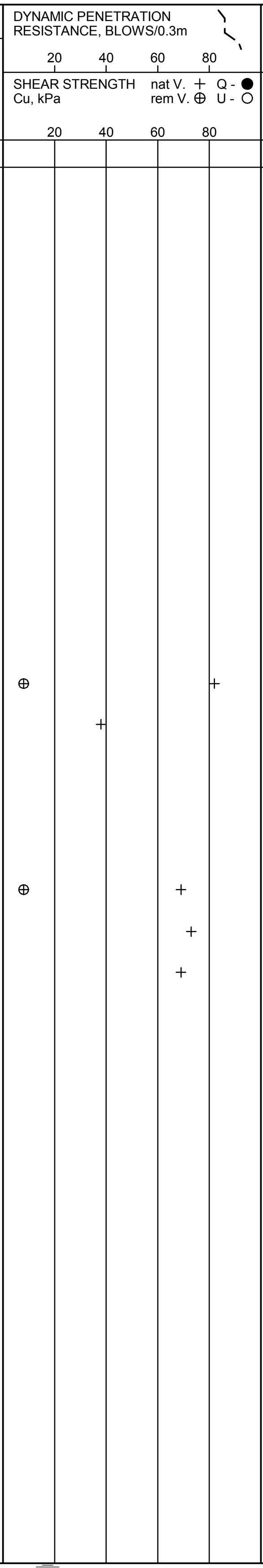
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, 200 mm Diam. (Hollow Stem)

ELEV. / DEPTH (m)	SOIL PROFILE – DESCRIPTION
90.56	GROUND SURFACE
0.00	TOPSOIL - (SM) SILTY SAND; dark brown; non-cohesive
90.33 0.23	(SM) SILTY SAND; brown; non-cohesive, moist
90.10 0.46	(CI/CH) SILTY CLAY to CLAY; grey brown to red brown, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff
89.19 1.37	(CI/CH-ML and SM) SILTY CLAY, CLAYEY SILT and SILTY SAND; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff
86.90 3.66	(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, firm to stiff
84.62 5.94	End of Borehole

SAMPLES NUMBER	TYPE	BLOWS/0.30m
1	GRAB	-
2	SS	6
3	SS	3
4	SS	3
5	SS	3
6	SS	WH



HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl: 20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-10A

SHEET 1 OF 1

LOCATION: N 5013218.0 ;E 368050.0

BORING DATE: January 16, 2017

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m				
		GROUND SURFACE		90.56							
0	Power Auger 200 mm Diam. (Hollow Stem)	For soil stratigraphy refer to Record of Borehole 17-10		0.00							
1											
2											
3											
4					1	TP	PH				
		End of Borehole		86.14 4.42							
5											
6											
7											
8											
9											
10											

MIS-BHS 001 1658448.GPJ GAL-MIS.GDT 10/10/17 JM

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-11

SHEET 1 OF 1

LOCATION: N 5013297.0 ;E 368157.3

BORING DATE: January 17, 2017

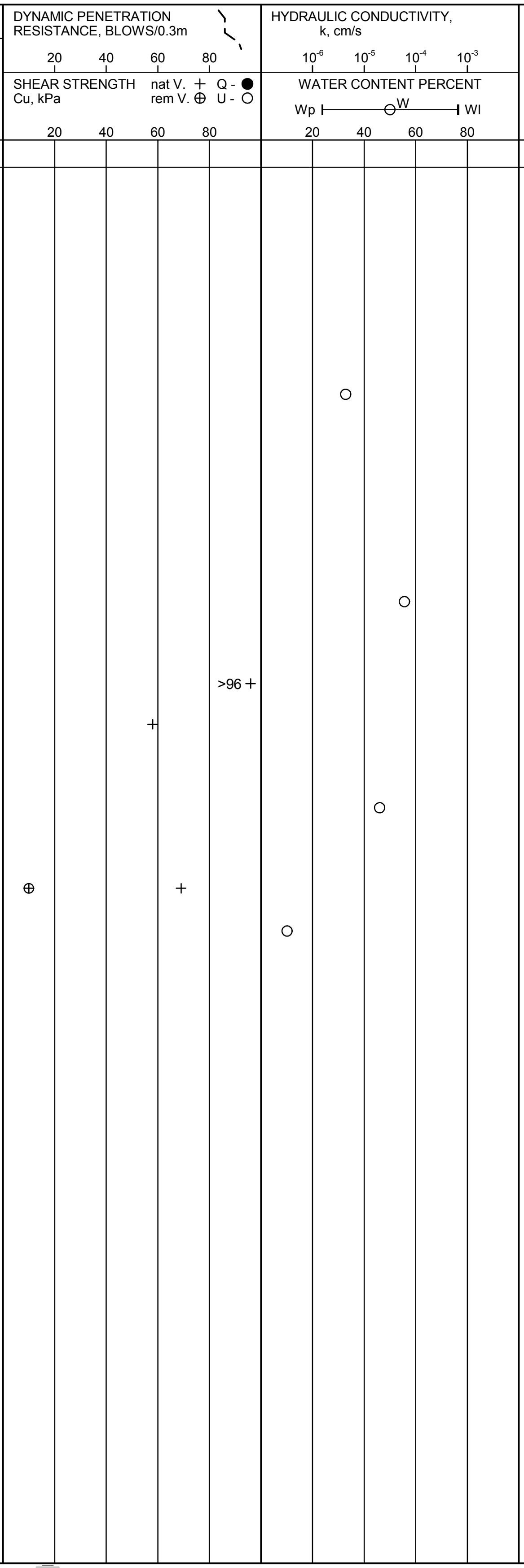
DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, 200 mm Diam. (Hollow Stem)

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m
0	GROUND SURFACE	90.58			
	TOPSOIL - (ML) sandy SILT; dark brown; non-cohesive	0.00			
	(CI/CH-ML and SM) SILTY CLAY, CLAYEY SILT and SILTY SAND; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff	90.38 0.20			
1			1	SS	6
			2	SS	2
2	(CI/CH) SILTY CLAY to CLAY; grey brown, contains silty fine sand seams, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff	88.60 1.98			
			3	SS	4
3			4	SS	2
4	(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, stiff	86.77 3.81			
			5	SS	1
5	(ML) sandy SILT, some gravel; grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, wet, very dense	85.25 5.33	6	SS	69
6	End of Borehole	84.64 5.94			
7					
8					
9					
10					



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: PAH
CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-12

SHEET 1 OF 1

LOCATION: N 5013161.9 ;E 367790.1

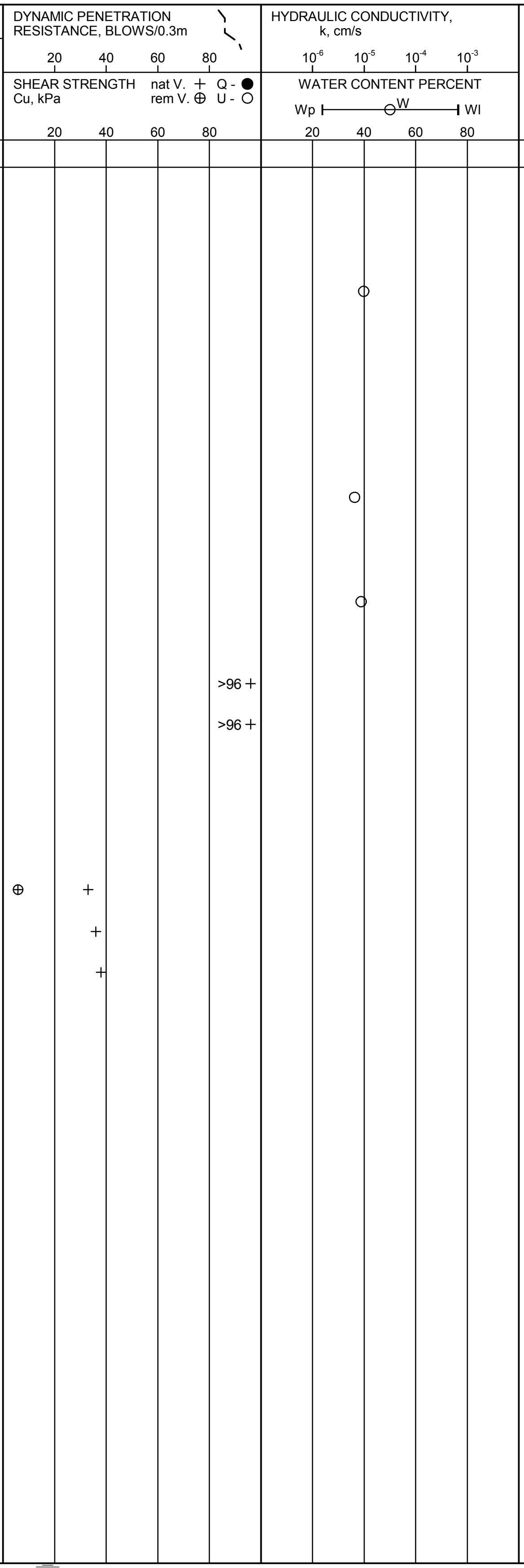
BORING DATE: January 20, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		89.76					
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) SILTY SAND; dark brown; non-cohesive		0.00					
		(SM) SILTY SAND; grey brown; non-cohesive, moist		0.08	1	GRAB	-		
		(CI/CH) SILTY CLAY to CLAY; red brown and grey brown, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff		89.15 0.61	2	SS	5		
1					3	SS	5		
2		(CI/CH-ML and SM) SILTY CLAY, CLAYEY SILT and SILTY SAND; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff		87.63 2.13	4	SS	2		∇
3		(CI/CH) SILTY CLAY to CLAY; grey brown, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff		86.86 2.90	5	SS	2		
4		(CI/CH) SILTY CLAY to CLAY; grey with black mottling; cohesive, w>PL, firm		85.49 4.27	6	SS	WH		
6		End of Borehole		83.82 5.94					WL in open borehole at 2.35 m depth below ground surface upon completion of drilling
7									
8									
9									
10									



