Consolidated Geotechnical Report

Activa Conservation Subdivision
Phase 2
Waterloo, Ontario

October 17, 2019

Prepared for:

Activa Group
55 Columbia Street E, Suite 1
Waterloo, ON N2J 4N7

Prepared by:

Stantec Consulting Ltd.
100 – 300 Hagey Blvd.
Waterloo, ON N2L 0A4

Project No. 60308671

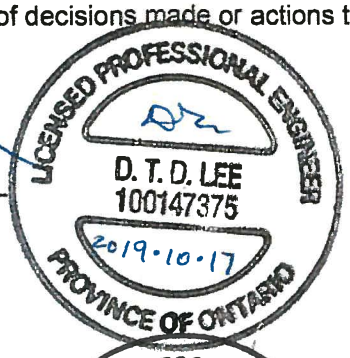
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Prepared by _____
(signature)

David Lee, B.E.Sc.,P.Eng.
Geotechnical Engineering



Reviewed/Approved by _____
(signature)

Jeff Dietz, P.Eng.
Senior Geotechnical Engineer



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1.0 INTRODUCTION

Previously, Activa Group (Client) had commissioned numerous geotechnical investigations to be completed at the Activa Conservation development in Waterloo, Ontario. This report consolidates the technical data from those previous investigations completed by Stantec and Others to support the proposed design and construction of Phase 2 of the residential subdivision development. Phase 2 is situated on the north side of Conservation Drive, between Roy Schmidt Road and Rideau River Street (Site) in Waterloo as shown on Figure 1 in Appendix B.

This report has been prepared specifically and solely for the project described herein. It contains the factual results of the previous geotechnical investigations and provides comments and recommendations and parameters for the proposed design and construction of the residential subdivision.

This report does not address any environmental or hydrogeological aspects of the project. A hydrogeological investigation is being prepared concurrently by Stantec; and, will be issued under separate cover. Limitations associated with this report and its contents are provided in the statement included in Appendix A.

2.0 SITE INVESTIGATION BY STANTEC

Stantec carried out and issued a test pit investigation letter for the site under Project No. 60308671, dated April 4, 2018. The purpose of the investigation was to allow infiltration testing to be conducted using the double ring apparatus; and, to document the soil and groundwater conditions to provide recommendations for pavement design. Nine test pits (TP01-18 through TP07-18) were excavated on March 20, 2018 at locations shown on Figure 2 in Appendix B.

Seven monitoring wells were installed at the site on January 17 and 18, 2018. The purpose of the wells was to monitor the stabilized groundwater levels across the site.

3.0 PREVIOUS SITE WORK BY OTHERS

The previous site investigation reports, listed below, were available to Stantec as technical information to incorporate into this consolidated investigation report. It should be noted that there may be other previous investigations carried out at the site by others not mentioned in this Subsection, however not provided to or reviewed by Stantec.

- Naylor Engineering Associates (Naylor) – Geotechnical Investigation report under Project No. 4500G1.R01, dated February 11, 2003;
  - The geotechnical investigation was conducted to determine subsurface and groundwater information at the site to provide geotechnical recommendations for the design and construction

of the subdivision. The investigation comprised a total of twenty-one (21) boreholes (BH1 through BH21) and thirty-four (34) test pits (TP1 through TP34) advanced across the entire subdivision site. Boreholes BH5, and BH8 through BH16; and, test pits TP1 through TP14, TP16, and TP32 through TP34 were located near to or within the area of Phase 2. The boreholes were advanced to depths between 5.1 m and 9.6 m below existing grades, and the test pits were advanced to depths between 1.0 m and 3.6 m below existing grades.

- Naylor – Groundwater Level Monitoring letter Project No. 4500G2.L08, dated June 9, 2006;
  - This groundwater level monitoring program took place from May 2003 through April 2006;
- Naylor – Monitoring Well Installation report Project No. 4500H1.R01, dated March 5, 2007; and,
  - The report included the installation of five (5) additional monitoring wells (boreholes BH101 through BH105) across the entire subdivision site to further determine subsurface and groundwater information at the site. Boreholes BH104 and BH105 were located within area of Phase 2. They were advanced to depths of 6.6 m and 10.7 m below existing grades.

In 2005 and 2006, area grading occurred in Phase 1 of the subdivision under the supervision of Naylor Engineering Associates Ltd. As part of this work, existing peat and marl deposits were removed near the east edge of the subdivision. The peat and marl removal, and engineered fill placement extended to some degree into the Phase 2 lands. Inspection and compaction reports related to the peat and marl subexcavation that extended into the Phase 2 lands are provided in Appendix E.

4.0 SITE DESCRIPTION

4.1 LOCATION AND CURRENT LAND USE

Phase 2 of the subdivision comprises approximately 7.5-hectares (18.5 acres) of total property situated in the northwest end of Waterloo. The irregular shaped property is bordered by Phase 1 of the subdivision to the north; by Conservation Drive to the south; Roy Schmidt Road to the west; and, by existing residential homes fronting on to Kelso Drive to the east. The Site comprises an agricultural field west of Kawartha Street and open grassed/bush field east of Kawartha Street. A newer house and an older farmhouse with a concrete silo are located on the east side of Roy Schmidt Road. It is noteworthy to mention that there is evidence of previous end fill dumping and fill placement in the central and east portion of the Site.

4.2 TOPOGRAPHY

The Site is sloped with grades falling down generally from north to south, with the lowest grade at the southwest corner of the site. The ground relief between the borehole and test pits locations was approximately 10 m.

It is understood that the topographic information available for this report was obtained out about two years prior.

4.3 REGIONAL GEOLOGY

The Physiography of Southern Ontario, by Chapman and Putnam (1984), indicates that the Site straddles two physiographic regions of Oxford Till Plains to the northeast; and, Waterloo Hills to the southwest. The Oxford Till Plains region is generally faintly drumlinized with flutings, where the till comprises “pale brown, calcareous loam”. The Waterloo Hills region generally comprises “sandy hills, some of them being ridges of sandy till”.

The Ontario Geological Survey Map P.2715, produced by the Ministry of Natural Resources, indicates that the Site straddles two physiographic landforms of Till Plains (drumlinized) on the northeast side; and, Kame Moraines on the southwest side.

5.0 SCOPE OF WORK

The Grading Plan under Stantec Project No. 60308671 was provided and reviewed in preparation of this report. It was understood that the current design includes various blocks for residential and mixed-use development; and, local roads including one new road, and extensions of Wasaga Crescent and Cranberry Street.

5.1 FIELD PROGRAM

Prior to commencing the field investigation, the various public utility companies were consulted to identify where public utilities crossed the property boundaries.

The drilling and excavating work completed by Stantec referred in this report was carried out between January 17 and March 20, 2018. A total of seven (7) boreholes with monitoring wells (MW01-18 through MW07-18) and nine (9) test pits (TP01-18 through TP09-18) were advanced at the Site for this investigation at the locations shown on Figure 2 in Appendix B.

The boreholes were advanced on January 17 and 18 using a track mounted drill rig equipped with solid-stem augers operated by a specialist drilling subcontractor. The boreholes were advanced to depths between 3.0 m and 7.6 m below existing grades. Stantec personnel recorded the subsoil and groundwater conditions encountered in the boreholes. The soil samples were recovered at 0.76 m and 1.52 m intervals using a 51 mm (outside diameter) split-tube sampler by conducting Standard Penetration Tests (SPTs) in accordance with the procedures outlined in ASTM specification D1586. All soil samples recovered from the boreholes were placed in moisture-proof bags and returned to our laboratory for detailed geotechnical classification and testing as required.

Groundwater monitoring wells were installed in all seven (7) boreholes, and the water levels were measured by geotechnical personnel on February 16, 2018. The monitoring wells consisted of 50 mm inside diameter, Schedule 40 PVC pipe, with a No. 10 slot screen (0.01-inch slot) with a length of 1.5 m. The annular space between the monitoring well pipe and surrounding geological formation was backfilled with well sand to the top of screen, with the remainder of the annular space being filled with a granular

bentonite to prevent a hydraulic connection from occurring between the soil layers along the length of the casing.

Stantec carried out a test pit investigation, where nine test pits (TP01-18 through TP09-18) were excavated on March 20, 2018 using a rubber-tired backhoe excavator operated by an excavating subcontractor. The test pits were laid out by Stantec Geomatics in areas where infiltration galleries are proposed to be constructed. The excavations extended to depths generally matching the anticipated basement levels of the surrounding proposed houses and extended to depths between 1.2 m and 2.6 m below existing grades. Bulk soil samples were recovered at regular depth intervals from each test pit. Ring infiltration tests were carried out in the test pits and the results are presented in Section 6.3.

All soil samples recovered from the boreholes were placed in moisture-proof bags and returned to our laboratory for detailed geotechnical classification and testing as required.

5.2 LABORATORY TESTING

All soil samples recovered from the geotechnical investigation were returned to Stantec's geotechnical and materials testing laboratory and were visually examined by a geotechnical specialist.

No geotechnical laboratory testing program was carried out for the Stantec boreholes or test pits.

The soil samples will be stored for a period of three months after issue of this geotechnical report. After the storage period, the samples will be discarded.

6.0 RESULTS OF INVESTIGATIONS

The following sections present the consolidated summary of technical information from the aforementioned previous investigations by Others and the previous fieldwork completed by Stantec. This report should be read in conjunction with the aforementioned investigations reports and letters.

6.1 SUBSURFACE CONDITIONS

The subsurface conditions encountered in the boreholes and test pits are shown on the Borehole Records and Test Pit Records provided in Appendix C. An explanation of the symbols and terms used on the Borehole and Test Pit Records is also provided in the Appendix A.

The stratigraphic boundaries shown on the borehole logs are inferred from non-continuous sampling and should be considered approximate only. Variations to the conditions reported and discussed herein must be anticipated.

In general, the subsurface stratigraphy encountered in the boreholes and test pits advanced at the Site consisted fill or topsoil overlying complex interlayered deposits of sand, silt, and glacial till. In general, existing fill was encountered in the east half of the site; and, sand deposits were predominantly encountered near the centre of the site. Deposits of silt and glacial till were encountered throughout the

site. It is noteworthy to highlight the presence of thick fill that extended past termination depth of 5.2 m in borehole MW07-18; and, thick buried peat that extended to depths between 2.0 m and 3.0 m below existing grades in test pit TP8 and TP13.

Stabilized groundwater levels observed in the boreholes and test pits upon drilling and excavation completion ranged from nil to depths between 0.7 m and 9.5 m below existing grades.

Bedrock was not encountered in the boreholes advanced in the investigations.

The following sections summarize the soil strata encountered in the boreholes and test pits completed for Phase 2 of the subdivision.

6.1.1 Topsoil

Topsoil was encountered at surface in all boreholes and test pits except in boreholes BH104, BH105, MW01-18, MW05-18, MW06-18, MW07-18, and test pits TP01-18 and TP02-18. The topsoil thickness generally ranged between 200 mm to 950 mm thick. Overly thick topsoil with 1450 mm to 1900 m thickness was encountered in test pits TP14 and TP13, respectively.

It is understood that in some time after the Naylor investigations, some topsoil has been stockpiled west of MW05-18 location.

6.1.2 Fill

It should be noted that evidence of significant fill dumping or placement at the site that likely occurred after the Naylor investigations, but before the fieldwork by Stantec.

Fill was encountered in boreholes BH104, BH105, MW01-18, MW05-18, MW06-18, MW07-18, and test pits TP01-18 and TP02-18. In general, the fill extended to depths between 1.4 m and 2.3 m below existing grades. Overly thick fill was encountered in borehole MW07-18 and extended past the termination depth of 5.2 m below existing grades.

The fill was heterogeneous and generally comprised silt, sandy silt, and silty sand, with occasional organics and topsoil inclusions. The fill encountered in Stantec boreholes was mostly described as sandy silt topsoil and sandy topsoil. The fill was observed to be in damp to moist conditions at the time of the fieldwork.

6.1.3 Peat and Marl

Peat and marl were reported in the Naylor report and were encountered in test pit TP8 and TP13 buried below topsoil or alluvial silt and clay at depths between 1.0 m and 1.9 m and extended to depths of 2.0 m and 2.7 m below existing grades. The peat was black amorphous with occasional pieces of wood. The peat had a saturated condition based on high moisture contents ranging between 360% and 610%. Marl was encountered beneath peat in test pit TP13 and was described as grey silty clay at wetter than plastic limit (WTPL) moisture condition. The marl extended to 3.0 m depth.

6.1.4 Silt and Clay (Alluvial)

Modern alluvial silt and clay was reported by Naylor, encountered in test pit TP8 below topsoil. The alluvial silt and clay extended to a depth of 1.0 m below existing grades. The silt and clay was at about the plastic limit (APL) moisture condition.

6.1.5 Silty Clay

Silty clay was encountered beneath topsoil in borehole MW02-18 and extended to a depth of 1.5 m below existing grade.

An N-value of 3 blows per 300 mm obtained from the Standard Penetration Test (SPT) indicated that the silty clay has a soft consistency.

6.1.6 Silt

Silt was encountered in boreholes and test pits; below topsoil in BH10, BH11, BH12, BH13, BH15, BH16, MW03-18, MW04-18, TP1 through TP5, TP9, TP11, TP12, TP16, TP32 through TP34, TP03-18, TP06-18 through TP09-18; below fill in BH105, MW01-18, MW06-18, TP01-18; below sand in BH5, BH8, BH14, TP08-18; and, below silt till in MW02-18. The silt extended past termination depths of 1.0 m and 11.2 m below existing grades in the aforementioned locations; except in boreholes BH10, BH12, BH13, BH16, BH16, BH105, MW03-18 through MW06-18, TP1, TP2, TP9, TP12, TP32, TP34, TP01-18, and TP07-18 where it extended to depths between 0.8 m and 3.1 m below existing grades.

N-values ranging from 6 to 50 blows per 300 mm obtained from the Standard Penetration Test (SPT) indicated that the material encountered in the boreholes has a variable loose to dense compactness condition.

The moisture content of selected samples of the silt ranged from 11% to 27%, which is indicative of wet conditions. One sample from TP12 had a high moisture content of 38%.

In general, the silt was described to contain trace to some sand. Occasional sand or clay seams were reported within the silt deposits. The silt in boreholes BH10, BH16, and in test pits TP3, TP12, TP16, TP34 were described as clayey silt. The silt in boreholes MW02-18, MW03-18, and in test pits TP01-18, TP03-18, TP06-18, TP07-18, TP09-18 was described to contain some clay.

6.1.7 Sand, Silty Sand

Sand or silty sand was encountered in boreholes and test pits; below topsoil in BH5, BH6, TP04-18, TP05-18; below fill in MW05-18; below silt in BH13, BH15, BH105, MW04-18, MW06-18, TP1, TP2, TP9, TP12, TP32, TP33, TP06-18; below silt till in BH14, BH104, TP6, TP08-18; and, below clay in TP13. The sand extended past termination depths of 1.1 m and 10.7 m below existing grades in the aforementioned locations; except in boreholes BH5, BH8, BH14, BH15, MW04-18, test pits TP06-18 and TP08-18 where it extended to depths between 1.0 m and 8.6 m below existing grades.



N-values generally ranging from 6 to greater than 50 blows per 300 mm obtained from the Standard Penetration Test (SPT) indicated that the materials encountered in the boreholes have a variable loose to very dense compactness condition. N-values of 2 to 3 were obtained from the upper 2.0 m in borehole BH5, which is indicative of very loose compactness condition.

The moisture contents of the sand ranged from 2% to 21% indicative of damp to wet conditions.

A grain size analysis was completed by Naylor on a sample of the silty sand, and the results are shown on Figure 1 in Appendix D and summarized in Table 6.1 below.

Table 6.1 Gradation Analysis Results for Silty Sand Soil

Borehole No.	Sample No.	Sample Median Depth (m)	Gravel (%)	Sand (%)	Silt and Clay (%)
BH5	SS4	3.3	0	61	39

A standard Proctor moisture-density test was completed by Naylor on a sample of the sand, and the results are shown on Figure 4 in Appendix D and summarized in Table 6.2 below.

Table 6.2 Standard Proctor Moisture-Density Test Results for Sand Soil

Borehole No.	Sample No.	Sample Median Depth (m)	Standard Proctor Maximum Dry Density (tonnes/m^3)	Optimum Moisture Content (%)
BH5	SS4	3.3	1.735	13.8

6.1.8 Silt Till

Silt till was encountered in boreholes and test pits; beneath topsoil in BH9, BH14; beneath fill in BH104; beneath silt in BH10, BH12, BH16, MW03-18, TP01-18; beneath sand in MW04-18; and, beneath silty clay in MW02-18. The silt till extended past termination depths of 1.3 m and 5.3 m below existing grades in the aforementioned locations; except in boreholes BH14, BH104, MW02-18, test pits TP6 and TP08-18 where it extended to depths between 0.7 m and 3.8 m below existing grades.

Silt till encountered in boreholes BH9, BH10, BH12, BH14, BH104, and in test pits TP6, TP7, TP10, TP14 was described as clayey silt till or silt till with some clay.

N-values generally ranging from 9 to 36 blows per 300 mm obtained from the Standard Penetration Test (SPT) indicated that the materials encountered in the boreholes have a loose to dense compactness condition for the non-cohesive till or stiff to hard consistencies for the cohesive till.

The moisture contents of the silt till ranged from 12% to 24% indicative of wet conditions.

A grain size analysis was completed by Naylor on a sample of the silt till, and the results are shown on Figure 1 in Appendix D and summarized in Table 6.3 below.

Table 6.3 Gradation Analysis Results for Silt Till Soil

Borehole No.	Sample No.	Sample Median Depth (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
BH14	SS2	1.7	0	22	57	21

A standard Proctor moisture-density test was completed by Naylor on a sample of the silt till, and the results are shown on Figure 3 in Appendix D and summarized in Table 6.4 below.

