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Terraprobe

Consulting Geotechnical & Environmental Engineering
Construction Materials Engineering, Inspection & Testing

FOUNDATION INVESTIGATION & DESIGN REPORT
KENNEDY ROAD WATERMAINS & SEWER INSTALLATIONS
HIGHWAY 410 EXTENSION – PHASE III
FROM 300 m EAST OF HEART LAKE ROAD TO HIGHWAY 10

PREPARED FOR: Giffels Associates Ltd.
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File No. 1-06-1346 (KR)
April 04, 2007

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the site where a watermain will be installed on both sides of the proposed Kennedy Road underpass structure, crossing under the proposed four-lanes of Highway 410 in the Town of Caledon, Ontario.

Previous, preliminary investigations were carried out by Terraprobe Limited for the Kennedy Road underpass structure and the applicable factual data from these investigations was used to supplement the current field investigation.

The purpose of this investigation was to explore the subsurface conditions at the site and based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profiles, laboratory test results and a description of the subsurface conditions. A model of the subsurface conditions along the proposed watermain alignments was developed using existing data and information obtained from this investigation.

Terraprobe conducted the investigation as a sub-consultant to Giffels Associates Ltd. (Giffels), for the Region of Peel.

The following documents are referenced in the preparation of this report:

- Terraprobe Limited, "Foundation Investigation & Design Report, Kennedy Road Underpass Structure, Highway 410 Extension – Phase III, From 300 m East of Heart Lake Road to Highway 10", Agreement No. 2005-A-000230, W.P. 105-00-00, dated May 05, 2006.

2 SITE DESCRIPTION

The site is located on Kennedy Road about 600± m north of the Kennedy Road/Mayfield Road intersection in the Town of Caledon. Kennedy Road is a two lane asphalt paved road with granular shoulders and ditches on both sides.

The site is located in a rural setting, surrounded generally by agricultural lands and the Etobicoke Creek valley further west. Vegetation is light consisting mainly of grass and occasional large trees.

The topography is generally flat on the east side of Kennedy Road. On the west side of Kennedy Road the ground surface falls to the Etobicoke Creek valley by about 20± m over a horizontal distance of 275± m.

The site is located in the physiographic region of Southern Ontario referred to as the Peel Plain whose topography slopes gradually and gently towards Lake Ontario. Etobicoke Creek and other rivers have cut deep valleys across the Peel Plain.

The Peel Plain is known to consist of generally clayey and silty soils that cover the central portion of the regions of York, Peel and Halton[1]. There are exceptions to be noted in these major soil groups. Trains of sandy alluvium can be found at various places in the stream valleys. These overburden soils are underlain by the Queenston Formation.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out during the period November 08 to 10, 2006 and consisted of drilling and sampling four boreholes to depths ranging from 15.7 m to 17.2 m below ground surface. The boreholes were numbered T1, T2, T3 and T4 and their approximate locations are shown on the attached Borehole Locations and Soil Strata Drawings in Appendix D.

The borehole locations and geodetic elevations were established in the field by Terraprobe Limited based on drawings provided by Giffels. Utility clearances were obtained by Terraprobe prior to drilling.

The drilling, sampling and in-situ testing operations were conducted with a track mounted drill rig owned and operated by Drill Tech Drilling of Newmarket, Ontario. Solid stem auger drilling techniques were used to advance the boreholes and samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the overburden soils.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. A standpipe piezometer consisting of 19 mm diameter PVC pipe with a slotted screen enclosed in sand was installed in each borehole to permit longer term groundwater level monitoring. The locations and completion details of the piezometers are shown in Table 3.1.

[1] Chapman and Putnam, "The Physiography of South Ontario", 3rd Edition, 1984.

Table 3.1 – Piezometer Installation Details

Piezometer Location	Piezometer Details	
	Tip Depth/ Elevation (m)	Completion Details
T1	16.7/247.2	Piezometer with 4.6 m slotted screen installed with filter sand to 12.2 m, bentonite seals from 12.2-10.4 m, 7.3-6.4 m, 3.0-2.4 m, 0.6-ground surface and auger cuttings from 10.4-7.3 m, 6.4-3.0 m and 2.4-0.6 m.
T2	15.2/249.3	Piezometer with 3 m slotted screen installed with filter sand to 12.2 m, bentonite seal from 12.2 m to 11.3 m, drill cuttings from 11.3 m to 0.9 m, and bentonite seal from 0.9 m to ground surface.
T3	16.7/248.7	Piezometer with 4.6 m slotted screen installed with filter sand to 12.2 m, bentonite seals from 12.2-10.4 m, 7.3-6.4 m, 3.0-2.4 m, 0.6-ground surface and auger cuttings from 10.4-7.3 m, 6.4-3.0 m and 2.4-0.6 m.
T4	16.1/250.3	Piezometer with 3 m slotted screen installed with filter sand to 12.2 m, bentonite seals from 12.2-10.4 m, 7.3-6.4 m and 0.6-ground surface, auger cuttings from 10.4-7.3 m and 6.4-0.6 m.