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DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-12A

SHEET 1 OF 1

LOCATION: N 5013162.0 ;E 367790.0

BORING DATE: January 23, 2017

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 / SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		89.76							
0	Power Auger 200 mm Diam. (Hollow Stem)	For soil stratigraphy refer to Record of Borehole 17-12		0.00							
2											∇
					1	TP	PH		⊢——⊣ ○	C	
5		End of Borehole		84.73 5.03							WL in open borehole at 2.35 m depth below ground surface upon completion of drilling

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: PAH
CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-13

SHEET 1 OF 1

LOCATION: N 5013287.2 ;E 367889.6

BORING DATE: January 20, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

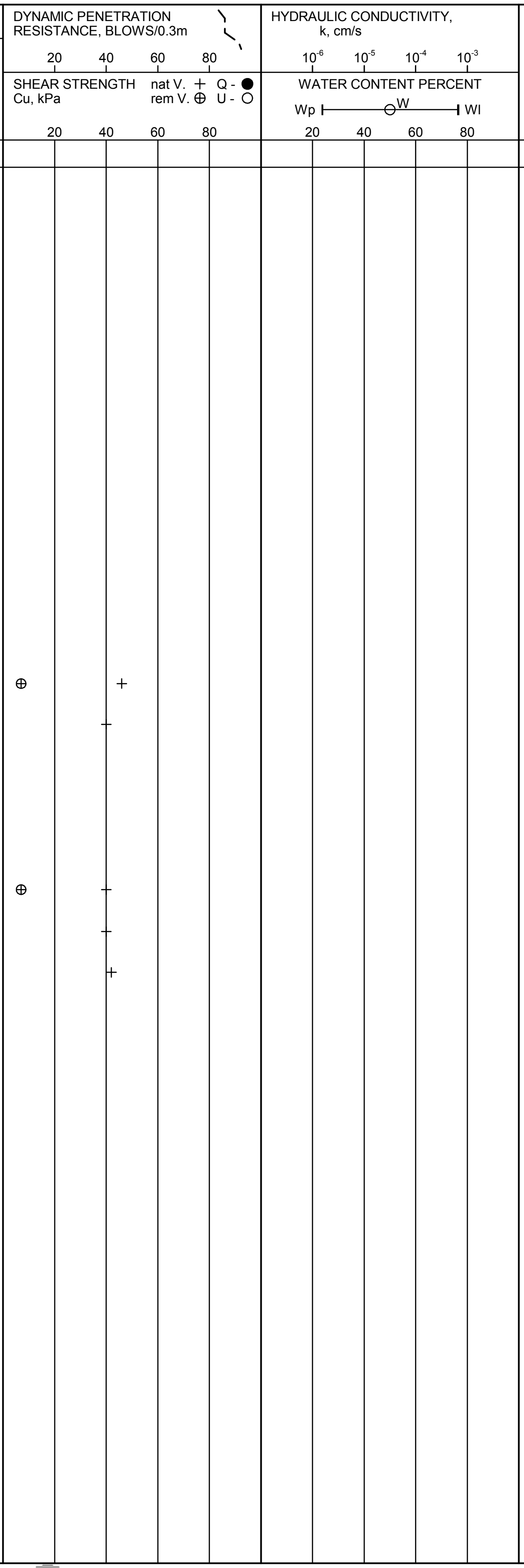
PENETRATION TEST HAMMER, 64kg; DROP, 760mm

SOIL PROFILE

BORING METHOD	DESCRIPTION	ELEV. DEPTH (m)
	GROUND SURFACE	90.32
Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) SILTY SAND; dark brown; non-cohesive	0.00
	(SP) SAND, some non-plastic fines; grey brown; non-cohesive, moist	90.09 0.23
	(CI/CH-ML and SM) SILTY CLAY, CLAYEY SILT and SILTY SAND; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff	89.59 0.73
	(CI/CH) SILTY CLAY to CLAY; red brown and grey brown, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff	89.10 1.22
	(CI/CH-ML and SM) SILTY CLAY, CLAYEY SILT and SILTY SAND; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff to stiff	88.19 2.13
	(CI/CH) SILTY CLAY to CLAY; grey, contains silty fine sand seams; cohesive, w>PL, firm	87.20 3.12
	End of Borehole	84.38 5.94

SAMPLES

NUMBER	TYPE	BLOWS/0.30m
1	GRAB	-
2	SS	4
3	SS	4
4	SS	2
5	SS	2
6	SS	WH



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

WL in open borehole at 1.00 m depth below ground surface upon completion of drilling

DEPTH SCALE

1 : 50

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-14

SHEET 1 OF 1

LOCATION: N 5013422.4 ;E 367850.2

BORING DATE: January 19, 2017

DATUM: Geodetic

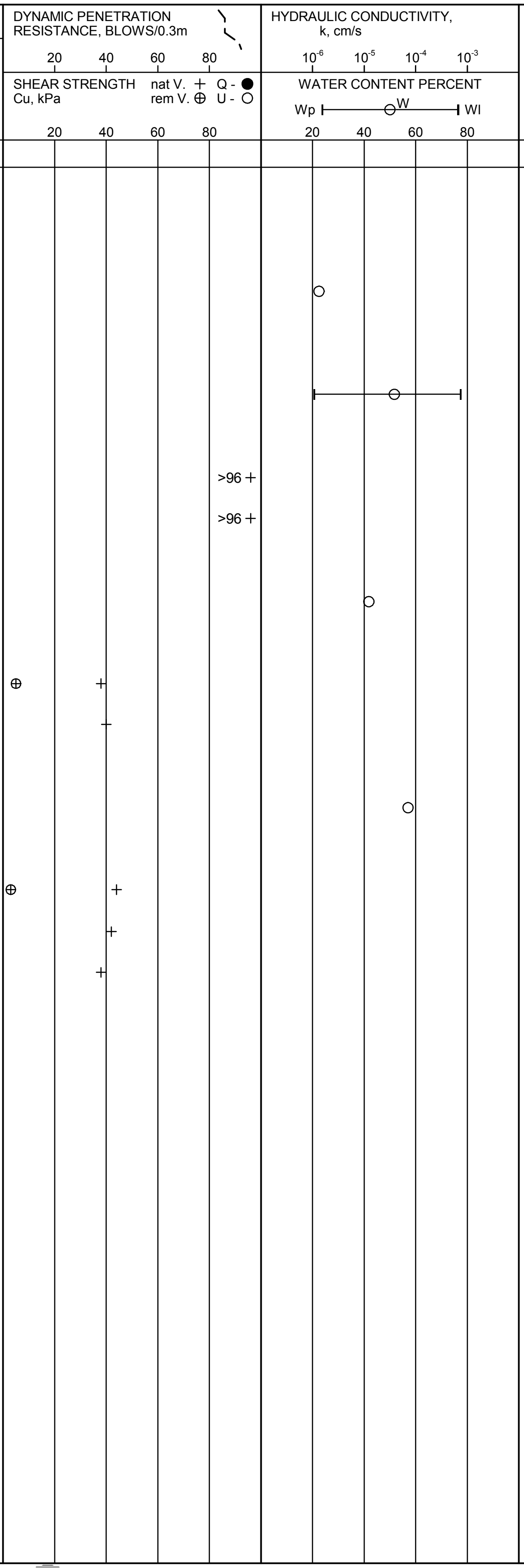
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger
200 mm Diam. (Hollow Stem)

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	90.50
TOPSOIL - (SM) SILTY SAND; dark brown; non-cohesive	0.00
(SM) SILTY SAND; brown, contains clayey silt seams; non-cohesive, wet, loose	90.20 0.30
(CI/CH) SILTY CLAY to CLAY; red brown and grey brown, contains silty fine sand seams, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff	89.20 1.30
(CI/CH) SILTY CLAY to CLAY; grey, contains silty fine sand seams; cohesive, w>PL, firm	87.76 2.74
(CI/CH) SILTY CLAY to CLAY; grey with black mottling; cohesive, w>PL, firm	86.99 3.51
End of Borehole	84.56 5.94

SAMPLES NUMBER	TYPE	BLOWS/0.30m
1	SS	8
2	SS	3
3	SS	1
4	SS	WH



PIEZOMETER OR STANDPIPE INSTALLATION

WL in open borehole at 1.00 m depth below ground surface upon completion of drilling

DEPTH SCALE

1 : 50

LOGGED: PAH

CHECKED: SAT

MIS-BHS 001 1658448.GPJ GAL-MIS.GDT 10/10/17 JM

PROJECT: 1658448

RECORD OF BOREHOLE: 17-14A

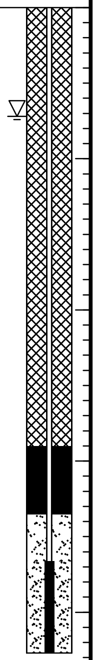
SHEET 1 OF 1

LOCATION: N 5013422.0 ;E 367850.0

BORING DATE: January 20, 2017

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80; SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}; WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		90.50							
0	Power Auger 200 mm Diam. (Hollow Stem)	For soil stratigraphy refer to Record of Borehole 17-14		0.00							
4					1	TP	PH				
		End of Borehole		86.23 4.27							



WL in Standpipe at Elev. 89.78 m on Jan. 30, 2017

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: PAH
CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-15