Table 6.4 Standard Proctor Moisture-Density Test Results for Silt Till Soil

Borehole No.	Sample No.	Sample Median Depth (m)	Standard Proctor Maximum Dry Density (tonnes/m^3)	Optimum Moisture Content (%)
BH14	SS2	1.7	1.960	11.9

6.2 GROUNDWATER

Groundwater observations were carried out in the open boreholes upon drilling completion; in the open test pits upon excavation completion; and, periodically in the groundwater monitoring wells installed across the site. Naylor had carried out a groundwater monitoring program between May 2003 and April 2006 as summarized in a letter under reference no. 4500G2.L08.

The following Table 6.5 includes the highest groundwater elevations measured by Naylor and by Stantec in boreholes from the Phase 2 area. A high groundwater contour plan prepared as part of the hydrogeological investigation is provided in Appendix B.

Table 6.5 Highest Measure Groundwater Level in Monitoring Well

Borehole No.	Date of Highest Groundwater Reading	Ground Surface Elevation at Date of Drilling (m)	Highest Depth to Groundwater Below Existing Grades (m)	Highest Recorded Groundwater Elevation (m)
BH5	Jul. 16, 2005	363.4	6.2	357.2
BH8	Jul. 30, 2004	362.3	7.7	354.6
BH9	Dec. 30, 2004	363.2	At surface	363.2
BH10	May 10, 2004	359.0	2.4	356.6
BH12	Dec. 11, 2003	355.50	0.2	355.3
BH15	May 10, 2004	357.6	3.5	354.1
BH16	May 10, 2004	358.3	4.2	354.1
BH104	Apr. 27, 2007	362.7	8.2	354.5
BH105	Apr. 27, 2007	358.0	3.9	354.1
MW01-18	Apr. 22, 2019	356.19	1.47	354.72
MW02-18	Apr. 22, 2019	353.54	0.62	352.92
MW03-18	Feb. 22, 2018	356.92	0.64	356.28

Borehole No.	Date of Highest Groundwater Reading	Ground Surface Elevation at Date of Drilling (m)	Highest Depth to Groundwater Below Existing Grades (m)	Highest Recorded Groundwater Elevation (m)
MW04-18	Apr. 22, 2019	354.58	0.55	354.03
MW05-18	Feb. 22, 2018	361.38	6.89	354.49
MW06-18	May 21, 2019	355.42	1.26	354.16
MW07-18	Mar 21, 2019	360.07	3.27	356.80

The following Table 6.6 includes test pits with groundwater seepage observed by Naylor and by Stantec from the Phase 2 area.

Table 6.6 Measured Seepage in Open Test Pits

Test Pit No.	Date of Highest Groundwater Reading	Ground Surface Elevation at Date of Excavating (m)	Depth to Seepage Below Existing Grades (m)	Elevation to Seepage (m)
TP8	Dec. 10, 2002	359.1	1.5	357.6
TP12	Dec. 10, 2002	357.7	0.6	357.1
TP03-18	Mar. 20, 2018	356.7	1.7	355.0
TP04-18	Mar. 20, 2018	354.4	0.8	353.6
TP06-18	Mar. 20, 2018	355.3	1.0	354.3

The seepage elevations noted are subject to seasonal fluctuations.

6.3 INFILTRATION TESTING

Stantec carried out infiltration testing at the bottom of test pits TP01-18 through TP06-18, and TP09-18. The test pit depths were chosen to be near the proposed basement depths of near-by proposed houses. A double ring apparatus was used for the tests. The results of the infiltration testing are provided in the following Table 6.7:

Table 6.7: Infiltration Testing

Test Pit No.	Test 1 (mm/hr)	Test 2 (mm/hr)	Average (mm/hr)	Notes
TP01-18	3	2	2.5	
TP02-18	20	18	19	
TP03-18	0	N/A	N/A	Groundwater upwelling into test pit, test abandoned
TP04-18	N/A	N/A	N/A	Groundwater in test pit
TP05-18	135	131	133	Only test to have seemingly sandy soils
TP06-18	N/A	N/A	N/A	Groundwater in test pit
TP09-18	3	4	3.5	

7.0 GEOTECHNICAL ENGINEERING ASSESSMENT

7.1 SUMMARY AND EVALUATION OF EXISTING CONDITIONS

The stratigraphy encountered in the boreholes and test pits generally consist of surficial topsoil or fill underlain by layers of sands, silts, and silt till. Buried peat and marl were encountered extending to depths between 2.0 m and 3.0 m below existing grades (Elevations 357.1 m and 355.2 m) in test pits TP8 and TP13, which were located along the north limits of Phase 2. Significant existing fill was encountered within the east half of the site, most notably in borehole MW07-18, where the fill extended past the termination depth of 5.2 m. The southwest corner of the site was underlain by shallow groundwater at or near surface.

The following general development considerations and constraints are provided with respect to observations made during the investigation, the subsurface conditions encountered, and the intended scope of development:

- Shallow groundwater and sub-artesian conditions were noted in borehole and test pit locations BH9, BH12, MW02-18, MW03-18, MW04-18, TP4, and TP12;
- Topsoil, buried peat, and existing fill are not suitable to support house and townhouse footings. The exception would be for any existing fill where there are records that can prove that it was placed as engineered fill for the purpose of supporting residential houses;
- Peat and marl were encountered in TP8 and TP12 from the previous investigations. Test pits are recommended to confirm whether this organic material has been removed during previous grading on the property;
- Options for foundation construction on site are provided below:
  - Footings Placed on Native Soil
    - The houses could be designed with basements to a depth such that footings are placed on the approved native subgrade soil below the minimum depths to competent subgrade, as outlined on Table 7.1 in Section 7.3.1 below;
  - Footings Placed on Engineered Fill
    - In areas where grades are required to be raised or where existing fill needs to be removed, engineered fill will be required. Engineered fill should comprise imported OPSS Granular 'B' (recommended), OPSS Select Subgrade Material (SSM), or approved on-site materials compacted to 98% SPMDD. The engineered fill must be placed under full-time monitoring by Stantec geotechnical personnel;
- The use of conventional asphalt pavements for roads, internal driveways, and parking areas are considered suitable for the site; and,
- The program for grading and earthworks should be designed in advance, and carefully executed in consideration of the time of year of execution, prevailing weather conditions, surface runoff control, and associated issues and concerns, and the intended end-use of the property as described.

Additional geotechnical comments, discussion, and recommendations are provided in the following sections with respect to the design and construction of low rise residential buildings.

If future plans for the proposed development changes to include medium or high-rise buildings, this office should be notified, and additional deeper boreholes should be advanced at the Site, at an additional cost.

7.2 GRADING AND EARTHWORKS

A Grading Plan showing the proposed lots and road alignment; proposed finished grades; and, topographic information was available for the Site at the time of this report. A Cut-Fill Plan based on topographic survey was also available for review. Significant area grading involving cutting and filling in the order of 2 to 5 m (exclusive of recent topsoil and fill stockpiles) is anticipated for this site as based on the Cut-Fill Plan. Refer to the Cut-Fill Plan shown in Figure 2 in Appendix B.

Any existing buildings in proposed cut and fill areas that are not to remain should be demolished and removed prior to grading activities. This should include removal of foundations and floor slabs.

As previously noted, fill was encountered in the east half of the site. Unless there is documentation showing that this material was placed and certified as engineered fill to support residential buildings, it will need to be subexcavated from below proposed building footprints and either removed from site or re-used to raise grades in landscaped areas. The excavated fill without topsoil may be used as foundation backfill, road subgrade fill, or as engineered fill subject to field approval by geotechnical personnel.

Prior to cut and fill operations, the existing surficial topsoil will need to be removed from both cut and fill locations. Subsequent to completing the stripping and removal of any fill materials, the exposed subgrade surface will largely consist of native sand, silt, or silt till. The exposed subgrade surface should be inspected by geotechnical personnel to confirm the removal of any deleterious materials, organics, or loose/soft materials or wet zones. Where such materials are identified, they should be removed, and the areas backfilled with engineered fill in accordance with the recommendations provided below.

Buried peat and marl were encountered in test pit TP8 and TP13 buried below topsoil or alluvial silt and clay at depths between 1.0 m and 1.9 m and extended to depths of 2.0 m and 3.0 m below existing grades. Records from previous materials testing and inspection work at the site (Appendix E) show that the peat at the northeast corner of the site was removed under the supervision of Naylor Engineering Associates Ltd. from Lot 43 Rideau River Street to 50 m south of Lot 43 Rideau River Street; however, this removal may not have included the rear 10 m of the lots. Additional test pits or boreholes should be advanced to delineate the extent of the peat or confirm that it has been removed during grading of previous stages of the subdivision.

The exposed subgrade surface must be proof-rolled and compacted using large, smooth drum vibratory compaction equipment with a minimum static weight of ten tonnes. This will provide a uniform, compact surface to provide a uniform surface for construction and to confirm that the surficial soils have been compacted to achieve the required density consistent with the placement of engineered fill as discussed below.



Excavation in the native mineral soils should be straight forward using large tracked excavating equipment. Further comments with respect to reuse of this soil are provided below. In general, it is recommended that engineered fill be placed immediately after stripping/subexcavation and inspection.

It is anticipated that native on-site soils from cut areas will be used to raise grades in low areas of the site, including areas requiring engineered fill to support buildings. The suitability of native soils for re-use on site is discussed in Section 7.2.1, below. Imported engineered fill materials may also be required for raising the grade on site. Additional details with respect to materials recommended for use during periods of poor weather conditions are discussed below. Imported Granular 'B' (recommended) or OPSS SSM are recommended for use as engineered fill below buildings. In areas of wet and pumping subgrade, a pit run (boney) sand and gravel is recommended for the initial lift of the engineered fill, which should be anticipated in areas with shallow or near surface groundwater, most notably around borehole BH12, MW02-18, MW03-18, and MW04-18 locations.

All fill materials imported to the site must meet all applicable municipal, provincial, and federal guidelines and requirements associated with environmental characterization of the materials.

All materials placed as engineered fill should be placed in 300 mm thick loose lifts. Each lift should be uniformly compacted to achieve a minimum of 98% of the material's Standard Proctor Maximum Dry Density (SPMDD). The edges of the engineered fill pad must extend horizontally 1.0 m from edges of proposed buildings, plus downwards and outwards at a slope of 1 horizontal to 1 vertical from the proposed bottom of foundations to competent soil. Geotechnical comments with respect to excavations are provided in Section 7.5.

Any fill placed in paved areas should be placed in 300 mm thick loose lifts compacted to a minimum of 95% SPMDD up to 1.0 m below the subgrade level and 98% above this level.

The program for grading and earthworks should be designed in advance, and carefully executed in consideration of the time of year of execution, prevailing weather conditions, construction storm-water management control, and associated issues and concerns, and the intended end-use of the subject property as described herein.

7.2.1 Site Materials Reuse

Generally, the existing fill encountered during the investigations can be considered suitable for reuse under landscaped areas or as general use in backfilling service and sewer trenches provided any buried topsoil or organic materials are not included. There is a potential to reuse some portions of the existing fill as engineered fill provided it is approved on-site by geotechnical personnel. This should be left as a field decision.

The existing fill is not suitable for reuse as granular base and sub-base materials, or for similar applications where development of frost could jeopardize the serviceability of the planned infrastructure.

The results of the moisture content tests and visual inspection of the samples obtained from the investigation indicate that the 'possible fill' may require drying prior to re-use.



The native mineral soils should be suitable for re-use as engineered fill or road fill. The moisture contents in the siltier portions may make allowing drying time necessary for use of this material as engineered fill. In dry and warm weather, it is possible that water may need to be added to the native sand to aid in compaction. The native sand is not expected to be suitable for use as road base or sub-base materials. Native clayey soils may become blocky when excavated, which will require to be broken down in thin lifts (200 mm or less).

7.2.2 Adverse Weather Construction

Additional precautions, effort, and measures may be required, when and where construction is undertaken during late fall, winter, and early spring when the temperature and climatic conditions have an adverse influence on the standard construction practices or during periods of inclement weather.

With respect to all earthworks activities undertaken during the late fall through to late spring, when less-than-ideal construction conditions may prevail, the following comments are provided:

1. Engineered fill may consist of granular materials, approved native soils and existing fill, imported Granular 'B' (recommended) or OPSS SSM.
2. The intended area of fill should be clearly identified in the field prior to commencing the work.
3. Temporary ramps or roads for construction access should be constructed outside of the limits of intended fill.
4. Fill placement should be inspected by qualified field personnel on a full-time basis under the supervision of a geotechnical engineer, with the authority to stop the placement of fill at any time when conditions are considered to be unfavourable.
5. Imported materials that contain ice, snow, or any frozen material should not be accepted for use.
6. Overnight frost penetration may occur, even in granular fill materials, where precipitation and ground surface runoff pools and accumulates, and freezing temperatures exist. Any frozen materials must be removed prior to placing subsequent lifts of engineered fill. Breaking the frost in-situ is not considered acceptable.
7. It may be necessary to stop the placement of engineered fill during periods of cold, where ambient temperatures of -5°C or less, occur.

It should be noted that the placement of engineered fill materials during cold weather conditions requires extra effort beyond that typical when better climatic conditions prevail. At any time where conditions are deemed unfavourable, the engineered fill operation must be suspended.

Appropriate scheduling of the work may also require specific consideration and revision from the typical adopted. The scope of work intended may have to be reduced or adjusted, and/or only select construction activities are undertaken during specific climatic conditions. The areas of planned engineered fill may have to be reduced on a daily basis, the extent of excavations may have to be limited, with all excavating and associated backfilling completed without delay.

7.3 FOUNDATIONS

The following subsections include discussions and recommendations for foundation options for review by the designer.



7.3.1 Footings on Native Subgrade

The existing fill, buried peat, and any soft or loose native soils are not suitable to support footings. Conventional shallow spread and strip footings for the buildings can be founded on approved competent native subgrade soils. The depth and elevation of competent soil identified in each borehole is provided in Table 7.1 below.

Table 7.1 Minimum Depth to Competent Soils

Borehole or Test Pit No.	Minimum Depth Below Existing Grades to Competent Subgrade (m)	Elevation of Competent Subgrade (m)	Measured Groundwater Depth (m)	Measured Groundwater Elevation (m)
BH11	1.5	360.6	Dry	N/A
BH12	0.5	355.0	1.5	354.0
BH13	1.7	359.5	Dry	N/A
BH14	0.5	356.8	3.0	354.3
BH15	0.5	357.1	4.2	353.4
BH16	0.5	357.8	4.1	354.1
BH105	1.0	357.0	3.9	354.1
MW01-18	3.0	353.2	2.1	354.1
MW02-18	1.5	352.0	0.9	352.6
MW03-18	1.0	355.9	0.7	356.2
MW04-18	0.8	353.8	0.8	353.8
MW05-18	2.4	359.0	6.9	354.5
MW06-18	1.6	353.8	1.7	353.7
MW07-18	TBC	TBC	4.7	355.4
TP1	1.1	354.3	Dry	N/A
TP2	1.1	354.3	Dry	N/A
TP3	0.5	358.5	Dry	N/A
TP4	0.9	353.4	Dry	Refer to MW04-18
TP5	1.0	355.7	Dry	Refer to MW03-18
TP6	0.5	364.7	Dry	TBC
TP7	0.7	359.7	Dry	TBC
TP8*	2.1	357.0	1.5	357.6
TP9	0.6	358.6	Dry	N/A
TP11	1.1	355.3	Dry	N/A
TP12	0.6	357.1	0.6	357.1
TP13*	3.1	355.1	Dry	N/A
TP34	0.8	360.6	Dry	N/A

Borehole or Test Pit No.	Minimum Depth Below Existing Grades to Competent Subgrade (m)	Elevation of Competent Subgrade (m)	Measured Groundwater Depth (m)	Measured Groundwater Elevation (m)
TP01-18	1.5	357.8	Dry	N/A
TP02-18	TBC	TBC	Dry	TBC
TP03-18	0.5	356.2	1.7	357.6
TP04-18	0.4	354.0	0.8	353.6
TP05-18	0.4	358.0	Dry	N/A
TP06-18	0.5	354.8	1.2	354.1
TP07-18	0.5	356.0	Dry	N/A
TP08-18	0.5	359.0	Dry	N/A
TP09-18	0.6	359.9	Dry	N/A

TBC denotes boreholes or test pits terminated in fill and require to be confirmed with additional boring or test pit.

*denotes buried peat

Footings constructed on the natural subgrade soil below the minimum depths as set in the above Table 7.1, or on engineered fill placed and compacted as noted in Section 7.2 can be proportioned for a geotechnical resistance at Serviceability Limit States (SLS) of 150 kPa, and a factored geotechnical resistance at Ultimate Limit States (ULS) of 225 kPa. The Ultimate Limits States (ULS) values provided above include a resistance factor of 0.5. The Serviceability Limits States (SLS) reaction values have been evaluated to provide a total settlement of 25 mm (or less) and differential settlement of 19 mm.

Where required, new footings can be stepped with a maximum height of 600 mm over a minimum 600 mm horizontal distance.

The footings must be provided with a minimum of 1.2 m of soil cover for frost protection. Where construction is undertaken during winter conditions, the footing subgrade must be protected from freezing.

7.3.2 Foundation Drainage

Foundation drainage should be provided for buildings constructed at this site with basements. The drainage should comprise 100 mm diameter perforated corrugated pipe with filter sock bedded in concrete sand. The drainage should outlet to a sump pit.

7.3.3 Earthquake Design Considerations

The National Building Code specifies that structures should be designed to withstand forces due to earthquake.

For the purpose of earthquake design the relevant geotechnical information required based on the conditions at this site is the “Site Class”. For buildings being designed under Part 4 of the Ontario Building Code, we recommend that Site Class D be applied to this site, in accordance with Table 4.1.8.4.A of the National Building Code (2010).

7.3.3.1 NBC Seismic Hazard Data

A copy of the NBC Seismic Hazard Calculation Data sheet prepared by Natural Resources Canada is provided in Appendix F for reference.