Members of Terraprobe's technical staff supervised the drilling and sampling operations on a full time basis. The supervisors logged the boreholes and processed the recovered soil samples for transport to Terraprobe's Brampton laboratory for further examination and testing.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and natural moisture content determination. The results of this testing program are shown on the Record of Borehole sheets in Appendix A. The grain size distribution curves and plasticity charts from previous investigations are illustrated in Appendix C.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A and the applicable Record of Borehole sheets from the previous Terraprobe investigations included in Appendix B. Details of the encountered soil stratigraphy are presented in these appendices and on the "Borehole Locations and Soil Strata" drawings in Appendix D. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

In general, the site is underlain by topsoil, fill and overburden deposits of stiff to hard clayey silt till, very dense sand and silt and silt and sand till and very dense silt.

5.1 Topsoil

Topsoil ranging from 150 mm to 250 mm in thickness was encountered in some of the boreholes. Topsoil thickness may vary between and beyond the boreholes.

5.2 Sand and Gravel Fill

Sand and Gravel fill was encountered at the site. This fill is approximately 0.4 m to 0.7 m thick and extends to elevations ranging from 265.6 m to 264.9 m.

The grain size distribution curve of a sample of this fill material is illustrated in Figure C1. The results show a grain size distribution consisting of 34% gravel, 57% sand, 7% silt and 2% clay size particles.

Standard Penetration tests in this fill material yielded 'N' values ranging from 8 to 37 blows for 0.3 m penetration indicating a loose to dense relative density.

The moisture content of samples of this fill ranged from 6% to 10% by weight.

5.3 Clayey Silt Fill

Clayey silt fill was encountered extending to depths ranging from 0.7 m to 1.1 m or to elevations ranging from 265.3 m to 263.2 m.

Standard Penetration tests in this fill material yielded 'N' values ranging from 8 to 13 blows for 0.3 m penetration. Based on these results the clayey silt fill is considered to have a firm to stiff consistency.

The moisture content of samples of this fill ranged from 11% to 33% by weight.

5.4 Upper Clayey Silt Till

Across the site a major deposit of clayey silt till was encountered. This deposit extends to depths ranging from 7.0 m to 10.1 m below ground surface or to elevations ranging from 257.5 m to 256.3 m.

The grain size distribution curves of samples of this clayey silt till are presented in Figure C2. These results show a grain size distribution consisting of 0-9% gravel, 5-32% sand, 42-75% silt and 12-20% clay size particles. Till soils are also known to contain cobbles and boulders due to their mode of deposition.

Samples of the clayey silt till were also subjected to Atterberg Limits tests and the results are illustrated in Figure C3. The index values from these tests are summarized below:

Liquid Limit:	21-25%
Plastic Limit:	14-18%
Plasticity Index:	4-9%
Natural Moisture Content:	13-24%

These values are characteristic of clayey soils of low plasticity.

Standard Penetration tests in this clayey silt till layer yielded 'N' values ranging from 10 to more than 100 blows for 0.3 m penetration indicating a stiff to hard consistency.

The moisture content of samples from this deposit ranged from 8% to 26% by weight.

5.5 Sand and Silt Till

A deposit of sand and silt till was encountered in some of the boreholes. This deposit extends to depths ranging from 10.0 m to 14.5 m below ground surface or to elevations ranging between 253.9 m and 250.9 m.

Refer to Figure C4 where the grain size distribution curves of five samples of the sand and silt till are illustrated. The results show a grain size distribution consisting of 3-8% gravel, 41-62% sand, 35-48% silt and 8-9% clay size particles. Cobbles and boulders can also be expected within the matrix of till soils.

Blow counts of more than 100 blows for 0.3 m penetration were obtained from Standard Penetration tests in this stratum indicating a very dense relative density.

The moisture contents of samples from this deposit ranged from 4% to 14% by weight.

5.6 Lower Clayey Silt Till

A lower layer of clayey silt till was encountered across the site extending to depths ranging from 14.7 m (Elev. 250.5 m) to 20.0 m (Elev. 246.0 m) below ground surface.