SHEET 1 OF 1

LOCATION: N 5013372.2 ;E 368018.8

BORING DATE: January 20, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

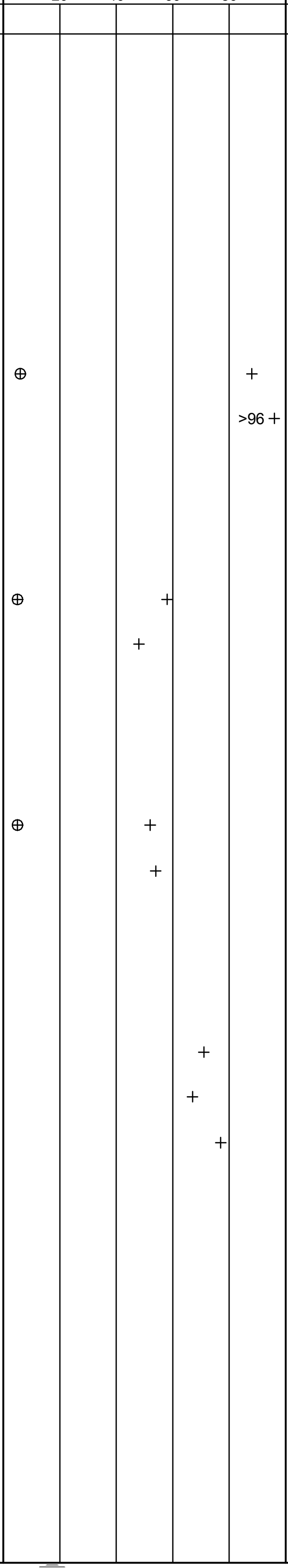
DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)
		GROUND SURFACE		90.66
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) SILTY SAND; dark brown; non-cohesive		0.00
		(SP) SAND, fine, some non-plastic fines; brown; non-cohesive, moist		90.43 0.23
		(CI/CH) SILTY CLAY to CLAY; red brown to grey brown, contains silty fine sand seams, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff to stiff		90.25 0.41
3		(CI/CH) SILTY CLAY to CLAY, some sand; grey with black mottling, contains silty fine sand seams; cohesive, w>PL, firm to stiff		87.76 2.90
		End of Borehole		82.89 7.77

SAMPLES NUMBER	TYPE	BLOWS/0.30m
1	GRAB	-
2	SS	4
3	SS	4
4	SS	2
5	SS	WH
6	SS	WH

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

20 40 60 80

SHEAR STRENGTH Cu, kPa — nat V. + Q - ● rem V. ⊕ U - ○



HYDRAULIC CONDUCTIVITY, k, cm/s

10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT

Wp ⊢—○W—⊣ Wl

20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

∇

WL in open borehole at 1.00 m depth below ground surface upon completion of drilling

MIS-BHS 001 1658448.GPJ GAL-MIS.GDT 10/10/17 JM

DEPTH SCALE

1 : 50

LOGGED: PAH

CHECKED: SAT

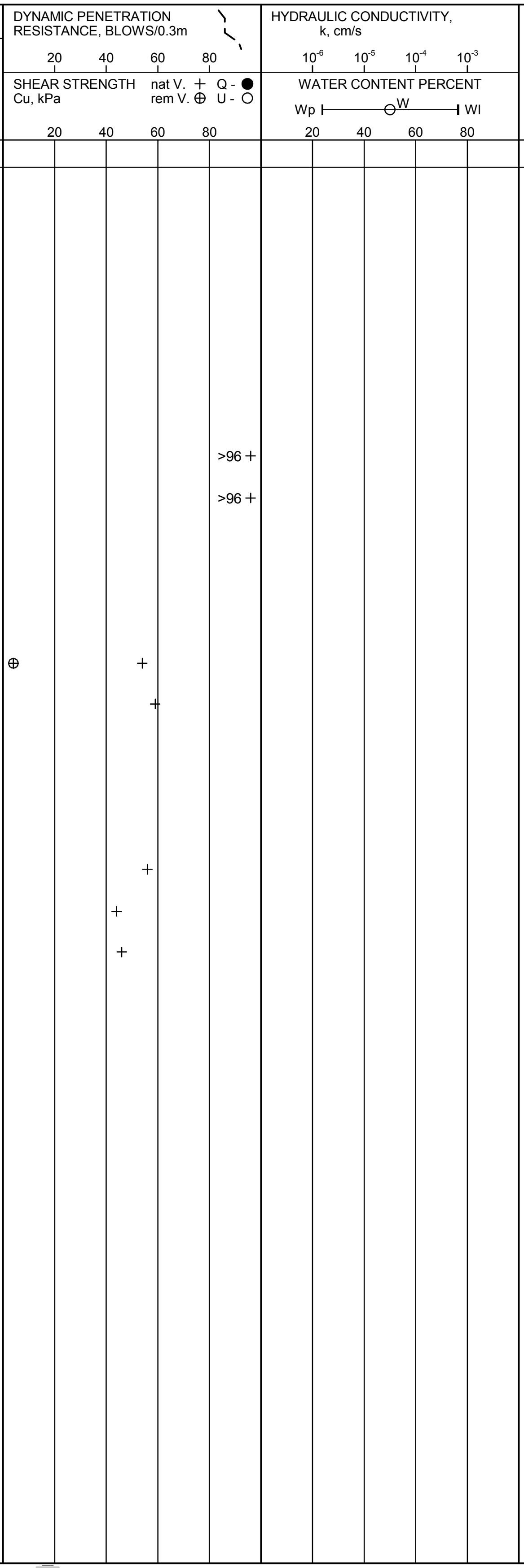
RECORD OF BOREHOLE: 17-16

PROJECT: 1658448
SHEET 1 OF 1

LOCATION: N 5013504.1 ;E 367981.5
BORING DATE: January 19, 2017
DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm
PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		90.43				
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML) sandy SILT; dark brown; non-cohesive		0.00	1	GRAB	-	
		(SM) SILTY SAND; brown, contains clayey silt seams; non-cohesive, wet		90.18 0.25	2	GRAB	-	∇
1		(CI/CH-ML and SM) SILTY CLAY, CLAYEY SILT and SILTY SAND; grey brown, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff		89.67 0.76	3	SS	2	
		(CI/CH) SILTY CLAY to CLAY; red brown and grey brown, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff		89.21 1.22	4	SS	2	
2								
3		(CI/CH) SILTY CLAY to CLAY; grey with black mottling; cohesive, w>PL, stiff to firm		87.84 2.59	5	SS	WH	
4								
5					6	SS	WH	
		End of Borehole		84.64 5.79				
6								WL in open borehole at 0.60 m depth below ground surface upon completion of drilling
7								
8								
9								
10								



DEPTH SCALE
1 : 50

Golder Associates

LOGGED: PAH
CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-17

SHEET 1 OF 1

LOCATION: N 5013432.3 ;E 368131.3

BORING DATE: January 17, 2017

DATUM: Geodetic

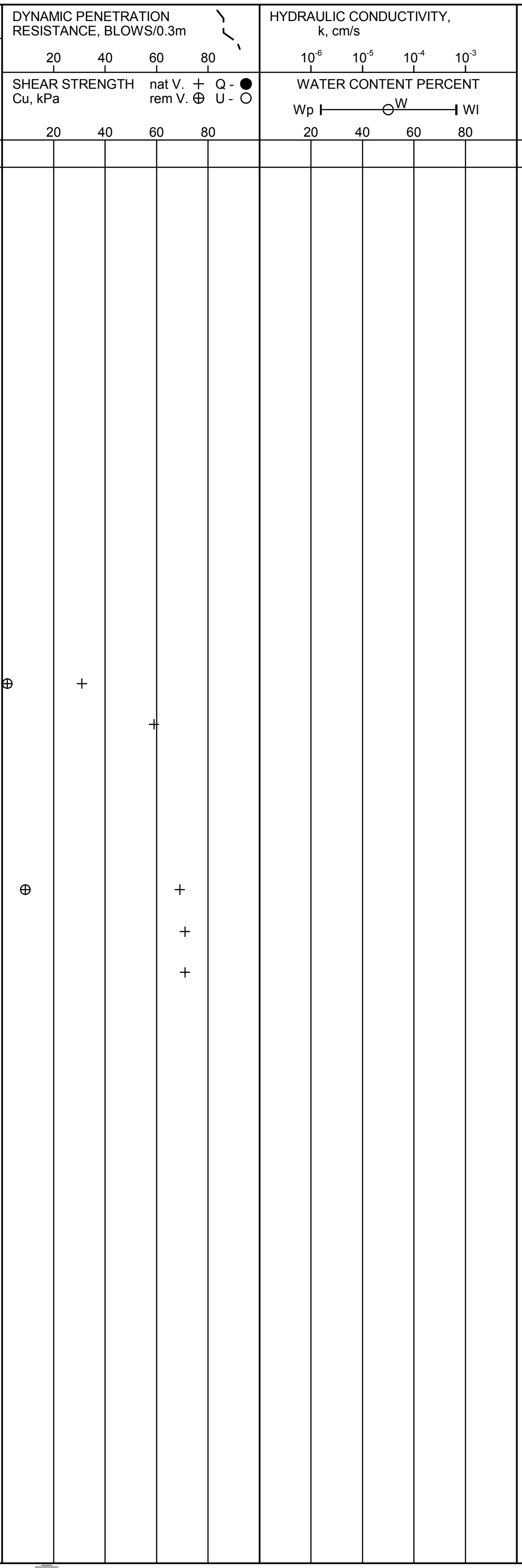
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, 200 mm Diam. (Hollow Stem)

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	90.44
TOPSOIL - (ML) CLAYEY SILT; dark brown; non-cohesive	0.00
(CI/CH) SILTY CLAY to CLAY; red brown and grey brown, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff	0.15
(CI/CH-ML and SM) SILTY CLAY, CLAYEY SILT and SILTY SAND, fine; grey brown (WEATHERED CRUST); cohesive, w>PL, stiff to very stiff	89.07 1.37
(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, firm	87.70 2.74
(CL/CI) SILTY CLAY to CLAY; grey with black mottling, contains clayey silt seams; cohesive, w>PL, stiff	86.48 3.96
End of Borehole	84.50 5.94

