Terraprobe
Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

GEOTECHNICAL INVESTIGATION
PROPOSED KANATA FUEL OUTLET
770 SILVER SEVEN ROAD
OTTAWA (KANATA), ONTARIO

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TABLE OF CONTENTS

FIGURES

APPENDICES

1.0 THE PROJECT

Terraprobe Inc. was retained by Costco Wholesale to conduct a subsurface investigation at the site of a proposed Costco retail fuel outlet adjacent to the existing Kanata Costco warehouse located at the municipal address 770 Silver Seven Road in Ottawa, Ontario as shown on Figure 1. It is proposed that the retail fuel outlet will be constructed north of the existing Costco warehouse, currently where a storm water management pond is located. The investigation is based on the latest drawing provided to Terraprobe by Costco: "*Context Layout Plan*", Dwg No. SP-29, Proj. No. 14.10213.001.P01, by MMM Group, dated October 3rd, 2011.

The proposed fuel outlet will consist of a sales controller kiosk, pump canopy structure, and three underground fuel storage tanks. A storm water management pond (SWMP) is currently situated at the location of the proposed fuel outlet. Two options to mitigate settlements in regards to the regrading of the SWM pond are included within this report, and include:

- Option 1 - found the canopy and tank slab on deep foundations consisting of low displacement driven piles and backfill the SWM pond with lightweight cellular concrete, backfilled with Granular B to prevent buoyant uplift, or

- Option 2 – found the canopy spread footings and tank slab on a monolithic slab of lightweight cellular concrete, backfilled with Granular B to prevent buoyant uplift.

Before the storm water management pond is filled in, an alternative underground storm water retention system will have to be in place (directly east of the proposed fuel outlet). The proposed system consists of precast concrete modular storm water management systems, the base of which are set at Elev. 91 m, approximately 7.5 m below existing grade. The excavation for the underground storage tanks will be made through into the underlying native clay and silt.

Terraprobe conducted a previous investigation for Costco Wholesale for a proposed retail fuel outlet east of the current Costco warehouse (File No. 1-10-5041, dated May 19, 2010). Based on the subsurface conditions encountered (primarily artesian ground water conditions and weak clay), it was Terraprobe's recommendation that the fuel outlet should not be constructed at that particular location. Along with Terraprobe's previous geotechnical report for the fuel outlet (referenced below), Costco provided the following reports to review in conjunction with our current investigation:

- "*Geotechnical Investigation, Costco Kanata, Highway 417 and Terry Fox Drive, Ottawa, Ontario*", prepared by Jacques, Whitford and Associates Limited for Costco Wholesale, Project No. ONO11520, dated April 25, 2002;

- "*Supplemental Geotechnical Investigation – BEDROCK Depths, Proposed Costco Wholesale Retail Store, Highway 417 & Terry Fox Drive, Kanata, Ontario*", prepared by Jacques, Whitford and Associates Limited for Costco Wholesale, Project No. ONO 11520, dated May 15, 2002;

- "*Supplemental Geotechnical Investigation, Costco Kanata, Highway 417 and Terry Fox Drive, Ottawa, Ontario*", prepared by Jacques, Whitford and Associates Limited for Costco Wholesale, Project No. ONO 11520, dated April 26, 2004;

- "*Geotechnical Investigation for Silver Seven Road Widening, Kanata, Ontario*", prepared by Jacques Whitford for Costco Wholesale, Project No. ONO 11808, dated June 29, 2005; and

- "*Geotechnical Investigation, Proposed Retail Fuel Outlet, Kanata Costco, 770 Silver Seven Road, Ottawa, Ontario*", prepared by Terraprobe Inc. for Costco Wholesale Corporation, File No. 1-10-5041, dated May 19, 2010.

The subsurface conditions were determined by advancing nine (9) exploratory boreholes in October 2011, at the locations as shown on Figure 2. Due to the siting of the proposed canopy structure and fuel tanks over the existing storm water management pond, the investigation consisted of a non-standard borehole layout that does not conform to the traditional Costco development guidelines. The boreholes could only be advanced using traditional drilling equipment around the periphery of the existing storm water management pond. The results of the individual boreholes are recorded on the Borehole and Rock Core Logs in Appendix "A". A summary of the geotechnical laboratory tests are provided in Appendix "B". A photograph of the bedrock core is provided in Appendix "C".

The ground surface elevations at the borehole locations were referenced to geodetic datum by level survey, relative to catch basins, the elevations of which were provided on "*Topographic Plan of Part of Lot 2, Concession 2, Geographic Township of March, Now City of Ottawa*", Project No. 14-10-213-001-SU1, Drawing No. 1410213_T01, by MMM Geomatics Ontario Limited, dated March 8, 2010, as provided to Terraprobe by Costco Wholesale.

Based on the information secured from this investigation; interpretation, analysis and advice with respect to the geotechnical engineering aspects of the proposed development are provided. The anticipated construction conditions pertaining to excavation, foundation construction, temporary groundwater control, and backfilling are discussed with regard to how the project design may be influenced.

2.0 SUBSURFACE CONDITIONS

Based on the findings in the boreholes, the subsurface conditions at the proposed Kanata Costco fuel outlet site are generally conceptualized as described below.

The storm water management pond, where the proposed canopy structure and underground fuel tanks are to be located, is approximately 30 meters wide (N-S) and 70 meters long (E-W). The ground surface surrounding the storm water management pond slopes down at an approximate 3 horizontal to 1 vertical slope into the SWM pond, and the water level within the storm water management pond is approximately 4 meters below the surrounding existing grade (Elev. ±94.5 m).

Surrounding the storm water management pond where the boreholes were sited, there is an approximately 50 mm layer of topsoil. In the majority of the boreholes, a layer of loose/firm earth fill was encountered, that ranged in thickness from 0.8 to 1.5 meters. Underlying the earth fill layer, a thin native deposit of clayey silt with frequent silty sand layers was encountered. Underlying the clayey silt with sand layer, is a relatively thick native deposit of very soft, compressible clay and silt. The clay and silt is underlain by limestone bedrock of the Verulam Formation.

2.1 Stratigraphy

The stratigraphic descriptions provided below are based on the geotechnical findings of the boreholes surrounding the proposed storm water management pond where the proposed canopy structure and underground fuel tanks will be situated. It must be noted that no boreholes were advanced in the existing SWM Pond area, and therefore the precise stratigraphy beneath SWM pond is estimated only. Refer to the enclosed Borehole Logs in Appendix A for more specific subsurface details.

The boreholes encountered a surficial layer of topsoil approximately 50 mm thick. A layer of earth fill was encountered all boreholes except Boreholes 3 and 5, which encountered native soils beneath the topsoil. The earth fill extended to depths of 0.8 to 1.5 meters below present grade (Elev. 98.3 to 95.7 m). The earth fill material is most commonly comprised of a sandy silt with some clay and trace organics and rootlets. In some locations the fill varied in composition from gravelly sand with some silt, to clayey silt with some sand. The earth fill is generally loose (where cohesionless) and firm (where cohesive).

The earth fill layer is underlain by a relatively thin native deposit of clayey silt with frequent silty sand layers. These shallow native soil layers were encountered at Elev. 99.1 to 96.9 and extend to the very soft clay and silt deposit at 1.5 to 3.1 meters below grade (Elev. 96.9 to 95.4 m). The clayey silt with frequent silty sand layers is generally characterized as brown and moist. Standard Penetration Test results (“N” Values) measured in the clayey silt ranged from 1 to 8 blows per 300 mm of penetration, indicating a very soft to firm consistency.

The clayey silt with frequent silty sand layers is underlain by a native deposit of compressible clay and silt with trace sand. The clay and silt was encountered in all boreholes at 1.5 to 3.1 meters below present grade (Elev. 96.9 to 95.4 m) and extends to the inferred bedrock surface in Borehole 1 at 8.0 meters below present grade (Elev. 89.7 m), to the top of the sandy silt deposit in Boreholes 3, 6 and 8 at 7.6 to 13.7 meters below present grade (Elev. 89.0 to 82.3 m), and beyond the vertical extent of sampling in the remainder of the boreholes. The clay and silt is generally characterized as grey and wet. Standard Penetration Test results ("N" Values) measured in the sand ranged from 0 to 3 blows per 300 mm of penetration, indicating a very soft to soft consistency. In-situ shear vane tests conducted in the silt and clay yielded in-situ undrained shear strengths of 15 to 20 kPa and remoulded shear strengths ranging from 2 to 9 kPa. The moisture content of the clay and silt varies from 22 to 94% with an average moisture content of 60%. The liquid limit varies from 22 to 24%. The plastic limit varies from 37 to 42%.

Underlying the clay and silt, a deposit of sandy silt with some clay and trace gravel was identified in Boreholes 3, 6 and 8. The sandy silt was encountered at 7.6 to 13.7 meters below present grade (Elev. 95.4 to 96.9 m) and extended to the inferred bedrock surface at 8.5 to 16.1 meters below present grade (Elev. 88.1 to 79.9 m). The sandy silt is generally characterized as being grey and wet. Standard Penetration Test results ("N" Values) measured in the till ranged from 0 to 2 blows per 300 mm of penetration, indicating a very soft consistency.

Dynamic cone penetration tests (DCPT) were performed in Boreholes 2, 4, 5 and 7 to determine the inferred bedrock depth/elevation. Though no samples were recovered from the depths where the dynamic cone penetration test was conducted, the stratigraphy is inferred to be similar to the descriptions provided above. The results of the DCPT show "N" values directly comparable to the consistency of both the clay and silt and sandy silt deposit (very soft). Contours of estimated compressible clay thickness are provided in Figure 3.

2.2 Bedrock

Bedrock was identified beneath the clay and silt/sandy silt deposits at depths varying from 7.5 to 16.1 m below grade (Elev. 89.7 to 83.0 m), as indicated by auger cuttings, auger grinding and rock coring. Bedrock core sampling was carried out at Borehole 3 and a detailed rock core log is included following the corresponding borehole log. The bedrock underlying the site is inferred to be of the Verulam Formation. The bedrock elevations at boreholes in which observed/inferred bedrock was encountered are noted on the enclosed borehole logs and are summarized below:

Borehole No.	Borehole Surface Elevation (m)	Depth to Bedrock (m)	Bedrock Elevation (m)	Method bedrock depth was determined/estimated
1	97.7	8.0	89.7	Auger Refusal
2	98.2	9.8	88.4	Dynamic Cone Refusal
3	99.1	16.0	83.1	Rock Coring
4	97.2	7.5	89.7	Dynamic Cone Refusal
5	99.6	13.6	86.0	Dynamic Cone Refusal
6	98.1	8.5	89.6	Auger Refusal
7	98.3	11.2	87.1	Dynamic Cone Refusal
8	98.4	10.6	87.8	Auger Refusal

The bedrock in this area of Kanata consists of the Verulam Formation. The Verulam Formation is a deposit predominantly comprised of interbedded bioclastic to very fine grained, thinly bedded limestone and calcareous shale of Ordovician age. Bedding of the Verulam Formation is expected to be flat lying. There is a known fault in the vicinity of the site. The bedrock was identified very near surface in the eastern outparcel, approximately 300 m southeast of the currently proposed fuel outlet site. The Rock Quality Designation (RQD) of the rock ranged from 58 to 61% indicating a “fair” rock quality. No weathered portions of the limestone bedrock were encountered. Contours of inferred bedrock elevation are provided in Figure 4.

2.3 Ground Water

Unstabilized ground water level observations were made in each of the boreholes as they were drilled and after completion, and are noted on the enclosed borehole logs. Two 50 mm diameter monitoring wells were installed in Boreholes 1 and 8 to facilitate long-term ground water monitoring. The measured water levels and depth at which the boreholes caved are provided on the borehole logs. The water levels within the wells, where water levels were taken, are summarized below:

Borehole No.	Depth of boring (m)	Depth to cave (m)	Unstabilized water level upon completion of drilling (m)	Water Level in Well on October 6, 2011 Depth / Elevation (m)
1	8.0	open	4.6	4.1 / 93.6
8	10.6	open	4.6	2.0 / 96.4

In general, the fine-grained soils found beneath the site are of low permeability and typically preclude the free flow of water. It can be assumed that vertical drainage is poor and nominal perched ground water will exist. The perched ground water level may even approach grade during the spring if positive drainage is not provided.

It should be noted that the water level taken in Borehole 8 may be representative of the pressure head within the sandy silt deposit. This layer is relatively more permeable than the overlying clay and silt deposit. Regrading of the site and seasonal fluctuations may cause changes to the depth of the water table over time.

2.4 Environmental Baseline Conditions

Soil and groundwater samples were recovered and tested for an assessment of volatile organic compounds (VOC's), petroleum hydrocarbons (PHC's) and metal and inorganic parameters. The samples selected that were and tested are as follows:

Sample ID	Location	Depth / Elevation (m)	Soil Type	Test Type
2837668	BH 1 Sa 2	1.1 / 96.6	Earth Fill – Clayey Silt	Metal and Inorganics
2837671	BH 3 Sa 7	6.3 / 92.8	Native Clay and Silt	Metal and Inorganics
2837677	BH 6 Sa 1	0.3 / 97.8	Earth Fill – Sandy Silt	Metal and Inorganics
2837688	BH 8 Sa 4	2.4 / 96.0	Native Clay and Silt	Metal and Inorganics
2837673	BH 4 Sa 4	2.4 / 94.8	Native Clay and Silt	VOC's
2837676	BH 5 Sa 5	3.2 / 96.4	Native Clay and Silt	VOC's
2868996	BH 1	N/A	Groundwater	Metal and Inorganics PHC's VOC's
2869012	BH 8	N/A	Groundwater	Metal and Inorganics PHC's VOC's

There were no samples recovered from the borings which had an identifiable odour suggestive of petroleum hydrocarbon or volatile chemical impacts. Nevertheless, two soil samples were selected and submitted to an analytical laboratory (AGAT Laboratories) for assessment of VOC's, as per Costco's requirements. As well, four soil samples were selected and submitted for an assessment of metal and other inorganic parameters and two groundwater samples were selected and submitted for assessment of metal and other inorganic parameters, VOC's and PHC's.

The results of the soil and water sampling were compared to O.Reg. 154/04, as amended by O.Reg. 511/09, Ministry of the Environment Table 3 Full Depth Site Condition Standards in a Non-Potable Water Condition for Industrial/Commercial/Community Property Use (Table 3 ICC), as found in the *Soil, Ground Water and Sediment Standards for Use Under Part XV. I of the Environmental Protection Act* (April 15, 2011). The certificates of analysis for the soil and groundwater can be found in Appendices D and E, respectively.

There were no exceedances of the O.Reg. 153/04 Table 3 ICC Standards for all the parameters analyzed.

2.5 Soil Corrosivity

Four samples of earth fill (BH2 Sa2, BH3 Sa3, BH7 Sa1, BH9 Sa3) were selected and tested for a suite of corrosivity parameters consisting of pH, Resistivity, Electrical Conductivity, Redox Potential, Sulphate, Sulphide and Chloride. A copy of the Certificate of Analysis is included in Appendix D. These parameters are used for assessing soil corrosivity applicable to cast iron alloys, according to the 10-point soil evaluation procedure described in the American Water Work Association (AWWA) C-105 standard. It should be noted that the analytical results only provide an indication of the potential for corrosion. A more recent study by the AWWA has suggested that soil with a resistivity of less than about 2000 ohm.cm should be considered aggressive. All four samples scored less than 10 points.

The above samples were also analysed for soluble sulphate concentration. The analytical results were compared to the Canadian Standard CAN3/CSA A23.1-M94 Table 3, *Additional Requirements for Concrete Subjected to Sulphate Attack*. It is anticipated that these results would be used to determine the type of cementing materials to be used to produce concrete for this project. Comparison of the test results indicates that the water soluble sulphate concentrations in soil are lower than 0.1 percent. Based on this result, there is a negligible potential for sulphate attack on the concrete, regardless of cementing material used.

3.0 GEOTECHNICAL DESIGN

3.1 Site Grading

On behalf of Costco, MMM Group provided Terraprobe with the following site drawings:

- "*Topographic Plan of Part of Lot 2, Concession 2, Geographic Township of March*", Project No. 14-10-213-001-SU1, Drawing No. 1410213_T01 by MMM Geomatics Ontario Limited dated September 13, 2011; and

- Preliminary sketch of the grading within the fuel outlet, sent by email to Terraprobe on November 11, 2011.

Based on the topographic plan and preliminary grading sketch provided, it is understood that the existing and proposed grades at the site are generally as follows:

Proposed Fuel Outlet Structure	Current Location	Approx. Existing Grade Elevation (m)	Approx. Proposed Grade Elevation (m)	Estimated Grade Raise (m)
Tank Excavation	West area of SWMP	94 to 95	98 to 98.5	3.0 to 4.4
Canopy Structure	South area of SWMP	94 to 96.5	98 to 99	0.1 to 3.5
Apron	North area of SWMP	94 to 96.5	98 to 99	3.5 to 4.8
Landscaping and Storm Retention Area	East area of SWMP and flat tableland east of SWMP	94 to 99	98 to 99	0.5 to 4.0
Drive Aisle	Flat tableland North and East of SWMP	98 to 99	97.5 to 99	0 to 0.1

In general, grade raises are made using an engineered fill comprised of Granular "B" (OPSS 1010) compacted to a minimum 95% Modified Proctor Maximum Dry Density (or 98% Standard Proctor Maximum Dry Density, which is equivalent for the purpose of these recommendations). Similarly, all new earth fill used to raise grades in non-settlement sensitive areas (such as landscaped areas) shall be inorganic, common earth fill or Granular "B" compacted to a minimum of 95% MPMDD.

Based on the above preliminary grading, the estimated grade raise over existing conditions is also detailed above. The grade raises using Granular "B" will cause consolidation settlement of the underlying very soft clay and silt. Terraprobe conducted consolidation testing and analyses based on compressible clay thicknesses as shown in Figure 3, the grade raises as indicated above, and on the consolidation properties of the clay as determined in our laboratory. The analysis has assumed that the existing SWMP was cut to its current position, and hence the ground surface was relatively level prior to the cut for the SWMP. That is, the underlying clay and silt will undergo some recompression, as well as some virgin compression due to the fill being placed. The clay and silt beneath the site is sensitive and highly compressible, with moisture contents exceeding the liquid limit.

It is understood that an underground storm water management and detention system will be installed in the proposed landscaping area to the east of the fuel outlet. This system must be designed as a net-unloading of the underlying soils such that there will be minimal long-term consolidation settlement. The system will need to function during the installation of the fuel outlet while the SWMP is filled.

If the SWMP is simply filled with an engineered fill comprised of Granular "B" to the preliminary grades provided to Terraprobe, then the estimated consolidation settlements are as shown in the table below and are estimated to take place over a period of about three years.