The peak horizontal ground acceleration (PGA) for various return periods based on the Natural Resource Canada values are summarized below in Table 7.2 for reference.

Table 7.2 Summary of Peak Horizontal Ground Accelerations

Return Period	Probability of Exceedance in 50 years	PGA (g)
100 yrs.	40%	0.0080
475 yrs.	10%	0.026
2500 yrs.	5%	0.042

7.4 BASEMENT FLOOR SLABS

The designer should ensure separation between the measured groundwater elevation noted in Table 7.1 and the lowest slab of structures. Shallow groundwater is observed at the Site.

At TP03-18 and TP06-18 the seepage was observed from a low permeability soil and the rate of seepage was low. Based on this observation, any seasonal groundwater above design house basement levels is considered to be in a perched condition and/or from thin seams within a low permeability soil deposit. As such, any seasonal seepage is expected to be adequately handled by the residential building’s footing weepers and sump pit.

A layer of free-draining granular material such as OPSS Granular ‘A’, or clear stone, at least 150 mm thick, should be placed immediately beneath the slab. This layer will act as a leveling course and as a moisture break under the floor slab(s).

7.5 EXCAVATIONS AND BACKFILL

7.5.1 Excavations

Concept plans for storm and sanitary sewer indicate that they will typically be 2 to 6 m below finished grade.

Temporary excavations must be carried out in accordance with the latest edition of the Occupational Health and Safety Act (OHSA).

The existing fill and native soils encountered in the investigations should be classified as Type 3 soils. The maximum excavation side slopes for a Type 3 soil is 1:1 (Horizontal: Vertical) from the base of excavation in accordance with the OHSA regulation.

Any soils encountered that have groundwater seepage, or organic soils should be classified as Type 4 soil. The maximum excavation side slope for a Type 4 soil is 3:1 (Horizontal: Vertical) in accordance with the OHSA regulation, in accordance with the OSHA regulation.

The side slopes of the excavations in soils should be protected from exposure to precipitation and associated ground surface runoff, to prevent further softening and loss of strength of these fill materials and soils that could lead to additional sloughing and caving.

If space is restricted such that the side slopes cannot be safely cut back in accordance with the OHSA Regulation, or sloughing and cave-in are encountered in the excavation, the slopes should be flattened to achieve a stable configuration or temporary shoring must be provided.

Any seepage encountered during the proposed construction should be handled by pumping from sumps using conventional submersible pumps provided the excavations remain open for a short period of time, less than 48 hours.

Locally, near the middle of the site (near MW04-18 and MW05-18), excavations may extend 1 to 2 m into saturated sand. A positive dewatering system may be required for sewer installation in this area.

If localized instability is noted during excavation or if wet conditions are encountered, the side slopes should be flattened to a stable configuration.

7.5.2 Bedding and Backfill

Pipe bedding materials specifications for underground utilities should be in accordance with the manufacturer's and/or the designer's recommendations. Granular bedding materials should be adequate for service installations for the subject property.

It is suggested that the bedding material be placed around the sewer pipes with a minimum of 300 mm cover on all sides of the pipe. The granular bedding should comprise OPSS Granular 'A' and be compacted to a minimum of 100% SPMDD. The bedding should meet the requirements of Region of Waterloo and Area Municipalities Design Guidelines and Supplementary Specifications Drawing E1-01.

Backfill for trenches may consist of approved portions of the 'proposed fill', or native soils, subject to the constraints and limitations stated above with respect to reuse of these soils, or the use of imported Granular 'B' Type I may also be considered for use as necessary to augment the available on-site materials.

All trench backfill should be placed in 300 mm thick loose lifts and compacted to a minimum of 98% SPMDD.

Water, sewer, and storm lines installed outside of heated areas should be provided with a minimum of 1.2 m of soil cover for adequate frost protection.

Backfill adjacent to the building perimeter foundation walls should consist of free-draining, non-frost susceptible granular materials, such as OPSS Granular 'B' Type I. Alternatively, siltier materials can be used as foundation backfill as long as a manufactured drainage layer is provided on the exterior of the portions of walls below grade.

7.6 DEWATERING

Concept plans for storm and sanitary sewer indicate that they will typically be 2 to 6 m below finished grade. In the middle of the site, proposed sanitary elevations are approximately Elevation 352 m in the area of MW04-18 and MW05-18.

Shallow free groundwater was encountered in monitoring wells located in low lying areas at the southwest corner of the site. Seepage from the silty and clayey soils should be handled by pumping from sumps using conventional submersible pumps provided the excavations remain open for a short period of time.

Locally, near the middle of the site (near MW04-18 and MW05-18), excavations for sewer construction may extend 1 to 2 m into saturated sand. A positive dewatering system may be required for sewer installation in this area.

It should be noted that consistent with the current Ontario Ministry of the Environment and Climate Change (MOECC) regulations, an Environmental Activity and Sector Registry (EASR) is required for dewatering more than 50,000 L/day and a Permit to Take Water (PTTW) is required for dewatering more than 400,000 L/day.

A contractor test dig is recommended at time of tendering in order to allow the prospective bidder to review the subsoil and groundwater conditions to their satisfaction.

7.7 PAVEMENT STRUCTURE DESIGN

Provided that the exposed subgrade surface is prepared in accordance with the recommendations provided in the previous sections of this report, and all required earthworks are conducted as recommended herein, the asphalt pavement structures provided below can be considered for use at this site.

The existing fill may remain in-place under the pavement structure providing a satisfactory proof-roll is carried out.



Table 7.3 Recommended Asphalt Pavement Structure Design

Material	Pavement Component Thicknesses (mm)	
	Local Road	Internal Road (Condos)
HL3 (top course asphaltic concrete) PGAC 58-28	35 mm	35 mm
HL8 (base course asphaltic concrete) PGAC 58-28	65 mm	55 mm
OPSS.MUNI 1010 Granular 'A' Base	150 mm	150 mm
RWSSP 1010 Granular 'B' Sub-base	450 mm	300 mm

The design shown above should provide a pavement service life in the order of 15 years, although additional operation and maintenance effort beyond that considered typical, may be required during the life cycle of the pavements. The above pavement design was based on typical expected use along with anticipated subgrade conditions. It should be noted that no traffic data was provided to Stantec at the time of this design, and thus a detailed pavement design analyses was not carried out.

The base and sub-base materials should be compacted to a minimum of 100% SPMDD. The asphaltic concrete should be compacted to a minimum of 92% Maximum Theoretical Relative Density (MTRD).

Pavement subdrains are recommended along the edges of roads, below the curbs in areas of poor draining subgrade. The subdrains should comprise 100 mm diameter perforated corrugated pipe with filter sock bedded in concrete sand. The top of pipe should be below the lower limit of the granular subbase, and the subgrade below the subbase should slope towards the subdrains. The subdrains should be graded towards a suitable frost-free outlet such as a catch basin. The locations requiring subdrains should be confirmed during the pavement subgrade inspection as the type of additional pavement subgrade fill that will be placed in the future is not known.

7.8 SURFACE WATER MANAGEMENT

7.8.1 Infiltration Galleries

Infiltration galleries are proposed throughout the Site. Based on the design drawings, infiltration galleries are proposed along the front boulevards of most roads.

7.8.2 Estimates of Hydraulic Conductivity

It is noted that the industry typically refers to "hydraulic conductivity" rather than "coefficient of permeability" in this respect. The terms are often considered interchangeable, but for purposes of this report the values provided are in the form of "length/time" (cm/sec) and are therefore considered strictly applicable to "hydraulic conductivity", and hence "hydraulic conductivity" is used herein.



Based on the results of the double ring infiltration testing, the following values are provided:

- Sand 10-3 to 10-4 cm/sec
- Silty Sand 10-4 to 10-5 cm/sec
- Silt 10-5 to 10-6 cm/sec
- Clayey Silt, Silt Till greater than 10-6 cm/sec

The OBC states, in part, that “it must be emphasized that, particularly for fine grained soils, there is no consistent relationship (between coefficient of permeability and soils of various types) due to the many factors involved”. Such factors as structure, mineralogy, density (compactness or consistency), plasticity, and organic content of the soil can have a large influence on the hydraulic conductivity; variations in excess of an “order of magnitude” are common place in this respect.

In general, the on-site sands are expected to be conductive to stormwater infiltration. Infiltration may also be considered in the native glacial till provided the infiltration trenches are properly sized for the lower hydraulic conductivity, and an overflow outlet is provided.

8.0 CLOSURE

Use of this report is subject to the Statement of General Conditions provided in Appendix A. It is the responsibility of Activa Group, who is identified as “the Client” within the Statement of General Conditions, and its agents to review the conditions and to notify Stantec should any these not be satisfied. The Statement of General Conditions addresses the following:

- Use of the report;
- Basis of the report;
- Standard of care;
- Interpretation of site conditions;
- Varying or unexpected site conditions; and,
- Planning, design or construction.

Respectfully Submitted,

STANTEC CONSULTING LTD.

APPENDICES

Appendix A

A.1 STATEMENT OF GENERAL CONDITIONS

STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec Consulting Ltd. and the Client. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Stantec Consulting Ltd.'s present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec Consulting Ltd. is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec Consulting Ltd. at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec Consulting Ltd. must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec Consulting Ltd. will not be responsible to any party for damages incurred as a result of failing to notify Stantec Consulting Ltd. that differing site or sub-surface conditions are present upon becoming aware of such conditions.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec Consulting Ltd., sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec Consulting Ltd. cannot be responsible for site work carried out without being present.

Appendix B

B.1 DRAWINGS



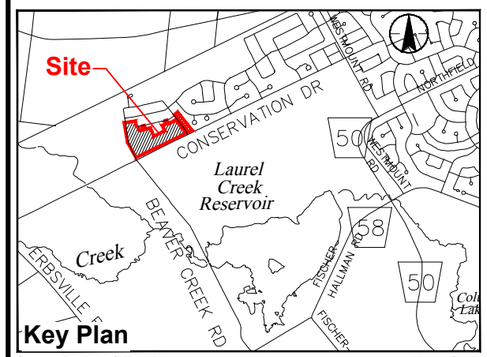
Stantec
100-300 Hagey Boulevard
Waterloo ON N2L 0A4
www.stantec.com

LEGEND

- PROPERTY LIMIT
- LOT LINE
- ROAD
- BOREHOLE LOCATION (STANTEC, FEBRUARY 2018)
- TEST PIT LOCATION (STANTEC, MARCH 2018)
- BOREHOLE LOCATION (NAYLOR, PROJ. No. 4500H1.R01, FEBRUARY 2007)
- BOREHOLE LOCATION (NAYLOR, PROJ. No. 4500G1.R01, FEBRUARY 2003)
- TEST PIT LOCATION (NAYLOR, PROJ. No. 4500G1.R01, FEBRUARY 2003)

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N.
2. BASE FEATURES PRODUCED UNDER LICENSE WITH THE ONTARIO MINISTRY OF NATURAL RESOURCES © QUEEN'S PRINTER FOR ONTARIO, 2018.



Source: Region of Waterloo — Not to Scale

20 m 0 20 40 m
1 : 2000

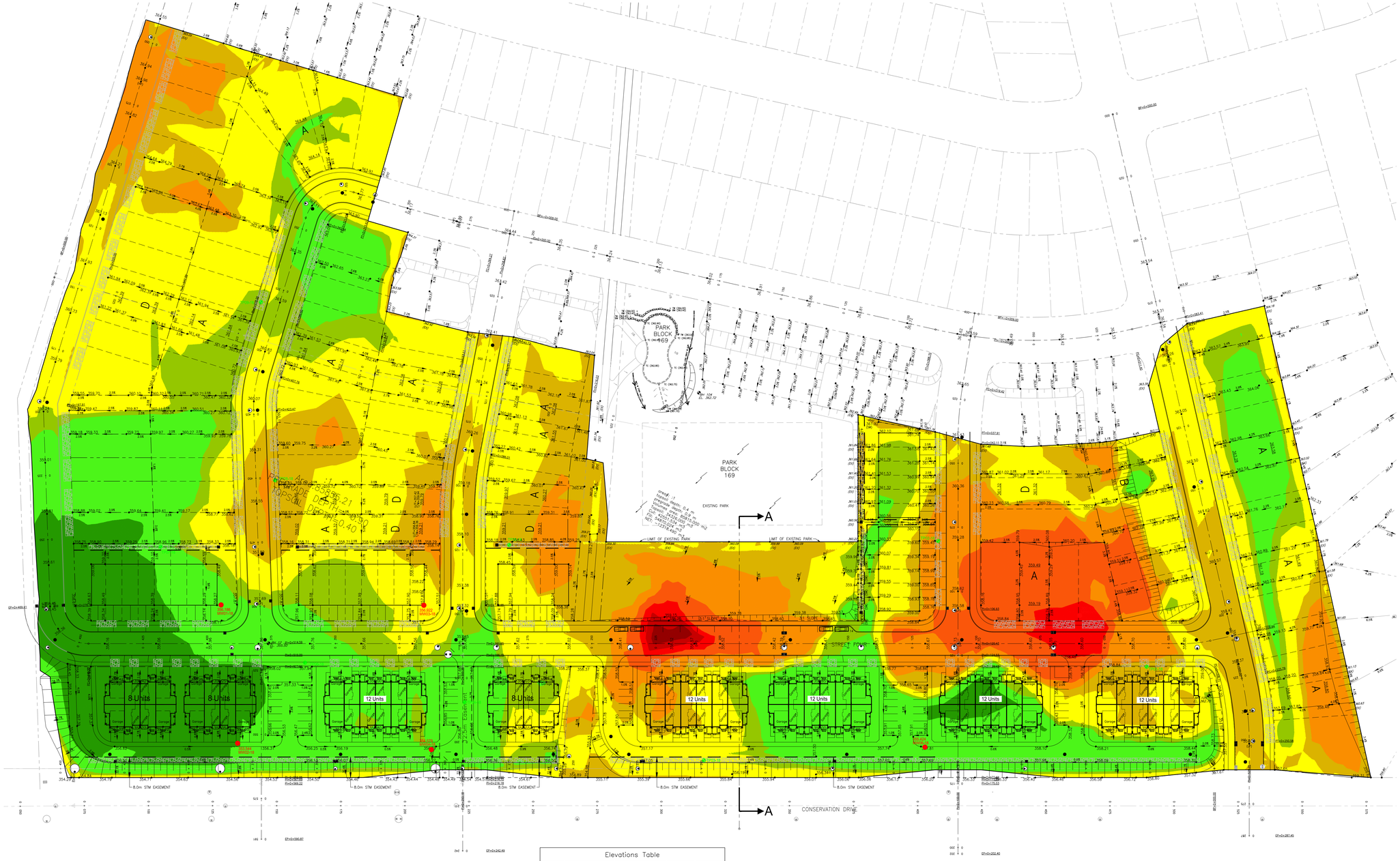
JULY 2019
Project No. 60308671

Client/Project
ACTIVA HOLDINGS INC.
CONSERVATION MEADOWS SUBDIVISION, PHASE 2
WATERLOO, ONTARIO

Figure No.
1

Title
BOREHOLE AND TEST PIT LOCATION PLAN

T:\Autocad\Drawings\Project Drawings\2019\CAD2019\60308671\60308671_2019_Update.dwg
2019/07/18 3:57 PM By: Briones, Glicera


PARK BLOCK 169
EXISTING PARK
LIMIT OF EXISTING PARK
LIMIT OF EXISTING PARK
A
A
CONSERVATION DRIVE
STREET FIVE
22.5m Eden-ish
8.0m STM EASEMENT
8.0m STM EASEMENT
8.0m STM EASEMENT
8.0m STM EASEMENT
8 Units
8 Units
12 Units
8 Units
12 Units
12 Units
12 Units
12 Units
Garage
Garage
Garage



Stantec

Legend

- Property Limit
- Monitoring Well (Stantec, 2018)
- Monitoring Well (Stantec, 2010)
- Monitoring Well (Naylor, 2007)
- Well Screened in Fill
- Well Screened in Sand
- Well Screened in Silt/Silt Till
- Well Screened in Sand and Silt/Silt Till
- 354.54 High Groundwater Elevation (m AMSL)
- High Groundwater Contour (m AMSL)
- Interpreted Direction of Groundwater Flow

0 50 100 metres

1:2,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2019.
3. Orthoimagery © First Base Solutions, 2019. Imagery flown in 2018.
4. Highest groundwater levels recorded at MW01-18 to MW07-18 based on measurements obtained between February and April 2018.
5. Highest groundwater levels recorded at BH104 and BH105 based on measurements obtained between January 2011 and April 2018.
6. Highest groundwater level recorded at MW7-10 based on measurements obtained between March 2010 and November 2017.



Project Location
Waterloo, ON

60308671 REVA
Prepared by CMC on 2019-10-01
Technical Review by BC on 2019-09-25

Client/Project
ACTIVA HOLDINGS INC.
CONSERVATION MEADOWS SUBDIVISON, PHASE 2
HYDROGEOLOGICAL ASSESSMENT

Figure No.
3

Title
Topography and High Groundwater Condition

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\\cat1004-f01\work_group\01603\active\60308671\planning\drawing\MXD\HydrogeologyMXD\HydrogeologyAssess_V2\160308671_MGV2_Fig03_HighGroundwater.mxd Revised 2019-10-01 By: CCoghlan

Appendix C

C.1 SYMBOLS AND TERMS USED ON THE BOREHOLE RECORD SHEETS

C.2 BOREHOLE RECORDS

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Rootmat	- vegetation, roots and moss with organic matter and topsoil typically forming a mattress at the ground surface
Topsoil	- mixture of soil and humus capable of supporting vegetative growth
Peat	- mixture of visible and invisible fragments of decayed organic matter
Till	- unstratified glacial deposit which may range from clay to boulders
Fill	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	- having cracks, and hence a blocky structure
Varved	- composed of regular alternating layers of silt and clay
Stratified	- composed of alternating successions of different soil types, e.g. silt and sand
Layer	- > 75 mm in thickness
Seam	- 2 mm to 75 mm in thickness
Parting	- < 2 mm in thickness

Terminology describing soil types:
The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488) which excludes particles larger than 75 mm. For particles larger than 75 mm, and for defining percent clay fraction in hydrometer results, definitions proposed by Canadian Foundation Engineering Manual, 4th Edition are used. The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):
Terminology describing materials outside the USCS, (e.g. particles larger than 75 mm, visible organic matter, and construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 20%

Terminology describing compactness of cohesionless soils:
The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test (SPT) N-Value - also known as N-Index. The SPT N-Value is described further on page 3. A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
Very Loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

Terminology describing consistency of cohesive soils:
The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests. Consistency may be crudely estimated from SPT N-Value based on the correlation shown in the following table (Terzaghi and Peck, 1967). The correlation to SPT N-Value is used with caution as it is only very approximate.