SAMPLES NUMBER	TYPE	BLOWS/0.30m
1	SS	7
2	SS	2
3	SS	2
4	SS	WH
5	SS	WH



PIEZOMETER OR STANDPIPE INSTALLATION

▽

WL in open borehole at 0.80 m depth below ground surface upon completion of drilling

DEPTH SCALE
1 : 50

LOGGED: PAH
CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-17A

SHEET 1 OF 1

LOCATION: N 5013432.0 ;E 368131.0

BORING DATE: January 17, 2017

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 / SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		90.44							
0	Power Auger 200 mm Diam. (Hollow Stem)	For soil stratigraphy refer to Record of Borehole 17-17		0.00							
1											
2											
3					1	TP	PH				
				86.78 3.66							
		End of Borehole									
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-18

SHEET 1 OF 1

LOCATION: N 5013586.9 ;E 368115.5

BORING DATE: January 19, 2017

DATUM: Geodetic

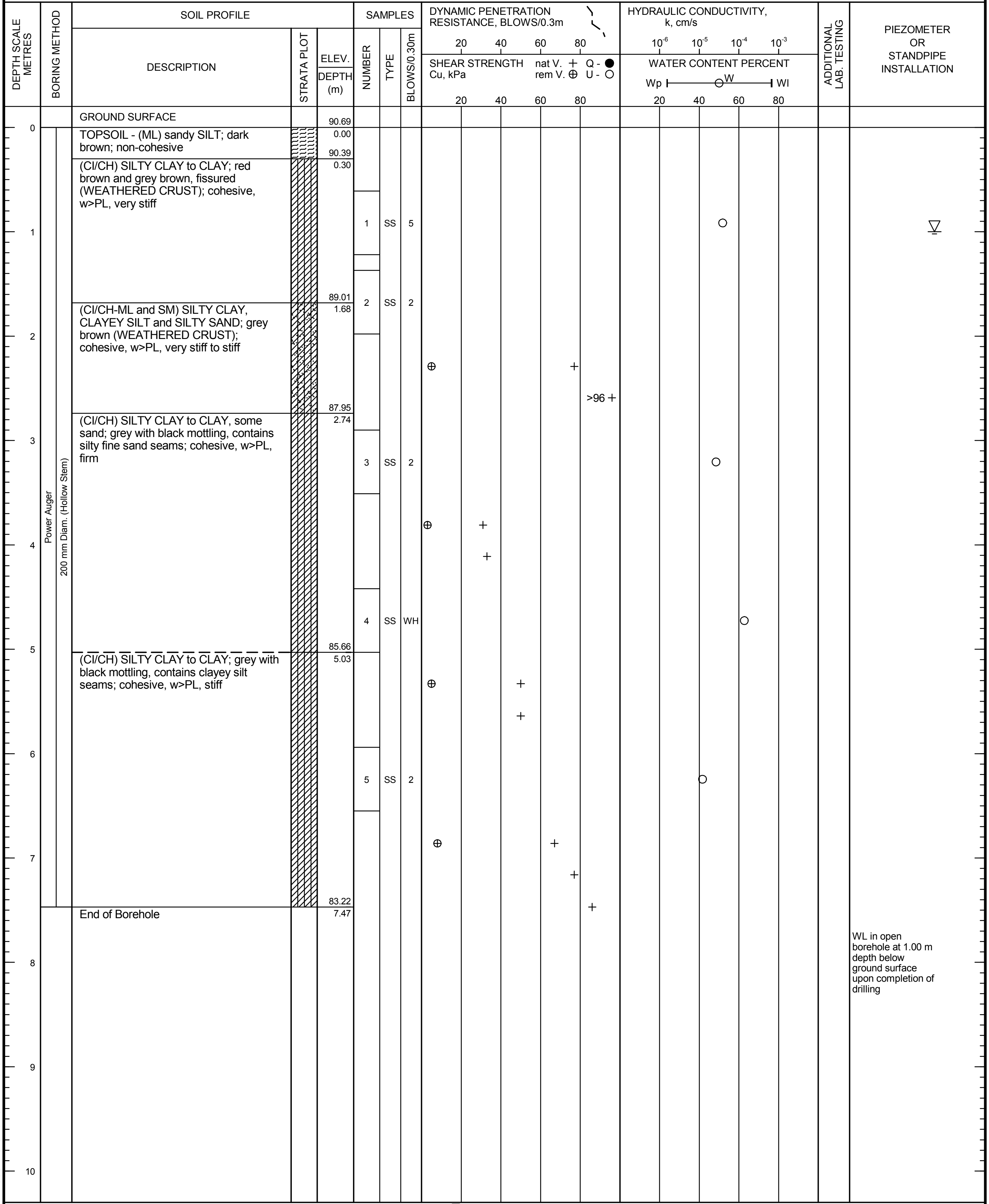
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, 200 mm Diam. (Hollow Stem)

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	90.69
TOPSOIL - (ML) sandy SILT; dark brown; non-cohesive	0.00
(CI/CH) SILTY CLAY to CLAY; red brown and grey brown, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff	90.39 0.30
(CI/CH-ML and SM) SILTY CLAY, CLAYEY SILT and SILTY SAND; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff to stiff	89.01 1.68
(CI/CH) SILTY CLAY to CLAY, some sand; grey with black mottling, contains silty fine sand seams; cohesive, w>PL, firm	87.95 2.74
(CI/CH) SILTY CLAY to CLAY; grey with black mottling, contains clayey silt seams; cohesive, w>PL, stiff	85.66 5.03
End of Borehole	83.22 7.47

SAMPLES NUMBER	TYPE	BLOWS/0.30m
1	SS	5
2	SS	2
3	SS	2
4	SS	WH
5	SS	2



WL in open borehole at 1.00 m depth below ground surface upon completion of drilling

MIS-BHS 001 1658448.GPJ GAL-MIS.GDT 10/10/17 JM

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-18A

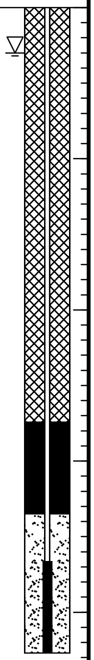
SHEET 1 OF 1

LOCATION: N 5013586.9 ;E 368115.5

BORING DATE: January 19, 2017

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		90.69							
0	Power Auger 200 mm Diam. (Hollow Stem)	For soil stratigraphy refer to Record of Borehole 17-18		0.00							Native Backfill Bentonite Seal Silica Sand
4					1	TP	PH		⊢—○—⊣	C	Standpipe
		End of Borehole		86.42 4.27							WL in Standpipe at Elev. 90.39 m on Jan. 30, 2017



DEPTH SCALE

1 : 50

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-19

SHEET 1 OF 1

LOCATION: N 5013512.2 ;E 368260.2

BORING DATE: January 17, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, 200 mm Diam. (Hollow Stem)

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	SHEAR STRENGTH Cu, kPa nat V. +	PIEZOMETER OR STANDPIPE INSTALLATION
GROUND SURFACE	91.35					
TOPSOIL - (ML) sandy SILT to CLAYEY SILT; dark brown; non-cohesive	0.00					
(CI/CH-ML and SM) SILTY CLAY, CLAYEY SILT and SILTY SAND; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff	91.15 0.20	1 2	SS SS	4 3		∇ (1.00 m)
(CI/CH) SILTY CLAY to CLAY, some clayey silt seams, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff	89.37 1.98	3 4	SS SS	3 3	>96 + >96 + >96 +	
(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, firm	86.78 4.57	5	SS	1		
(SM) gravelly SILTY SAND; grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, wet, compact	86.24 5.11	6	SS	24		
End of Borehole	85.25 6.10					WL in open borehole at 1.00 m depth below ground surface upon completion of drilling

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: PAH
CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-20

SHEET 1 OF 1

LOCATION: N 5013674.4 ;E 368246.4

BORING DATE: January 18, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80; SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}; WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		92.23							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) SILTY SAND; dark brown; non-cohesive		0.00	1	GRAB	-				
		(SM) SILTY SAND; grey brown; non-cohesive, wet, loose		91.98 0.25							∇
1		(SM) gravelly SILTY SAND; grey brown, contains cobbles and boulders (GLACIAL TILL); non-cohesive, wet, compact to dense		91.32 0.91	2	SS	11				
					3	SS	26				
2											
					4	SS	50				
3					5	SS	32				
4					6	SS	25				
					7	SS	11				
5											
		(SM/GM) SILTY SAND and GRAVEL; grey; non-cohesive, wet, compact		87.05 5.18							
					8	SS	15				
6											
		End of Borehole		86.13 6.10							WL in open borehole at 0.61 m depth below ground surface upon completion of drilling
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-21

SHEET 1 OF 1

LOCATION: N 5013613.9 ;E 368382.0

BORING DATE: January 18, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, 200 mm Diam. (Hollow Stem)

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	94.69
TOPSOIL - (SM) SILTY SAND; dark brown; non-cohesive	0.00
(SM) SILTY SAND, some gravel; brown; non-cohesive, moist	94.46 0.23
(SM/GM) SILTY SAND and GRAVEL; grey brown, contains cobbles and boulders; non-cohesive, moist, dense to very dense	93.90 0.79
(SM) SILTY SAND, some gravel; grey brown; non-cohesive, wet, compact	91.79 2.90
(ML) sandy SILT, some gravel; grey brown, contains cobbles and boudlers (GLACIAL TILL); non-cohesive, wet, compact	91.18 3.51
(SM) gravelly SILTY SAND; grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, wet, compact	89.51 5.18
(SM) SILTY SAND; grey; non-cohesive, wet, compact	87.68 7.01
End of Borehole	86.77 7.92