Proposed Fuel Outlet Structure	Estimated Settlement Using Granular "B" Engineered Fill (mm)
Tank Area	25 to 110
Canopy Area	35 to 225
Apron Area	35 to 250
Drive Aisle	0 to 5

The above estimated consolidation settlements for the tank, canopy, and apron areas are well in excess of the Costco Development Guidelines. The drive aisle north and east of the SWMP does not appear to be subject to consolidation settlements, as no grade raises are anticipated in these areas. In consultation with Costco Wholesale and Mulvanny G2, two options for construction of the fuel outlet are being considered in order to minimize total and differential settlement:

1. Provide piled foundations, driven to bedrock, for the canopy and the fuel tank slab, and fill the SWMP partially with light weight cellular concrete and partially with Granular B to reduce the loading on and consolidation settlement of the underlying highly-compressible clay and silt; and

2. Subexcavate some portions of the pond to create a monolithic slab (approximately 3 m thick) of lightweight cellular concrete, backfilled with Granular B to prevent buoyant uplift, the canopy spread footings and tank slab would be set upon the cellular concrete slab.

When one of these options is finally chosen by Costco Wholesale, Terraprobe should be retained to provide detailed analysis of the final option.

3.1.1 Option 1 – Pile Support Canopy & Tanks Slab, Backfill with Lightweight Fill

With this option, piled foundations for the canopy and the tank slab are extended to bedrock to eliminate any post-construction settlements of the canopy and tanks. Piling recommendations are provided later in this report.

In order to minimize long-term consolidation settlement of the underlying soils, the pond area would be filled with lightweight cellular concrete to a depth of 1.9 m below ground surface. The lightweight cellular concrete must be a monolithic pour of air entrained cellular concrete, which has a unit weight of no higher than 5 kN/m^3. In order balance against buoyancy for an extreme high ground water table approaching ground surface, there must be a minimum cover of 1.9 m of Granular B, compacted to 95% Modified Proctor dry density, placed on top of the cellular concrete.

With this option, the resulting estimated consolidation settlements are as shown in the table below.

Proposed Fuel Outlet Structure	Option 1 Estimated Settlement Using LWF Combined with Granular Fill (mm)
Tank Area	20 to 25
Canopy Area	5 to 20
Apron Area	15 to 20
Drive Aisle	0 to 5

The settlements shown above are estimated to take place over a period of 12 to 24 months. With this option, since the tanks and the canopy will be supported on piled foundations set into bedrock, the lightweight cellular concrete fill will help to mitigate differential settlements between the structures.

3.1.2 Option 2 – Canopy Footings and Tank Slab on a Monolithic Slab of Lightweight Cellular Concrete

Option 2 involves creating a monolithic slab of cellular concrete that would be used not only to reduce settlement, but also to allow the footings of the canopy to be placed on the cellular concrete, instead of supported on piles to rock.

In order for option work, there would need to be a monolithic slab of cellular concrete of 3.1 m thickness, with 1.9 m of Granular B layer on top to ensure that the slab does not become buoyant. With this thickness of slab, the canopy can be supported using spread footings set on Granular B above the cellular concrete slab, or set directly upon the cellular concrete slab. As well, using a consistent thickness of this cellular concrete will nearly eliminate any differential settlements. Long term settlements of 5 to 25 mm are predicted based on consolidation analyses and literature reviews confirming Terraprobe's estimated soil parameters in the vicinity of the site.

As with Option 1, the lightweight cellular concrete must be a monolithic pour of air entrained cellular concrete, which has a unit weight of no higher than 5 kN/m^3. In order balance against buoyancy for an extreme high ground water table approaching ground surface, there must be a minimum cover of 1.9 m of Granular B, compacted to 95% Modified Proctor dry density, placed on top of the cellular concrete.

With this option, the resulting estimated consolidation settlements are as shown in the table below.

Proposed Fuel Outlet Structure	Option 2 Estimated Settlement Using LWF Combined with Granular Fill (mm)
Tank Area	20 to 25
Canopy Area	15 to 20
Apron Area	15 to 20
Drive Aisle	0 to 5

The settlements shown above are estimated to take place over a period of 12 to 24 months. With this option, since the tanks and the canopy will be supported on the monolithic 3.1 m thick slab of lightweight cellular concrete, differential settlements will be nearly eliminated.

The monolithic slab must extend a minimum of 1 m south of any proposed canopy footings. With this option, therefore, there will need to be excavation to the south of the proposed canopy area. In order to accommodate this excavation, shoring must be provided to maintain integrity of the adjacent internal Costco road and services. Shoring and excavation recommendations are provided later in this report.

3.2 Foundation Design Parameters

All foundations, wall bases, or grade beam structures exposed to freezing temperatures must be provided with not less than 1.8 metres of earth cover or equivalent insulation to protect against frost effects. The earth fill and native soils at this site are weak soils and are not suitable for the support of building foundations on conventional spread footings. Small, low-load foundations such as that for retaining walls up to 1.2 m high may be designed for a geotechnical resistance at SLS of 45 kPa. The total estimated settlement at this SLS pressure is less than 25 mm. The factored geotechnical resistance at ULS is 75 kPa.

As previously discussed, foundations for the canopy structure, tank foundation, and any buildings can either be supported using end bearing piles advanced to the underlying bedrock, or upon a monolithic 3.1 m thick slab of light-weight cellular concrete.

3.2.1 Option 1 - End-Bearing Driven Piles

With Option 1, the canopy, tanks, kiosk, and any other buildings, must be supported on piled foundations. The elevation of the bedrock in the currently proposed location of the canopy varies from 89.5 to 87 m, from west to east. The elevation of the bedrock in the currently proposed location of the tanks varies from 89.5 to 86 m. The bedrock elevation in the apron area varies from 88 to 85 m.

Driven steel pile foundations are broadly categorized as either low displacement of high displacement units. Low displacement piles are constituted of HP steel sections. High displacement piles are made by driving closed end steel tubes. It is not prudent to use high displacement piles in an area with sensitive clay cover, the disturbance caused by the high displacement piles would be extensive.

The piles are to be driven to refusal and they must be fitted with manufactured driving points or shall be reinforced in accordance with the provisions of OPED 3000.100. If piles need to be spliced then all splices shall be made in compliance with the requirements of OPED 3000.200.

During the driving of piles there should be quite a dramatic increase in driving resistance expected when the tip of the pile encounters the rock. For the purposes of estimating pile driving lengths, additional boreholes should be made in the re-located fuel outlet location. However, actual installed pile lengths and set must be determined in the field based on continuous monitoring of the piles operations as required by the Ontario Building Code 4.2.2.2. Contractual arrangements for pile driving usually include specified foundation levels and a plus/minus pricing structure to compensate for the actual driven length of the installed piles.

A table is provided of typical steel sections used for low displacement piles. For each steel HP section the maximum design capacity as derived from static analysis, to be field verified by dynamic analysis, as prescribed in CAN/CSA-S6-00 Canadian Highway Bridge Design Code, has been tabulated.

Maximum Pile Capacity for Limit States Design Method

Section	Area of Steel (mm^2)	factored axial resistance at ULS fy = 350 MPa	axial resistance at SLS fy = 350 MPa
HP 310 x 110	14,100	1763 kN	1469 kN
HP 310 x 79	9,980	1247 kN	1039 kN
HP 250 x 85	10,900	1357 kN	1100 kN
HP 250 x 62	7,980	993 kN	800 kN
HP 200 x 54	6,820	840 kN	700 kN

The pile sections are to be driven to practical refusal and a *dynamic analysis* to evaluate the "setting" of the piles shall be carried out using the *Hiley Dynamic Pile Driving Formula*, in accordance with MTO Standards SS103-10 or SS103-11. The Hiley Formula generates an unfactored ultimate pile capacity which must equal or exceed the following tabulated ultimate axial capacity values.

Unfactored Ultimate Capacity for Comparison to Hiley Dynamic Analysis

Section	Area of Steel (mm^2)	ultimate capacity fy = 350 MPa
HP 310 x 110	14,100	4408 kN
HP 310 x 79	9,980	3119 kN
HP 250 x 85	10,900	3393 kN
HP 250 x 62	7,980	2483 kN
HP 200 x 54	6,820	2102 kN

Preliminary estimates of the actual required pile "set" requirements can be made when details of the proposed hammer and helmet configuration are known. In this regard, care should be taken in selection of the pile driving hammer so that driving stresses in the piles are limited to a maximum of 90% of the yield strength of the steel.

3.2.2 Option 2 – Spread Footings, Monolithic Slab of Cellular Concrete

Option 2 involves the excavation and creation of a large area to create a monolithic slab of lightweight cellular concrete of 3.1 m thickness, with 1.9 m of Granular B on top to ensure that the slab does not become buoyant. In this case, spread footing foundations for the canopy and kiosk can be set upon the Granular B engineered fill above, or upon the cellular concrete slab. The minimum specified unconfined compressive strength of the cellular concrete is 400 kPa. In this case the geotechnical resistance at SLS is 200 kPa, for predicted settlements of no more than 25 mm. The factored geotechnical resistance at ULS is 500 kPa.

3.3 Earthquake Design Parameters

The Ontario Building Code (2006) stipulates the methodology for earthquake design analysis, as set out in Subsection 4.1.8.7. The determination of the type of analysis is predicated on the importance of the structure, the spectral response acceleration and the site classification.

The parameters for determination of Site Classification for Seismic Site Response are set out in Table 4.1.8.4A of the Ontario Building Code (2006). The classification is based on the determination of the average shear wave velocity in the top 30 meters of the site stratigraphy, where shear wave velocity (v_s) measurements have been taken. Alternatively, the classification is estimated on the basis of rational analysis of undrained shear strength (s_u) or penetration resistance (N-values).

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

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

At this site, the stratigraphy in the existing parking area consists of soft clay and silt overlying bedrock. The clay and silt, which is greater than 3 metres thick, has a plasticity index generally less than 20%, a moisture content greater than 40%, and low undrained shear strengths. On this basis, the site designation for seismic analysis is Class E, according to Table 4.1.8.4.A of the Ontario Building Code (2006). Tables 4.1.8.4.B and 4.1.8.4.C. of the same code provide the applicable acceleration and velocity based site coefficients.

Site Class	Values of F_a				
	$S_a(0.2) \leq 0.25$	$S_a(0.2) = 0.50$	$S_a(0.2) = 0.75$	$S_a(0.2) = 1.00$	$S_a(0.2) \geq 1.25$
E	2.1	1.4	1.1	0.9	0.9

Site Class	Values of F_v				
	$S_a(0.2) \leq 0.25$	$S_a(0.2) = 0.50$	$S_a(0.2) = 0.75$	$S_a(0.2) = 1.00$	$S_a(0.2) \geq 1.25$
E	2.1	2.0	1.9	1.7	1.7

3.4 Earth Pressure Design Considerations

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

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

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

Stratum/Parameter	φ	γ	Ka	Ko	Kp
Compact Granular Fill Granular 'B' (OPSS 1010)	32	21.0	0.31	0.47	3.25
Existing Earth Fill	30	19.0	0.33	0.50	3.00
Clay and Silt / Sandy Silt	28	17.0	0.32	0.48	3.12
Verulam Formation (Bedrock)	28	26.0	n/a	n/a	n/a

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

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

where,
- **P** = the horizontal pressure at depth, **h** (m)
- **K** = the earth pressure coefficient,
- h_w = the depth below the groundwater level (m)
- **γ** = the bulk unit weight of soil, (kN/m3)
- **γ'** = the submerged unit weight of the exterior soil, (γ - 9.8 kN/m^3)
- **q** = the complete surcharge loading (kPa)

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

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

The factored geotechnical resistance to sliding of earth retaining structures is developed by friction between the base of the footing and the soil. This friction **(R)** depends on the normal load on the soil contact (**N**) and the frictional resistance of the soil (**tan φ**) expressed as: **R = N tan φ**. This is an unfactored resistance. The factored resistance at ULS is $\mathbf{R_f = 0.8\ N \tan \varphi}$.

3.5 Site Servicing

3.5.1 Bedding

In general, the proposed engineered fill (Granular "B"), and upper sandy silt native soils at the site will provide adequate support for piping provided with conventional Class 'B' bedding. Bedding materials can be well graded, granular fill, such as Granular "A" (OPSS 1010) or 19 mm Crusher Run Limestone. Where sand or silt subgrade is encountered, it is recommended to separate the bedding material from the

subgrade using a suitable geotextile. All granular bedding must be compacted to a minimum of 95% of Modified Proctor Maximum Dry Density or compacted by vibration to a dense state in the case of clear stone bedding.

3.5.2 Backfill

Excavated existing earth fill materials or the upper native sandy silt, encountered on site may be re-used as backfill (in non-settlement sensitive areas) with selection and sorting and after removing any deleterious materials, provided the moisture content of these materials is within optimum or 2 percent greater than optimum to ensure adequate compaction, and the trenches are wide enough to accommodate a large sheeps-foot compaction roller. The lower clay and silt must not be used as backfill and must be wasted. If narrow trenches are excavated, then use of aggregate fill is required, if there is to be post-construction grade integrity. The utility trench backfill must be compacted to at least 95% of Modified Proctor Maximum dry density.

3.6 Tank Installation

In the proposed fuel outlet area, an existing storm water management pond was present at the time of the 2011 investigation. The water level within the pond was approximately at Elev. 94.5 ± meters with the slopes of the storm water management pond reaching existing grade at approximately Elev. 98 ± meters (for a total depth of approximately 3.5 to 4 metres). The tank excavation will be into the underlying very soft clay and silt. Excavations into the very soft clay and silt may be cut neat to a slope of no steeper than 3 H : 1 V in a natural, undisturbed state. There shall be no vehicular traffic permitted on any sloped excavations at this site. Alternatively, excavations can be shored using conventional sheet pile walls, extended to the bedrock, and must be braced for support. Recommendations for shoring are provided in Section 5 of this report.

In order to ensure less than 25 mm of post-construction settlement, the tank structure must be supported by piled foundations set on bedrock, or set within the monolithic slab of cellular concrete as detailed above. Regardless of the elevation of the bottom of the tanks, there must be a minimum of 400 mm thickness of cellular concrete slab beneath the tanks.

In designing tank structures, consideration must be given to the potential that the tank backfill can flood under storm events and during spring thaw. Unless provisions are made to positively underdrain the fuel storage tank installations, the tanks may become buoyant. Normal design practice for tank installation is to assume a flood condition with ground water in the backfill at grade, and to ensure the tank is restrained in such a way that it is not buoyant under this condition.

Buoyancy resistance is often provided by restraints can be made to individual dead man ground anchors, which are set upon the cellular concrete. The tank excavations should be backfilled with free draining aggregate which is to be compacted to not less than 95% of Modified Proctor Maximum Dry Density.

3.7 Storm Water Retention System Installation

Before the existing storm water management pond is filled in, an alternative underground storm water retention system will be constructed directly east of the proposed fuel outlet. The proposed system consists of precast concrete modular storm water management systems, the base of which are set at Elev. 91 m, approximately 7.5 m below existing grade. The excavation for the underground storm water retention system will be made through into the underlying native clay and silt.

Excavations into the very soft clay and silt may be cut neat to a slope of no steeper than 3 H : 1 V in a natural, undisturbed state. Based on the configuration of the underground storm water retention system, the extent of the site will not allow for sloped excavations. Thus, the south, east and north portions of the retention system excavation must be shored, as there is not enough room to effectively slope the site at safe angles. The western portion of the retention system excavation can be sloped to match the fuel outlet excavation, depending on the final configuration. To this end, it is probably best to shore the entire south wall of the excavation to facilitate installation of the fuel outlet components as well as the storm water retention system. Recommendations for shoring are provided in Section 5 of this report.

The proposed system was checked for potential buoyancy using the following assumptions:

- ground water table at surface and the retention system empty (worst case scenario),
- ground surface (and ground water table) at Elev. 98.5 m,
- base of storm water retention system Elev. 91.0 m,
- top of storm water retention system at Elev. 95.0 m,
- backfill on top of structure (3.5 m thick) is Granular “B” with a unit weight of 21 kN/m^3.

Based on these assumptions, and using load factored resistance design (LFRD) factors of 1.0 for loads (ground water cannot possibly be higher than ground surface, and unit weight of water is a well known constant), and 0.9 for dead weight resistance; the structure is safe against buoyancy.

The net load of removing the existing soil and replacing with the retention system full of water and a cap of 3.5 m of Granular “B” as indicated above, is a negative net loading, i.e. a net unloading. This means that there will be no settlement caused by the installation of the storm water retention system at this design elevation.

4.0 PAVEMENT DESIGN

4.1 Portland Cement Concrete Pavement

A rigid concrete pavement will be made in the fuel outlet pump area. Since this is an exposed concrete pavement, uniform support is important to mitigate heave of the slab during the cold months of the year. Regardless, the slab must be physically separated from the canopy superstructure. Consideration should be given to the relative merits and economies of reinforced versus unreinforced concrete pavement, given an environment where the concrete will be exposed to de-icing salts. The subgrade for the slab on grade construction will consist of engineered fill comprised of Granular "B". Surface compaction is required below all pavements. The modulus of subgrade reaction appropriate for slab design will on the Granular "B" engineered fill will be 40,000 kPa/m. Concrete pavement is specified under CSA A23.1 for Class C-2 exposure which implies a minimum compressive strength at 28 days of 32 MPa.

The following Portland cement concrete pavement structure recommended for this site is comprised as follows:

Pavement Layer	Placement Requirements	Bus/Truck Traffic Minimum Component Thickness
Portland Cement Concrete Surface CSA A23.1 Class C-2	CSA A23.1	200 mm
Base Course: Granular A (OPSS 1010) or 19mm Crusher Run Limestone	98% Modified Proctor Maximum Dry Density (ASTM-D1557)	300 mm

The on-site material or similar imported soil is not readily compacted in small volumes, such as trenches or in areas adjacent to foundations. For areas of limited extent, readily compactable aggregate source backfills are recommended, if there is to be post-construction grade integrity. All new fill shall be compacted to a minimum of 95% of Modified Proctor Maximum Dry Density.

To prevent the formation of irregular cracking and control stressing within the concrete slab, it is recommended that joints be designed within the concrete slab at a maximum spacing of 4.5 meters. Along the concrete/asphalt interface, the concrete slab should be sufficiently thickened to enhance the load-carrying capacity.

The native soils have high fines content, and therefore are not free draining. It will be difficult to handle should the soils become wetter as a result of inclement weather or seepage. It can be expected that earthworks will be difficult during wet periods (i.e., spring and fall) of the year. Soils which are or become overly wet as the result of rainfall or seepage may prove difficult to compact, and should be mixed with drier soil, left aside, or wasted. Should construction be conducted during the winter season, it

is imperative to ensure that frozen material is not utilized as trench backfill or foundation wall backfill. The subgrade for all new pavement structures shall be frost tapered at a 3H to 1V slope to match with existing pavement structures, to reduce differential settlements due to frost heave.