Consistency	Undrained Shear Strength		Approximate SPT N-Value
	kips/sq.ft.	kPa	
Very Soft	<0.25	<12.5	<2
Soft	0.25 - 0.5	12.5 - 25	2-4
Firm	0.5 - 1.0	25 - 50	4-8
Stiff	1.0 - 2.0	50 – 100	8-15
Very Stiff	2.0 - 4.0	100 - 200	15-30
Hard	>4.0	>200	>30

ROCK DESCRIPTION

Except where specified below, terminology for describing rock is as defined by the International Society for Rock Mechanics (ISRM) 2007 publication "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006"

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	*Very Poor Quality*
25-50	*Poor Quality*
50-75	*Fair Quality*
75-90	*Good Quality*
90-100	*Excellent Quality*

Alternate (Colloquial) Rock Mass Quality	
Very Severely Fractured	*Crushed*
Severely Fractured	*Shattered or Very Blocky*
Fractured	*Blocky*
Moderately Jointed	*Sound*
Intact	*Very Sound*

RQD (Rock Quality Designation) denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. RQD is determined in accordance with ASTM D6032.

SCR (Solid Core Recovery) denotes the percentage of solid core (cylindrical) retrieved from a borehole of any orientation. All pieces of solid (cylindrical) core are summed and divided by the total length of the core run (It excludes all portions of core pieces that are not fully cylindrical as well as crushed or rubble zones).

Fracture Index (FI) is defined as the number of naturally occurring fractures within a given length of core. The Fracture Index is reported as a simple count of natural occurring fractures.

Terminology describing rock with respect to discontinuity and bedding spacing:

Spacing (mm)	Discontinuities	Bedding
>6000	*Extremely Wide*	-
2000-6000	*Very Wide*	*Very Thick*
600-2000	*Wide*	*Thick*
200-600	*Moderate*	*Medium*
60-200	*Close*	*Thin*
20-60	*Very Close*	*Very Thin*
<20	*Extremely Close*	*Laminated*
<6	-	*Thinly Laminated*

Terminology describing rock strength:

Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	<1
Very Weak	R1	1 – 5
Weak	R2	5 – 25
Medium Strong	R3	25 – 50
Strong	R4	50 – 100
Very Strong	R5	100 – 250
Extremely Strong	R6	>250

Terminology describing rock weathering:

Term	Symbol	Description
Fresh	W1	No visible signs of rock weathering. Slight discoloration along major discontinuities
Slightly	W2	Discoloration indicates weathering of rock on discontinuity surfaces. All the rock material may be discolored.
Moderately	W3	Less than half the rock is decomposed and/or disintegrated into soil.
Highly	W4	More than half the rock is decomposed and/or disintegrated into soil.
Completely	W5	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.
Residual Soil	W6	All the rock converted to soil. Structure and fabric destroyed.

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders Cobbles Gravel | Sand | Silt | Clay | Organics | Asphalt | Concrete | Fill | Igneous Bedrock | Meta-morphic Bedrock | Sedi-mentary Bedrock

SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT



measured in standpipe, piezometer, or well



inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (63.5 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (300 mm) into the soil. In accordance with ASTM D1586, the N-Value equals the sum of the number of blows (N) required to drive the sampler over the interval of 6 to 18 in. (150 to 450 mm). However, when a 24 in. (610 mm) sampler is used, the number of blows (N) required to drive the sampler over the interval of 12 to 24 in. (300 to 610 mm) may be reported if this value is lower. For split spoon samples where insufficient penetration was achieved and N-Values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N-values corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to 'A' size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (300 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
γ	Unit weight
G_s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q_u	Unconfined compression
I_p	Point Load Index (I_p on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm)

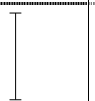
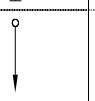
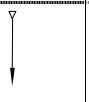
	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer

Table 1 - Summary of Test Pit Findings

Test Pit Number	Surface Elevation/ Depth Below Grade (m)	Soil Description
TP01-18	359.3	
	0.0-1.4	FILL: brown silt, trace sand and clay, moist. Occasional debris (bricks and rope)
		FILL: brown sand, trace to some silt, trace gravel, moist. Occasional small organics
	1.4-2.0	Brown to greyish brown SILT, some clay, moist to wet
		Brown Silt TILL, trace gravel and sand, moist
	2.0-2.5	Test Pit terminated
	2.5-2.6	Note: Test Pit sides stable and no groundwater seepage observed.
	2.6	
TP02-18	359.9	
	0.0-1.8	FILL: brown to dark brown silty sand, moist. A few pieces of grass in fill.
	1.8	Test Pit terminated
		Note: Test Pit sides stable and no groundwater seepage observed.
TP03-18	356.7	
	0.0-0.3	TOPSOIL
	0.3-1.7	Brown SILT, some clay, wet
	1.7-1.9	Brown SILT, some sand, moist
	1.9-2.0	Brown SILT, moist
	2.0	Test Pit terminated
		Note: after 2 h, groundwater seepage observed at 1.7 m depth.
TP04-18	354.4	
	0.0-0.2	TOPSOIL
	0.2-0.8	Brown medium SAND, trace silt, moist to wet
	0.8-1.2	Brown medium SAND, trace silt, saturated
	1.2	Test Pit terminated
		Note: after 2 h, water level at 0.8 m depth.
TP05-18	358.4	
	0.0-0.2	TOPSOIL
	0.2-1.6	Light brown fine SAND, trace silt, damp
	1.6	Test Pit terminated
		Note: Test Pit sides stable and no groundwater seepage observed
TP06-18	355.3	
	0.0-0.3	TOPSOIL
	0.3-0.6	Brown SILT, some sand, moist
	0.6-1.2	Brown SAND, trace silt, moist
	1.2-1.3	Brown SILT, trace to some clay, trace sand, moist
	1.3	Test Pit terminated
		Note: after 1.75h, water level at 1.2 m depth. Minor seepage noted at 1.0 m depth.

Test Pit Number	Surface Elevation/ Depth Below Grade (m)	Soil Description
TP07-18	356.5 0.0-0.3 0.3-1.4 1.4-1.7 1.7	 TOPSOIL Brown sandy SILT, moist Brown SILT, some clay, trace sand, wet Test Pit terminated Note: after 1.5h, water level at 1.6 m depth.
TP08-18	359.5 0.0-0.3 0.3-0.7 0.7-1.0 1.0-2.5 2.5	 TOPSOIL Brown Silt TILL, some gravel and sand, moist Brown SAND, trace silt, damp Brown SILT, damp to moist Test Pit terminated Note: Test Pit sides stable and no groundwater seepage observed.
TP09-18	360.5 0.0-0.4 0.4-0.7 0.7-1.3 1.3	 TOPSOIL Brown SILT, some clay, trace sand, most to wet Light brown SILT, trace sand, moist Test Pit terminated Note: Test Pit sides stable and no groundwater seepage observed.

Stantec

BOREHOLE RECORD

N: 4 815 067 E: 533 138

MW01-18

CLIENT Activa

PROJECT No. 60308671

LOCATION Conservation Drive, Waterloo

DATUM

DATES: BORING Jan 18, 2018

WATER LEVEL Feb 16, 2018

TPC ELEVATION 356.975

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	DEPTH (ft)	SAMPLES TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	356.2	**Snow Covered ~ 50 mm**	0				
0		FILL: brown sand - some silt, organics and topsoil - damp to moist	1	SS	1	460/610	2
			2				
1			3	SS	2	250/610	8
			4				
			5				
2			6	SS	3	51/610	2
	353.9		7				
		Loose to compact brown to light grey SILT (ML) - trace sand and clay - very wet	8	SS	4	410/610	7
			9				
3			10				
			11	SS	5	51/610	10
			12				
4			13	SS	6	610/610	18
			14				
			15				
			16	SS	7	510/610	23
5	350.9		17				
		- Borehole terminated at 5.3 m below existing grade. - Groundwater level at elevation 354.06 m on February 16, 2018. - Monitoring Well installed with screen from 3.8 m to 5.3 m.	18				
			19				
6			20				
			21				
			22				
7			23				
			24				
			25				
8			26				
			27				
			28				
9			29				
			30				
			31				
10			32				

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100

GR SA SI CL

□ Field Vane Test, kPa

■ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

Stantec

BOREHOLE RECORD

N: 4 815 022 E: 533 165

MW02-18

CLIENT Activa — PROJECT No. 60308671

LOCATION Conservation Drive, Waterloo — DATUM

DATES: BORING Jan 18, 2018 — WATER LEVEL Feb 16, 2018 — TPC ELEVATION 354.239

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	DEPTH (ft)	TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	353.5	**Snow/Vegetation**	0				
		TOPSOIL: Black	1	SS	1	51/610	2
	352.9		2				
1		Soft brown SILTY CLAY (CL-ML) - organics above 0.9 m - moist to wet	3	SS	2	300/610	3
	352.0		4				
		Compact brown to light grey silt (ML) TILL - trace sand, clay and fine gravel - moist to wet - some clay below 2.3 m - very wet below 2.4 m	5				
2			6	SS	3	610/610	10
			7				
			8	SS	4	610/610	14
3	350.5		9				
		Stiff grey SILT (ML) - some clay, trace sand - wet	10				
			11	SS	5	610/610	11
			12				
4			13				
			14	SS	6	510/610	16
	348.9		15				
		- Borehole terminated at 4.6 m below existing grade. - Groundwater level at elevation 352.58 m on February 16, 2018. - Monitoring Well Installed with screen from 3.0 m to 4.6 m.	16				
5			17				
			18				
			19				
6			20				
			21				
			22				
7			23				
			24				
			25				
8			26				
			27				
			28				
9			29				
			30				
			31				
10			32				

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100

GR SA SI CL

□ Field Vane Test, kPa

■ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

Stantec

BOREHOLE RECORD

N: 4 815 102 E: 533 210

MW03-18

CLIENT Activa

PROJECT No. 60308671

LOCATION Conservation Drive, Waterloo

DATUM

DATES: BORING Jan 18, 2018

WATER LEVEL Feb 16, 2018

TPC ELEVATION 357.764

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	DEPTH (ft)	SAMPLES TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	356.9	**Snow Covered ~ 100 mm**	0				
		TOPSOIL: dark brown sandy silt - some organics	1	SS	1	300/610	
	356.0		2				
1		Stiff light brown SILT (ML) - some sand and clay	3	SS	2	410/610	9
	355.4	- wet	4				
		Stiff to very stiff light brown silt (ML) TILL - some clay and sand, trace gravel - moist to wet	5				
2			6	SS	3	610/610	16
			7				
			8	SS	4	610/610	19
3			9				
			10				
			11	SS	5	610/610	21
			12				
4		- grey	13	SS	6	610/610	15
			14				
			15				
			16	SS	7	610/610	12
5	351.6		17				
		- Borehole terminated at 5.3 m below existing grade. - Groundwater level at elevation 356.21 m on February 16, 2018. - Monitoring Well Installed from 3.8 m to 5.3 m.	18				
			19				
6			20				
			21				
			22				
7			23				
			24				
			25				
8			26				
			27				
			28				
9			29				
			30				
			31				
10			32				

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100

GR SA SI CL

□ Field Vane Test, kPa

■ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

Stantec

BOREHOLE RECORD

N: 4 815 054 E: 533 234

MW04-18

CLIENT Activa PROJECT No. 60308671

LOCATION Conservation Drive, Waterloo DATUM

DATES: BORING Jan 18, 2018 WATER LEVEL Feb 16, 2018 TPC ELEVATION 355.472

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	DEPTH (ft)	TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	**354.6**	**Snow/Vegetation**	0				
	354.3	TOPSOIL: dark brown sandy silt	1	SS	1	510/610	5
		Compact to loose brown SILT (ML) - trace sand - wet	2				
1			3	SS	2	150/610	10
			4				
			5				
2			6	SS	3	300/610	11
			7				
			8	SS	4	510/610	9
			9				
3	351.6		10				
		Compact brown SAND (SW-SM) - some silt - wet	11	SS	5	510/610	12
			12				
4			13				
	350.0		14				
		Stiff grey silt (ML) TILL - trace clay, sand and fine gravel - very wet	15				
			16	SS	6	510/610	9
5	349.3		17				
		- Borehole terminated at 5.3 m below existing grade. - Groundwater level at elevation 353.78 m on February 16, 2018. - Monitoring Well installed with screen from 3.8 m to 5.3 m.	18				
			19				
6			20				
			21				
			22				
7			23				
			24				
			25				
8			26				
			27				
			28				
9			29				
			30				
			31				
10			32				

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100

GR SA SI CL

□ Field Vane Test, kPa

■ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

Stantec

BOREHOLE RECORD

N: 4 815 149 E: 533 307

MW05-18

CLIENT Activa — PROJECT No. 60308671

LOCATION Conservation Drive, Waterloo — DATUM

DATES: BORING Jan 17, 2018 — WATER LEVEL Feb 16, 2018 — TPC ELEVATION 362.107

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	DEPTH (ft)	TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	361.4	**Snow Covered ~ 50 mm**	0				
0		FILL: Dark brown sandy silt topsoil - moist	0–2	SS	1	410/610	14
1			3–4	SS	2	510/610	6
2	359.1		6–7	SS	3	610/610	4
		Compact light brown fine SAND (SW) - trace silt above 7.5 m - some silt below 7.5 m - damp	8–9	SS	4	610/610	12
3			10–12	SS	5	610/610	16
4			13–15	SS	6	460/610	24
5			16–17	SS	7	460/610	30
			18–20	SS	8	610/610	26
6		- moist to wet	21–22	SS	9	610/610	16
7		- saturated	23–25	SS	10	510/610	18
8	353.2		26–27	SS	11	510/610	6
		- Borehole terminated at 7.6 m below existing grade. - Groundwater level at elevation 354.51 m on February 16, 2018. - Monitoring Well Installed with screen from 6.1 m to 7.6 m.	28–32				
9							
10							

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100

GR SA SI CL

□ Field Vane Test, kPa

■ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

Stantec

BOREHOLE RECORD

N: 4 815 139 E: 533 406

MW06-18

CLIENT Activa

PROJECT No. 60308671

LOCATION Conservation Drive, Waterloo

DATUM

DATES: BORING Jan 17, 2018

WATER LEVEL Feb 16, 2018

TPC ELEVATION 356.265

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	DEPTH (ft)	SAMPLES TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	355.4	**Snow/ice Covered**	0				
		FILL: Dark brown sandy topsoil - wet	1	SS	1	510/610	5
1	353.9		3	SS	2	610/610	4
		Stiff light brown/grey SILT (ML) - wet	5	SS	3	300/610	14
2	353.1		7				
		Compact light brown SILTY SAND (SM) - wet	8	SS	4	300/610	15
3	351.7		10	SS	5	610/610	29
		- Borehole terminated at 3.0 m below existing grade. - Groundwater level at elevation 353.74 m on February 16, 2018. - Monitoring Well installed with screen from 1.5 m to 3.0 m.	12				
4			13				
			14				
			15				
5			16				
			17				
			18				
			19				
6			20				
			21				
			22				
			23				
7			24				
			25				
			26				
			27				
8			28				
			29				
			30				
			31				
9			32				
10							

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100

GR SA SI CL

□ Field Vane Test, kPa

■ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

Stantec

BOREHOLE RECORD

N: 4 815 211 E: 533 438

MW07-18

CLIENT Activa

PROJECT No. 60308671

LOCATION Conservation Drive, Waterloo

DATUM

DATES: BORING Jan 17, 2018

WATER LEVEL Feb 16, 2018

TPC ELEVATION 360.891

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	DEPTH (ft)	SAMPLES TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	360.1	**Snow Covered ~ 50 mm**	0				
0	359.3	FILL: silt with some sand and occasional gravel, - frozen at time of investigation	1	SS	1	610/610	57
1	357.8	FILL: light brown to grey sand - some silt - moist	3	SS	2	460/610	19
2			6	SS	3	150/610	4
3	356.1	FILL: brown silt, some sand and trace gravel - moist	8	SS	4	360/610	20
4			11	SS	5	460/610	12
5	354.9	FILL: dark brown silty topsoil	13	SS	6	510/610	13
			16	SS	7	510/610	5
6		- Borehole terminated at 4.6 m below existing grade. - Groundwater level at elevation 355.41 m on February 16, 2018. - Monitoring Well Installed from 3.1 m to 4.6 m.	17				
7			23				
8			26				
9			30				
10			32				