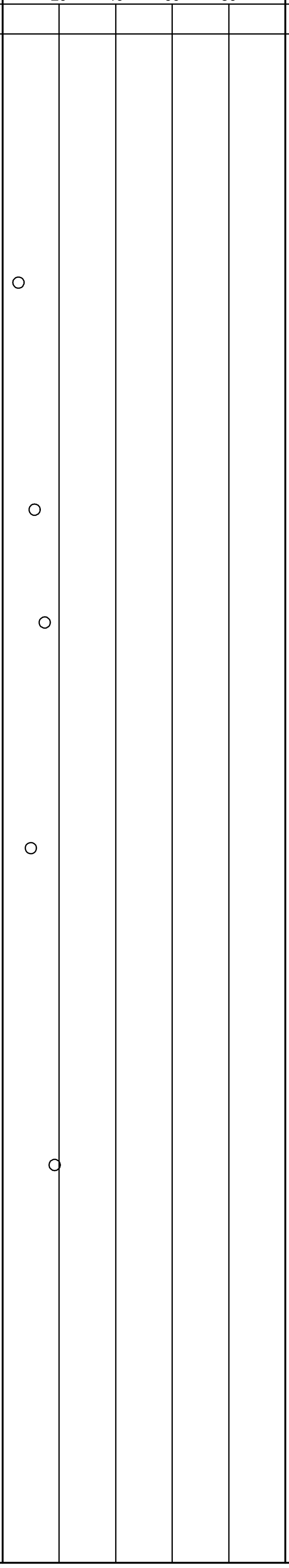
SAMPLES NUMBER	TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING
1	GRAB	-	
2	SS	>50	
3	SS	47	
4	SS	81	
5	SS	28	MH
6	SS	17	
7	SS	21	
8	SS	12	MH
9	SS	18	
10	SS	15	

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

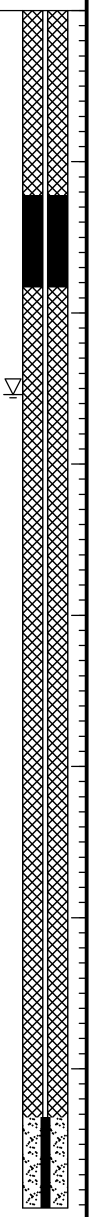
SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl



PIEZOMETER OR STANDPIPE INSTALLATION



Native Backfill

Bentonite Seal

Native Backfill

Standpipe

WL in Standpipe at Elev. 92.15 m on Jan. 30, 2017

DEPTH SCALE

1 : 50

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-22

SHEET 1 OF 1

LOCATION: N 5013759.1 ;E 368386.0

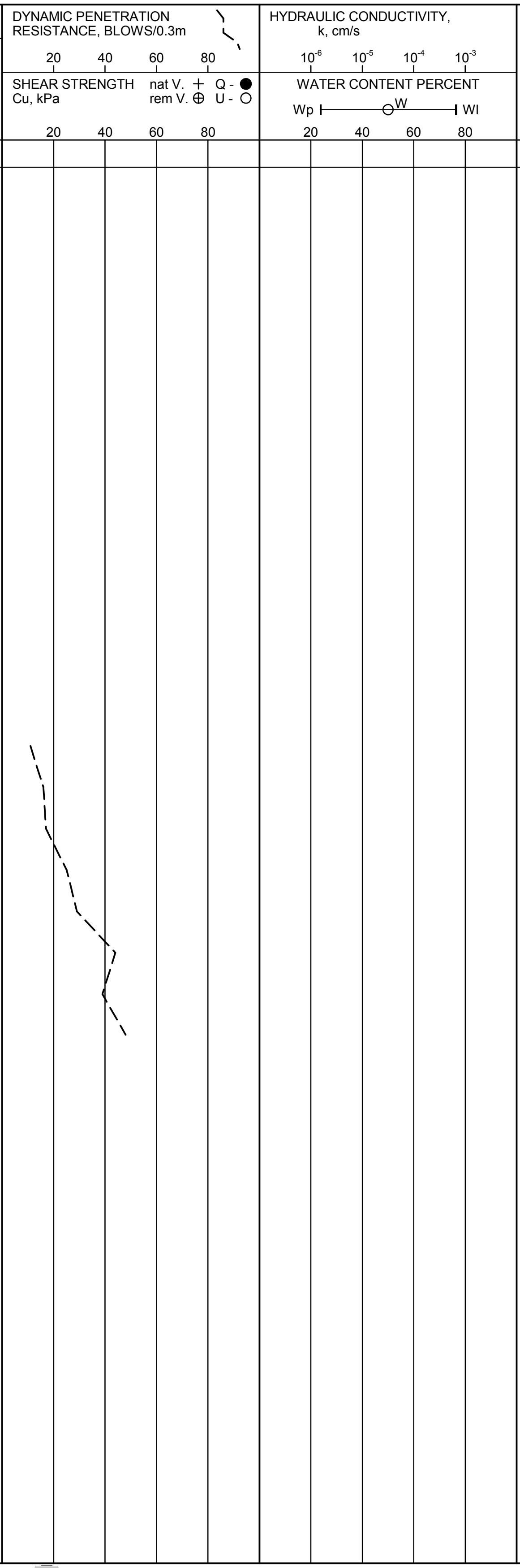
BORING DATE: January 24, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		91.97					
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML) CLAYEY SILT; dark brown; non-cohesive		0.00					
		(CI/CH-ML and SM) SILTY CLAY, CLAYEY SILT and SILTY SAND; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff		91.74 0.23	1	SS	5		
1		(CI/CH) SILTY CLAY to CLAY; grey brown, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff		90.60 1.37	2	SS	4		
2		(ML) sandy SILT, some gravel; grey brown, contains cobbles and boulders (GLACIAL TILL); non-cohesive, wet, compact		89.99 1.98	3	SS	17		
3		(SM) SILTY SAND, some gravel; grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, wet, compact		88.92 3.05	4	SS	10		
4	DCPT Open Hole	Probable Glacial Till		88.31 3.66					
6		End of Borehole End of DCPT		85.57 6.40					



DEPTH SCALE
1 : 50

Golder Associates

LOGGED: PAH
CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-23

SHEET 1 OF 1

LOCATION: N 5013679.9 ;E 368527.7

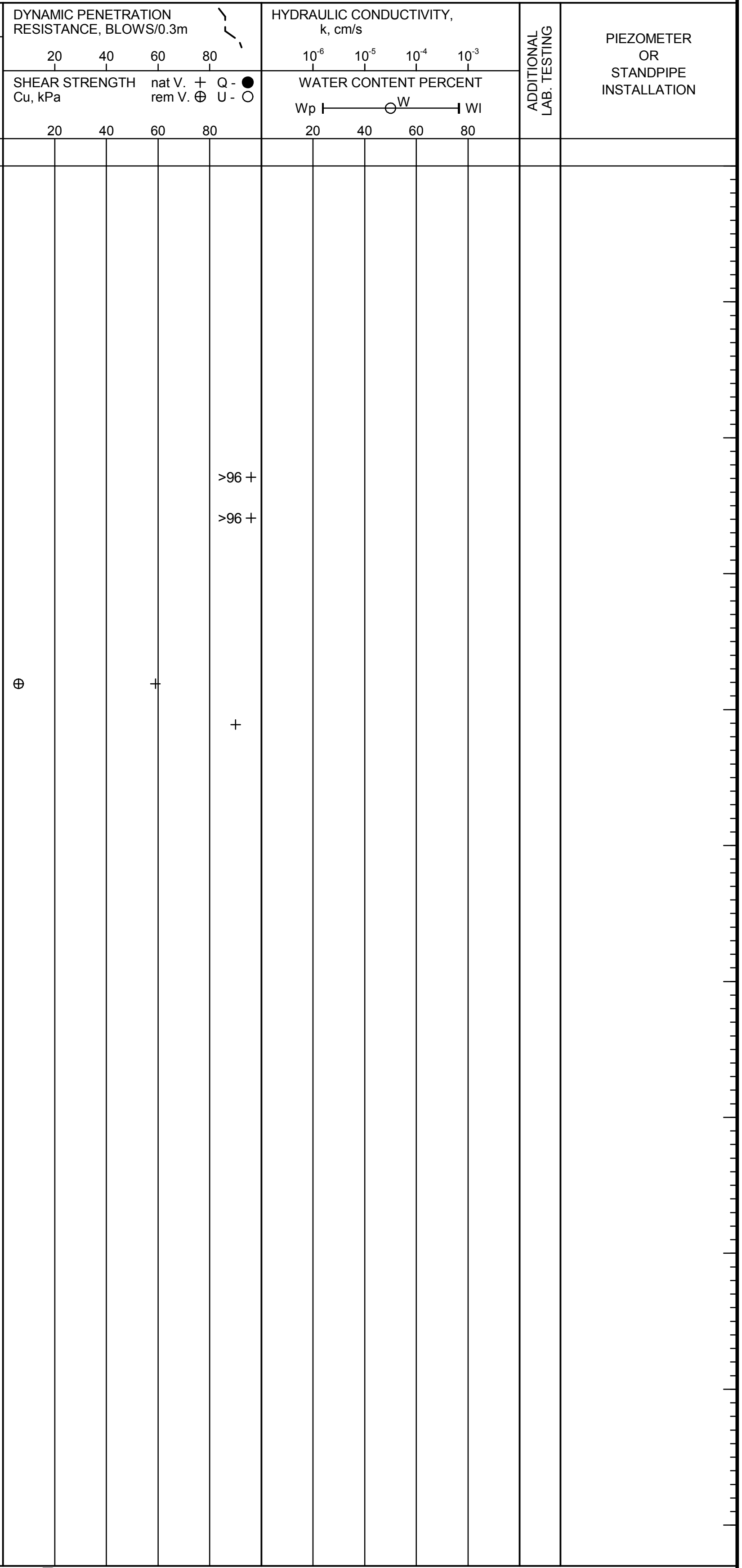
BORING DATE: January 25, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m
		GROUND SURFACE	92.56			
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML) CLAYEY SILT; dark brown; non-cohesive	0.00	1	GRAB	-
		(CI/CH-ML and SM) SILTY CLAY, CLAYEY SILT and SILTY SAND; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff	92.26 0.30	2	SS	5
1		(CI/CH) SILTY CLAY to CLAY; grey brown, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff	91.34 1.22	3	SS	4
2						
3		(CI/CH) SILTY CLAY to CLAY; grey, contains clayey silt seams; cohesive, w>PL, stiff	89.66 2.90	4	SS	1
4		End of Borehole Auger Refusal	88.22 4.34			
5						
6						
7						
8						
9						
10						