4.2 Asphaltic Concrete Pavement Design

The pavement design recommendations are based on the subgrade support capabilities that will be available from the prepared subgrade compacted to a minimum 95% of Modified Proctor maximum dry density, or the neatly cut undisturbed soil. It is anticipated that the modulus of subgrade reaction on the Granular "B" engineered fill will be 40,000 kPa/m. The typical Performance Graded (PG) asphalt binder recommended in the Ottawa area is PG 58-34, however, it is understood that a higher grade preferred and hence PG 64-34 is recommended for this project.

A pavement design which can be expected to have a service life of 20 years before significant rehabilitation is provided, depending on the actual traffic volumes. It is noted that portions of the new paving will support the tanker truck deliveries and must be designed accordingly.

Prior the placement of the aggregate pavement components, it is recommended that the cut subgrade be inspected for obvious loose or disturbed areas as exposed. These areas shall be replaced with Granular B compacted to 95% Modified Proctor Maximum Dry Density.

The following table provides the recommended asphalt pavement structure for the pavement at the site.

Pavement Layer	Compaction Requirements	Car Traffic Minimum Component Thickness	Truck Traffic Minimum Component Thickness
Surface Course Asphaltic Concrete HL3F (OPSS 1150) with PG Asphalt Cement (OPSS 1101)	OPSS 310	40 mm	40 mm
Base Course Asphaltic Concrete HL8 (OPSS 1150) with PG Asphalt Cement (OPSS 1101)	OPSS 310	50 mm	80 mm
Base Course: Granular A (OPSS 1010) or 19mm Crusher Run Limestone	98% Modified Proctor Maximum Dry Density (ASTM-D1557)	150 mm	150 mm
Subbase Course: Granular B Type II (OPSS 1010) or 50mm Crusher Run Limestone	95% Modified Proctor Maximum Dry Density (ASTM-D1557)	400 mm	450 mm

4.3 Drainage

Control of surface water is a significant factor in achieving good pavement life. Grading of adjacent pavement areas must be designed so that water is not allowed to pond adjacent to the outside edges of the pavement or curb. The existing native soils have a slight frost susceptibility to frost heave, and pavement on these materials must be designed accordingly. The need for adequate subgrade drainage cannot be over-emphasized. The subgrade must be free of depressions and sloped (preferably at a minimum grade of two percent) to provide effective drainage toward subgrade drains. Subgrade drains are recommended to intercept excess subsurface moisture at the curb lines and catch basins. Typical pavement drainage details are provided in Appendix F.

5.0 DESIGN CONSIDERATIONS FOR CONSTRUCTABILITY

5.1 Excavations

Excavations must be carried out in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects, November 1993 (Part III - Excavations, Section 222 through 242). These regulations designate four (4) broad classifications of soils to stipulate appropriate measures for excavation safety. The earth fill and sandy silt are Type 3 Soils whereas the underlying very soft clay and silt is a Type 4 soil. Excavations in the very soft clay and silt may must be shored and not sloped.

Where workers must enter excavations advanced deeper than 1.2 m, the trench walls should be suitably sloped and/or braced in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. The regulation stipulates maximum slopes of excavation by soil type as follows:

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

Minimum support system requirements for steeper excavations are stipulated in the Occupational Health and Safety Act and Regulations for Construction Projects, and include provisions for timbering, shoring and moveable trench boxes.

Notwithstanding the above, Terraprobe completed slope stability analyses assuming a worst case scenario of the ground water table at the surface. Based on our analyses, any cut slopes on the site must not be

made any steeper than 3 H : 1 V. All slopes must be cut neat, leaving the slopes in a natural undisturbed state. There must be no vehicular traffic allowed on any cut slopes on site.

It must be noted that larger size debris may be found in the earth fill material. The size and distribution of such obstructions cannot be predicted with borings, because the borehole sampler size is insufficient to secure representative samples of particles of this size. Provision must be made in the excavation contracts to allocate risks associated with the time spent and equipment utilized to remove or penetrate such obstructions when encountered.

The earth fill at the site may contain perched water that will seep into excavations in the short-term. It is expected that trapped ground water zones, are of limited extent and can be allowed to drain into the excavation, to be pumped out. This may take time, and issues of delay in excavation must be addressed in the excavation contract. In general, the volume of water to be anticipated to flow into open excavations is such that temporary pumping from the excavations is expected to suffice for the control of the ground water.

5.2 Shoring and Excavation Design

Terraprobe can provide detailed shoring design and engineering services for this project. Where excavations made in the clay and silt cannot be sloped, excavations must be made using shoring. In general the east and south portions of the site must be fully shored, along with portions of the north and west excavation faces to preserve the integrity of the adjacent land.

Shoring must be made using conventional sheet pile walls that are extended to the bedrock surface. Note that the bedrock elevation varies considerably across the site, as shown in Figure 4.

All shoring must be supported using anchors embedded into bedrock. Anchors embedded into rock can be designed using a factored adhesion at ULS of 400 kPa. Higher bond stresses may be possible, but performance testing of anchorages on site is required. Proof testing of every anchor must also be performed.

Where shoring is supported with a single level of bracing, a triangular earth pressure distribution similar to that used for the basement wall design is appropriate.

$$P = K(\gamma h + q)$$

where: **P =** the horizontal pressure at depth, h
K = the earth pressure coefficient
h = depth below surface in metres
γ = the bulk unit weight of the soil (kN/m^3)
q = the complete surcharge loading (kPa)

5.3 Site Work

The earth fill and native soils near surface at this site will become disturbed and will lose their integrity to support when subjected to traffic. It can be expected that subgrade will be disturbed unless an adequate granular working surface is provided to protect the integrity of the subgrade soils from construction traffic. Subgrade preparation works cannot be adequately accomplished during wet weather and the project must be scheduled accordingly. The disturbance caused by the traffic can result in the removal of disturbed soil and use of granular fill material for site restoration or underfloor fill that is not intrinsic to the project requirements. There shall be no vehicular traffic permitted on any sloped excavations at this site.

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

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

5.4 Quality Control

The foundation installations must be field reviewed by the geotechnical engineer as they are constructed to ensure the engineered fill remains undisturbed. The on-site review of the condition of the foundation soil as the foundations are constructed is an integral part of the geotechnical design function and is required by Section 4.2.2.2 of the Ontario Building Code 2006. If Terraprobe is not retained to carry out foundation evaluations during construction, then Terraprobe accepts no responsibility for the performance or non-performance of the foundations, even if they are ostensibly constructed in accordance with the conceptual design advice contained in this report.

The long term performance of the slab on grade is highly dependent upon the subgrade support conditions. Stringent construction control procedures should be maintained to ensure that uniform subgrade moisture and density conditions are achieved as much as practically possible. The design advice in this report is based on an assessment of the subgrade support capabilities as indicated by the borings. These conditions may vary across the site depending on the final design grades and therefore, the preparation of the subgrade and the compaction of all fill should be monitored by Terraprobe at the time of construction to confirm material quality, thickness, and to ensure adequate compaction.

The requirements for fill placement on this project have been stipulated relative to Modified Proctor Maximum Dry Density. In situ determinations of density during fill and asphaltic placement on site are

required to demonstrate that the specified placement density is achieved. Terraprobe is a CNSC certified operator of appropriate nuclear density gauges for this work and can provide sampling and testing services for the project as necessary, with our qualified technical staff.

Concrete will be specified in accordance with the requirements of CAN3 - CSA A23.1. Terraprobe maintains a CSA certified concrete laboratory and can provide concrete sampling and testing services for the project as necessary.

Terraprobe staff can also provide quality control services for Building Envelope, Roofing and Structural Steel, as necessary, for the Structural and Architectural quality control requirements of the project. Terraprobe is certified by the Canadian Welding Bureau under W178.1-1996.

6.0 LIMITATIONS AND USE OF REPORT

6.1 Procedures

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

The drilling work was carried out by a drilling contractor and was observed and recorded by Terraprobe on a full time basis. The borings were made by a continuous flight power auger machine using solid stem augers. The Terraprobe technician logged the borings and examined the samples as they were obtained. The samples obtained were sealed in clean, air-tight containers and transferred to the Terraprobe laboratory, where they were reviewed for consistency of description by a geotechnical engineer. Ground water observations were made in the boreholes as drilling proceeded. In the two monitoring wells installed on site, longer term ground water monitoring was conducted as part of this investigative programme.

The samples of the strata penetrated were obtained using the technique, Split-Barrel Method, ASTM D1586. The samples were taken at intervals. The conventional interval sampling procedure used for this investigation does not recover continuous samples of soil at any borehole location. There is consequently some interpolation of the borehole layering between samples, therefore, the indications of changes in stratigraphy as shown on the borehole logs are approximate.

It must be recognized that there are special risks whenever engineering or related disciplines are applied to identify subsurface conditions. A comprehensive sampling and testing programme implemented in accordance with the most stringent level of care may fail to detect certain conditions. Terraprobe has

assumed for the purposes of providing design parameters and advice, that the conditions that exist between sampling points are similar to those found at the sample locations.

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

6.2 Changes in Site and Scope

It must be recognized that the passage of time, natural occurrences, and direct or indirect human intervention at or near the site have the potential to alter subsurface conditions. In particular, caution should be exercised in the consideration of contractual responsibilities as they relate to control of seepage, disturbance of soils, and frost protection.

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

6.3 Use of Report

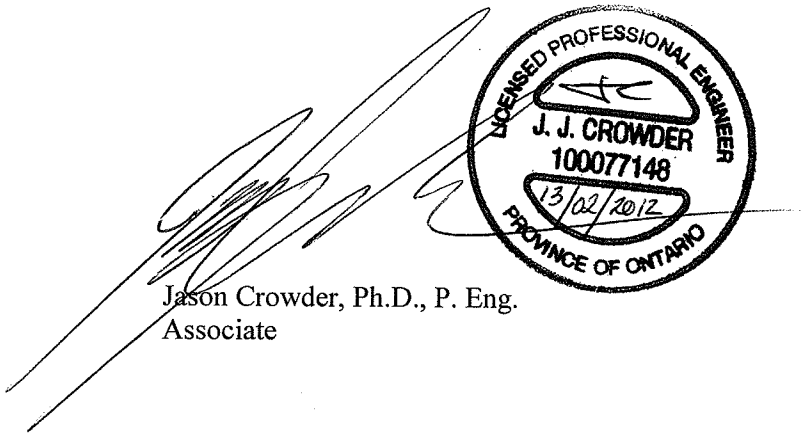
This report is prepared for the express use of Costco Wholesale Corporation and its retained design consultants. It is not for use by others. This report is copyright of Terraprobe Inc., and no part of this report may be reproduced by any means, in any form, without the prior written permission of Terraprobe Inc., Costco Wholesale Corporation, and its retained design consultants are authorized users.

It is recognized that the City of Ottawa, in its capacity as the planning and building authority under Provincial statues, will make use of and rely upon this report, cognizant of the limitations thereof, both as are expressed and implied.

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

Terraprobe Inc.

Alexander Winkelmann, B.Sc.(Eng.), E.I.T.
Project Manager



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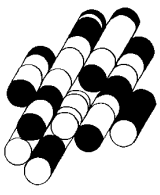
APPENDIX A

TERRAPROBE INC.



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ABBREVIATIONS AND TERMINOLOGY

SAMPLING METHODS

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

PENETRATION RESISTANCE

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

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

COHESIONLESS SOILS

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

COHESIVE SOILS

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

COMPOSITION

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

TESTS AND SYMBOLS

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

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

FIELD MOISTURE DESCRIPTIONS

Damp	refers to a soil sample that does not exhibit any observable pore water from field/hand inspection.
Moist	refers to a soil sample that exhibits evidence of existing pore water (e.g. sample feels cool, cohesive soil is at plastic limit) but does not have visible pore water
Wet	refers to a soil sample that has visible pore water

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EXPLANATION OF CORE LOG TERMS

Column Number

1. Elevation of borehole collar.
2. Depth of geotechnical boundary in borehole
3. Geologic symbol for rock or soil material
4. General description of geotechnical unit - qualitative description, including rock type(s), percentage rock types, frequency and sizes of interbeds, colour, texture.

Joint (discontinuity) Characteristics

5. Number of joint sets: a rock mass can be intersected by a number of joint sets of varying orientations.

6. Joint type: B = Bedding joint C = Cross joint

7. Orientation: only variations in dip can be identified in core; dip direction is from field mapping or oriented core:

F = Flat = 0 - 20º D = Dipping = 20 - 50º V = Vertical = 50 - 90º

8. Joint spacing: this is an approximate measure of spacing between joints in specific joint sets.

SPACING	>3 m	1 m – 3 m	0.3 m – 1 m	50 mm – 300 mm	<50 mm
	VERY WIDE	*WIDE*	*MODERATE*	*CLOSE*	*VERY CLOSE*

9. Roughness:

RU = Rough Undulating
SU = Smooth Undulating
LU = Slickensided Undulating
RP = Rough Planar
SP = Smooth Planar
LP = Slickensided Planar

10 Filling:

	Approximate ø
T = Tight, hard, non-softened	
O = Oxidation surface staining only	25 - 35
SA = Slightly altered; clay-free	25 - 30
S = Sandy particles; clay-free	25 - 30
Si = Sandy and silty, minor clay	20 - 25
NC = Non-softening Clays; 5mm	16 - 24
SC = Swelling Clay fillings; 5mm	6 - 12

11. Aperture: estimated size of joint opening.

12. Degree of weathered rock material:

DEGREE	DESCRIPTION
UNWEATHERED	NO SIGNS OF DISCOLOURATION OR OXIDIZATION
SLIGHTLY WEATHERED	PARTIAL DISCOLOURATION; FRACTURES (JOINTS), TYPICALLY OXIDIZED
MODERATELY WEATHERED	TOTAL DISCOLOURATION
HIGHLY WEATHERED	TOTAL DISCOLOURATION; TYPICALLY FRIABLE AND PITTED
COMPLETELY WEATHERED	RESEMBLES A SOIL; ROCK STRUCTURE - USUALLY PRESERVED

13. Strength of rock material:

		MPa
VERY HIGH STRENGTH	SPECIMEN CAN ONLY BE CHIPPED BY GEOLOGICAL HAMMER	> 200
HIGH STRENGTH	SPECIMEN REQUIRES A NUMBER OF BLOWS OF A GEOLOGICAL HAMMER TO FRACTURE IT; CANNOT BE SCRAPED WITH POCKET KNIFE	50 – 200
MEDIUM STRENGTH	SPECIMEN CANNOT BE FRACTURED BY A SINGLE, FIRM BLOW OF GEOLOGICAL HAMMER; CAN BE SCRAPED WITH POCKET KNIFE, NOT PEELED	15 – 50
LOW STRENGTH	SHALLOW INDENTATIONS MADE BY FIRM BLOW WITH POINT OF GEOLOGICAL HAMMER; CAN BE PEELED WITH POCKET KNIFE WITH DIFFICULTY	4 – 15
VERY LOW STRENGTH	CRUMBLES UNDER FIRM BLOW WITH POINT OF GEOLOGICAL HAMMER; CAN BE PEELED	1 - 4

14. Fracture frequency: number of natural joints occurring over a meter length of core. All natural joints are counted irrespective of the number of joint sets.

FRACTURE FREQUENCY	JOINT SPACING	LENGTH
0.3m	VERY WIDE	> 3m
0.3 – 1m	WIDE	1m - 3m
1 - 3m	MODERATE	0.03m - 1m
3 - 20m	CLOSE	0.005m TO 0.03m
20m	VERY CLOSE	< 0.005m

15. Run number and Total Core Recovery

(i) Drill run number
(ii) Total Core Recovery is the total length of core pieces, irrespective of their individual lengths obtained in a core run, and expressed as a percentage of the length of that core run.

16. Rock Quantity Designation (RQD): The total length of those pieces of sound core which are 0.01 metres or greater in length in a core run, expressed as a percentage of the total length of that core run. Sound pieces of rock are those pieces separated by natural breaks and not machine breaks or subsequent artificial breaks.