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

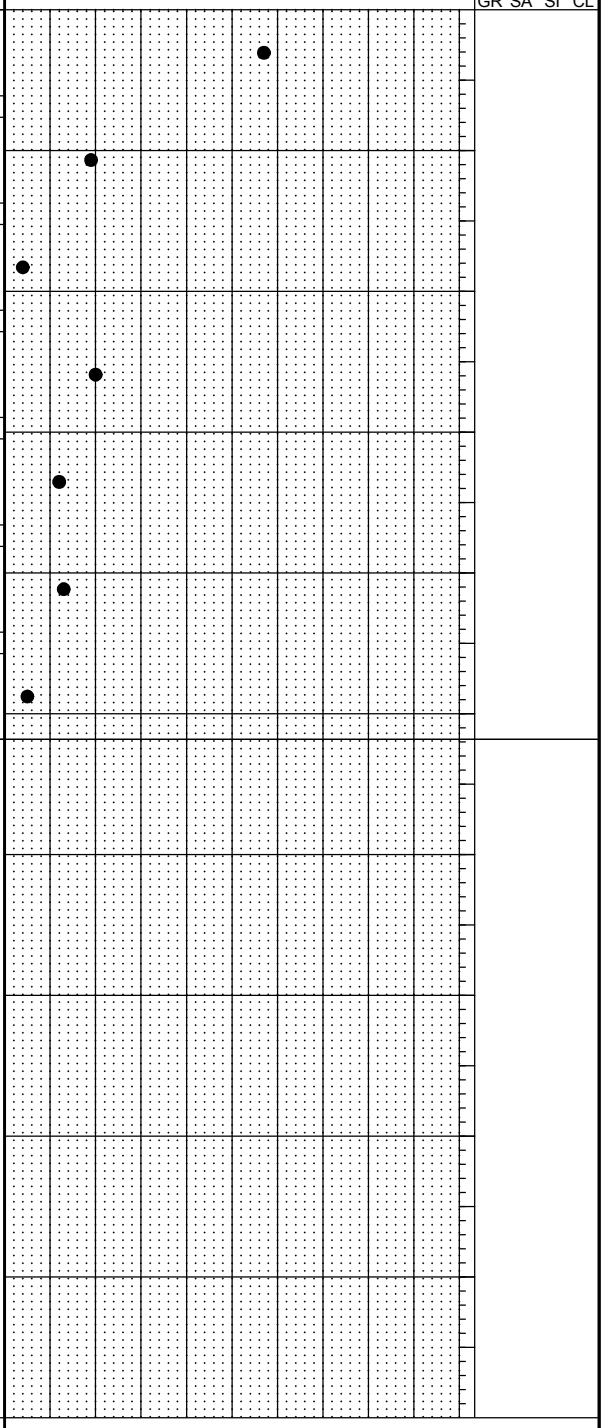
DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m

STANDARD PENETRATION TEST, BLOWS/0.3m

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100

GR SA SI CL



- Field Vane Test, kPa
- Remoulded Vane Test, kPa
- Pocket Penetrometer Test, kPa

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

BOREHOLE: 5
Sheet 1 of 1

PROJECT Proposed Residential Subdivision
DATE 6 December 2002
JOB NO. 4500G01
LOCATION Activa Conservation Lands, Waterloo, Ontario
FIELD ENG/TECH RM

DEPTH (m)	DESCRIPTION	ELEV.	NUMBER	TYPE	N-VALUE
	GROUND ELEVATION: 363.36				
0.30	TOPSOIL: dark brown silt, moist	363			
	SAND: very loose rusty brown silty sand, moist		1	SS	3
		362	2	SS	2
2.00	compact light brown fine to medium sand, some silt, damp	361	3	SS	30
3.05	dense brown silty fine sand, moist	360	4	SS	55
4.55	dense to very dense, damp	359	5	SS	42
		358			
		357	6	SS	40 /150 mm
		356			
			7	SS	50
8.55	SILT AND SAND: dense brown silt and fine sand, wet	355			
9.50	compact, saturated	354	8	SS	31
		353			
11.15	Borehole terminated at 11.15 m.		9	SS	19

SHEAR STRENGTH, kPa(ksf)
FV. NAT. ■ REM. □
UC ✣ PP ▲
50(1)100(2)150(3)200(4)
PENETRATION RESISTANCE
DYNAMIC CONE ×
STANDARD PENETRATION ●
20 40 60 80

WATER CONTENT (%)
Wp W Wl
10 20 30

GROUNDWATER OBSERVATIONS & PIEZOMETER DETAILS

bentonite seal

13 mm pipe

native backfill

1.2 m slotted filter

At drilling completion, water level at 9.8 m.

December 12, 2002
Water level at 9.48 m
(Elev. 353.88)

NOTES: Bulk sample taken at 3.0 to 4.6 m.

DRILLING METHOD: Solid Stem Augers

ENGINEER:

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

BOREHOLE: 8
Sheet 1 of 1

PROJECT Proposed Residential Subdivision
DATE 5 December 2002
JOB NO. 4500G01
LOCATION Activa Conservation Lands, Waterloo, Ontario
FIELD ENG/TECH RM

DEPTH (m)	DESCRIPTION	LEGEND	ELEV.	NUMBER	TYPE	N-VALUE
	GROUND ELEVATION: 362.31					
0	TOPSOIL: dark brown sandy silt, moist		362			
0.40	SAND: compact to dense brown silty fine to medium sand, damp to moist			1	SS	18
			361			
				2	SS	36
			360			
				3	SS	20
			359			
				4	SS	39
			358			
4.55	some silt layers, moist			5	SS	30
			357			
6.10	very dense, wet					
			356	6	SS	27 / 150 mm
			355			
				7	SS	26 / 150 mm
8.25	SILT: dense brown silt, trace sand, wet		354			
			353	8	SS	38
9.60	Borehole terminated at 9.60 m.					

SHEAR STRENGTH, kPa(ksf)
FV. NAT ■ REM. □
UC ✣ PP ▲
50(1) 100(2) 150(3) 200(4)
PENETRATION RESISTANCE
DYNAMIC CONE ✕
STANDARD PENETRATION ●
20 40 60 80

WATER CONTENT (%)
Wp W Wl
10 20 30

GROUNDWATER OBSERVATIONS & PIEZOMETER DETAILS

bentonite seal

13 mm pipe

native backfill

1.2 m slotted filter

At drilling completion, wet cave at 8.8 m.

December 12, 2002. Water level at 8.52 m (Elev. 353.79)

NOTES: ~~Borehole deepened to find water.~~

DRILLING METHOD: Solid Stem Augers

ENGINEER: JD

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

BOREHOLE: 9
Sheet 1 of 1

PROJECT Proposed Residential Subdivision | DATE 5 December 2002 | JOB NO. 4500G01
LOCATION Activa Conservation Lands, Waterloo, Ontario | FIELD ENG/TECH RM

DEPTH (m)	DESCRIPTION	ELEV.	SAMPLES NUMBER	TYPE	N-VALUE
	GROUND ELEVATION: 363.21				
0	TOPSOIL: dark brown silt, moist	363			
0.35	SILT TILL: very stiff brown clayey silt, trace sand, DTPL-APL				
1		362	1	SS	16
			2	SS	23
2		361			
2.30	hard, DTPL		3	SS	30
3		360			
3.35	very stiff, grey, APL		4	SS	27
4		359			
5			5	SS	21
5.05	Borehole terminated at 5.05 m.				

SHEAR STRENGTH kPa(ksf)
FV NAT ■ REM. □
UC ✜ PP ▲
50(1)100(2)150(3)200(4)
PENETRATION RESISTANCE
DYNAMIC CONE ×
STANDARD PENETRATION ●
20 40 60 80

WATER CONTENT (%)
Wp W Wl
10 20 30

GROUNDWATER OBSERVATIONS & PIEZOMETER DETAILS

bentonite seal

13 mm pipe

native backfill

1.2 m slotted filter

At drilling completion, dry cave at 4.6 m.

December 12, 2002. Water level at 1.87 m (Elev. 361.34)

NOTES: Bulk sample taken at 1.5 to 2.1 m.

DRILLING METHOD: Solid Stem Augers

ENGINEER: RD

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

BOREHOLE: 10
Sheet 1 of 1

PROJECT Proposed Residential Subdivision DATE 5 December 2002 JOB NO. 4500G01
LOCATION Activa Conservation Lands, Waterloo, Ontario FIELD ENG/TECH RM

DEPTH (m)	DESCRIPTION	ELEV.	NUMBER	TYPE	N-VALUE
	GROUND ELEVATION: 359.02				
0	TOPSOIL: dark brown silt, moist				
0.45	SILT: stiff mottled grey/brown silt, some clay, APL	358	1	SS	8
1.50	SILT TILL: very stiff brown clayey silt, DTPL-APL, some sand layers, saturated	357	2	SS	16
2.45	very stiff to hard, grey, APL	356	3	SS	18
3.05	trace gravel	355	4	SS	24
5.05	Borehole terminated at 5.05 m.	354	5	SS	21

SHEAR STRENGTH kPa(ksf)
FV NAT ■ REM. □
UC ✣ PP ▲
50(1) 100(2) 150(3) 200(4)
PENETRATION RESISTANCE
DYNAMIC CONE ✕
STANDARD PENETRATION ●
20 40 60 80

WATER CONTENT (%)
Wp W Wl
10 20 30

GROUNDWATER OBSERVATIONS & PIEZOMETER DETAILS

bentonite seal

13 mm pipe

native backfill

1.2 m slotted filter

At drilling completion, wet cave at 3.7 m.

December 12, 2002. Water level at 3.11 m (Elev. 355.91)

NOTES:

DRILLING METHOD: Solid Stem Augers

ENGINEER:

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

BOREHOLE: 11
Sheet 1 of 1

PROJECT Proposed Residential Subdivision
DATE 5 December 2002
JOB NO. 4500G01
LOCATION Activa Conservation Lands, Waterloo, Ontario
FIELD ENG/TECH RM

DEPTH (m)	DESCRIPTION	LEGEND	ELEV.	NUMBER	TYPE	N-VALUE
	GROUND ELEVATION: 362.05					
0.30	TOPSOIL: dark brown silt, moist					
	SILT: loose brown silt, some fine sand, wet		361	1	SS	8
1.50						
1.85	compact			2	SS	23
	some sand layers, damp		360			
2.60				3	SS	23
	some brown clayey silt layers, DTPL					
3.05			359	4	SS	43
	dense, some sand seams, saturated					
3.50						
	dense brown silt, trace fine sand, very moist		358			
5.05			357	5	SS	50
	Borehole terminated at 5.05 m.					

SHEAR STRENGTH, kPa(ksf)
FV. NAT. ■ REM. □
UC ✣ PP ▲
50(1)100(2)150(3)200(4)
PENETRATION RESISTANCE
DYNAMIC CONE ✕
STANDARD PENETRATION ●
20 40 60 80

WATER CONTENT (%)
Wp W Wl
10 20 30

GROUNDWATER OBSERVATIONS & PIEZOMETER DETAILS

bentonite seal

13 mm pipe

native backfill

1.2 m slotted filter

At drilling completion, dry cave at 4.6 m.

December 12, 2002. Standpipe dry.

NOTES:

DRILLING METHOD: Solid Stem Augers

ENGINEER: RM

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

BOREHOLE: 12
Sheet 1 of 1

PROJECT Proposed Residential Subdivision
DATE 5 December 2002
JOB NO. 4500G01
LOCATION Activa Conservation Lands, Waterloo, Ontario
FIELD ENG/TECH RM

DEPTH (m)	DESCRIPTION	ELEV.	NUMBER	TYPE	N-VALUE
	GROUND ELEVATION: 355.50				
0	TOPSOIL: dark brown silt, moist				
0.40	SILT: compact brown sandy silt, very moist	355			
1			1	SS	21
1.50	SILT TILL: very stiff to hard brown clayey silt, trace sand, DTPL	354	2	SS	20
2					
2.30	grey, trace gravel	353	3	SS	35
3					
		352	4	SS	24
4					
		351			
5			5	SS	23
5.05	Borehole terminated at 5.05 m.				

SHEAR STRENGTH, kPa(ksf)
FV NAT ■ REM □
UC ✜ PP ▲
50(1) 100(2) 150(3) 200(4)
PENETRATION RESISTANCE
DYNAMIC CONE ✕
STANDARD PENETRATION ●
20 40 60 80

WATER CONTENT (%)
Wp W Wl
10 20 30

GROUNDWATER OBSERVATIONS & PIEZOMETER DETAILS

bentonite seal

13 mm pipe

native backfill

1.2 m slotted filter

At drilling completion, dry cave at 4.6 m.

December 12, 2002. Water level at 1.56 m (Elev. 353.94)

NOTES:

DRILLING METHOD: Solid Stem Augers

ENGINEER: RD

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

BOREHOLE: 13
Sheet 1 of 1

PROJECT Proposed Residential Subdivision
DATE 5 December 2002
JOB NO. 4500G01
LOCATION Activa Conservation Lands, Waterloo, Ontario
FIELD ENG/TECH RM

DEPTH (m)	DESCRIPTION	LEGEND	ELEV.	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES N-VALUE	SHEAR STRENGTH kPa(ksf) FV NAT ■ REM □ UC ✣ PP ▲ 50(1) 100(2) 150(3) 200(4) PENETRATION RESISTANCE DYNAMIC CONE ✕ STANDARD PENETRATION ● 20 40 60 80	WATER CONTENT (%) Wp W Wl 10 20 30	GROUNDWATER OBSERVATIONS & COMMENTS
	GROUND ELEVATION: 361.24								
0			361						
0.30	TOPSOIL: dark brown sandy silt, moist								
	SILT: loose rusty brown fine sandy silt, very moist			1	SS	8			
1			360						
1.70				2	SS	11			
	SAND: compact to loose light brown silty fine sand, damp to moist								
2			359						
				3	SS	9			
3.05									
	compact brown fine to medium sand, some coarse sand seams, trace silt, damp		358	4	SS	14			
4			357						
				5	SS	27			
5.05									
	Borehole terminated at 5.05 m.								At drilling completion, dry cave at 4.6 m.

NOTES: Bulk sample taken at 2.1 to 3.4 m.

DRILLING METHOD: Solid Stem Augers

ENGINEER: JD

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

BOREHOLE: 14
Sheet 1 of 1

PROJECT Proposed Residential Subdivision
DATE 5 December 2002
JOB NO. 4500G01
LOCATION Activa Conservation Lands, Waterloo, Ontario
FIELD ENG/TECH RM

DEPTH (m)	DESCRIPTION	ELEV.	NUMBER	TYPE	N-VALUE
	GROUND ELEVATION: 357.35				
0.40	TOPSOIL: dark brown silt, moist	357			
	SILT TILL: very stiff brown sandy clayey silt, APL		1	SS	16
1.85	some sand layers	356	2	SS	22
2.45	SAND: compact brown fine to medium sand, trace silt, wet	355	3	SS	23
3.05	SILT: compact to dense brown silt, trace sand, some sand layers, saturated	354	4	SS	15
		353			
		352	5	SS	37
6.55	Borehole terminated at 6.55 m.	351	6	SS	50

SHEAR STRENGTH, kPa(ksf)
FV NAT ■ REM □
UC ✜ PP ▲
50(1) 100(2) 150(3) 200(4)
PENETRATION RESISTANCE
DYNAMIC CONE ×
STANDARD PENETRATION ●
20 40 60 80

WATER CONTENT (%)
Wp W Wl
10 20 30

GROUNDWATER OBSERVATIONS & PIEZOMETER DETAILS

bentonite seal

13 mm pipe

native backfill

1.2 m slotted filter

At drilling completion, water level at 3.0 m.

December 12, 2002. Water level at 3.06 m (Elev. 354.29)

NOTES: Bulk sample taken at 1.2 to 2.1 m.

DRILLING METHOD: Solid Stem Augers

ENGINEER: JD

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

BOREHOLE: 15
Sheet 1 of 1

PROJECT Proposed Residential Subdivision
DATE 5 December 2002
JOB NO. 4500G01
LOCATION Activa Conservation Lands, Waterloo, Ontario
FIELD ENG/TECH RM

DEPTH (m)	DESCRIPTION	LEGEND	ELEV.	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES N-VALUE
	GROUND ELEVATION: 357.58					
0	TOPSOIL; dark brown sandy silt, moist					
0.40	SILT: compact brown silt, trace sand, moist		357			
1.05	SAND: compact to dense brown fine to medium sand, some silt, moist to very moist; some silty sand layers			1	SS	14
			356	2	SS	19
2						
			355	3	SS	40
3						
				4	SS	34
			354			
4						
4.20	saturated					
			353	5	SS	18
5						
5.50	SILT: dense brown silt, saturated, dilatant; some sand layers		352			
6				6	SS	43
6.55	Borehole terminated at 6.55 m.					

SHEAR STRENGTH, kPa(ksf)
FV. NAT. ■ REM. □
UC ✣ PP ▲
50(1)100(2)150(3)200(4)
PENETRATION RESISTANCE
DYNAMIC CONE ✕
STANDARD PENETRATION ●
20 40 60 80

WATER CONTENT (%)
Wp W Wl
10 20 30

GROUNDWATER OBSERVATIONS & PIEZOMETER DETAILS

bentonite seal

13 mm pipe

native backfill

1.2 m slotted filter

At drilling completion, wet cave at 5.2 m.

December 12, 2002. Water level at 4.22 m (Elev. 353.36)

NOTES: Bulk sample taken at 1.5 to 2.3 m.

DRILLING METHOD: Solid Stem Augers

ENGINEER:

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

BOREHOLE: 16
Sheet 1 of 1

PROJECT Proposed Residential Subdivision
DATE 5 December 2002
JOB NO. 4500G01
LOCATION Activa Conservation Lands, Waterloo, Ontario
FIELD ENG/TECH RM

DEPTH (m)	DESCRIPTION	LEGEND	ELEV.	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES N-VALUE
	GROUND ELEVATION: 358.29					
0	TOPSOIL: dark brown silt, moist		358			
0.45	SILT: stiff to very stiff brown silt, some clay, DTPL-APL			1	SS	10
1			357			
1.70	loose brown silt, some fine sand, wet			2	SS	6
2			356			
2.75	some sand layers, very moist			3	SS	7
3.05	SILT TILL: compact to dense brown sandy silt, wet; some sand layers, moist		355	4	SS	29
4			354			
5.05	Borehole terminated at 5.05 m.			5	SS	36

SHEAR STRENGTH kPa(ksf)
FV NAT ■ REM □
UC ✣ PP ▲
50(1)100(2)150(3)200(4)
PENETRATION RESISTANCE
DYNAMIC CONE ✕
STANDARD PENETRATION ●
20 40 60 80

WATER CONTENT (%)
Wp W Wl
10 20 30

GROUNDWATER OBSERVATIONS & PIEZOMETER DETAILS



At drilling completion, dry cave at 4.6 m.