DEPTH SCALE

1 : 50

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-23A

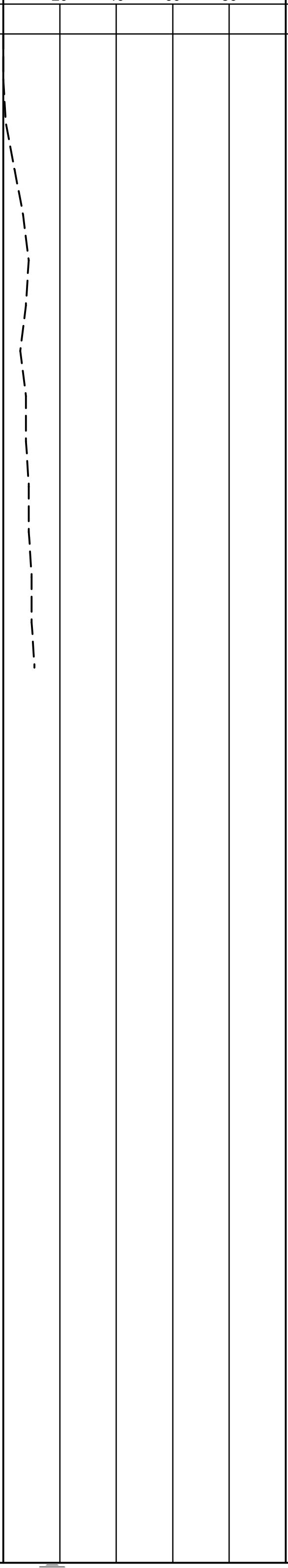
SHEET 1 OF 1

LOCATION: N 5013679.9 ;E 368527.7

BORING DATE: January 25, 2017

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80; SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}; WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		92.56							
0	DCPT Open Hole	For soil stratigraphy refer to Record of Borehole 17-23		0.00							
4.27		End of Borehole DCPT Refusal		88.29 4.27							



DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-24

SHEET 1 OF 1

LOCATION: N 5013840.9 ;E 368514.0

BORING DATE: January 24, 2017

DATUM: Geodetic

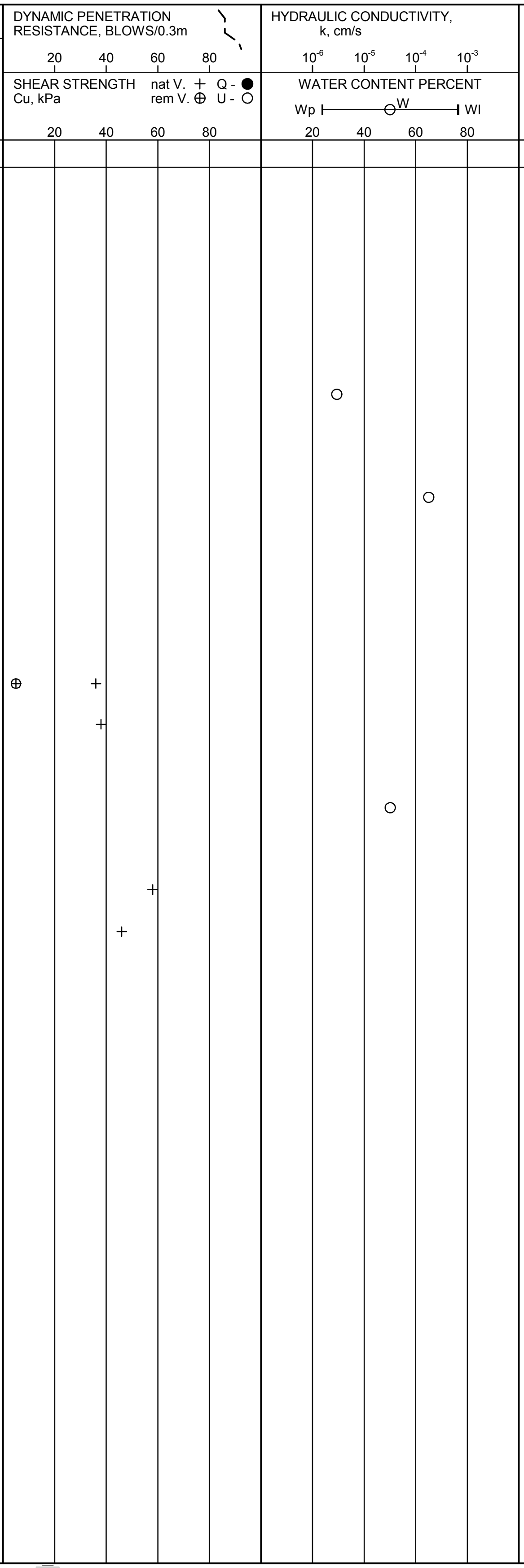
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger 200 mm Diam. (Hollow Stem)

SOIL PROFILE – DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	92.58
TOPSOIL - (ML) sandy SILT; dark brown; non-cohesive	0.00
(CI/CH-ML and SM) SILTY CLAY, CLAYEY SILT and SILTY SAND; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff	92.31 0.27
(CI/CH) SILTY CLAY to CLAY; grey brown, slightly fissured (WEATHERED CRUST); cohesive, w>PL, stiff	90.60 1.98
(CI/CH) SILTY CLAY to CLAY; grey, contains silty fine sand seams; cohesive, w>PL, firm to stiff	89.53 3.05
(ML) sandy SILT, some gravel; grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, wet, very loose	86.33 6.25
End of Borehole Auger Refusal	86.03 6.55

SAMPLES NUMBER	TYPE	BLOWS/0.30m
1	SS	4
2	SS	2
3	SS	1
4	SS	WH
5	SS	WH
6	SS	3



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: PAH
CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-24A

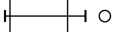
SHEET 1 OF 1

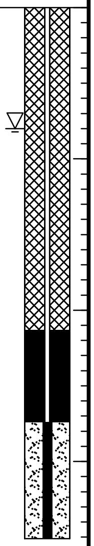
LOCATION: N 5013841.0 ;E 368514.0

BORING DATE: January 24, 2017

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		92.58							
0	Power Auger 200 mm Diam. (Hollow Stem)	For soil stratigraphy refer to Record of Borehole 17-24		0.00							Native Backfill
											Bentonite Seal
3					1	TP	PH			C	Standpipe
		End of Borehole		89.07 3.51							WL in Standpipe at Elev. 91.78 m on Jan. 30, 2017





DEPTH SCALE
1 : 50

LOGGED: PAH
CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-25

SHEET 1 OF 1

LOCATION: N 5013760.8 ;E 368661.4

BORING DATE: January 25, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		93.17							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML) sandy SILT; dark brown; non-cohesive		0.00							∇
1		(CI/CH-ML and SM) SILTY CLAY, CLAYEY SILT and SILTY SAND; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff		92.92 0.25	1	SS	6				
2 3		(CI/CH) SILTY CLAY to CLAY; grey brown, contains clayey silt seams, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff		91.95 1.22	2 3 4	SS SS SS	5 5 2	>96 +			
4		(ML) sandy SILT, some gravel; grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, wet, very dense		89.33 3.84	5	SS	>50				
5 6 7 8 9 10		End of Borehole Auger Refusal		88.98 4.19							WL in open borehole at 0.30 m depth below ground surface upon completion of drilling

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: PAH
CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-26