Rock Mass Classification (after Deere)

RQD (%)	0 – 25	25 – 50	50 – 75	75 – 90	90 – 100
DESCRIPTION	*VERY POOR*	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

17. Core and Casing sizes: changes of core and casing sizes are indicated.

18. Water recovery, level and tests:

(i) percentage drill water recovery
(ii) water level depth
(iii) positions and results of tests, e.g., permeability and packer tests

BOREHOLE LOG 1

Terraprobe

Client : Costco Wholesale
Project : Kanata Costco
Location : 770 Silver Seven Road, Kanata, Ontario

Project No.: 11-11-1130
Date started : October 18, 2011
Sheet No. : 1 of 1

Position : E: 428282, N: 5017051 (NAD83, 18T)
Elevation Datum : Geodetic
Rig type : CME 55 ,Track-mounted
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
	97.7	**GROUND SURFACE**				
0		50mm **TOPSOIL**		1	SS	11
	96.9	**FILL**, sandy silt, some clay, trace organics, trace rootlets; compact, dark brown, moist				
	0.8	**CLAYEY SILT**, some sand to sandy (layers), firm to soft, brown, moist		2	SS	7
2				3	SS	2
	95.4					
	2.3	**SILT AND CLAY**, trace sand, very soft, grey, wet		4	SS	0
				5	SS	0
4					FV	
		...at 4.6m, trace sand to 5.0m		6	ST	
					FV	
6				7	SS	1
					FV	
8	89.7					
	8.0					

Penetration Test Values (Blows / 0.3m)
Dynamic Cone: 10 20 30 40
Undrained Shear Strength (kPa)
Unconfined, Pocket Penetrometer, Field Vane, Lab Vane
40 80 120 160

Elevation Scale (m): 96, 94, 92, 90

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

Headspace Vapour

Instrument Details

Unstabilized Water Level

Lab Data and Comments
GRAIN SIZE DISTRIBUTION (%) (MIT)
GR SA SI CL

Moisture values: 45, 64, 57, 52
Lab Data: 0 5 55 40

...at 8.0m, heavy auger grinding for 10 min

END OF BOREHOLE
Auger refusal on inferred bedrock

Unstabilized water level measured at 4.6m below grade; borehole was open upon completion of drilling.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
November 1, 2011	4.1	93.6

BOREHOLE LOG 2

Terraprobe

Client : Costco Wholesale
Project : Kanata Costco
Location : 770 Silver Seven Road, Kanata, Ontario

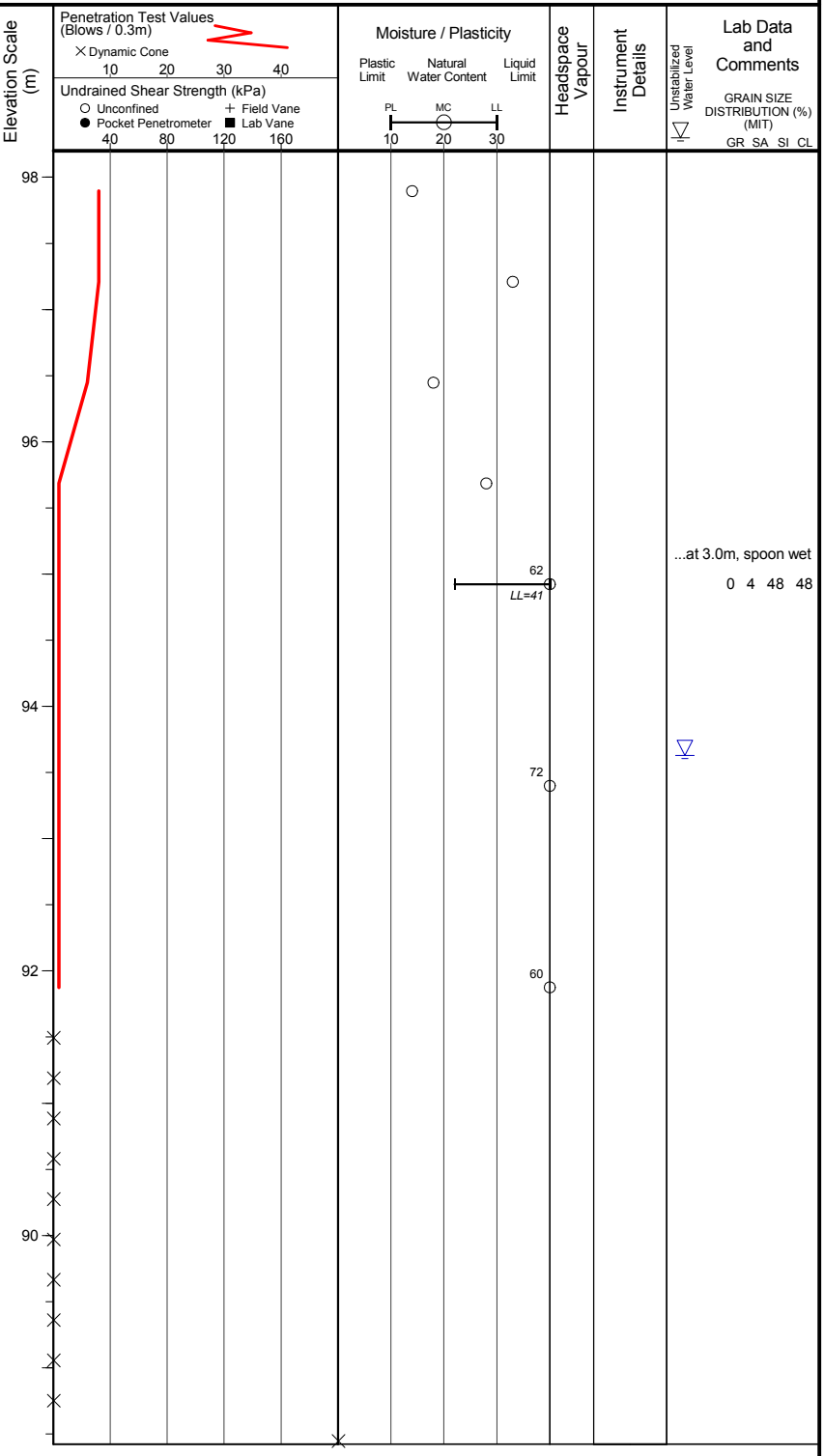
Project No.: 11-11-1130
Date started : October 21, 2011
Sheet No. : 1 of 1

Position : E: 428305, N: 5017063 (NAD83, 18T)
Elevation Datum : Geodetic
Rig type : CME 55 ,Track-mounted
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
	98.2	**GROUND SURFACE**				
0		50mm **TOPSOIL**		1	SS	8
	97.4	**FILL**, sandy silt, some clay, trace organics, trace rootlets; loose, dark brown, moist				
	0.8	**CLAYEY SILT**, some sand, firm, brown, moist		2	SS	8
2				3	SS	6
	95.9					
	2.3	**CLAY AND SILT**, trace sand, very soft, grey, wet		4	SS	1
				5	SS	1
4						
				6	SS	1
6						
	91.7			7	SS	1
	6.6	No samples below 6.6 m				
8	88.4					
	9.8	**END OF BOREHOLE**				

Dynamic cone refusal on inferred bedrock.

Unstabilized water level measured at 4.6m below grade; borehole was open upon completion of drilling.



library: library - terraprobe gint - md.glb report: terraprobe soil log

BOREHOLE LOG 3

Terraprobe

Client : Costco Wholesale
Project : Kanata Costco
Location : 770 Silver Seven Road, Kanata, Ontario

Project No.: 11-11-1130
Date started : October 20, 2011
Sheet No. : 1 of 2

Position : E: 428330, N: 5017086 (NAD83, 18T)
Elevation Datum : Geodetic
Rig type : CME 55 ,Track-mounted
Drilling Method : Solid stem augers, HQ rock coring

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value	Elevation Scale (m)	Penetration Test Values (Blows / 0.3m) / Undrained Shear Strength (kPa)	Moisture / Plasticity (PL, MC, LL)	Headspace Vapour	Instrument Details	Unstabilized Water Level	Lab Data and Comments / GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL
0	99.1	**GROUND SURFACE**											
		50mm **TOPSOIL**		1	SS	7							
		CLAYEY SILT, some sand to sandy (layers), trace shell fragments, firm, dark brown to brown, moist		2	SS	8	98						
		...at 1.5m, no recovery to 2.3m		3	SS	6							
2	96.8												
	2.3	**CLAY AND SILT**, trace sand, very soft, grey, wet		4	SS	0							
				5	SS	0	96			94			
4													
				6	SS	0	94			78			...at 4.6m, spoon wet
6				7	SS	0				65			
							92						
				8	SS	0				55			
8													
				9	SS	1	90			49			
10													
				10	SS	1	88			50			

Penetration Test Values (Blows / 0.3m): Dynamic Cone (10, 20, 30, 40)
Undrained Shear Strength (kPa): Unconfined, Pocket Penetrometer, Field Vane, Lab Vane (40, 80, 120, 160)
Moisture / Plasticity: Plastic Limit, Natural Water Content, Liquid Limit (PL, MC, LL; 10, 20, 30)

(continued next page)

BOREHOLE LOG 3

Terraprobe

Client : Costco Wholesale
Project : Kanata Costco
Location : 770 Silver Seven Road, Kanata, Ontario

Project No.: 11-11-1130
Date started : October 20, 2011
Sheet No. : 2 of 2

Position : E: 428330, N: 5017086 (NAD83, 18T)
Elevation Datum : Geodetic
Rig type : CME 55 ,Track-mounted
Drilling Method : Solid stem augers, HQ rock coring

Depth Scale (m)	Elev Depth (m)	Description (continued)	Graphic Log	Number	Type	SPT 'N' Value
12		**CLAY AND SILT**, trace sand, very soft, grey, wet *(continued)*		11	SS	0
	85.4 13.7	**SANDY SILT**, some clay, trace gravel, very soft, grey, wet		12	SS	0
14				13	SS	0
16	83.1 16.1	**VERULAM FORMATION** (See rock core log for details)		1	CORE	
18				2	CORE	
	80.1 19.0	**END OF BOREHOLE**				

Unstabilized water level measured at 10.7m below grade; borehole was open upon completion of drilling.

Elevation Scale (m): 86, 84, 82

Penetration Test Values (Blows / 0.3m): Dynamic Cone; 10 20 30 40
Undrained Shear Strength (kPa): Unconfined, Pocket Penetrometer, Field Vane, Lab Vane; 40 80 120 160

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

Headspace Vapour: 61

Instrument Details

Unstabilized Water Level

Lab Data and Comments: GRAIN SIZE DISTRIBUTION (%) (MIT); GR SA SI CL: 9 36 41 14

library: library - terraprobe gint - md.glb report: terraprobe soil log

ROCK CORE LOG 3

Terraprobe

Client	: Costco Wholesale	Project No.	11-11-1130
Project	: Kanata Costco	Date started :	October 20, 2011
Location	: 770 Silver Seven Road, Kanata, Ontario	Sheet No.	1 of 1

Position : E: 428330, N: 5017086 (NAD83, 18T) | Elevation Datum : Geodetic | Hole Diameter : **HQ**, OD=96mm, ID=64mm

Rig type : CME 55, Track-mounted | Drilling Method : Solid stem augers, HQ rock coring

Depth (m)	Graphic Log	General Description	Run Number	Recovery	Elevation (m)	Weathering Zones (Z1 Z2 Z3 Z4)	Estimated Strength (R1 R2 R3 R4 R5 R6)	Joint Frequency (v close, close, mod close, wide, v wide, ex wide)	Laboratory Testing	Comments
		Rock coring started at 16.1m below grade								
17		**VERULAM FORMATION** Limestone, light grey to grey, laminated to thinly bedded, strong; joint set 1: dipping at 20 degrees, joint set 2: vertical at 70 degrees, joints are rough planar, unaltered to sealed with calcite, closed *(continued)*	R1 17.5m	TCR = **82**% SCR = **73**% RQD = **61**%	83 82					83 82
18			R2 19.0m	TCR = **97**% SCR = **83**% RQD = **58**%	81					**18.0-18.1m:** *rubbilized zone* 81

END OF BOREHOLE

BOREHOLE LOG 4

Terraprobe

Client : Costco Wholesale
Project : Kanata Costco
Location : 770 Silver Seven Road, Kanata, Ontario

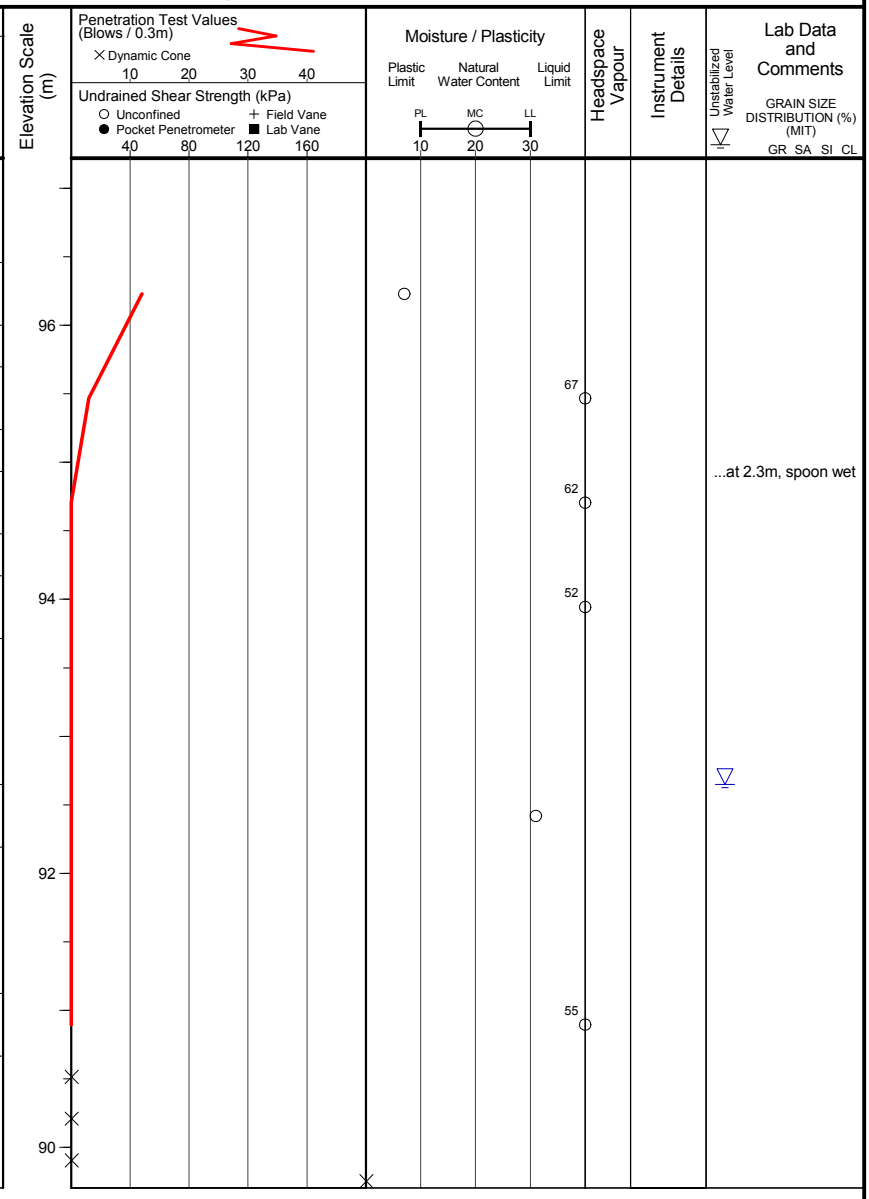
Project No.: 11-11-1130
Date started : October 21, 2011
Sheet No. : 1 of 1

Position : E: 428293, N: 5017031 (NAD83, 18T)
Elevation Datum : Geodetic
Rig type : CME 55 ,Track-mounted
Drilling Method : Solid stem augers

Depth Scale (m)	Elev / Depth (m)	Description	Graphic Log	Sample Number	Sample Type	SPT 'N' Value
0	97.2	**GROUND SURFACE**				
		No recovery		1	SS	
	96.5					
	0.8	**FILL**, gravelly sand, some silt; compact, dark blackish brown, moist		2	SS	12
	95.7					
	1.5	**CLAY AND SILT**, trace sand, soft, brown, wet		3	SS	3
2						
		...at 2.3m, very soft		4	SS	0
				5	SS	0
4						
		...at 4.6m, some gravel, some sand to 5.0m		6	SS	0
				7	SS	0
6	90.7					
	6.6	No samples below 6.5 m				
	89.7					
	7.5	**END OF BOREHOLE**				

Dynamic cone refusal on inferred bedrock.

Unstabilized water level measured at 4.6m below grade; borehole was open upon completion of drilling.



BOREHOLE LOG 5

Terraprobe

Client : Costco Wholesale
Project : Kanata Costco
Location : 770 Silver Seven Road, Kanata, Ontario

Project No.: 11-11-1130
Date started : October 20, 2011
Sheet No. : 1 of 2

Position : E: 428358, N: 5017096 (NAD83, 18T)
Elevation Datum : Geodetic
Rig type : CME 55 ,Track-mounted
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
0	99.6	**GROUND SURFACE**				
		50mm **TOPSOIL**				
		SANDY SILT, trace organics, trace rootlets, trace gravel, loose, dark brown, moist		1	SS	7
	98.8					
	0.8	**SAND and SILT**, trace gravel, trace clay, very loose, brown, wet		2	SS	2
		...at 1.5m, silty, no clay		3	SS	1
2		...at 2.3m, some gravel, loose		4	SS	5
	96.6					
	3.1	**CLAY AND SILT**, trace sand, very soft, grey, wet		5	SS	1
	96.1					
	3.5	No samples below 3.5 m				
4						
6						
8						
10						

Elevation Scale (m): 98, 96, 94, 92, 90

Penetration Test Values (Blows / 0.3m)
× Dynamic Cone
10 20 30 40
Undrained Shear Strength (kPa)
○ Unconfined + Field Vane
● Pocket Penetrometer ■ Lab Vane
40 80 120 160

Moisture / Plasticity
Plastic Limit | Natural Water Content | Liquid Limit
PL MC LL
10 20 30

Headspace Vapour: 62

Instrument Details

Unstabilized Water Level

Lab Data and Comments
GRAIN SIZE DISTRIBUTION (%) (MIT)
GR SA SI CL

...at 1.5m, spoon wet

(continued next page)

BOREHOLE LOG 5

Client : Costco Wholesale
Project : Kanata Costco
Location : 770 Silver Seven Road, Kanata, Ontario

Project No.: 11-11-1130
Date started : October 20, 2011
Sheet No. : 2 of 2

Position : E: 428358, N: 5017096 (NAD83, 18T)
Elevation Datum : Geodetic
Rig type : CME 55 ,Track-mounted
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value	Elevation Scale (m)	Penetration Test Values (Blows / 0.3m) / Undrained Shear Strength (kPa)	Moisture / Plasticity	Headspace Vapour	Instrument Details	Unstabilized Water Level	Lab Data and Comments
		SOIL PROFILE (continued)		SAMPLES				Dynamic Cone 10 20 30 40; Unconfined, Pocket Penetrometer, Field Vane, Lab Vane 40 80 120 160	Plastic Limit / Natural Water Content / Liquid Limit; PL MC LL 10 20 30				GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL
12		No samples below 3.5 m *(continued)*					88						
	86.0 13.6	**END OF BOREHOLE**											

Dynamic cone refusal on inferred bedrock.

Unstabilized water level measured at 4.6m below grade; borehole was open upon completion of drilling.