December 12, 2002. Standpipe dry.

NOTES:

DRILLING METHOD: Solid Stem Augers

ENGINEER: JD

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

Borehole Number: 104

Ground Elevation: *362.72 m*

Project: *Groundwater Level Monitoring, Construction Phase*

Job No.: *4500H1*

Location: *Activa Conservation Lands, Waterloo, Ontario*

Drill Date: *February 1, 2007*

Depth (m)	Description	Symbol	Elevation (m)	Sample Number	Sample Type	N-Value
0.00	Ground Elevation		362.72			
	FILL: dark brown silt (topsoil), moist		362.00			
1.00	***SILT TILL:*** hard brown clayey silt, trace sand, DTPL; some thin sand seams, damp		361.00	1	SS	22
2.00						
3.00			360.00	2	SS	29
4.00	***SAND:*** compact brown fine to medium sand, trace silt, damp		359.00			
5.00			358.00	3	SS	18
6.00			357.00			
				4	SS	21
7.00			356.00			
8.00			355.00	5	SS	22
	saturated		354.00			
9.00						
				6	SS	19
10.00			353.00			
				7	AS	
11.00	Borehole terminated at 10.67 m		352.00			
12.00			351.00			

Dynamic Cone (X) and Standard Penetration (●): 20 40 60 80

Shear Strength (PP) (▲) and Shear Strength (FV) (■) kPa: 50 100 150 200

Water Content (%): WP – WL; 10 20 30

Groundwater Observations and Standpipe Details:
- protective cover
- concrete seal
- bentonite seal
- 19 mm pipe
- sand pack
- February 28, 2007 water level at 8.43 m (Elev. 354.29 m)
- 3.05 m slotted filter
- At drilling completion, wet cave at 8.23 m

Reviewed by: *CF*

Drill Method: *Solid Stem Auger*

Notes:

Field Tech.: *RM*

Sheet: *1 of 1*

Drafted by: *DC(01a)*

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

Borehole Number: 105

Ground Elevation: ~~362.70~~ 358.03 m

Project: *Groundwater Level Monitoring, Construction Phase*

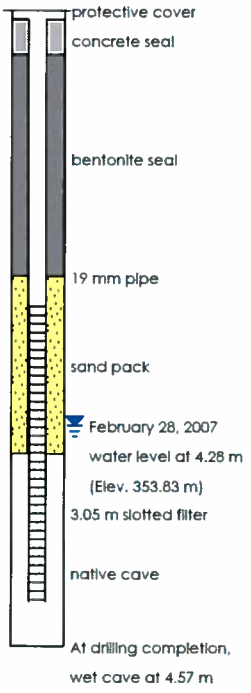
Job No.: *4500H1*

Location: *Activa Conservation Lands, Waterloo, Ontario*

Drill Date: *February 1, 2007*

Depth (m)	Description	Symbol	Elevation (m)	Sample Number	Sample Type	N-Value
0.00	Ground Elevation		362.70			
	FILL: brown clayey silt, APL					
1.00			362.00			
	SILT: compact brown fine sandy silt, moist					
2.00			361.00	1	SS	13
	SAND: dense brown silty fine to medium sand, damp					
3.00			360.00	2	SS	31
4.00			359.00			
	saturated					
5.00			358.00	3	SS	29
6.00			357.00			
				4	SS	20
7.00	Borehole terminated at 6.55 m		356.00			
8.00			355.00			
9.00			354.00			
10.00			353.00			
11.00			352.00			
12.00			351.00			

Dynamic Cone: X 20 40 60 80 X
Standard Penetration: ● 20 40 60 80 ●
Shear Strength (PP) kPa: ▲ 50 100 150 200 ▲
Shear Strength (FV) kPa: ■ 50 100 150 200 ■
Water Content (%): WP — WL; 10 20 30



Reviewed by: *CF*

Drill Method: *Solid Stem Auger*

Notes:

Field Tech.: *RM*

Sheet: *1 of 1*

Drafted by: *DC(01a)*

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

TEST PIT: 1

LOCATION Proposed Residential Subdivision DATE 10 December 2002 JOB NO. 4500G01

PROJECT Activa Conservation Lands, Waterloo, Ontario FIELD ENG/TECH RM

SOIL PROFILE					WATER CONTENT (%) Wp W Wl	GROUNDWATER OBSERVATIONS AND HEADSPACE READINGS (ppm)
DEPTH m	DESCRIPTION	LEGEND	ELEV.	SAMPLE	10 20 30	
	GROUND ELEVATION: 355.37					
0	TOPSOIL: dark brown silt, moist		355			
0.95	SILT: rusty brown fine sandy silt, wet					
1.10	SAND: brown silty fine sand, wet					
1.40	Test pit terminated at 1.40 m.		354			Upon completion of excavation, test pit sidewalls stable. No free groundwater encountered during excavation.

NOTES:

ENGINEER:

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

TEST PIT: 2

LOCATION Proposed Residential Subdivision DATE 10 December 2002 JOB NO. 4500G01

PROJECT Activa Conservation Lands, Waterloo, Ontario FIELD ENG/TECH RM

SOIL PROFILE					WATER CONTENT (%) Wp W Wl	GROUNDWATER OBSERVATIONS AND HEADSPACE READINGS (ppm)
DEPTH m	DESCRIPTION	LEGEND	ELEV.	SAMPLE	10 20 30	
	GROUND ELEVATION: 355.42					
0	TOPSOIL: dark brown silt, moist		355			
0.95	SILT: brown fine sandy silt, wet		354			
1.70	SAND: brown fine to medium sand, some silt, wet					
1.90	Test pit terminated at 1.90 m.					Upon completion of excavation, test pit sidewalls stable. No free groundwater encountered during excavation.

NOTES:

ENGINEER:

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

TEST PIT: 3

LOCATION Proposed Residential Subdivision DATE 10 December 2002 JOB NO. 4500G01

PROJECT Activa Conservation Lands, Waterloo, Ontario FIELD ENG/TECH RM

SOIL PROFILE					WATER CONTENT (%) Wp W Wl	GROUNDWATER OBSERVATIONS AND HEADSPACE READINGS (ppm)
DEPTH m	DESCRIPTION	LEGEND	ELEV.	SAMPLE	10 20 30	
	GROUND ELEVATION: 358.96					
0	TOPSOIL; dark brown silt, moist					
0.35	SILT: brown fine sandy silt, wet					
0.60	some brown clayey silt pockets, APL					
1.00	Test pit terminated at 1.00 m.		358			Upon completion of excavation, test pit sidewalls stable. No free groundwater encountered during excavation.

NOTES:

ENGINEER: JD

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

TEST PIT: 4

LOCATION Proposed Residential Subdivision DATE 10 December 2002 JOB NO. 4500G01

PROJECT Activa Conservation Lands, Waterloo, Ontario FIELD ENG/TECH RM

SOIL PROFILE					WATER CONTENT (%) Wp W Wl	GROUNDWATER OBSERVATIONS AND HEADSPACE READINGS (ppm)
DEPTH m	DESCRIPTION	LEGEND	ELEV.	SAMPLE	10 20 30	
	GROUND ELEVATION: 354.27					
0	TOPSOIL; dark brown silt, moist		354			
0.75	SILT: brown silt, some fine sand, moist; some clayey silt layers, APL		353			
1.40	Test pit terminated at 1.40 m.					Upon completion of excavation, test pit sidewalls stable. No free groundwater encountered during excavation.

NOTES:

ENGINEER:

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

TEST PIT: 5

LOCATION Proposed Residential Subdivision DATE 10 December 2002 JOB NO. 4500G01

PROJECT Activa Conservation Lands, Waterloo, Ontario FIELD ENG/TECH RM

SOIL PROFILE					WATER CONTENT (%) Wp W Wl	GROUNDWATER OBSERVATIONS AND HEADSPACE READINGS (ppm)
DEPTH m	DESCRIPTION	LEGEND	ELEV.	SAMPLE	10 20 30	
	GROUND ELEVATION: 356.74					
0	TOPSOIL: dark brown silt, moist		356			
0.90	SILT AND SAND: brown layered silt and fine sand, wet					
1.70	SILT: brown clayey silt, APL		355			
1.90	Test pit terminated at 1.90 m.					Upon completion of excavation, test pit sidewalls stable. No free groundwater encountered during excavation.

NOTES:

ENGINEER: JD

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

TEST PIT: 6

LOCATION Proposed Residential Subdivision DATE 10 December 2002 JOB NO. 4500G01

PROJECT Activa Conservation Lands, Waterloo, Ontario FIELD ENG/TECH RM

DEPTH m	DESCRIPTION	LEGEND	ELEV.	SAMPLE	WATER CONTENT (%) Wp W Wl (10 20 30)	GROUNDWATER OBSERVATIONS AND HEADSPACE READINGS (ppm)
	SOIL PROFILE					
	GROUND ELEVATION: 365.17					
0	TOPSOIL: dark brown silt, moist		365			
0.35	SILT TILL: brown clayey silt, trace sand, APL		364			
2			363	1		
3.00	SAND: brown fine to medium sand, some silt, moist		362			
3.60	Test pit terminated at 3.60 m.					

Upon completion of excavation, test pit sidewalls stable.

No free groundwater encountered during excavation.

NOTES:

ENGINEER: JD

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

TEST PIT: 7

LOCATION Proposed Residential Subdivision DATE 10 December 2002 JOB NO. 4500G01

PROJECT Activa Conservation Lands, Waterloo, Ontario FIELD ENG/TECH RM

SOIL PROFILE					WATER CONTENT (%) Wp W Wl	GROUNDWATER OBSERVATIONS AND HEADSPACE READINGS (ppm)
DEPTH m	DESCRIPTION	LEGEND	ELEV.	SAMPLE	10 20 30	
	GROUND ELEVATION: 360.38					
0	TOPSOIL: dark brown silt, moist		360			
0.50	SILT TILL: brown clayey silt, trace sand, APL					
1.30	Test pit terminated at 1.30 m.					Upon completion of excavation, test pit sidewalls stable. No free groundwater encountered during excavation.

NOTES:

ENGINEER:

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

TEST PIT: 8

PROJECT Proposed Residential Subdivision DATE 10 December 2002 JOB NO. 4500G01

LOCATION Activa Conservation Lands, Waterloo, Ontario FIELD ENG/TECH RM

SOIL PROFILE

DEPTH m	DESCRIPTION	LEGEND	ELEV.	SAMPLE	WATER CONTENT (%) Wp W Wl (10 20 30)	GROUNDWATER OBSERVATIONS AND HEADSPACE READINGS (ppm)
	GROUND ELEVATION: 359.12					
0	TOPSOIL: dark brown silt, moist		359			
0.3	SILT AND CLAY: alluvial brown silt and silty clay, APL					
1.0	PEAT: black amorphous peat, wet; occasional pieces of wood		358			360
2 2.0	CLAY: grey silty clay, APL-WTPL		357			
3.2	Test pit terminated at 3.20 m.		356			

Upon completion of excavation, test pit sidewalls stable.

Seepage at 1.5 m from peat.

NOTES:

ENGINEER:

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

TEST PIT: 9

LOCATION Proposed Residential Subdivision DATE 10 December 2002 JOB NO. 4500G01

PROJECT Activa Conservation Lands, Waterloo, Ontario FIELD ENG/TECH RM

SOIL PROFILE					WATER CONTENT (%) Wp W Wl	GROUNDWATER OBSERVATIONS AND HEADSPACE READINGS (ppm)
DEPTH m	DESCRIPTION	LEGEND	ELEV.	SAMPLE	10 20 30	
	GROUND ELEVATION: 359.20					
0	TOPSOIL: dark brown silt, moist		359			
0.45	SILT: brown fine sandy silt, wet					
1.20			358			
1.30	SAND: brown fine sand, some silt, very moist					
	Test pit terminated at 1.30 m.					Upon completion of excavation, test pit sidewalls stable. No free groundwater encountered during excavation.

NOTES:

ENGINEER:

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

TEST PIT: 10

LOCATION Proposed Residential Subdivision DATE 10 December 2002 JOB NO. 4500G01

PROJECT Activa Conservation Lands, Waterloo, Ontario FIELD ENG/TECH RM

SOIL PROFILE

DEPTH m	DESCRIPTION	LEGEND	ELEV.	SAMPLE	WATER CONTENT (%) Wp W Wl	GROUNDWATER OBSERVATIONS AND HEADSPACE READINGS (ppm)
	GROUND ELEVATION: 362.88				10 20 30	
0	TOPSOIL: dark brown silt, moist					
0.25	SILT TILL: brown clayey silt, trace sand, APL		362			
2			361			
2.80	trace gravel, DTPL		360			
3.20	Test pit terminated at 3.20 m.					Upon completion of excavation, test pit sidewalls stable. No free groundwater encountered during excavation.

NOTES:

ENGINEER: JD

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

TEST PIT: 11

LOCATION Proposed Residential Subdivision DATE 10 December 2002 JOB NO. 4500G01

PROJECT Activa Conservation Lands, Waterloo, Ontario FIELD ENG/TECH RM

SOIL PROFILE					WATER CONTENT (%) Wp W Wl	GROUNDWATER OBSERVATIONS AND HEADSPACE READINGS (ppm)
DEPTH m	DESCRIPTION	LEGEND	ELEV.	SAMPLE	10 20 30	
	GROUND ELEVATION: 356.35					
0	TOPSOIL: dark brown silt, moist		356			
0.95	SILT: brown fine sandy silt, wet		355			
1.90	Test pit terminated at 1.90 m.					Upon completion of excavation, test pit sidewalls stable. No free groundwater encountered during excavation.

NOTES:

ENGINEER:

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

TEST PIT: 12

LOCATION Proposed Residential Subdivision DATE 10 December 2002 JOB NO. 4500G01

PROJECT Activa Conservation Lands, Waterloo, Ontario FIELD ENG/TECH RM

SOIL PROFILE					WATER CONTENT (%) Wp W Wl	GROUNDWATER OBSERVATIONS AND HEADSPACE READINGS (ppm)
DEPTH m	DESCRIPTION	LEGEND	ELEV.	SAMPLE	10 20 30	
	GROUND ELEVATION: 357.67					
0	TOPSOIL; dark brown silt, moist					
0.45	SILT: brown clayey silt, APL		357		W	
1.00						
1.10	SAND: brown silty sand, moist					
	Test pit terminated at 1.10 m.					Upon completion of excavation, test pit sidewalls stable. Seepage from tile drain at 0.6 m.

NOTES:

ENGINEER: JD

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

TEST PIT: 13

PROJECT Proposed Residential Subdivision DATE 10 December 2002 JOB NO. 4500G01

LOCATION Activa Conservation Lands, Waterloo, Ontario FIELD ENG/TECH RM

SOIL PROFILE

DEPTH m	DESCRIPTION	LEGEND	ELEV.	SAMPLE	WATER CONTENT (%) Wp W Wl	GROUNDWATER OBSERVATIONS AND HEADSPACE READINGS (ppm)
	GROUND ELEVATION: 358.18				10 20 30	
0	TOPSOIL: dark brown silt, moist		358			
0.5	some brown silt and silty clay, APL		357			
1.9	PEAT: black amorphous peat, some large pieces of wood, wet		356			610
2.7	MARL: grey marl, WTPL; some shells					
3.0	CLAY: grey silty clay, WTPL		355			
3.5						
3.6	some grey sand layers, moist					
	SAND: grey fine to medium sand, some silt, moist					
4.0	Test pit terminated at 4.00 m.					

Test pit sidewalls caving below 2.0 m.

No free groundwater encountered during excavation.

NOTES:

ENGINEER:

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

TEST PIT: 14

LOCATION Proposed Residential Subdivision DATE 10 December 2002 JOB NO. 4500G01

PROJECT Activa Conservation Lands, Waterloo, Ontario FIELD ENG/TECH RM

SOIL PROFILE					WATER CONTENT (%) Wp W Wl	GROUNDWATER OBSERVATIONS AND HEADSPACE READINGS (ppm)
DEPTH m	DESCRIPTION	LEGEND	ELEV.	SAMPLE	10 20 30	
	GROUND ELEVATION: 360.03					
0	TOPSOIL: dark brown silt, moist		359			
1.45	SILT TILL: brown clayey silt, trace sand, DTPL		358			
2						
2.20	Test pit terminated at 2.20 m.					Upon completion of excavation, test pit sidewalls stable. No free groundwater encountered during excavation.

NOTES:

ENGINEER: JD

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

TEST PIT: 16

LOCATION Proposed Residential Subdivision DATE 10 December 2002 JOB NO. 4500G01

PROJECT Activa Conservation Lands, Waterloo, Ontario FIELD ENG/TECH RM

DEPTH m	DESCRIPTION	LEGEND	ELEV.	SAMPLE	WATER CONTENT (%) Wp W Wl (10 20 30)	GROUNDWATER OBSERVATIONS AND HEADSPACE READINGS (ppm)
	GROUND ELEVATION: 362.46					
0	TOPSOIL; dark brown silt, moist		362			
0.80	SILT: mottled brown clayey silt, APL					
1.20	brown clayey silt, APL					
1.50	Test pit terminated at 1.50 m.		361			Upon completion of excavation, test pit sidewalls stable. No free groundwater encountered during excavation.