SHEET 1 OF 1

LOCATION: N 5013917.4 ;E 368640.0

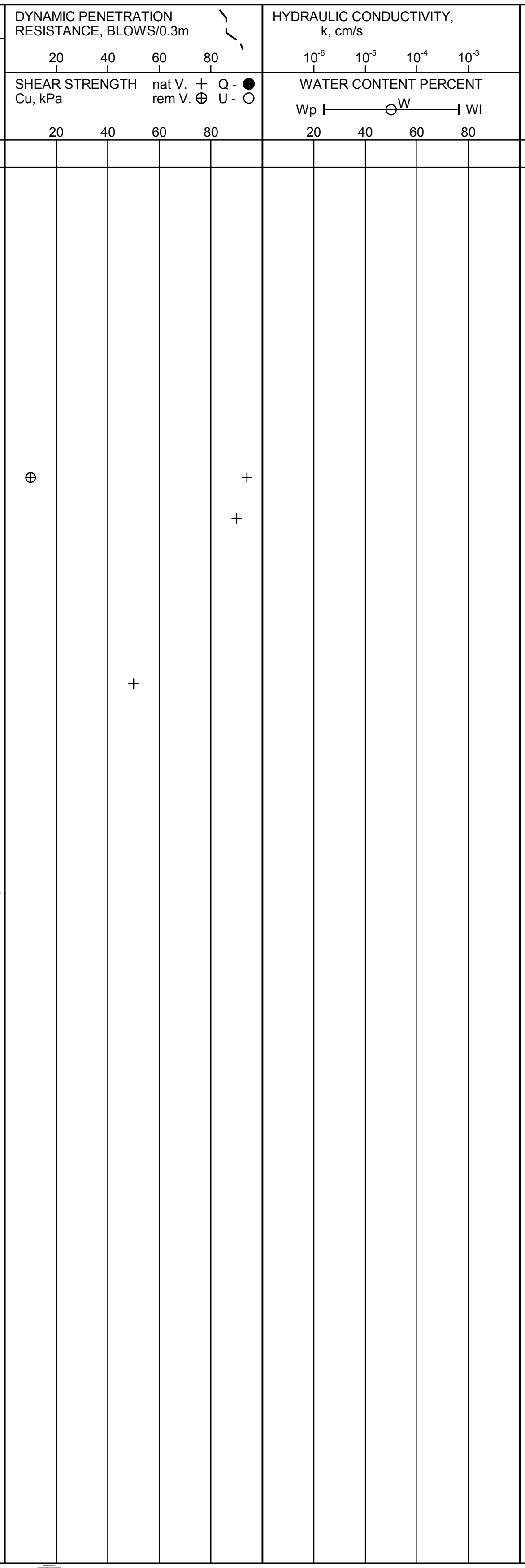
BORING DATE: January 25, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m
		GROUND SURFACE		93.09			
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML) CLAYEY SILT; dark brown; non-cohesive		0.00	1	GRAB	-
		(CI/CH) SILTY CLAY to CLAY; grey brown, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff to stiff		92.86 0.23	2 3	SS SS	5 4
3		(CI/CH) SILTY CLAY to CLAY; grey, contains clayey silt seams; cohesive, w>PL, stiff		90.04 3.05	4	SS	1
		(SP) SAND; grey brown; non-cohesive, wet, compact		89.28 3.81	5	SS	11
		(SM) gravelly SILTY SAND; brown, contains cobbles and boulders; non-cohesive, wet, compact to very dense		88.52 4.57	6	SS	>50
		End of Borehole Auger Refusal		87.57 5.52			



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

∇

WL in open borehole at 0.50 m depth below ground surface upon completion of drilling

MIS-BHS 001 1658448.GPJ GAL-MIS.GDT 10/10/17 JM

DEPTH SCALE

1 : 50

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-27

SHEET 1 OF 2

LOCATION: N 5013836.4 ;E 368790.7

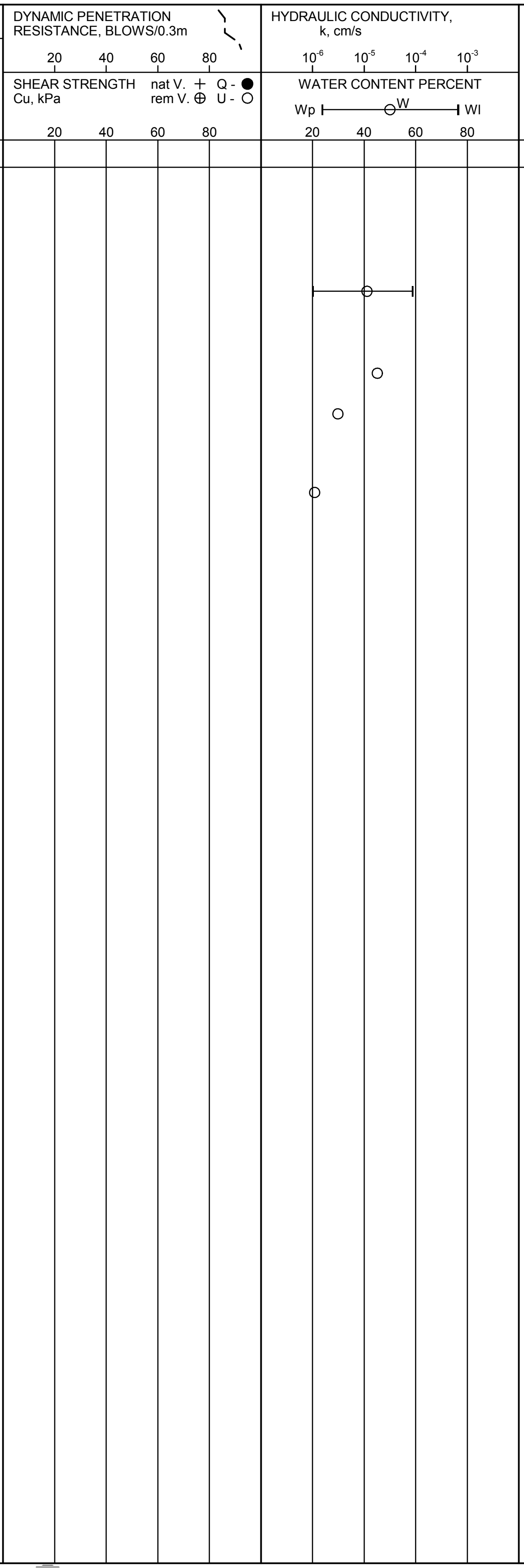
BORING DATE: January 25-26, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	93.85					
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (CL) SILTY CLAY; dark brown; cohesive	0.00					
		(CI/CH) SILTY CLAY to CLAY; grey brown, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff	93.65 0.20					
1				1	SS	6		
				2	SS	4		
2		(SM) gravelly SILTY SAND; brown, contains cobbles and boulders; non-cohesive, wet, loose	92.02 1.83					Native Backfill
				3	SS	8	MH	
3	Rotary Drill NW Tricone			4	RC	DD		
		Borehole continued on RECORD OF DRILLHOLE 17-27	90.57 3.28					
4								
5								
6								
7								
8								
9								
10								



DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF DRILLHOLE: 17-27

SHEET 2 OF 2

LOCATION: N 5013836.4 ;E 368790.7

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: January 25-26, 2017

DRILL RIG: CME 850

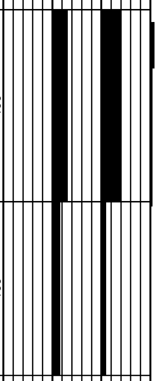
DRILLING CONTRACTOR: CCC

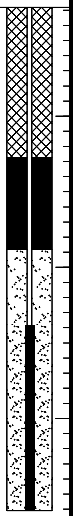
DATUM: Geodetic

JN - Joint
FLT - Fault
SHR- Shear
VN - Vein
CJ - Conjugate
BD- Bedding
FO- Foliation
CO- Contact
OR- Orthogonal
CL - Cleavage
PL - Planar
CU- Curved
UN- Undulating
ST - Stepped
IR - Irregular
PO- Polished
K - Slickensided
SM- Smooth
Ro - Rough
MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN FLUSH	RECOVERY TOTAL CORE % 80 60 40 20	RECOVERY SOLID CORE % 80 60 40 20	R.Q.D. % 80 60 40 20	FRACT. INDEX PER 0.25 m 5 10 15 20	DISCONTINUITY DATA B Angle 0 90 180 270	DIP w.r.t. CORE AXIS 0 30 60 90	TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}	Diametral Point Load Index (MPa) 2 4 6	RMC -Q' AVG.	
		BEDROCK SURFACE		90.57																
4	Rotary Drill NW Tricone	Fresh, thinly to medium bedded, grey, fine grained LIMESTONE BEDROCK		3.28	1	100														Native Backfill
5	Rotary Drill NQ Core				2	100														Bentonite Seal Silica Sand
6				87.24	3	100														Standpipe
7 8 9 10 11 12 13		End of Drillhole		6.61																WL in Standpipe at Elev. 93.05 m on Jan. 30, 2017





DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-27A

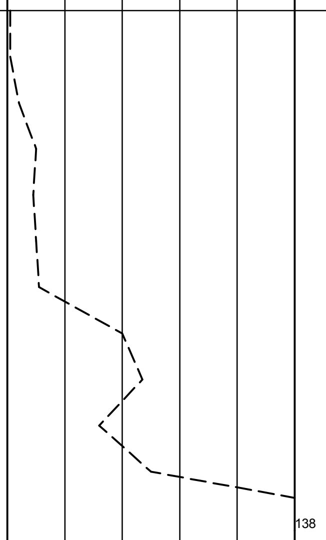
SHEET 1 OF 1

LOCATION: N 5013836.4 ;E 368790.7

BORING DATE: January 25, 2017

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80; SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}; WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		93.85							
0	Power Auger 200 mm Diam. (Hollow Stem)	For soil stratigraphy refer to Record of Borehole 17-27		0.00							
		End of Borehole DCPT Refusal		90.41 3.44				138			



DEPTH SCALE

1 : 50

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-28

SHEET 1 OF 1

LOCATION: N 5013987.7 ;E 368751.8

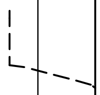
BORING DATE: January 26, 2017

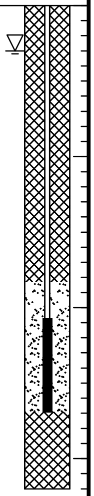
DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa, nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		93.95							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML) CLAYEY SILT; dark brown; non-cohesive		0.00							
		(CI/CH) SILTY CLAY to CLAY; grey brown, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff		93.72 0.23							
1					1	SS	5				Native Backfill
					2	SS	6				
2											Silica Sand
		(SM) gravelly SILTY SAND; brown, contains cobbles and boulders; non-cohesive, wet, compact to dense		91.82 2.13	3	SS	29				Standpipe
3	DCPT Open Hole										Cave
		End of Borehole DCPT Refusal		90.75 3.20							WL in Standpipe at Elev. 93.65 m on Jan. 30, 2017
4											
5											
6											
7											
8											
9											
10											





DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-29

SHEET 1 OF 1

LOCATION: N 5013007.0 ;E 367859.2

BORING DATE: January 23, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] ⊕ ND = Not Detected 20 40 60 80

HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS ☐ [%LEL] ND = Not Detected 20 40 60 80

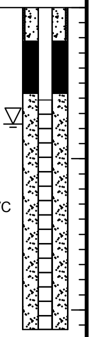
HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80

ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m
		GROUND SURFACE	90.22			
0	Power Auger 200 mm Diam. (Hollow Stem)	FILL - Asphaltic concrete grinding and chunks	0.00	1	GRAB	-
		TOPSOIL - (SM) SILTY SAND; dark brown; non-cohesive	89.84 0.38	2	GRAB	-
		(ML) sandy SILT; grey, with black staining; non-cohesive, moist	0.46			
1		(CI/CH) SILTY CLAY to CLAY; dark grey to red grey with staining, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff	89.46 0.76	3	SS	5
2				4	SS	5
		End of Borehole	88.09 2.13			
3						
4						
5						
6						
7						
8						
9						
10						

PIEZOMETER OR STANDPIPE INSTALLATION



WL in Screen at Elev. 89.45 m on Jan. 30, 2017

DEPTH SCALE
1 : 50

LOGGED: PAH
CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-30

SHEET 1 OF 1

LOCATION: N 5013004.5 ;E 367889.2

BORING DATE: January 13, 2017

DATUM: Geodetic

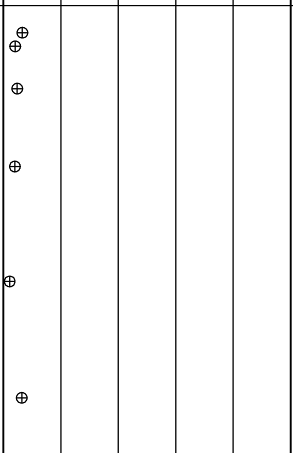
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m
		GROUND SURFACE	89.95			
0	Power Auger 200 mm Diam. (Hollow Stem)	ASPHALTIC CONCRETE	0.00			
		FILL - (SW-GW) SAND and GRAVEL; dark grey brown (PAVEMENT STRUCTURE); non-cohesive, moist	0.10			
		TOPSOIL - (SM) SILTY SAND, fine; black and grey; non-cohesive	0.20			
		(CI/CH) SILTY CLAY to CLAY; grey brown, contains silty fine sand seams, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff	0.34	1	SS	18
1				2	SS	7
2				3	SS	3
				4	SS	2
			87.05			
3		End of Borehole	2.90			
4						
5						
6						
7						
8						
9						
10						

HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] ⊕
ND = Not Detected
20 40 60 80

HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [%LEL] *ND = Not Detected* ☐
20 40 60 80

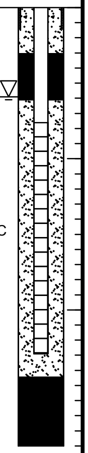


HYDRAULIC CONDUCTIVITY, k, cm/s
10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT
Wp ⊢—○W—⊣ Wl
20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



WL in Screen at Elev. 89.36 m on Jan. 30, 2017

DEPTH SCALE
1 : 50

LOGGED: PAH
CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-31

SHEET 1 OF 1

LOCATION: N 5013000.4 ;E 367874.4

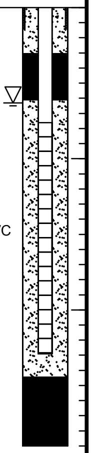
BORING DATE: January 13, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] ⊕ ND = Not Detected (20 40 60 80) / HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [%LEL] ND = Not Detected ☐ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		90.07							
0	Power Auger 200 mm Diam. (Hollow Stem)	FILL - (GP) sandy GRAVEL, angular; grey, contains asphalt fragments; non-cohesive, moist		0.00	1	GRAB	-	⊕			Flush Mount Casing Silica Sand
		(CI/CH) SILTY CLAY to CLAY; grey brown, contains silty fine sand seams, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff		89.77 0.30							Bentonite Seal Silica Sand
1					2	SS	5	⊕			50 mm Diam. PVC #10 Slot Screen
2					3	SS	6	⊕			Silica Sand
					4	SS	2	⊕			Bentonite Seal
3		End of Borehole		87.17 2.90							WL in Screen at Elev. 89.44 m on Jan. 30, 2017
4											
5											
6											
7											
8											
9											
10											



DEPTH SCALE

1 : 50

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-32

SHEET 1 OF 1

LOCATION: N 5013010.6 ;E 367910.1

BORING DATE: January 13, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] ⊕ ND = Not Detected (20, 40, 60, 80) / HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [%LEL] ND = Not Detected ☐ (20, 40, 60, 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}) / WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20, 40, 60, 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	89.84							
0	Power Auger 200 mm Diam. (Hollow Stem)	FILL - (SM-GM) SILTY SAND and GRAVEL; brown; non-cohesive	0.00	1	GRAB	-	⊕			
		TOPSOIL - (ML) sandy SILT; dark brown to black; non-cohesive	0.08							
		(CI/CH) SILTY CLAY to CLAY; grey brown, contains silty fine sand seams, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff	89.54 0.30							
1				2	SS	7	⊕			∇
2				3	SS	3	⊕			
		End of Borehole	87.71 2.13							WL in open borehole at 1.30 m depth below ground surface upon completion of drilling
3										
4										
5										
6										
7										
8										
9										
10										

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: PAH
CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-33

SHEET 1 OF 1

LOCATION: N 5013039.4 ;E 367857.2

BORING DATE: January 23, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] ⊕ ND = Not Detected (20 40 60 80) HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [%LEL] ND = Not Detected ☐ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) WATER CONTENT PERCENT Wp ⊢—O^W—⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		89.99							
0	Power Auger 200 mm Diam. (Hollow Stem)	ASPHALTIC CONCRETE	■	0.00							
		FILL - Asphaltic concrete	▩	0.12 89.66	1	GRAB	-	⊕			
		(ML) CLAYEY SILT; grey with black staining (WEATHERED CRUST); cohesive, w>PL	▨	0.33 89.38	2	GRAB	-	⊕			
1		(CI/CH) SILTY CLAY to CLAY; grey brown and red brown, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff	▨	0.61 88.47	3	SS	6	⊕			
2		(CI/CH-ML and SM) SILTY CLAY, CLAYEY SILT and SILTY SAND; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff	▨	1.52 87.86	4	SS	3	⊕			
		End of Borehole		2.13							
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-34

SHEET 1 OF 1

LOCATION: N 5012981.8 ;E 367911.1

BORING DATE: January 13, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES			HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] ⊕ ND = Not Detected (20, 40, 60, 80) HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS ☐ [%LEL] ND = Not Detected (20, 40, 60, 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}) WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20, 40, 60, 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m				
		GROUND SURFACE		89.99							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML) sandy SILT; dark brown; non-cohesive		0.00	1	GRAB	-	⊕			
		(CI/CH) SILTY CLAY to CLAY; grey brown, contains silty sand seams, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff		89.69 0.30							
1					2	SS	6	⊕			∇
					3	SS	3	⊕			
2		End of Borehole		87.86 2.13							WL in open borehole at 1.06 m depth below ground surface upon completion of drilling
3											
4											
5											
6											
7											
8											
9											
10											

MIS-BHS 001 1658448.GPJ GAL-MIS.GDT 10/10/17 JM

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED: SAT

PROJECT: 1658448

RECORD OF BOREHOLE: 17-35

SHEET 1 OF 1

LOCATION: N 5012965.0 ;E 367856.7

BORING DATE: January 13, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.30m	HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] ⊕ ND = Not Detected (20 40 60 80) / HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS ☐ [%LEL] ND = Not Detected (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	90.45							
0	Power Auger 200 mm Diam. (Hollow Stem)	ASPHALTIC CONCRETE	0.06							
		FILL - (SP-GP) SAND and GRAVEL, angular; grey (PAVEMENT STRUCTURE); non-cohesive, moist		1	GRAB	-	⊕			
		TOPSOIL - (ML) sandy SILT; dark brown; non-cohesive	90.11 0.34							
1		(SM) SILTY SAND; grey brown, contains clayey silt seams; non-cohesive, wet, loose	89.84 0.61	2	SS	7	⊕			
2		(CI/CH) SILTY CLAY to CLAY; grey brown, fissured (WEATHERED CRUST); cohesive, w>PL, very stiff	89.23 1.22	3	SS	5	⊕			
		End of Borehole	88.32 2.13							
3										
4										
5										
6										
7										
8										
9										
10										

DEPTH SCALE

1 : 50

LOGGED: PAH

CHECKED: SAT

APPENDIX B

Results of Chemical Analysis
Eurofins Environmental Testing Report No. 1702728

Certificate of Analysis

Client:	Golder Associates Ltd. (Ottawa) 1931 Robertson Road Ottawa, ON K2H 5B7	Report Number:	1702728
		Date Submitted:	2017-02-23
		Date Reported:	2017-03-01
		Project:	1658448
		COC #:	815945
Attention:	Mr. Alex Meacoe		
PO#:			
Invoice to:	Golder Associates Ltd. (Ottawa)		

Group	Analyte	MRL	Units	Lab I.D. Sample Matrix Sample Type Sampling Date Sample I.D. Guideline	1282299 Soil 2017-01-16 BH17-9 sa3 5-7	1282300 Soil 2017-01-16 BH17-20 sa3 4.5-6.5
General Chemistry	Cl	0.002	%		0.003	<0.002
	Electrical Conductivity	0.05	mS/cm		0.23	0.09
	pH	2.0			7.0	8.4
	Resistivity	1	ohm-cm		4350	11100
	SO4	0.01	%		<0.01	<0.01

Guideline = *** = Guideline Exceedence**

All analysis completed in Ottawa, Ontario (unless otherwise indicated by ** which indicates analysis was completed in Mississauga, Ontario).

Results relate only to the parameters tested on the samples submitted.

Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

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