BOREHOLE LOG 6

Terraprobe

Client : Costco Wholesale
Project : Kanata Costco
Location : 770 Silver Seven Road, Kanata, Ontario

Project No.: 11-11-1130
Date started : October 19, 2011
Sheet No. : 1 of 1

Position : E: 428327, N: 5017031 (NAD83, 18T)
Elevation Datum : Geodetic
Rig type : CME 55 ,Track-mounted
Drilling Method : Solid stem augers

Elev Depth (m)	Description	Number	Type	SPT 'N' Value
98.1	**GROUND SURFACE**			
	50mm **TOPSOIL**			
	FILL, sandy silt, some clay, some gravel, trace organics, trace rootlets; loose, dark brown, moist	1	SS	5
97.3 / 0.8	**CLAYEY SILT**, some sand to sandy (layers), firm, brown, moist	2	SS	8
96.6 / 1.5	**CLAY AND SILT**, trace sand, very soft, grey, wet	3	SS	0
		4	SS	0
		5	SS	0
		6	SS	0
		7	SS	0
90.5 / 7.6	**SANDY SILT**, some clay, trace gravel, hard, grey, wet	8	SS	50 / 150mm
89.6 / 8.5				

Penetration Test Values (Blows / 0.3m): Dynamic Cone (10, 20, 30, 40)
Undrained Shear Strength (kPa): Unconfined, Pocket Penetrometer, Field Vane, Lab Vane (40, 80, 120, 160)
Moisture / Plasticity: Plastic Limit, Natural Water Content, Liquid Limit (PL, MC, LL; 10, 20, 30)

Moisture values: 59, 53, 63, 59, 68 (LL=42), 62

Lab Data and Comments: ...at 1.5m, spoon wet

GRAIN SIZE DISTRIBUTION (%) (MIT): GR SA SI CL
0 3 47 50

END OF BOREHOLE
Auger refusal on inferred bedrock

Unstabilized water level measured at 4.6m below grade; borehole was open upon completion of drilling.

library: library - terraprobe gint - md.glb **report:** terraprobe soil log

BOREHOLE LOG 7

Terraprobe

Client : Costco Wholesale
Project : Kanata Costco
Location : 770 Silver Seven Road, Kanata, Ontario

Project No.: 11-11-1130
Date started : October 19, 2011
Sheet No. : 1 of 2

Position : E: 428336, N: 5017044 (NAD83, 18T)
Elevation Datum : Geodetic
Rig type : CME 55 ,Track-mounted
Drilling Method : Solid stem augers

Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
98.3	**GROUND SURFACE**				
	50mm **TOPSOIL**				
	FILL, silt and sand, trace clay, trace gravel; loose, brown, moist		1	SS	8
97.5					
0.8	**CLAYEY SILT**, some sand to sandy (layers), trace shell fragments, firm, brown, moist		2	SS	7
96.8					
1.5	**CLAY AND SILT**, trace sand, very soft, grey, wet		3	SS	0
			4	SS	0
			5	SS	0
			6	SS	0
			7	SS	0
91.8					
6.6	No samples below 6.6 m				

Penetration Test Values (Blows / 0.3m)
Dynamic Cone
10 20 30 40
Undrained Shear Strength (kPa)
Unconfined + Field Vane
Pocket Penetrometer Lab Vane
40 80 120 160

Moisture / Plasticity
Plastic Limit | Natural Water Content | Liquid Limit
PL MC LL
10 20 30

Headspace Vapour: 70, 74, 64, 71, 70

Instrument Details

Unstabilized Water Level

Lab Data and Comments
GRAIN SIZE DISTRIBUTION (%) (MIT)
GR SA SI CL
...at 2.3m, spoon wet
0 3 49 48

(continued next page)

BOREHOLE LOG 7

Client : Costco Wholesale
Project : Kanata Costco
Location : 770 Silver Seven Road, Kanata, Ontario

Project No.: 11-11-1130
Date started : October 19, 2011
Sheet No. : 2 of 2

Position : E: 428336, N: 5017044 (NAD83, 18T)
Elevation Datum : Geodetic
Rig type : CME 55 ,Track-mounted
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value	Elevation Scale (m)	Penetration Test Values (Blows / 0.3m) / Undrained Shear Strength (kPa)	Moisture / Plasticity	Headspace Vapour	Instrument Details	Unstabilized Water Level	Lab Data and Comments
10		*(continued)*						Dynamic Cone 10 20 30 40; Unconfined, Field Vane, Pocket Penetrometer, Lab Vane 40 80 120 160	Plastic Limit, Natural Water Content, Liquid Limit PL MC LL 10 20 30				GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL
		No samples below 6.6 m *(continued)*					88						
11	87.1 11.2	**END OF BOREHOLE**											

Dynamic cone refusal on inferred bedrock.

Unstabilized water level measured at 4.6m below grade; borehole was open upon completion of drilling.

BOREHOLE LOG 8

Terraprobe

Client : Costco Wholesale
Project : Kanata Costco
Location : 770 Silver Seven Road, Kanata, Ontario

Project No.: 11-11-1130
Date started : October 18, 2011
Sheet No. : 1 of 2

Position : E: 428365, N: 5017054 (NAD83, 18T)
Elevation Datum : Geodetic
Rig type : CME 55 ,Track-mounted
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
0	98.4	**GROUND SURFACE**				
		50mm **TOPSOIL**				
		FILL, sandy silt, some clay; loose, dark brown, moist		1	SS	4
1		...at 0.8m, no recovery due to limestone block		2	SS	
	96.9					
	1.5	**CLAY AND SILT**, trace sand, very soft, grey, wet		3	SS	2
2				4	SS	0
3				5	SS	0
4					FV	
				6	SS	1
5					FV	
6				7	ST	
7					FV	
				8	SS	2
8					FV	
9	89.3					
	9.1	**SANDY SILT**, some clay, trace gravel, very soft, grey, wet		9	SS	2

Penetration Test Values (Blows / 0.3m)
Dynamic Cone: 10 20 30 40
Undrained Shear Strength (kPa)
Unconfined / Pocket Penetrometer / Field Vane / Lab Vane
40 80 120 160

Elevation Scale (m): 98 97 96 95 94 93 92 91 90 89

10.0
6.7
3.8
4.3

Moisture / Plasticity
Plastic Limit | Natural Water Content | Liquid Limit
PL MC LL
10 20 30

Headspace Vapour: 71 71 76 59 59

Instrument Details

Unstabilized Water Level

Lab Data and Comments
GRAIN SIZE DISTRIBUTION (%) (MIT)
GR SA SI CL

...at 1.5m, spoon wet

4 28 54 14

BOREHOLE LOG 8

Client : Costco Wholesale
Project : Kanata Costco
Location : 770 Silver Seven Road, Kanata, Ontario

Project No.: 11-11-1130
Date started : October 18, 2011
Sheet No. : 2 of 2

Position : E: 428365, N: 5017054 (NAD83, 18T)
Elevation Datum : Geodetic
Rig type : CME 55 ,Track-mounted
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value	Elevation Scale (m)	Penetration Test Values (Blows / 0.3m) / Undrained Shear Strength (kPa)	Moisture / Plasticity (PL, MC, LL)	Headspace Vapour	Instrument Details	Unstabilized Water Level	Lab Data and Comments / GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL
10		*(continued)*						Dynamic Cone: 10 20 30 40 / Unconfined, Pocket Penetrometer, Field Vane, Lab Vane: 40 80 120 160	Plastic Limit, Natural Water Content, Liquid Limit: 10 20 30				
	87.8	**SANDY SILT**, some clay, trace gravel, very soft, grey, wet *(continued)*			FV		88						
	10.6												

END OF BOREHOLE
Auger refusal on inferred bedrock

Unstabilized water level measured at 4.6m below grade; borehole was open upon completion of drilling.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
November 1, 2011	2.0	96.4

BOREHOLE LOG 9

Terraprobe

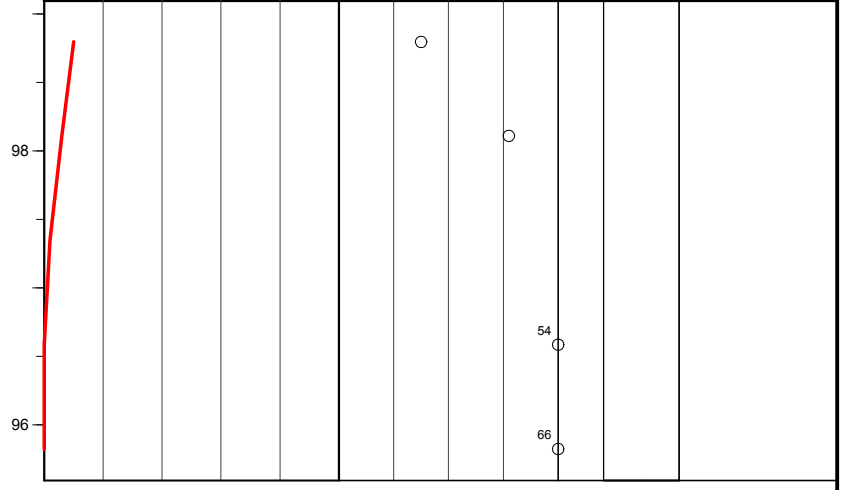
Client : Costco Wholesale
Project : Kanata Costco
Location : 770 Silver Seven Road, Kanata, Ontario

Project No.: 11-11-1130
Date started : October 20, 2011
Sheet No. : 1 of 1

Position : E: 428376, N: 5017083 (NAD83, 18T)
Elevation Datum : Geodetic
Rig type : CME 55 ,Track-mounted
Drilling Method : Solid stem augers

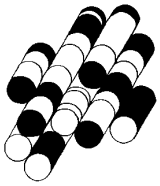
Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
0	99.1	**GROUND SURFACE**				
		50mm **TOPSOIL**		1	SS	5
	98.3	**FILL**, clay and silt, some sand, trace organics, trace rootlets; firm, brownish grey, moist				
	0.8	**CLAYEY SILT**, some sand to sandy (layers), soft to very soft, brownish grey, moist		2	SS	3
2		...at 1.5m, no recovery		3	SS	1
	96.8					
	2.3	**CLAY AND SILT**, trace sand, very soft, grey, wet		4	SS	0
				5	SS	0
	95.6					
	3.5	**END OF BOREHOLE**				

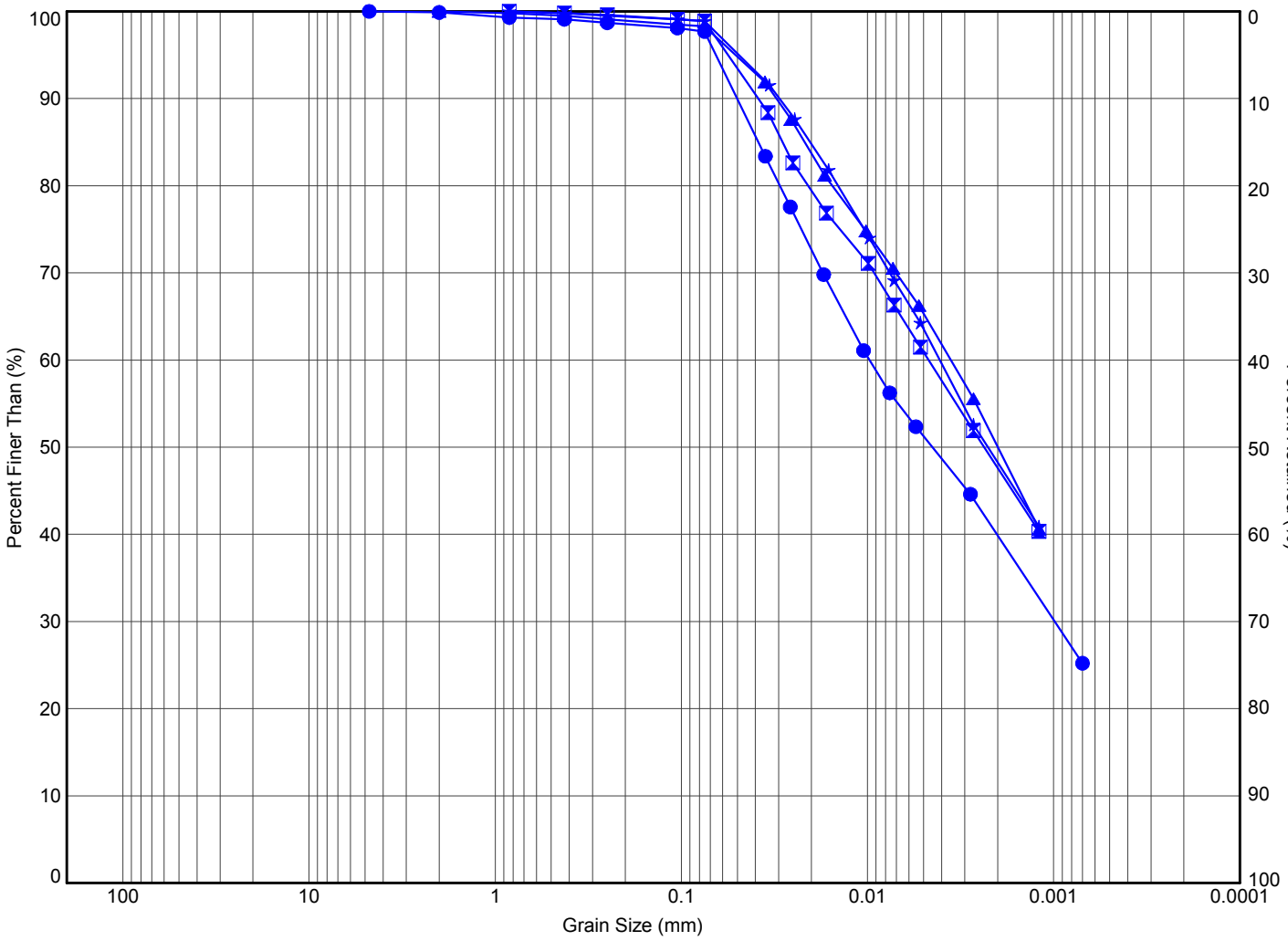
Borehole was dry and open upon completion of drilling.



APPENDIX B

TERRAPROBE INC.





MIT SYSTEM	COBBLES	GRAVEL			SAND			SILT	CLAY
		COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE		

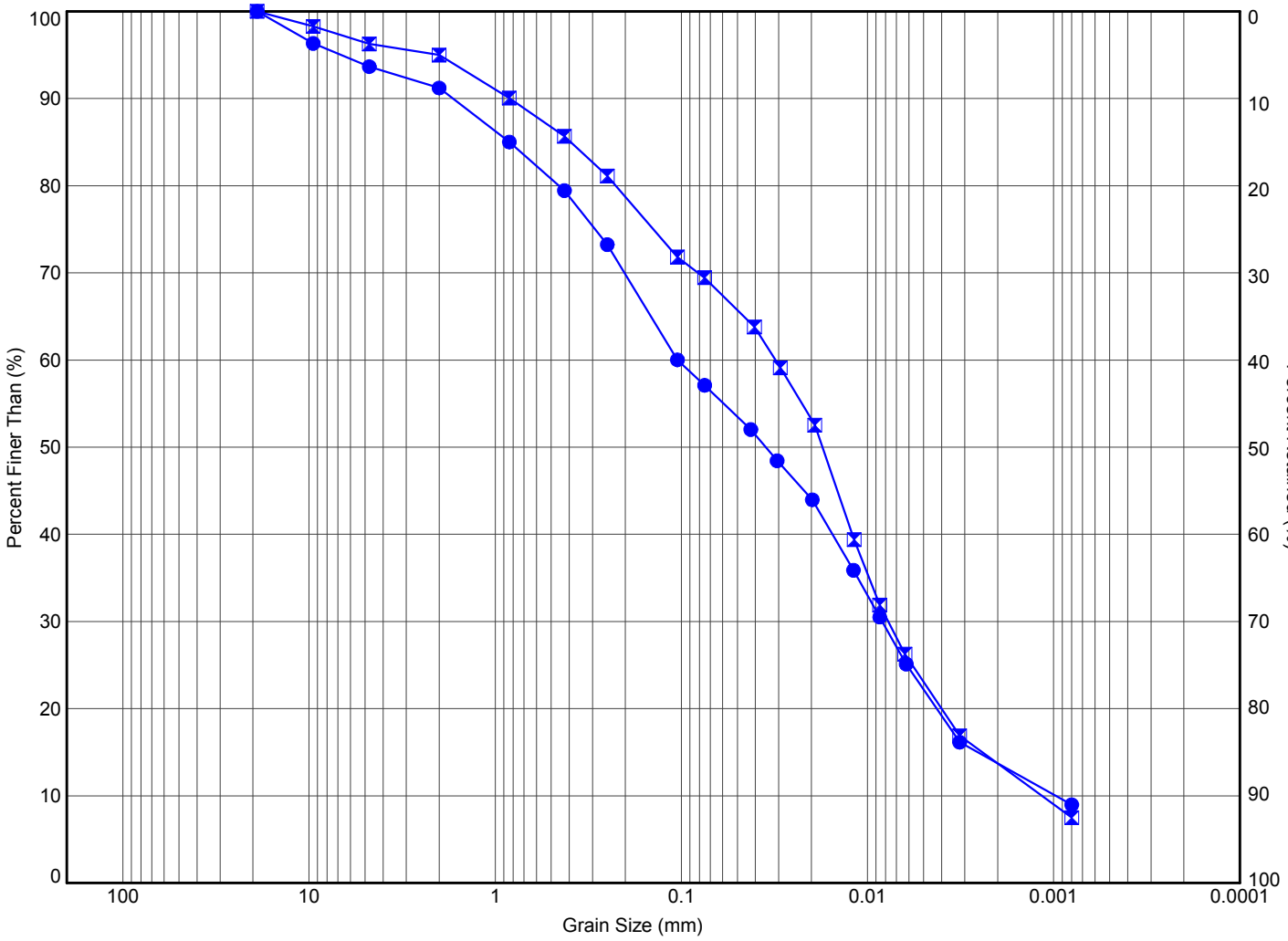
MIT SYSTEM

	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines)* (%)
●	**1**	ST6	4.8	92.9	0	5	55	40	
⊠	**2**	SS5	3.3	94.9	0	4	48	48	
▲	**6**	SS6	4.8	93.3	0	3	47	50	
★	**7**	SS4	2.5	95.8	0	3	49	48	

Terraprobe
11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title: **GRAIN SIZE DISTRIBUTION**
CLAY AND SILT, TRACE SAND

File No.: **11-11-1130**



MIT SYSTEM	COBBLES	GRAVEL			SAND			SILT	CLAY
		COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE		

MIT SYSTEM

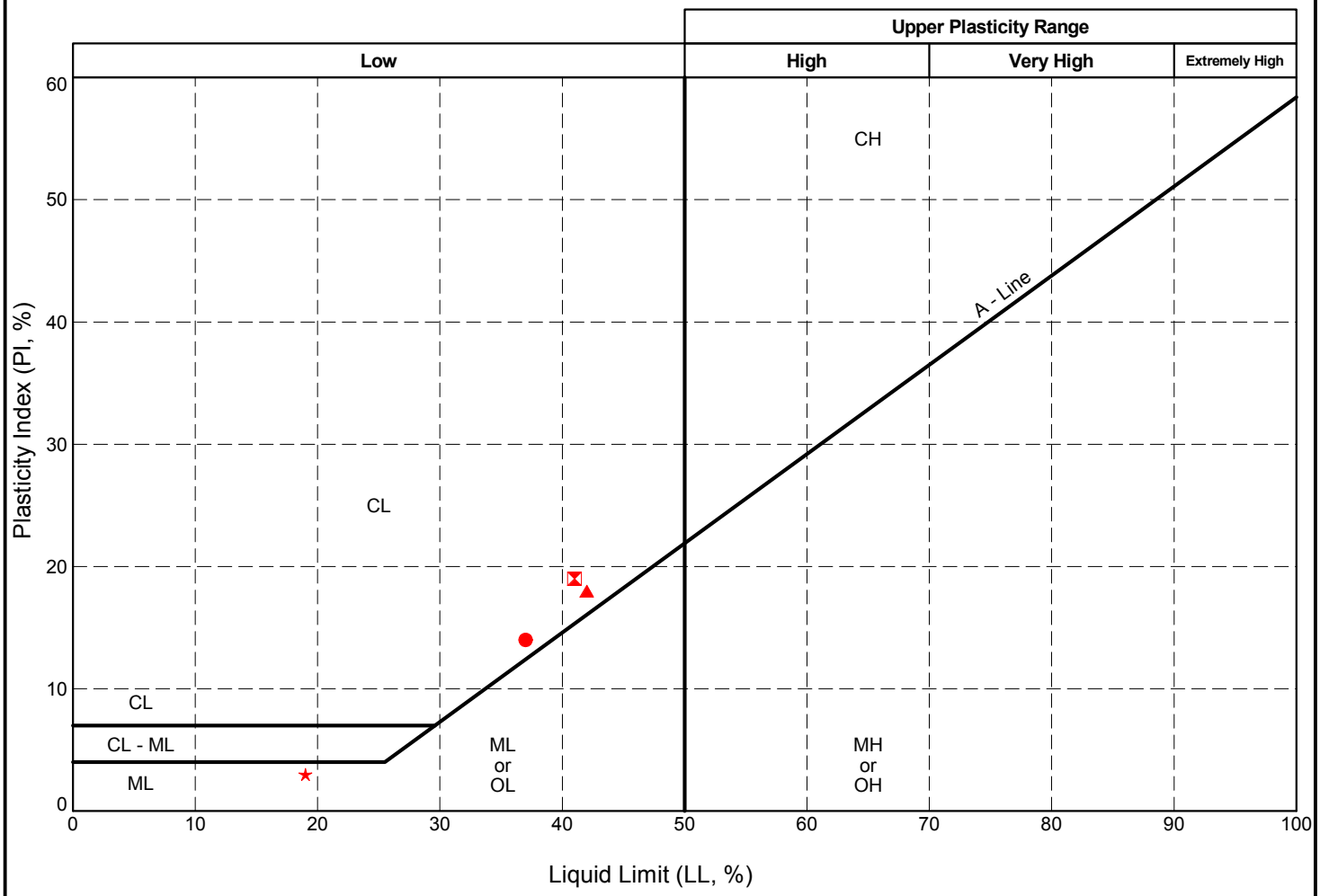
	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines)* (%)
●	**3**	SS12	13.9	85.2	9	36	41	14	
⊠	**8**	SS9	9.4	89.1	4	28	54	14	

Terraprobe
11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
SANDY SILT, SOME CLAY, TRACE GRAVEL

File No.: **11-11-1130**



	Borehole	Sample	Depth (m)	Elev. (m)	LL	PL	PI
●	1	ST6	4.8	92.9	37	23	14
⊠	2	SS5	3.3	94.9	41	22	19
▲	6	SS6	4.8	93.3	42	24	18
★	8	SS9	9.4	89.1	19	16	3

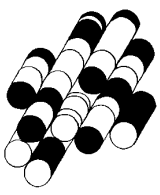
Terraprobe
11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title: **ATTERBERG LIMITS CHART**

File No.: **11-11-1130**

APPENDIX C

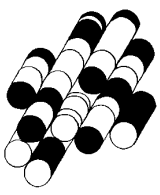
TERRAPROBE INC.