NOTES:

ENGINEER:

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

TEST PIT: 32

LOCATION Proposed Residential Subdivision DATE 10 December 2002 JOB NO. 4500G01

PROJECT Activa Conservation Lands, Waterloo, Ontario FIELD ENG/TECH RM

SOIL PROFILE					WATER CONTENT (%) Wp W Wl	GROUNDWATER OBSERVATIONS AND HEADSPACE READINGS (ppm)
DEPTH m	DESCRIPTION	LEGEND	ELEV.	SAMPLE	10 20 30	
	GROUND ELEVATION: 362.74					
0	TOPSOIL: dark brown silt, moist					
0.50	SILT: brown to rusty brown silt, trace sand, wet		362			
1.20	SAND: light brown fine to medium sand, trace silt, damp					
1.50	Test pit terminated at 1.50 m.					Upon completion of excavation, test pit sidewalls stable. No free groundwater encountered during excavation.

NOTES:

ENGINEER: JD

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

TEST PIT: 33

LOCATION Proposed Residential Subdivision DATE 10 December 2002 JOB NO. 4500G01

PROJECT Activa Conservation Lands, Waterloo, Ontario FIELD ENG/TECH RM

DEPTH m	SOIL PROFILE: DESCRIPTION	LEGEND	ELEV.	SAMPLE	WATER CONTENT (%) Wp W Wl (10 20 30)	GROUNDWATER OBSERVATIONS AND HEADSPACE READINGS (ppm)
	GROUND ELEVATION: 361.43					
0	TOPSOIL: dark brown silt, moist					
0.40	SILT: rusty brown fine sandy silt, wet		361			
0.75	SAND: light brown fine to medium sand, trace silt, damp				◉	
1.00	Test pit terminated at 1.00 m.					Upon completion of excavation, test pit sidewalls stable. No free groundwater encountered during excavation.

NOTES:

ENGINEER: JD

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

TEST PIT: 34

LOCATION Proposed Residential Subdivision DATE 10 December 2002 JOB NO. 4500G01

PROJECT Activa Conservation Lands, Waterloo, Ontario FIELD ENG/TECH RM

SOIL PROFILE					WATER CONTENT (%) Wp W Wl	GROUNDWATER OBSERVATIONS AND HEADSPACE READINGS (ppm)
DEPTH m	DESCRIPTION	LEGEND	ELEV.	SAMPLE	10 20 30	
	GROUND ELEVATION: 360.69					
0	TOPSOIL: dark brown silt, moist					
0.60	SILT: brown to rusty brown silt, trace clay and sand, wet		360			
0.80	brown silt, some clay, trace sand, DTPL					
1.20	Test pit terminated at 1.20 m.					Upon completion of excavation, test pit sidewalls stable. No free groundwater encountered during excavation.

NOTES:

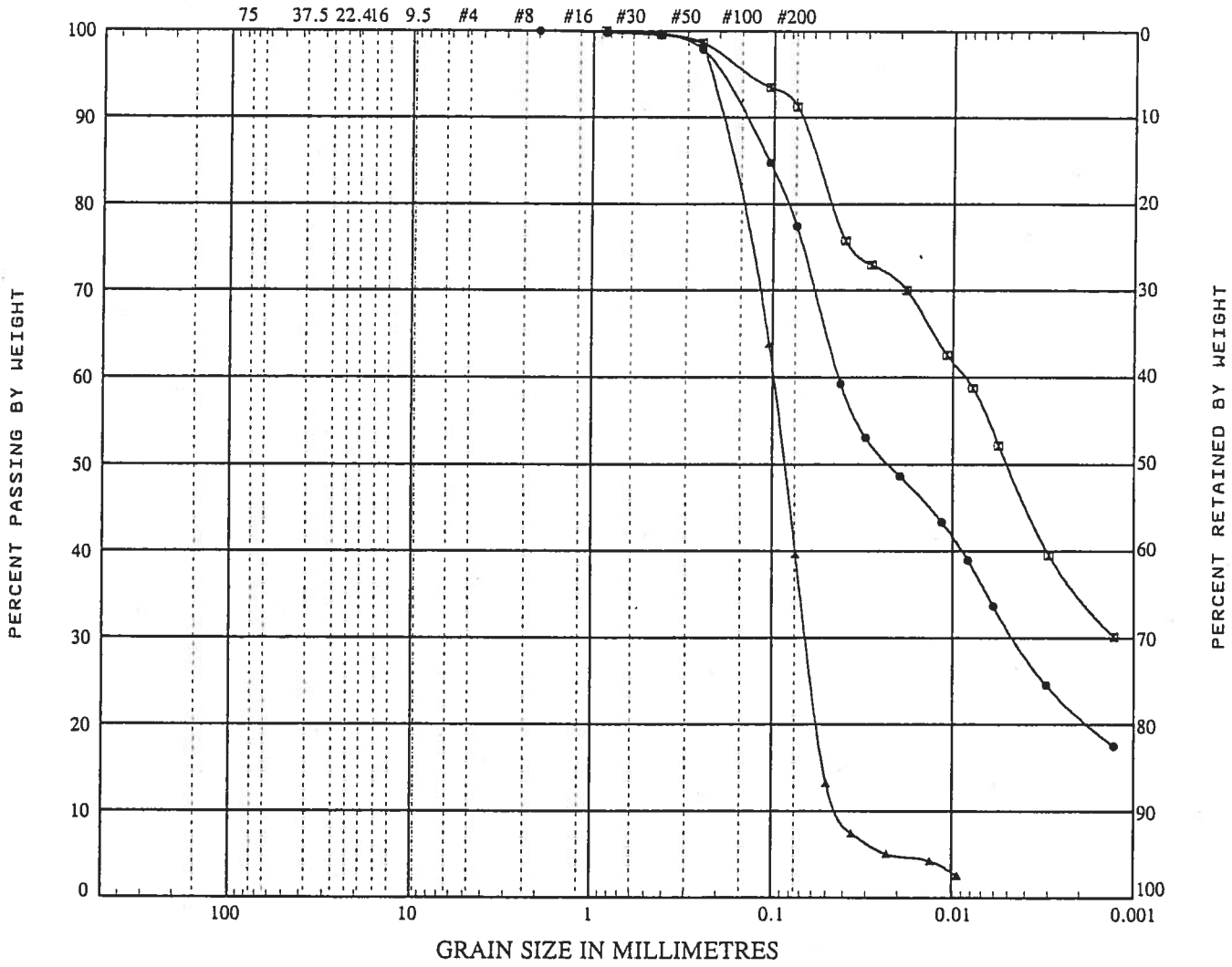
ENGINEER: JD

Appendix D

D.1 GEOTECHNICAL LABORATORY TEST RESULTS

UNIFIED SOIL CLASSIFICATION

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	
U.S. SIEVE SIZE IN MILLIMETRES			U.S. STANDARD SIEVE No.			HYDROMETER



PROJECT Proposed Residential Subdivision

LOCATION Activa Conservation Lands, Waterloo, Ontario JOB NO. 4500G01

CURVE ID	BOREHOLE/ TEST PIT	SAMPLE NO.	DEPTH (m)	SOIL DESCRIPTION
●	BH14	2	1.5-1.8	SILT TILL: Sandy Clayey Silt
⊠	BH2	4	3.0-3.5	SILT TILL: Clayey Silt, trace Sand
▲	BH5	4	3.0-3.5	Silty fine SAND

REMARKS

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

Figure No. 1

FIGURE NO. 3

Naylor Engineering Associates Ltd
CONSULTING ENGINEERS

LABORATORY PROCTOR MOISTURE-DENSITY TEST

PROJECT Proposed Residential Subdivision - Activa Conservation Lands

LOCATION Waterloo, Ontario JOB NO. 4500G1

BOREHOLE NO. 14 DATE TESTED December 11, 2002

SAMPLE DEPTH 1.2 - 2.1 m TESTED BY SC

SOIL TYPE SILT TILL MOISTURE CONTENT 18.6%

REMARKS For particle size distribution, see Figure 1

METHOD LS - 706

PROCEDURE: 1☑ 2☐ 3☐

Procedure 1 (Mold ø - 101.6 mm)
Procedure 2 (Mold ø - 101.6 mm)
Procedure 3 (Mold ø - 152.4 mm)

MAXIMUM DRY DENSITY 1.960 t/m³

OPTIMUM MOISTURE 11.9%

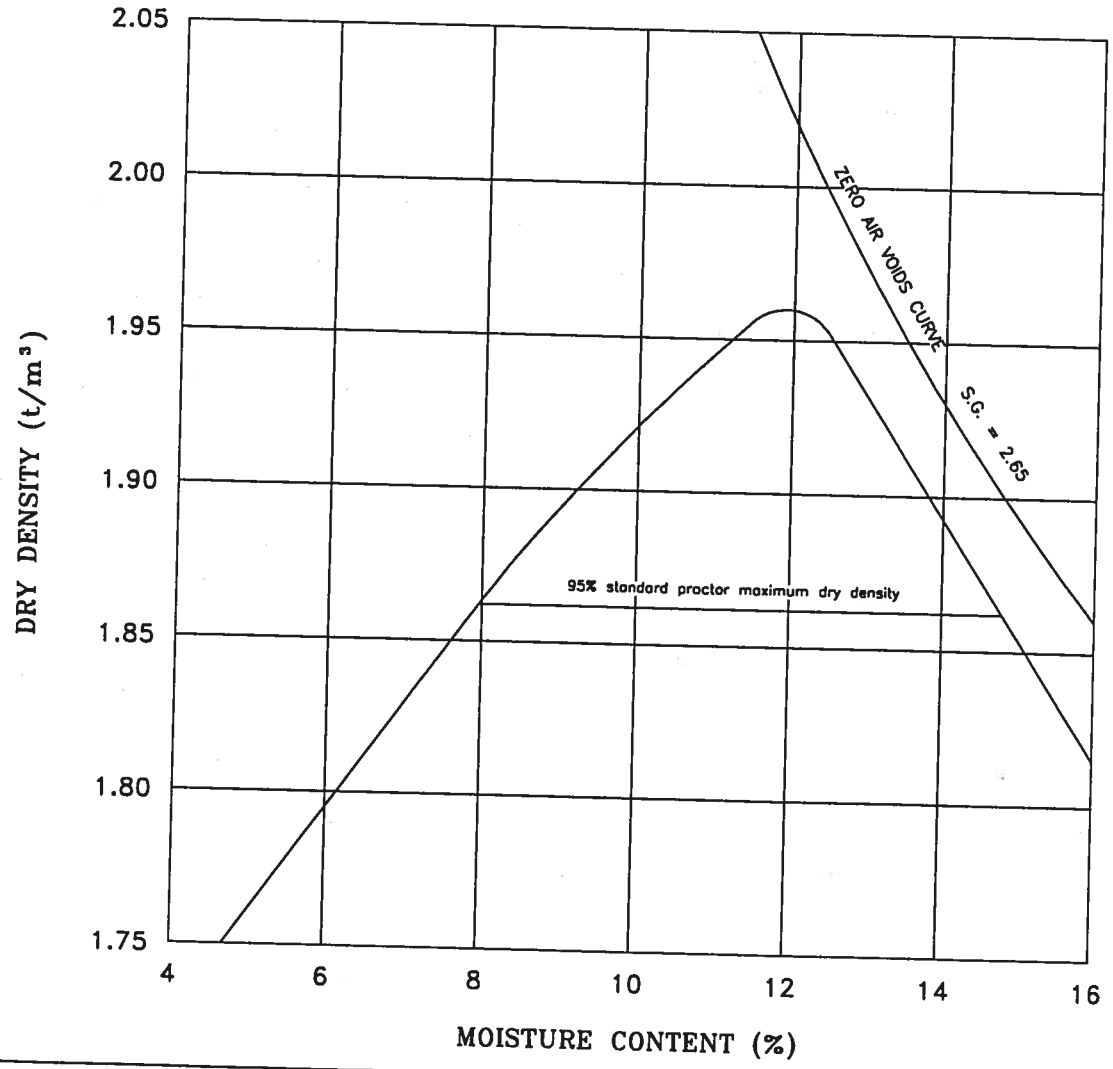


FIGURE NO. 4

Naylor Engineering Associates Ltd
CONSULTING ENGINEERS

LABORATORY PROCTOR MOISTURE-DENSITY TEST

PROJECT Proposed Residential Subdivision – Activa Conservation Lands

LOCATION Waterloo, Ontario JOB NO. 4500G1

BOREHOLE NO. 5 DATE TESTED December 11, 2002

SAMPLE DEPTH 3.0 – 4.6 m TESTED BY RT

SOIL TYPE SAND MOISTURE CONTENT 5.5%

REMARKS For particle size distribution, see Figure 1

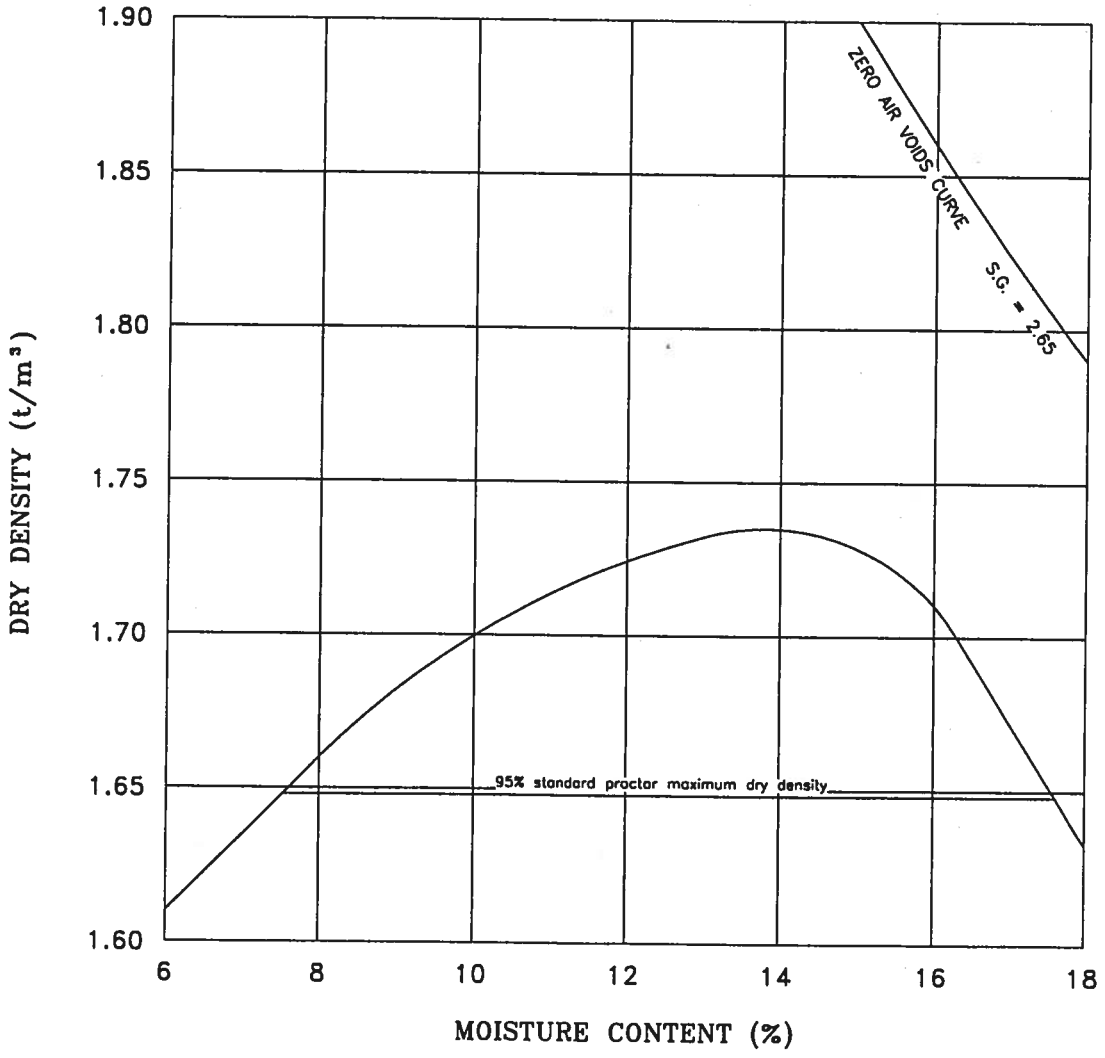
METHOD LS – 706

PROCEDURE: 1☑ 2☐ 3☐

Procedure 1 (Mold ø – 101.6 mm)
Procedure 2 (Mold ø – 101.6 mm)
Procedure 3 (Mold ø – 152.4 mm)

MAXIMUM DRY DENSITY 1.735 t/m³

OPTIMUM MOISTURE 13.8%



Appendix E

E.1 PREVIOUS MATERIALS TESTING AND INSPECTION RECORDS

603086 71 -103/62

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS
353 Bridge Street East
Kitchener, Ontario N2K 2Y5
519-741-1313, Fax 741-5422
www.nayloreng.com

INSPECTION REPORT

No. 3

Project: Activa Conservation Area Grading

Location: Waterloo, Ontario Job No.: 4500C1

Contractor: H. Kerr Construction Ltd.

Inspection By: J. Dietz

Date: October 26, 2005 Time: 12:00 p.m.

Purpose/Type of Inspection:

Inspection of beginning of peat subexcavation for Lots 43 to 50 m into unnumbered lots south of Lot 43 Rideau Street.

Inspection Comments:

1. At the time of the inspection, the contractor was beginning subexcavation of peat in the above-noted area. The contractor was beginning at the north end and will be working south.
2. The area the contractor has subexcavated at this time has been suitably cleaned of all organic soils and native sandy silt with some gravel has been exposed.
3. Following subexcavation, over 5 m of structural fill will be required. Due to some minor seepage the initial lift of fill may be 0.6 m thick.
4. The contractor will use an on-site clean sand as the initial lift of fill. If the initial lift des not become firm enough for placement of further lifts due to the groundwater, then it will have to be subexcavated and imported sand and gravel will have to be used.
5. The subexcavation of peat will have to continue to the east into the existing slope, as well as to the south.