Bedrock Core Sample
Borehole: 3
Runs: 1 & 2
Depth: 16.1 - 19.0m (Elev. 83.1 – 80.1 m)

APPENDIX D

TERRAPROBE INC.



AGAT Laboratories

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CLIENT NAME: TERRAPROBE INC.
11 INDELL LANE
BRAMPTON, ON L6T3Y3

ATTENTION TO: Alexander Winkelmann

PROJECT NO: 11-11-1130

AGAT WORK ORDER: 11T542323

SOIL ANALYSIS REVIEWED BY: Anthony Dapaah, PhD (Chem), Inorganic Lab Manager

TRACE ORGANICS REVIEWED BY: Jacky Takeuchi, BScH (Chem Eng), BSc (Bio), C.Chem, Laboratory Manager

DATE REPORTED: Oct 31, 2011

PAGES (INCLUDING COVER): 10

VERSION*: 1

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

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

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Certificate of Analysis

AGAT WORK ORDER: 11T542323

PROJECT NO: 11-11-1130

CLIENT NAME: TERRAPROBE INC.

ATTENTION TO: Alexander Winkelmann

Corrosivity Package

DATE SAMPLED: Oct 19, 2011 | **DATE RECEIVED: Oct 25, 2011** | **DATE REPORTED: Oct 31, 2011** | **SAMPLE TYPE: Soil**

Parameter	Unit	G / S	RDL	BH2 Sa2 2837670	BH3 Sa3 2837672	BH7 Sa1 2837685	BH9 Sa3 2837689
Sulphide*	%		0.01	<0.01	<0.01	<0.01	<0.01
Chloride (2:1)	µg/g		2	16	12	13	18
Sulphate (2:1)	µg/g		2	15	8	31	112
pH (2:1)	pH Units		N/A	8.72	8.05	8.01	8.31
Electrical Conductivity (2:1)	mS/cm	1.4	0.002	0.331	0.192	0.269	0.281
Resistivity (2:1)	ohm.cm		1	3020	5210	3720	3560
Redox Potential (2:1)	mV		5	218	214	150	198

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to T3(ICC) - Current

2837670-2837689 * Analysis was performed at AGAT's Mining Division.

EC,pH,Chloride,Redox Potential and Sulphate were determined on the extract obtained from the 2:1 extraction procedure (2 parts DI water: 1 part soil).

Certified By:

AGAT Laboratories

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AGAT WORK ORDER: 11T542323

PROJECT NO: 11-11-1130

CLIENT NAME: TERRAPROBE INC.

ATTENTION TO: Alexander Winkelmann

O. Reg. 153(511) - Metals & Inorganics (Soil)

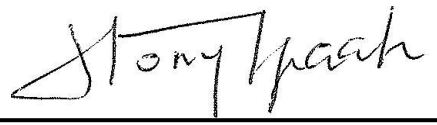
DATE SAMPLED: Oct 18, 2011 | **DATE RECEIVED: Oct 25, 2011** | **DATE REPORTED: Oct 31, 2011** | **SAMPLE TYPE: Soil**

Parameter	Unit	G / S	RDL	BH1 Sa2 2837668	BH3 Sa7 2837671	BH6 Sa1 2837677	BH8 Sa4 2837688
Antimony	µg/g	40	0.8	<0.8	<0.8	<0.8	<0.8
Arsenic	µg/g	18	1	2	1	2	2
Barium	µg/g	670	2	87	256	106	273
Beryllium	µg/g	8	0.5	<0.5	0.7	<0.5	0.7
Boron	µg/g	120	5	<5	11	5	9
Boron (Hot Water Soluble)	µg/g	2	0.10	0.13	0.43	0.13	0.66
Cadmium	µg/g	1.9	0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/g	160	2	26	63	26	63
Cobalt	µg/g	80	0.5	5.9	15.2	6.3	15.9
Copper	µg/g	230	1	14	33	12	34
Lead	µg/g	120	1	4	6	7	5
Molybdenum	µg/g	40	0.5	<0.5	0.9	<0.5	0.9
Nickel	µg/g	270	1	13	30	13	34
Selenium	µg/g	5.5	0.4	<0.4	<0.4	<0.4	<0.4
Silver	µg/g	40	0.2	<0.2	<0.2	<0.2	<0.2
Thallium	µg/g	3.3	0.4	<0.4	<0.4	<0.4	<0.4
Uranium	ug/g	33	0.5	0.5	1.3	0.6	1.0
Vanadium	µg/g	86	1	33	78	29	80
Zinc	µg/g	340	5	31	94	43	100
Chromium VI	µg/g	8	0.2	<0.2	<0.2	<0.2	<0.2
Cyanide	µg/g	0.051	0.05	<0.05	<0.05	<0.05	<0.05
Mercury	µg/g	3.9	0.01	<0.01	<0.01	0.02	<0.01
Electrical Conductivity	mS/cm	1.4	0.002	0.217	0.241	0.267	0.410
Sodium Adsorption Ratio	N/A	12	N/A	2.01	0.643	0.560	0.744
pH, 2:1 CaCl2 Extraction	pH Units			8.48	8.16	7.46	8.22

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to T3(ICC) - Current

2837668-2837688 EC & SAR were determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl2 extract prepared at 2:1 ratio.

Certified By:



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AGAT WORK ORDER: 11T542323

PROJECT NO: 11-11-1130

CLIENT NAME: TERRAPROBE INC.

ATTENTION TO: Alexander Winkelmann

O. Reg. 153(511) - VOCs (Soil)

DATE SAMPLED: Oct 20, 2011 | **DATE RECEIVED: Oct 25, 2011** | **DATE REPORTED: Oct 31, 2011** | **SAMPLE TYPE: Soil**

Parameter	Unit	G / S	RDL	BH4 Sa4 2837673	BH5 Sa5 2837676
Dichlorodifluoromethane	µg/g	16	0.05	<0.05	<0.05
Vinyl Chloride	ug/g	0.032	0.02	<0.02	<0.02
Bromomethane	ug/g	0.05	0.05	<0.05	<0.05
Trichlorofluoromethane	ug/g	4	0.05	<0.05	<0.05
Acetone	ug/g	16	0.50	<0.50	<0.50
1,1-Dichloroethylene	ug/g	0.064	0.05	<0.05	<0.05
Methylene Chloride	ug/g	1.6	0.05	<0.05	<0.05
Trans- 1,2-Dichloroethylene	ug/g	1.3	0.05	<0.05	<0.05
Methyl tert-butyl Ether	ug/g	11	0.05	<0.05	<0.05
1,1-Dichloroethane	ug/g	17	0.02	<0.02	<0.02
Methyl Ethyl Ketone	ug/g	70	0.50	<0.50	<0.50
Cis- 1,2-Dichloroethylene	ug/g	55	0.02	<0.02	<0.02
Chloroform	ug/g	0.47	0.04	<0.04	<0.04
1,2-Dichloroethane	ug/g	0.05	0.03	<0.03	<0.03
1,1,1-Trichloroethane	ug/g	6.1	0.05	<0.05	<0.05
Carbon Tetrachloride	ug/g	0.21	0.05	<0.05	<0.05
Benzene	ug/g	0.32	0.02	<0.02	<0.02
1,2-Dichloropropane	ug/g	0.16	0.03	<0.03	<0.03
Trichloroethylene	ug/g	0.91	0.03	<0.03	<0.03
Bromodichloromethane	ug/g	18	0.05	<0.05	<0.05
Methyl Isobutyl Ketone	ug/g	31	0.50	<0.50	<0.50
1,1,2-Trichloroethane	ug/g	0.05	0.04	<0.04	<0.04
Toluene	ug/g	68	0.05	<0.05	<0.05
Dibromochloromethane	ug/g	13	0.05	<0.05	<0.05
Ethylene Dibromide	ug/g	0.05	0.04	<0.04	<0.04
Tetrachloroethylene	ug/g	4.5	0.05	<0.05	<0.05
1,1,1,2-Tetrachloroethane	ug/g	0.087	0.04	<0.04	<0.04
Chlorobenzene	ug/g	2.4	0.05	<0.05	<0.05
Ethylbenzene	ug/g	9.5	0.05	<0.05	<0.05
m & p-Xylene	ug/g		0.05	<0.05	<0.05
Bromoform	ug/g	0.61	0.05	<0.05	<0.05
Styrene	ug/g	34	0.05	<0.05	<0.05
1,1,2,2-Tetrachloroethane	ug/g	0.05	0.05	<0.05	<0.05

Certified By: Jordy Takewaki

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Certificate of Analysis

AGAT WORK ORDER: 11T542323

PROJECT NO: 11-11-1130

CLIENT NAME: TERRAPROBE INC.

ATTENTION TO: Alexander Winkelmann

O. Reg. 153(511) - VOCs (Soil)

DATE SAMPLED: Oct 20, 2011 | **DATE RECEIVED: Oct 25, 2011** | **DATE REPORTED: Oct 31, 2011** | **SAMPLE TYPE: Soil**

Parameter	Unit	G / S	RDL	BH4 Sa4 2837673	BH5 Sa5 2837676
o-Xylene	ug/g		0.05	<0.05	<0.05
1,3-Dichlorobenzene	ug/g	9.6	0.05	<0.05	<0.05
1,4-Dichlorobenzene	ug/g	0.2	0.05	<0.05	<0.05
1,2-Dichlorobenzene	ug/g	6.8	0.05	<0.05	<0.05
Xylene Mixture	ug/g	26	0.05	<0.05	<0.05
1,3-Dichloropropene	µg/g	0.18	0.04	<0.04	<0.04
n-Hexane	µg/g	46	0.05	<0.05	<0.05
Moisture Content	%		0.1	35.8	36.6
Surrogate	**Unit**	**Acceptable Limits**			
Toluene-d8	% Recovery	50-140		96	116
4-Bromofluorobenzene	% Recovery	50-140		76	79

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to T3(ICC) - Current

2837673-2837676 The sample was analysed using the high level technique. The sample was extracted using methanol, a small amount of the methanol extract was diluted in water and the purge & trap GC/MS analysis was performed. Results are based on the dry weight of the soil.

Certified By: Jordy Takewaki

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Quality Assurance

CLIENT NAME: TERRAPROBE INC.

AGAT WORK ORDER: 11T542323

PROJECT NO: 11-11-1130

ATTENTION TO: Alexander Winkelmann

Soil Analysis

RPT Date: Oct 31, 2011			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - Metals & Inorganics (Soil)															
Antimony	1		1.4	1.5	6.9%	< 0.8	118%	70%	130%	105%	80%	120%	103%	70%	130%
Arsenic	1		3	4	28.6%	< 1	106%	70%	130%	103%	80%	120%	105%	70%	130%
Barium	1		92	98	6.3%	< 2	117%	70%	130%	106%	80%	120%	98%	70%	130%
Beryllium	1		< 0.5	< 0.5	0.0%	< 0.5	100%	70%	130%	98%	80%	120%	110%	70%	130%
Boron	1		9	10	10.5%	< 5	102%	70%	130%	109%	80%	120%	111%	70%	130%
Boron (Hot Water Soluble)	1		0.18	0.18	0.0%	< 0.10	98%	60%	140%	104%	70%	130%	101%	60%	140%
Cadmium	1		0.5	0.5	0.0%	< 0.5	100%	70%	130%	100%	80%	120%	99%	70%	130%
Chromium	1		31	32	3.2%	< 2	118%	70%	130%	104%	80%	120%	104%	70%	130%
Cobalt	1		6.2	6.7	7.8%	< 0.5	111%	70%	130%	100%	80%	120%	95%	70%	130%
Copper	1		58	59	1.7%	< 1	101%	70%	130%	103%	80%	120%	91%	70%	130%
Lead	1		39	41	5.0%	< 1	98%	70%	130%	97%	80%	120%	87%	70%	130%
Molybdenum	1		1.2	1.2	0.0%	< 0.5	104%	70%	130%	99%	80%	120%	105%	70%	130%
Nickel	1		14	15	6.9%	< 1	107%	70%	130%	98%	80%	120%	92%	70%	130%
Selenium	1		< 0.4	< 0.4	0.0%	< 0.4	113%	70%	130%	97%	80%	120%	100%	70%	130%
Silver	1		0.4	0.4	0.0%	< 0.2	108%	70%	130%	118%	80%	120%	113%	70%	130%
Thallium	1		< 0.4	< 0.4	0.0%	< 0.4	103%	70%	130%	102%	80%	120%	101%	70%	130%
Uranium	1		0.5	0.5	0.0%	< 0.5	96%	70%	130%	98%	80%	120%	100%	70%	130%
Vanadium	1		24	26	8.0%	< 1	117%	70%	130%	98%	80%	120%	97%	70%	130%
Zinc	1		204	214	4.8%	< 5	92%	70%	130%	99%	80%	120%	88%	70%	130%
Chromium VI	1		< 0.2	< 0.2	0.0%	< 0.2	96%	70%	130%	93%	80%	120%	97%	70%	130%
Cyanide	1		< 0.05	< 0.05	0.0%	< 0.05	100%	70%	130%	110%	80%	120%	112%	70%	130%
Mercury	1		< 0.01	< 0.01	0.0%	< 0.01	103%	70%	130%	101%	80%	120%	101%	70%	130%
Electrical Conductivity	1	2837671	0.241	0.245	1.6%	< 0.002	104%	90%	110%						
Sodium Adsorption Ratio	1	2837671	0.643	0.631	1.8%	N/A									
pH, 2:1 CaCl2 Extraction	1		7.77	7.82	0.6%	<	102%	90%	110%						
Corrosivity Package															
Sulphide*	1	2837670	< 0.01	<0.01		< 0.01	98%	90%	110%						
Chloride (2:1)	1		7	10		< 2	100%	90%	110%	97%	80%	120%	107%	70%	130%
Sulphate (2:1)	1		143	141	1.4%	< 2	103%	90%	110%	97%	80%	120%	114%	70%	130%
pH (2:1)	1	2837670	8.72	8.67	0.6%	N/A	102%	90%	110%						
Redox Potential (2:1)	1		207	210	1.4%	< 5	110%	70%	130%						

Certified By:

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Quality Assurance

CLIENT NAME: TERRAPROBE INC.

AGAT WORK ORDER: 11T542323

PROJECT NO: 11-11-1130

ATTENTION TO: Alexander Winkelmann

Trace Organics Analysis

RPT Date: Oct 31, 2011			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - VOCs (Soil)															
Dichlorodifluoromethane	1		< 0.05	< 0.05	0.0%	< 0.05	74%	50%	140%	90%	50%	140%	91%	50%	140%
Vinyl Chloride	1		< 0.02	< 0.02	0.0%	< 0.02	88%	50%	140%	88%	50%	140%	86%	50%	140%
Bromomethane	1		< 0.05	< 0.05	0.0%	< 0.05	106%	50%	140%	94%	50%	140%	88%	50%	140%
Trichlorofluoromethane	1		< 0.05	< 0.05	0.0%	< 0.05	95%	50%	140%	93%	50%	140%	83%	50%	140%
Acetone	1		< 0.50	< 0.50	0.0%	< 0.50	94%	50%	140%	99%	50%	140%	104%	50%	140%
1,1-Dichloroethylene	1		< 0.05	< 0.05	0.0%	< 0.05	111%	50%	140%	82%	60%	130%	100%	50%	140%
Methylene Chloride	1		< 0.05	< 0.05	0.0%	< 0.05	103%	50%	140%	99%	60%	130%	104%	50%	140%
Trans- 1,2-Dichloroethylene	1		< 0.05	< 0.05	0.0%	< 0.05	103%	50%	140%	103%	60%	130%	100%	50%	140%
Methyl tert-butyl Ether	1		< 0.05	< 0.05	0.0%	< 0.05	117%	50%	140%	109%	60%	130%	106%	50%	140%
1,1-Dichloroethane	1		< 0.02	< 0.02	0.0%	< 0.02	113%	50%	140%	96%	60%	130%	104%	50%	140%
Methyl Ethyl Ketone	1		< 0.50	< 0.50	0.0%	< 0.50	81%	50%	140%	93%	50%	140%	102%	50%	140%
Cis- 1,2-Dichloroethylene	1		< 0.02	< 0.02	0.0%	< 0.02	107%	50%	140%	100%	60%	130%	107%	50%	140%
Chloroform	1		< 0.04	< 0.04	0.0%	< 0.04	115%	50%	140%	101%	60%	130%	106%	50%	140%
1,2-Dichloroethane	1		< 0.03	< 0.03	0.0%	< 0.03	119%	50%	140%	108%	60%	130%	112%	50%	140%
1,1,1-Trichloroethane	1		< 0.05	< 0.05	0.0%	< 0.05	105%	50%	140%	99%	60%	130%	100%	50%	140%
Carbon Tetrachloride	1		< 0.05	< 0.05	0.0%	< 0.05	103%	50%	140%	101%	60%	130%	94%	50%	140%
Benzene	1		< 0.02	< 0.02	0.0%	< 0.02	99%	50%	140%	99%	60%	130%	94%	50%	140%
1,2-Dichloropropane	1		< 0.03	< 0.03	0.0%	< 0.03	106%	50%	140%	101%	60%	130%	106%	50%	140%
Trichloroethylene	1		< 0.03	< 0.03	0.0%	< 0.03	109%	50%	140%	90%	60%	130%	97%	50%	140%
Bromodichloromethane	1		< 0.05	< 0.05	0.0%	< 0.05	104%	50%	140%	104%	60%	130%	114%	50%	140%
Methyl Isobutyl Ketone	1		< 0.50	< 0.50	0.0%	< 0.50	73%	50%	140%	104%	50%	140%	81%	50%	140%
1,1,2-Trichloroethane	1		< 0.04	< 0.04	0.0%	< 0.04	91%	50%	140%	102%	60%	130%	120%	50%	140%
Toluene	1		< 0.05	< 0.05	0.0%	< 0.05	82%	50%	140%	116%	60%	130%	107%	50%	140%
Dibromochloromethane	1		< 0.05	< 0.05	0.0%	< 0.05	86%	50%	140%	111%	60%	130%	116%	50%	140%
Ethylene Dibromide	1		< 0.04	< 0.04	0.0%	< 0.04	75%	50%	140%	96%	60%	130%	74%	50%	140%
Tetrachloroethylene	1		< 0.05	< 0.05	0.0%	< 0.05	78%	50%	140%	101%	60%	130%	100%	50%	140%
1,1,1,2-Tetrachloroethane	1		< 0.04	< 0.04	0.0%	< 0.04		50%	140%	103%	60%	130%	113%	50%	140%
Chlorobenzene	1		< 0.05	< 0.05	0.0%	< 0.05	74%	50%	140%	86%	60%	130%	107%	50%	140%
Ethylbenzene	1		< 0.05	< 0.05	0.0%	< 0.05	81%	50%	140%	98%	60%	130%	107%	50%	140%
m & p-Xylene	1		< 0.05	< 0.05	0.0%	< 0.05	80%	50%	140%	86%	60%	130%	86%	50%	140%
Bromoform	1		< 0.05	< 0.05	0.0%	< 0.05	71%	50%	140%	73%	60%	130%	113%	50%	140%
Styrene	1		< 0.05	< 0.05	0.0%	< 0.05	70%	50%	140%	89%	60%	130%	107%	50%	140%
1,1,2,2-Tetrachloroethane	1		< 0.05	< 0.05	0.0%	< 0.05		50%	140%	79%	60%	130%	109%	50%	140%
o-Xylene	1		< 0.05	< 0.05	0.0%	< 0.05	76%	50%	140%	82%	60%	130%	82%	50%	140%
1,3-Dichlorobenzene	1		< 0.05	< 0.05	0.0%	< 0.05	88%	50%	140%	103%	60%	130%	99%	50%	140%
1,4-Dichlorobenzene	1		< 0.05	< 0.05	0.0%	< 0.05	88%	50%	140%	105%	60%	130%	100%	50%	140%
1,2-Dichlorobenzene	1		< 0.05	< 0.05	0.0%	< 0.05	87%	50%	140%	101%	60%	130%	108%	50%	140%
Xylene Mixture	1		< 0.05	< 0.05	0.0%	< 0.05	76%	50%	140%	82%	60%	130%	82%	50%	140%
1,3-Dichloropropene	1		< 0.04	< 0.04	0.0%	< 0.04	99%	50%	140%	101%	60%	130%	105%	50%	140%

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Quality Assurance

CLIENT NAME: TERRAPROBE INC.

AGAT WORK ORDER: 11T542323

PROJECT NO: 11-11-1130

ATTENTION TO: Alexander Winkelmann

Trace Organics Analysis (Continued)

RPT Date: Oct 31, 2011			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
n-Hexane	1		< 0.05	< 0.05	0.0%	< 0.05		50%	140%	108%	60%	130%	103%	50%	140%

Certified By:

AGAT Laboratories

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Method Summary

CLIENT NAME: TERRAPROBE INC.

AGAT WORK ORDER: 11T542323

PROJECT NO: 11-11-1130

ATTENTION TO: Alexander Winkelmann

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sulphide*	MIN-200-12000	ASTM E1915-07a	LECO C_S
Chloride (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Electrical Conductivity (2:1)	INOR 1036	McKeague 4.12, SM 2510 B	EC METER
Resistivity (2:1)	INOR 1036		CALCULATION
Redox Potential (2:1)		SM 2510 B	REDOX POTENTIAL ELECTRODE
Antimony	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Arsenic	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Barium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Beryllium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Boron	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Boron (Hot Water Soluble)	MET-93-6104	EPA SW 846 6010C; MSA, Part 3, Ch.21	ICP/OES
Cadmium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Chromium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Cobalt	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Copper	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Lead	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Molybdenum	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Nickel	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Selenium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Silver	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Thallium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Uranium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Vanadium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Zinc	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Chromium VI	INOR-93-6029	SM 3500 B; MSA Part 3, Ch. 25	SPECTROPHOTOMETER
Cyanide	INOR-93-6052	MOE CN-3015 & E 3009 A;SM 4500 CN	TECHNICON AUTO ANALYZER
Mercury	MET-93-6101	EPA SW 846 7471A 245.5	CVAAS
Electrical Conductivity	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Sodium Adsorption Ratio	INOR-93-6007	McKeague 4.12 & 3.26 & EPA SW-846 6010C	ICP/OES
pH, 2:1 CaCl2 Extraction	INOR-93-6031	MSA part 3 & SM 4500-H+ B	PH METER

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Method Summary

CLIENT NAME: TERRAPROBE INC.

AGAT WORK ORDER: 11T542323

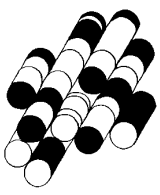
PROJECT NO: 11-11-1130

ATTENTION TO: Alexander Winkelmann

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Dichlorodifluoromethane	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Vinyl Chloride	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Bromomethane	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Trichlorofluoromethane	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Acetone	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,1-Dichloroethylene	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Methylene Chloride	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Trans- 1,2-Dichloroethylene	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Methyl tert-butyl Ether	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,1-Dichloroethane	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Methyl Ethyl Ketone	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Cis- 1,2-Dichloroethylene	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Chloroform	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,2-Dichloroethane	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,1,1-Trichloroethane	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Carbon Tetrachloride	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Benzene	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,2-Dichloropropane	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Trichloroethylene	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Bromodichloromethane	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Methyl Isobutyl Ketone	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,1,2-Trichloroethane	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Toluene	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Dibromochloromethane	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Ethylene Dibromide	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Tetrachloroethylene	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,1,1,2-Tetrachloroethane	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Chlorobenzene	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Ethylbenzene	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
m & p-Xylene	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Bromoform	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Styrene	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,1,2,2-Tetrachloroethane	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
o-Xylene	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,3-Dichlorobenzene	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,4-Dichlorobenzene	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,2-Dichlorobenzene	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Xylene Mixture	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,3-Dichloropropene	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
n-Hexane	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Toluene-d8	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
4-Bromofluorobenzene	VOL-91-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Moisture Content		MOE E3139	BALANCE

APPENDIX E

TERRAPROBE INC.



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CLIENT NAME: TERRAPROBE INC.
11 INDELL LANE
BRAMPTON, ON L6T3Y3

ATTENTION TO: Alexander Winkelmann

PROJECT NO:

AGAT WORK ORDER: 11T545794

TRACE ORGANICS REVIEWED BY: Inga Kuzmina, Analytical Chemist

WATER ANALYSIS REVIEWED BY: Elizabeth Polakowska, MSc (Animal Sci), PhD (Agri Sci), Inorganic Lab Supervisor

DATE REPORTED: Nov 09, 2011

PAGES (INCLUDING COVER): 10

VERSION*: 1

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

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

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Certificate of Analysis

AGAT WORK ORDER: 11T545794

PROJECT NO:

CLIENT NAME: TERRAPROBE INC.

ATTENTION TO: Alexander Winkelmann

O. Reg. 153(511) - PHCs F1 - F4 (-BTEX) (Water)

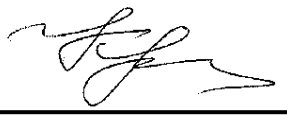
DATE SAMPLED: Nov 01, 2011 | DATE RECEIVED: Nov 03, 2011 | DATE REPORTED: Nov 09, 2011 | SAMPLE TYPE: Water

Parameter	Unit	G / S	RDL	MW1 2868996	MW8 2869012
F1 (C6 to C10)	µg/L		25	<25	<25
F1 (C6 to C10) minus BTEX	µg/L	750	25	<25	<25
F2 (C10 to C16)	µg/L	150	100	<100	<100
F3 (C16 to C34)	µg/L	500	100	<100	<100
F4 (C34 to C50)	µg/L	500	100	<100	<100
Gravimetric Heavy Hydrocarbons	µg/L		500	NA	NA

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to T3(NPGW) - Current

2868996-2869012 The C6-C10 fraction is calculated using Toluene response factor.
The C10 - C16, C16 - C34, and C34 - C50 fractions are calculated using the average response factor for n-C10, n-C16, and nC34.
Gravimetric Heavy Hydrocarbons are not included in the Total C16 - C50 and are only determined if the chromatogram of the C34 - C50 Hydrocarbons indicated that hydrocarbons >C50 are present.
Total C6-C50 results are corrected for BTEX and PAH contributions.
This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.
nC6 and nC10 response factors are within 30% of Toluene response factor.
nC10, nC16 and nC34 response factors are within 10% of their average.
C50 response factor is within 70% of nC10 + nC16 nC34 average.
Linearity is within 15%.
Extraction and holding times were met for this sample.
Fractions 1-4 are quantified without the contribution of PAHs. Under Ontario Regulation 153, results are considered valid without determining the PAH contribution if not requested by the client.

Certified By:



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Certificate of Analysis

AGAT WORK ORDER: 11T545794
PROJECT NO:

CLIENT NAME: TERRAPROBE INC.

ATTENTION TO: Alexander Winkelmann

O. Reg. 153(511) - VOCs (Water)

DATE SAMPLED: Nov 01, 2011 | DATE RECEIVED: Nov 03, 2011 | DATE REPORTED: Nov 09, 2011 | SAMPLE TYPE: Water

Parameter	Unit	G / S	RDL	MW1 2868996	MW8 2869012
Dichlorodifluoromethane	µg/L	4400	0.20	<0.20	<0.20
Vinyl Chloride	µg/L	0.5	0.17	<0.17	<0.17
Bromomethane	µg/L	5.6	0.20	<0.20	<0.20
Trichlorofluoromethane	µg/L	2500	0.40	<0.40	<0.40
Acetone	µg/L	130000	1.0	<1.0	<1.0
1,1-Dichloroethylene	µg/L	1.6	0.30	<0.30	<0.30
Methylene Chloride	µg/L	610	0.30	<0.30	<0.30
trans- 1,2-Dichloroethylene	µg/L	1.6	0.20	<0.20	<0.20
Methyl tert-butyl ether	µg/L	190	0.20	<0.20	<0.20
1,1-Dichloroethane	µg/L	320	0.30	<0.30	<0.30
Methyl Ethyl Ketone	µg/L	470000	1.0	<1.0	<1.0
cis- 1,2-Dichloroethylene	µg/L	1.6	0.20	<0.20	<0.20
Chloroform	µg/L	2.4	0.20	<0.20	<0.20
1,2-Dichloroethane	µg/L	1.6	0.20	<0.20	<0.20
1,1,1-Trichloroethane	µg/L	640	0.30	<0.30	<0.30
Carbon Tetrachloride	µg/L	0.79	0.20	<0.20	<0.20
Benzene	µg/L	44	0.20	<0.20	<0.20
1,2-Dichloropropane	µg/L	16	0.20	<0.20	<0.20
Trichloroethylene	µg/L	1.6	0.20	0.30	0.64
Bromodichloromethane	µg/L	85000	0.20	<0.20	<0.20
Methyl Isobutyl Ketone	µg/L	140000	1.0	<1.0	<1.0
1,1,2-Trichloroethane	µg/L	4.7	0.20	<0.20	<0.20
Toluene	µg/L	18000	0.20	<0.20	<0.20
Dibromochloromethane	µg/L	82000	0.10	<0.10	<0.10
Ethylene Dibromide	µg/L	0.25	0.20	<0.20	<0.20
Tetrachloroethylene	µg/L	1.6	0.20	<0.20	<0.20
1,1,1,2-Tetrachloroethane	µg/L	3.3	0.10	<0.10	<0.10
Chlorobenzene	µg/L	630	0.10	<0.10	<0.10
Ethylbenzene	µg/L	2300	0.10	<0.10	<0.10
m & p-Xylene	µg/L		0.20	<0.20	<0.20
Bromoform	µg/L	380	0.10	<0.10	<0.10
Styrene	µg/L	1300	0.10	<0.10	<0.10
1,1,2,2-Tetrachloroethane	µg/L	3.2	0.10	<0.10	<0.10

Certified By:

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Certificate of Analysis

AGAT WORK ORDER: 11T545794
PROJECT NO:

CLIENT NAME: TERRAPROBE INC.

ATTENTION TO: Alexander Winkelmann

O. Reg. 153(511) - VOCs (Water)

DATE SAMPLED: Nov 01, 2011 | DATE RECEIVED: Nov 03, 2011 | DATE REPORTED: Nov 09, 2011 | SAMPLE TYPE: Water

Parameter	Unit	G / S	RDL	MW1 2868996	MW8 2869012
o-Xylene	µg/L		0.10	<0.10	<0.10
1,3-Dichlorobenzene	µg/L	9600	0.10	<0.10	<0.10
1,4-Dichlorobenzene	µg/L	8	0.10	<0.10	<0.10
1,2-Dichlorobenzene	µg/L	4600	0.10	<0.10	<0.10
1,3-Dichloropropene	µg/L	5.2	0.30	<0.30	<0.30
Xylene Mixture	µg/L	4200	0.20	<0.20	<0.20
n-Hexane	µg/L	51	0.20	<0.20	<0.20
Surrogate	**Unit**	**Acceptable Limits**			
Toluene-d8	% Recovery	50-140		92	95
4-Bromofluorobenzene	% Recovery	50-140		79	76

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to T3(NPGW) - Current

Certified By:

AGAT Laboratories

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AGAT WORK ORDER: 11T545794
PROJECT NO:

CLIENT NAME: TERRAPROBE INC.

ATTENTION TO: Alexander Winkelmann

O. Reg. 153(511) - Metals & Inorganics (Water)

DATE SAMPLED: Nov 01, 2011 | DATE RECEIVED: Nov 03, 2011 | DATE REPORTED: Nov 09, 2011 | SAMPLE TYPE: Water

Parameter	Unit	G / S	RDL	MW1 2868996	MW8 2869012
Antimony	µg/L	20000	0.5	<0.5	<0.5
Arsenic	µg/L	1900	1.0	4.4	1.4
Barium	µg/L	29000	2.0	377	251
Beryllium	µg/L	67	0.5	<0.5	<0.5
Boron	µg/L	45000	10.0	47.3	55.3
Cadmium	µg/L	2.7	0.2	<0.2	<0.2
Chromium	µg/L	810	2.0	8.0	5.4
Cobalt	µg/L	66	0.5	<0.5	<0.5
Copper	µg/L	87	1.0	<1.0	<1.0
Lead	µg/L	25	0.5	<0.5	<0.5
Molybdenum	µg/L	9200	0.5	1.5	1.9
Nickel	µg/L	490	1.0	1.6	1.3
Selenium	µg/L	63	1.0	<1.0	<1.0
Silver	µg/L	1.5	0.2	<0.2	<0.2
Thallium	µg/L	510	0.3	<0.3	<0.3
Uranium	µg/L	420	0.5	<0.5	<0.5
Vanadium	µg/L	250	0.4	1.4	1.5
Zinc	µg/L	1100	5.0	<5.0	5.2
Mercury	µg/L	0.29	0.02	<0.02	<0.02
Chromium VI	µg/L	140	5	<5	<5
Cyanide	µg/L	66	2	<2	<2
Sodium	µg/L	2300000	500	143000	33700
Chloride	µg/L	2300000	100	344000	197000
Nitrate as N	µg/L		50	<50	<50
Nitrite as N	µg/L		50	<50	<50
Electrical Conductivity	uS/cm		2	1320	823
pH	pH Units		NA	8.10	8.13

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to T3(NPGW) - Current

Certified By: Elizabeth Rolokowska

AGAT Laboratories

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Quality Assurance

CLIENT NAME: TERRAPROBE INC.