Distribution:

1cc: H. Kerr Construction Ltd.
1cc: Activa Group
1cc: Stantec Consulting Ltd.
jb

Jeff Dietz, P. Eng

603 08671-103 / 62

JG

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS
25 Market Place
Stratford, Ont. N5A 1A4
519-273-0101, Fax 273-7188
www.nayloreng.com

NOV 8 - 2005

INSPECTION REPORT

No. 6

Project: Activa Conservation Area Grading

Location: Waterloo, Ontario

Job No.: 4500C1

Contractor: H. Kerr Construction Ltd.

Inspection By: J. Dietz

Date: October 28, 2005

Time: 9:00 a.m.

Purpose/Type of Inspection:

Inspection of marl removal from Lot 43 and unnumbered lots immediately south of Lot 43.

Inspection Comments:

1. The contractor is continuing to subexcavate marl from this area.
2. The subexcavation is extending down to a grey sandy till that is suitable to support structural fill.
3. Granular 'B' is being used as a base lift for the fill.
4. The marl has not yet been removed in the rear 10 m of these lots. The marl will have to be removed from this area at a later date.

Distribution:

1cc: H. Kerr Construction Ltd.
1cc: Activa Group
1cc: Stantec Consulting Ltd.
jb

Jeff Dietz, P. Eng

6030871-103/62

NOV 1 6 2005

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

353 Bridge Street East
Kitchener, Ontario N2K 2Y5
519-741-1313, Fax 741-5422
www.nayloreng.com

INSPECTION REPORT

No. 7

Project: Activa Conservation Area Grading

Location: Waterloo, Ontario

Job No.: 4500C1

Contractor: H. Kerr Construction Ltd.

Inspection By: J. Dietz

Date: November 4, 2005

Time: 9:30 a.m.

Purpose/Type of Inspection:

Inspection of removal of organic soils from depression at Lot 43 extending 50 m south of Lot 43

Inspection Comments:

1. The contractor has completed removal of organic and other unsuitable soils from the above-noted area.
2. At the south end of this area, the subgrade following excavation comprises brown silt till.
3. The contractor is continuing to fill this area with sand cut from other areas of the site.
4. The subexcavation has been completed satisfactorily.

Distribution:

1cc: H. Kerr Construction Ltd.
1cc: Activa Group
1cc: Stantec Consulting Ltd.
jb

Jeff Dietz, P. Eng

603 08671-103/62

~~DM~~
SCT

Naylor Engineering Associates Ltd
CONSULTING ENGINEERS

353 Bridge Street East
Kitchener, Ontario N2K 2Y5
519-741-1313, Fax 741-5422
www.nayloreng.com

4500C1.R02

November 22, 2005

NOV 30 2005

H. Kerr Construction Ltd.
P.O. Box 1058
Wingham, Ontario
N0G 2W0

Attention: Mr. Randy Morrow

Dear Sir:

Re: Soil Compaction Test Results
Activa Conservation Area Grading
Conservation Drive
Waterloo, Ontario

Attached are the results of soil compaction tests taken at this project site during the period of October 26 to November 8, 2005.

The tests were taken on the structural fill for lots on Wasaga Crescent, and structural fill in the area of a marl hole at Lot 43 and unnumbered lots south of Lot 43 Rideau Street. The results indicate that the specified level of compaction was achieved in the areas tested on these dates.

I trust that this information meets your present requirements. If you have any questions, please do not hesitate to call.

Yours very truly,

Jeff Dietz, P.Eng.
Project Engineer
tm

1cc: Stantec Consulting Ltd., Mr. Vaughan Milligan, A.Sc.T.
1cc: Activa Group, Mr. Peter Armbruster, P.Eng.

Encl. Compaction 05/10/26 to 05/11/08

SOIL INSPECTION/SUMMARY OF COMPACTION TESTING

Job No.: 4500C1.R02

Date: October 26, 2005

Technician: P. St. John

Project: Activa Conservation Area Grading

Location: Waterloo, Ontario

Contractor: H. Kerr Construction Ltd.

Areas Inspected/Tested: Structural fill for lots on Wasaga Crescent.

Areas Not Tested (Reason):

Test No.	Elevation	Location	Material Tested	Dry Density (t/m^3)	Moisture Content (%)	Percent Standard Proctor	Percent Specified
1	361.5 m	Lot 145, 5 m from rear of lot	silt with sand	1.833	15.4	98	98
2	363.2 m	Lot 123, 15 m from front of lot	sand	1.799	11.8	100+	98
3	367.2 m	Lot 119, 15 m from front of lot	sand	1.801	9.1	100+	98
4	361.8 m	Lot 141, 20 m from front of lot	silt with sand	1.850	10.6	99	98
5	362.3 m	Lot 147, 11 m from rear of lot	silt with sand	1.847	11.3	99	98
6	360.7 m	Lot 150, 7 m from rear of lot	silt with sand	1.864	14.2	100	98

Standard Proctor: 1.865 t/m^3 @ 14.0 % moisture
1.735 t/m^3 @ 13.8 % moisture

Compaction Equipment: Smooth Drum Vibratory Roller

Testing Requested By: Ron of H. Kerr Construction Ltd.

Test Results Reported To: Ron of H. Kerr Construction Ltd.

Comments and Observations:

Naylor Engineering Associates Ltd.

SOIL INSPECTION/SUMMARY OF COMPACTION TESTING

Job No.: 4500C1.R02

Date: October 27, 2005

Technician: P. St. John

Project: Activa Conservation Area Grading

Location: Waterloo, Ontario

Contractor: H. Kerr Construction Ltd.

Areas Inspected/Tested: Structural fill for lots on Wasaga Crescent.

Areas Not Tested (Reason):

Test No.	Elevation	Location	Material Tested	Dry Density (t/m^3)	Moisture Content (%)	Percent Standard Proctor	Percent Specified
1	361.1 m	Lot 151, 8 m from rear of lot	silt with sand	1.864	10.9	100	98
2	362.3 m	Lot 148, 10 m from front of lot	sand	1.816	10.4	100+	98
3	363.4 m	Lot 122, 13 m from front of lot	sand	1.770	5.2	100+	98
4	363.3 m	Lot 120, 15 m from front of lot	silt with sand	1.831	6.3	98	98
5	361.4 m	Lot 152, 9 m from front of lot	silt with sand	1.823	13.7	98	98

Standard Proctor: 1.865 t/m^3 @ 14.0 % moisture
1.735 t/m^3 @ 13.8 % moisture

Compaction Equipment: Smooth Drum Vibratory Roller

Testing Requested By: Ron of H. Kerr Construction Ltd.

Test Results Reported To: Ron of H. Kerr Construction Ltd.

Comments and Observations:

SOIL INSPECTION/SUMMARY OF COMPACTION TESTING

Job No.: 4500C1.R02

Date: October 28, 2005

Technician: P. St. John

Project: Activa Conservation Area Grading

Location: Waterloo, Ontario

Contractor: H. Kerr Construction Ltd.

Areas Inspected/Tested: Structural fill for Lot 142 Wasaga Crescent and 43 Rideau Street.

Areas Not Tested (Reason):

Test No.	Elevation	Location	Material Tested	Dry Density (t/m^3)	Moisture Content (%)	Percent Standard Proctor	Percent Specified
1	362.7 m	Lot 142, 5 m from front of lot	sand	1.699	4.2	98	98
2	354.8 m	Lot 43, 15 m from front of lot	Granular 'B'	2.247	--	99	98
3	354.4 m	unnumbered lot, 18 m from front of lot	Granular 'B'	2.259	--	100	98
4	355.0 m	Lot 43, 8 m from front of lot	Granular 'B'	2.274	--	100	98
5	358.0 m	Sta -0+080 Rideau Street	sand	1.746	4.2	100+	98
6	356.9 m	unnumbered lot, 1 m from front of lot		1.835	7.4	98	98

Standard Proctor: 1.735 t/m^3 @ 13.8 % moisture

Compaction Equipment: Smooth Drum Vibratory Roller

Testing Requested By: Ron of H. Kerr Construction Ltd.

Test Results Reported To: Ron of H. Kerr Construction Ltd.

Comments and Observations:

Naylor Engineering Associates Ltd.

SOIL INSPECTION/SUMMARY OF COMPACTION TESTING

Job No.: 4500C1.R02

Date: October 31, 2005

Technician: P. St. John

Project: Activa Conservation Area Grading

Location: Waterloo, Ontario

Contractor: H. Kerr Construction Ltd.

Areas Inspected/Tested: Structural fill for lots on Wasaga Crescent and Rideau Street.

Areas Not Tested (Reason):

Test No.	Elevation	Location	Material Tested	Dry Density (t/m^3)	Moisture Content (%)	Percent Standard Proctor	Percent Specified
1	356.7 m	unnumbered lot, 12 m from front of lot	sand	1.797	4.9	100+	98
2	361.4 m	Lot 163, 15 m from front of lot	silt till	1.921	13.6	100+	98
3	358.0 m	unnumbered lot, 10 m from front of lot	sand	1.802	12.2	100+	98
4	359.8 m	Lot 42, 5 m from front of lot	sand	1.784	4.2	100+	98
5	358.2 m	Lot 43, 13 m from front of lot	sand	1.789	16.6	100+	98
6	358.2 m	unnumbered lot, 11 m from front of lot	sand	1.713	16.1	99	98
7	359.1 m	unnumbered lot, 5 m from front of lot	sand	1.807	11.9	100+	98
8	360.1 m	Lot 42, 8 m from front of lot	sand	1.813	7.9	100+	98
9	359.9 m	Lot 43, 7 m from front of lot	sand	1.767	17.8	100+	98

Standard Proctor: 1.735 t/m^3 @ 13.8 % moisture
1.900 t/m^3 @ 13.8 % moisture

Compaction Equipment: Smooth Drum Vibratory Roller

Testing Requested By: Murray of H. Kerr Construction Ltd.

Test Results Reported To: Murray of H. Kerr Construction Ltd.

Comments and Observations:

Naylor Engineering Associates Ltd.

SOIL INSPECTION/SUMMARY OF COMPACTION TESTING

Job No.: 4500C1.R02

Date: November 2, 2005

Technician: P. St. John

Project: Activa Conservation Area Grading

Location: Waterloo, Ontario

Contractor: H. Kerr Construction Ltd.

Areas Inspected/Tested: Structural fill for lots on Rideau Street.

Areas Not Tested (Reason):

Test No.	Elevation	Location	Material Tested	Dry Density (t/m^3)	Moisture Content (%)	Percent Standard Proctor	Percent Specified
1	357.8 m	Lot 42, 8 m from rear of lot	silt with sand	1.818	11.6	98	98
2	357.3 m	Lot 43, 9 m from rear of lot	silt with sand	1.839	11.6	99	98

Standard Proctor: 1.865 t/m^3 @ 14.0 % moisture

Compaction Equipment: Smooth Drum Vibratory Roller

Testing Requested By: Murray of H. Kerr Construction Ltd.

Test Results Reported To: Murray of H. Kerr Construction Ltd.

Comments and Observations:

Naylor Engineering Associates Ltd.

SOIL INSPECTION/SUMMARY OF COMPACTION TESTING

Job No.: 4500C1.R02

Date: November 3, 2005

Technician: P. St. John

Project: Activa Conservation Area Grading

Location: Waterloo, Ontario

Contractor: H. Kerr Construction Ltd.

Areas Inspected/Tested: Structural fill for lots on Rideau Street.

Areas Not Tested (Reason):

Test No.	Elevation	Location	Material Tested	Dry Density (t/m^3)	Moisture Content (%)	Percent Standard Proctor	Percent Specified
1	357.4 m	Lot A, 12 m from rear of lot	silt with sand	1.854	7.4	99	98
2	358.1 m	unnumbered lot, 8 m from rear of lot	silt with sand	1.819	7.9	98	98
3	357.5 m	Lot B, 9 m from rear of lot	silt till	1.925	12.1	98	98
4	358.7 m	Lot 43, 5 m from rear of lot	silt till	1.948	11.8	99	98

Standard Proctor: 1.865 t/m^3 @ 14.0 % moisture
1.960 t/m^3 @ 11.9 % moisture

Compaction Equipment: Smooth Drum Vibratory Roller

Testing Requested By: Murray of H. Kerr Construction Ltd.

Test Results Reported To: Murray of H. Kerr Construction Ltd.

Comments and Observations:

Naylor Engineering Associates Ltd.

SOIL INSPECTION/SUMMARY OF COMPACTION TESTING

Job No.: 4500C1.R02

Date: November 4, 2005

Technician: P. St. John

Project: Activa Conservation Area Grading

Location: Waterloo, Ontario

Contractor: H. Kerr Construction Ltd.

Areas Inspected/Tested: Structural fill for lots on Rideau Street.

Areas Not Tested (Reason):

Test No.	Elevation	Location	Material Tested	Dry Density (t/m^3)	Moisture Content (%)	Percent Standard Proctor	Percent Specified
1	357.7 m	Lot C, 10 m from rear of lot	sand	1.776	4.7	100+	98
2	359.5 m	Lot 43, 5 m from rear of lot	silt till	1.974	6.2	100+	98
3	360.0 m	Lot D, 8 m from rear of lot	silt with sand	1.822	16.5	98	98
4	359.8 m	Lot 43, 4 m from rear of lot	silt till	1.930	6.0	100+	98
5	358.6 m	Lot B 13 m from rear of lot	silt till	1.890	13.4	100	98

Standard Proctor: 1.735 t/m^3 @ 13.8 % moisture
1.960 t/m^3 @ 11.9 % moisture
1.865 t/m^3 @ 14.0 % moisture

Compaction Equipment: Smooth Drum Vibratory Roller

Testing Requested By: Murray of H. Kerr Construction Ltd.

Test Results Reported To: Murray of H. Kerr Construction Ltd.

Comments and Observations:

Naylor Engineering Associates Ltd.

SOIL INSPECTION/SUMMARY OF COMPACTION TESTING

Job No.: 4500C1.R02

Date: November 8, 2005

Technician: P. St. John

Project: Activa Conservation Area Grading

Location: Waterloo, Ontario

Contractor: H. Kerr Construction Ltd.

Areas Inspected/Tested: Structural fill for lots on Rideau Street.

Areas Not Tested (Reason):

Test No.	Elevation	Location	Material Tested	Dry Density (t/m^3)	Moisture Content (%)	Percent Standard Proctor	Percent Specified
1	356.8 m	Lot 32, 8 m from rear of lot	silt with sand	1.854	10.1	99	98
2	358.0 m	Lot 29, 20 m from rear of lot	silt with sand	1.885	12.1	100+	98
3	358.4 m	Lot 24, 14 m from rear of lot	silt with sand	1.862	5.2	100	98
4	357.5 m	Lot 30, 9 m from rear of lot	silt till	1.967	13.1	100	98
5	358.3 m	Lot 32, 18 m from rear of lot	silt till	1.943	11.6	99	98
6	358.5 m	Lot 26, 7 m from rear of lot	silt till	1.977	11.5	100+	98

Standard Proctor: 1.865 t/m^3 @ 14.0 % moisture
1.960 t/m^3 @ 11.9 % moisture

Compaction Equipment: Smooth Drum Vibratory Roller

Testing Requested By: Murray of H. Kerr Construction Ltd.

Test Results Reported To: Murray of H. Kerr Construction Ltd.

Comments and Observations:

Naylor Engineering Associates Ltd.

Appendix F

F.1 NBC SEISMIC HAZARD CALCULATION

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

June 27, 2018

Site: 43.4883 N, 80.5883 W User File Reference: Activa Conservation Subdivision Phase 2, Waterloo, C

Requested by: , Stantec Consulting Ltd.

National Building Code ground motions: 2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.05)	Sa(0.1)	**Sa(0.2)**	Sa(0.3)	**Sa(0.5)**	**Sa(1.0)**	**Sa(2.0)**	**Sa(5.0)**	**Sa(10.0)**	**PGA (g)**	**PGV (m/s)**
0.093	0.124	**0.115**	0.094	**0.074**	**0.044**	**0.022**	**0.0054**	**0.0023**	**0.069**	**0.060**

Notes. Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC 2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are specified in **bold** font. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. ***These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.***

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.05)	0.0092	0.033	0.054
Sa(0.1)	0.015	0.047	0.075
Sa(0.2)	0.016	0.047	0.072
Sa(0.3)	0.014	0.040	0.060
Sa(0.5)	0.011	0.032	0.048
Sa(1.0)	0.0055	0.019	0.029
Sa(2.0)	0.0023	0.0089	0.014
Sa(5.0)	0.0005	0.0019	0.0034
Sa(10.0)	0.0004	0.0009	0.0014
PGA	0.0080	0.026	0.042
PGV	0.0066	0.023	0.037

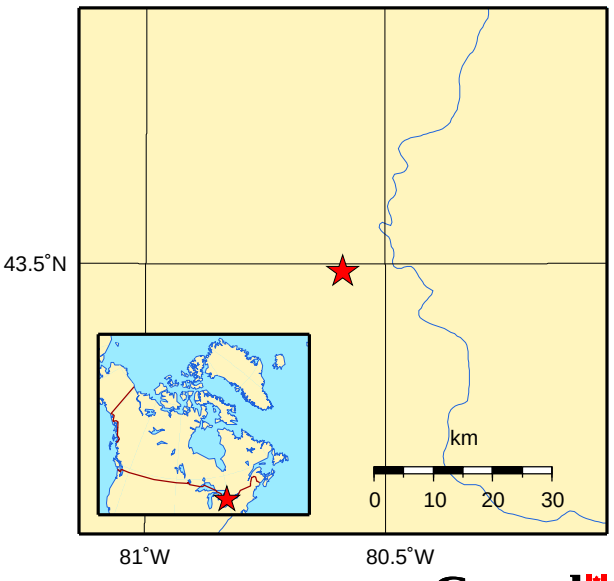
References

National Building Code of Canada 2015 NRCC no. 56190;
Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

User's Guide - NBC 2015, Structural Commentaries NRCC no. xxxxxx (in preparation)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites *www.EarthquakesCanada.ca* and *www.nationalcodes.ca* for more information



Aussi disponible en français