AGAT WORK ORDER: 11T545794

PROJECT NO:

ATTENTION TO: Alexander Winkelmann

Trace Organics Analysis

RPT Date: Nov 09, 2011			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - VOCs (Water)															
Dichlorodifluoromethane	1		< 0.20	< 0.20	0.0%	< 0.20	76%	50%	140%	70%	50%	140%	70%	50%	140%
Vinyl Chloride	1		< 0.17	< 0.17	0.0%	< 0.17	82%	50%	140%	72%	50%	140%	73%	50%	140%
Bromomethane	1		< 0.20	< 0.20	0.0%	< 0.20	73%	50%	140%	70%	50%	140%	72%	50%	140%
Trichlorofluoromethane	1		< 0.40	< 0.40	0.0%	< 0.40	87%	50%	140%	71%	50%	140%	73%	50%	140%
Acetone	1		< 1.0	< 1.0	0.0%	< 1.0	116%	50%	140%	97%	50%	140%	98%	50%	140%
1,1-Dichloroethylene	1		< 0.30	< 0.30	0.0%	< 0.30	71%	50%	140%	77%	60%	130%	71%	50%	140%
Methylene Chloride	1		< 0.30	< 0.30	0.0%	< 0.30	86%	50%	140%	95%	60%	130%	95%	50%	140%
trans- 1,2-Dichloroethylene	1		< 0.20	< 0.20	0.0%	< 0.20	82%	50%	140%	86%	60%	130%	84%	50%	140%
Methyl tert-butyl ether	1		< 0.20	< 0.20	0.0%	< 0.20	103%	50%	140%	100%	60%	130%	117%	50%	140%
1,1-Dichloroethane	1		< 0.30	< 0.30	0.0%	< 0.30	99%	50%	140%	90%	60%	130%	102%	50%	140%
Methyl Ethyl Ketone	1		< 1.0	< 1.0	0.0%	< 1.0	103%	50%	140%	120%	50%	140%	114%	50%	140%
cis- 1,2-Dichloroethylene	1		< 0.20	< 0.20	0.0%	< 0.20	123%	50%	140%	110%	60%	130%	113%	50%	140%
Chloroform	1		< 0.20	< 0.20	0.0%	< 0.20	122%	50%	140%	113%	60%	130%	123%	50%	140%
1,2-Dichloroethane	1		< 0.20	< 0.20	0.0%	< 0.20	106%	50%	140%	107%	60%	130%	115%	50%	140%
1,1,1-Trichloroethane	1		< 0.30	< 0.30	0.0%	< 0.30	100%	50%	140%	88%	60%	130%	88%	50%	140%
Carbon Tetrachloride	1		< 0.20	< 0.20	0.0%	< 0.20	98%	50%	140%	93%	60%	130%	92%	50%	140%
Benzene	1		< 0.20	< 0.20	0.0%	< 0.20	122%	50%	140%	106%	60%	130%	103%	50%	140%
1,2-Dichloropropane	1		< 0.20	< 0.20	0.0%	< 0.20	108%	50%	140%	99%	60%	130%	101%	50%	140%
Trichloroethylene	1		< 0.20	< 0.20	0.0%	< 0.20	109%	50%	140%	101%	60%	130%	102%	50%	140%
Bromodichloromethane	1		< 0.20	< 0.20	0.0%	< 0.20	116%	50%	140%	99%	60%	130%	103%	50%	140%
Methyl Isobutyl Ketone	1		< 1.0	< 1.0	0.0%	< 1.0	97%	50%	140%	110%	50%	140%	117%	50%	140%
1,1,2-Trichloroethane	1		< 0.20	< 0.20	0.0%	< 0.20	127%	50%	140%	116%	60%	130%	121%	50%	140%
Toluene	1		< 0.20	< 0.20	0.0%	< 0.20	122%	50%	140%	111%	60%	130%	114%	50%	140%
Dibromochloromethane	1		< 0.10	< 0.10	0.0%	< 0.10	107%	50%	140%	87%	60%	130%	94%	50%	140%
Ethylene Dibromide	1		< 0.20	< 0.20	0.0%	< 0.20	108%	50%	140%	94%	60%	130%	102%	50%	140%
Tetrachloroethylene	1		< 0.20	< 0.20	0.0%	< 0.20	115%	50%	140%	98%	60%	130%	98%	50%	140%
1,1,1,2-Tetrachloroethane	1		< 0.10	< 0.10	0.0%	< 0.10		50%	140%	82%	60%	130%	85%	50%	140%
Chlorobenzene	1		< 0.10	< 0.10	0.0%	< 0.10	114%	50%	140%	102%	60%	130%	103%	50%	140%
Ethylbenzene	1		< 0.10	< 0.10	0.0%	< 0.10	116%	50%	140%	93%	60%	130%	91%	50%	140%
m & p-Xylene	1		< 0.20	< 0.20	0.0%	< 0.20	129%	50%	140%	100%	60%	130%	99%	50%	140%
Bromoform	1		< 0.10	< 0.10	0.0%	< 0.10	105%	50%	140%	86%	60%	130%	92%	50%	140%
Styrene	1		< 0.10	< 0.10	0.0%	< 0.10	78%	50%	140%	78%	60%	130%	74%	50%	140%
1,1,2,2-Tetrachloroethane	1		< 0.10	< 0.10	0.0%	< 0.10		50%	140%	128%	60%	130%	129%	50%	140%
o-Xylene	1		< 0.10	< 0.10	0.0%	< 0.10	128%	50%	140%	103%	60%	130%	104%	50%	140%
1,3-Dichlorobenzene	1		< 0.10	< 0.10	0.0%	< 0.10	74%	50%	140%	70%	60%	130%	72%	50%	140%
1,4-Dichlorobenzene	1		< 0.10	< 0.10	0.0%	< 0.10	83%	50%	140%	81%	60%	130%	77%	50%	140%
1,2-Dichlorobenzene	1		< 0.10	< 0.10	0.0%	< 0.10	81%	50%	140%	77%	60%	130%	72%	50%	140%
1,3-Dichloropropene	1		< 0.30	< 0.30	0.0%	< 0.30	91%	50%	140%	87%	60%	130%	78%	50%	140%
Xylene Mixture	1		< 0.20	< 0.20	0.0%	< 0.20	128%	50%	140%	103%	60%	130%	104%	50%	140%

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Quality Assurance

CLIENT NAME: TERRAPROBE INC.

AGAT WORK ORDER: 11T545794

PROJECT NO:

ATTENTION TO: Alexander Winkelmann

Trace Organics Analysis (Continued)

RPT Date: Nov 09, 2011			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
n-Hexane	1		< 0.20	< 0.20	0.0%	< 0.20		50%	140%	124%	60%	130%	72%	50%	140%
O. Reg. 153(511) - PHCs F1 - F4 (-BTEX) (Water)															
F1 (C6 to C10)	1		< 25	< 25	0.0%	< 25	96%	60%	140%	83%	60%	140%	83%	60%	140%
F2 (C10 to C16)	1		< 100	< 100	0.0%	< 100	100%	60%	140%	97%	60%	140%	80%	60%	140%
F3 (C16 to C34)	1		< 100	< 100	0.0%	< 100	102%	60%	140%	113%	60%	140%	108%	60%	140%
F4 (C34 to C50)	1		< 100	< 100	0.0%	< 100	92%	60%	140%	106%	60%	140%	123%	60%	140%

Certified By:

AGAT Laboratories

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Quality Assurance

CLIENT NAME: TERRAPROBE INC.

AGAT WORK ORDER: 11T545794

PROJECT NO:

ATTENTION TO: Alexander Winkelmann

Water Analysis

RPT Date: Nov 09, 2011			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - Metals & Inorganics (Water)															
Antimony	1	2868996	< 0.5	< 0.5	0.0%	< 0.5	107%	70%	130%	96%	80%	120%	99%	70%	130%
Arsenic	1	2868996	4.4	4.5	2.2%	< 1.0	99%	70%	130%	106%	80%	120%	119%	70%	130%
Barium	1	2868996	377	373	1.1%	< 2.0	99%	70%	130%	106%	80%	120%	103%	70%	130%
Beryllium	1	2868996	< 0.5	< 0.5	0.0%	< 0.5	106%	70%	130%	106%	80%	120%	112%	70%	130%
Boron	1	2868996	47.3	45.2	4.5%	< 10.0	103%	70%	130%	106%	80%	120%	111%	70%	130%
Cadmium	1	2868996	< 0.2	< 0.2	0.0%	< 0.2	101%	70%	130%	115%	80%	120%	114%	70%	130%
Chromium	1	2868996	8.0	9.4	16.1%	< 2.0	102%	70%	130%	110%	80%	120%	109%	70%	130%
Cobalt	1	2868996	< 0.5	< 0.5	0.0%	< 0.5	97%	70%	130%	105%	80%	120%	99%	70%	130%
Copper	1	2868996	< 1.0	< 1.0	0.0%	< 1.0	100%	70%	130%	106%	80%	120%	99%	70%	130%
Lead	1	2868996	< 0.5	< 0.5	0.0%	< 0.5	98%	70%	130%	104%	80%	120%	100%	70%	130%
Molybdenum	1	2868996	1.5	1.5	0.0%	< 0.5	100%	70%	130%	103%	80%	120%	103%	70%	130%
Nickel	1	2868996	1.6	1.7	6.1%	< 1.0	97%	70%	130%	103%	80%	120%	101%	70%	130%
Selenium	1	2868996	< 1.0	< 1.0	0.0%	< 1.0	100%	70%	130%	99%	80%	120%	101%	70%	130%
Silver	1	2868996	< 0.2	< 0.2	0.0%	< 0.2	98%	70%	130%	110%	80%	120%	105%	70%	130%
Thallium	1	2868996	< 0.3	< 0.3	0.0%	< 0.3	99%	70%	130%	105%	80%	120%	102%	70%	130%
Uranium	1	2868996	< 0.5	< 0.5	0.0%	< 0.5	106%	70%	130%	102%	80%	120%	100%	70%	130%
Vanadium	1	2868996	1.4	1.7	19.4%	< 0.4	98%	70%	130%	106%	80%	120%	107%	70%	130%
Zinc	1	2868996	< 5.0	< 5.0	0.0%	< 5.0	100%	70%	130%	104%	80%	120%	107%	70%	130%
Mercury	1		< 0.02	< 0.02	0.0%	< 0.02	103%	70%	130%	95%	80%	120%	100%	70%	130%
Chromium VI	1		< 5	< 5	0.0%	< 5	102%	70%	130%	100%	80%	120%	102%	70%	130%
Cyanide	1	2868996	< 2	< 2	0.0%	< 2	90%	70%	130%	110%	80%	120%	100%	70%	130%
Sodium	1		35000	34800	0.6%	< 500	100%	70%	130%	100%	80%	120%	98%	70%	130%
Chloride	1		198000	199000	0.5%	< 100	93%	70%	130%	94%	80%	120%	112%	70%	130%
Nitrate as N	1		< 50	< 50	0.0%	< 50	99%	70%	130%	97%	80%	120%	108%	70%	130%
Nitrite as N	1		< 50	< 50	0.0%	< 50	NA	70%	130%	96%	80%	120%	108%	70%	130%
Electrical Conductivity	1		463	436	6.0%	< 2	102%	90%	110%						
pH	1		8.18	8.28	1.2%	N/A	100%	90%	110%						

Certified By: Elizabeth Rolakowska

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Method Summary

CLIENT NAME: TERRAPROBE INC.

AGAT WORK ORDER: 11T545794

PROJECT NO:

ATTENTION TO: Alexander Winkelmann

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
F1 (C6 to C10)	VOL-91-5010	MOE PHC E3421	(P&T)GC/FID
F1 (C6 to C10) minus BTEX	VOL-91-5010	MOE PHC E3421	(P&T)GC/FID
F2 (C10 to C16)	VOL-91-5010	MOE PHC E3421	GC / FID
F3 (C16 to C34)	VOL-91-5010	MOE PHC E3421	GC / FID
F4 (C34 to C50)	VOL-91-5010	MOE PHC E3421	GC / FID
Gravimetric Heavy Hydrocarbons	VOL-91-5010	MOE PHC E3421	BALANCE
Dichlorodifluoromethane	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Vinyl Chloride	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Bromomethane	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Trichlorofluoromethane	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Acetone	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
1,1-Dichloroethylene	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Methylene Chloride	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
trans- 1,2-Dichloroethylene	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Methyl tert-butyl ether	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
1,1-Dichloroethane	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Methyl Ethyl Ketone	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
cis- 1,2-Dichloroethylene	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Chloroform	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
1,2-Dichloroethane	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
1,1,1-Trichloroethane	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Carbon Tetrachloride	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Benzene	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
1,2-Dichloropropane	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Trichloroethylene	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Bromodichloromethane	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Methyl Isobutyl Ketone	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
1,1,2-Trichloroethane	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Toluene	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Dibromochloromethane	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Ethylene Dibromide	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Tetrachloroethylene	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
1,1,1,2-Tetrachloroethane	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Chlorobenzene	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Ethylbenzene	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
m & p-Xylene	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Bromoform	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Styrene	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
1,1,2,2-Tetrachloroethane	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
o-Xylene	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
1,3-Dichlorobenzene	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
1,4-Dichlorobenzene	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
1,2-Dichlorobenzene	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
1,3-Dichloropropene	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Xylene Mixture	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
n-Hexane	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
Toluene-d8	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS
4-Bromofluorobenzene	VOL-91-5001	EPA SW-846 5030 & 8260	(P&T)GC/MS

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Method Summary

CLIENT NAME: TERRAPROBE INC.

AGAT WORK ORDER: 11T545794

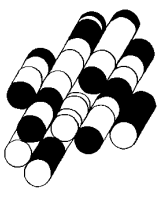
PROJECT NO:

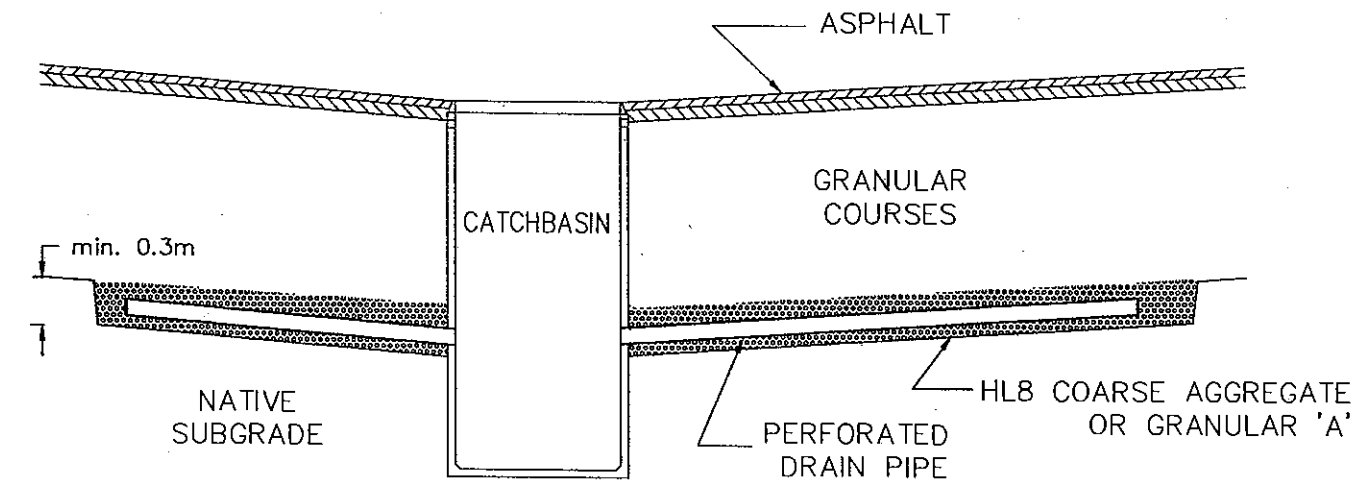
ATTENTION TO: Alexander Winkelmann

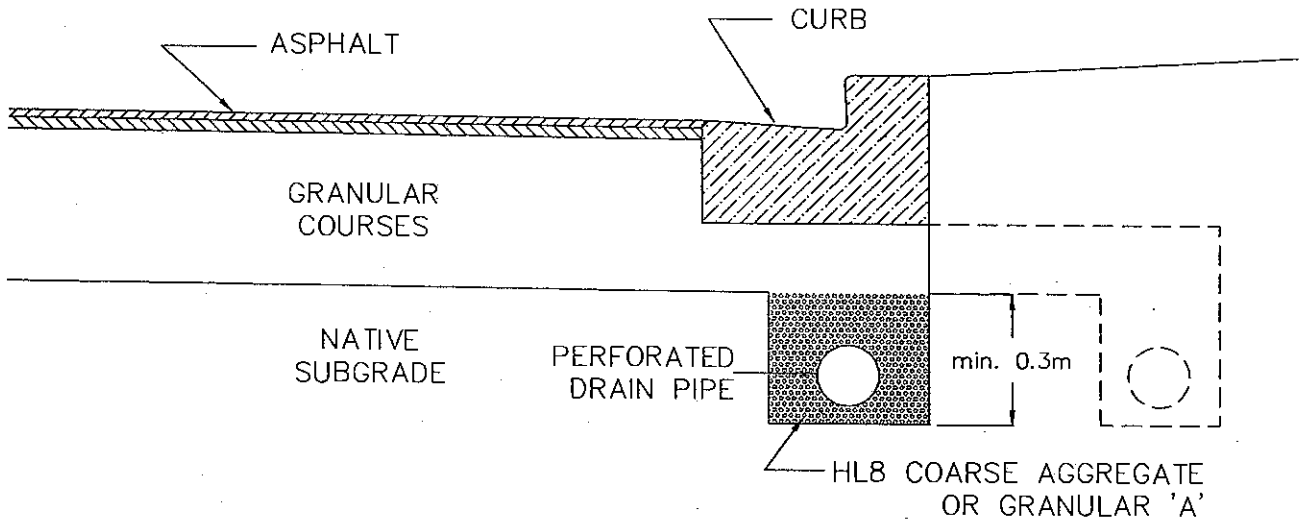
PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Antimony	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Arsenic	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Barium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Beryllium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Boron	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Cadmium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Chromium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Cobalt	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Copper	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Lead	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Molybdenum	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Nickel	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Selenium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Silver	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Thallium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Uranium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Vanadium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Zinc	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Mercury	MET-93-6100	EPA SW-846 7470 & 245.1	CVAAS
Chromium VI	INOR-93-6034	SM 3500-Cr B	SPECTROPHOTOMETER
Cyanide	INOR-93-6052	MOE METHOD CN- 3015 & SM 4500 CN- I	TECHNICON AUTO ANALYZER
Sodium	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Chloride	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrate as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Electrical Conductivity	INOR-93-6000	SM 2510 B	PC TITRATE
pH	INOR-93-6000	SM 4500-H+ B	PC TITRATE

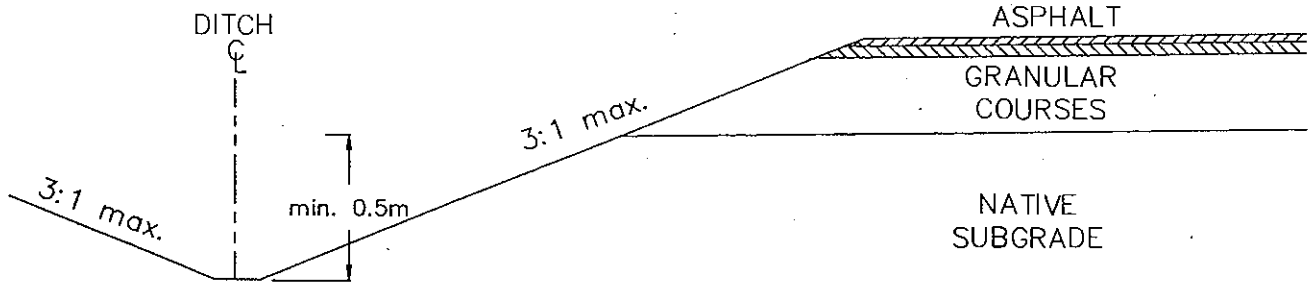
APPENDIX F

TERRAPROBE INC.









PAVEMENT DRAINAGE ALTERNATIVES

TERRAPROBE