A sample from this clayey silt till deposit was subjected to a grain size analysis and the results are presented in Figure C5. These results show a grain size distribution consisting of 10% gravel, 25% sand, 52% silt and 13% clay size particles. Cobbles and boulders can also be expected to occur in till soils.

Standard Penetration tests conducted in this clayey silt till gave 'N' values ranging from 41 to more than 100 blows for 0.3 m penetration. Based on these results the clayey silt till is considered to have a hard consistency.

The moisture contents of samples retrieved from this stratum ranged from 6% to 22% by weight.

5.7 Silt and Sand Till

A granular stratum of silt and sand till was encountered across the site. This deposit was fully penetrated in some of the boreholes where it was found to extend to depths ranging from 22.1 m (Elev. 243.2 m) to 22.2 m (Elev. 243.8 m) below ground surface.

Refer to Figure C6 for the grain size distribution curves of tested samples from this deposit. The results show a grain size distribution consisting of 6-21% gravel, 35-52% sand, 23-50% silt and 4-9% clay size particles.

Standard Penetration tests in this stratum gave 'N' values ranging from 54 to more than 100 blows for 0.3 m penetration. Based on these results the silt and sand till is considered to have a very dense relative density.

The moisture contents of samples of this silt and sand till ranged from 7% to 13% by weight.

5.8 Silt

Boreholes K2A, K5A and T3 encountered a layer of silt that extends to borehole termination depths ranging from 17.1 (Elev. 248.3 m) to 27.7 m (Elev. 238.3 m).

A sample from this stratum was subjected to a grain size analysis and the grain size distribution curve is presented in Figure C7. The results show a grain size distribution consisting of 0% gravel, 1% sand, 91% silt and 8% clay sized particles.

The blow counts from Standard Penetration tests conducted in this stratum ranged from 70 to more than 100 blows for 0.3 m penetration. Based on these results the silt is considered to have a very dense relative density.

The moisture contents of samples of this silt ranged from 7% to 19% by weight.

5.9 Water Levels

A standpipe piezometer was installed in the four boreholes. The water level readings were measured on a separate visit made after the completion of drilling. The water level measurements of the present and previous readings at this site are presented in Table 5.1 below.

Table 5.1 – Water Level Measurements

Borehole	Date	Water Levels	
		Depth (m)	Elevation (m)
T1	Nov. 20, 2006	8.4	255.5
T2	Nov. 20, 2006	6.7	257.8
T3	Nov. 20, 2006	7.7	257.7
T4	Nov. 20, 2006	10.5	255.9
K2	Nov. 25, 2002	9.6	255.8
K5	Nov. 25, 2002	11.2	254.8

These observations suggest that the local groundwater level at the site is likely to exist at elevations ranging between 254.8 m and 257.8 m. All groundwater observations at this site are short term and the levels are expected to fluctuate seasonally and after severe weather events.

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FOUNDATION INVESTIGATION AND DESIGN REPORT
KENNEDY ROAD WATERMAINS & SEWER INSTALLATIONS
HIGHWAY 410 EXTENSION – PHASE III
ONTARIO

PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

6 GENERAL

This report presents interpretation of the geotechnical data in the factual report and provides geotechnical design recommendations for the proposed watermains and sewer installations.

It is understood that the proposed construction sequence will be to install the watermains and sewer during highway construction and before the Kennedy Road underpass structure is constructed.

The discussion and recommendations presented in this report are based on our understanding of the project and on the factual data obtained in the course of the investigations.

6.1 PVC Watermain

A 113 m± long, 300 mm diameter PVC watermain will be installed about 21 m± east of the existing centre line of Kennedy Road. This watermain will cross under the proposed four-lanes of Highway 410 at about Sta. 23+752 and will be aligned 10 m± away from the perimeter of the proposed foundation elements of the widened Kennedy Road underpass structure.

At the south limit of the alignment the watermain invert will be about Elev. 264.5 m± falling to Elev. 250.7 m over a horizontal distance of 15.5 m±. The watermain will then cross under the proposed Highway 410 at Elev. 250.7 m over a horizontal distance of 70.5 m± and will rise upwards (over a horizontal distance of 27 m±) to an invert elevation of Elev. 262.5 m at the north limit.

Below Highway 410 the watermain will be installed in a 42 m long, 762 mm diameter steel liner with invert and obvert elevations of Elev. 250.5 m and Elev. 251.3 m respectively.

6.2 CPP Watermain & Sanitary Sewer

On the west side of Kennedy Road approximately 24 m away from the existing centre line of Kennedy Road a 105 m± long, 500 mm diameter concrete pressure pipe (CPP) watermain will be installed. This watermain will cross under the proposed four-lanes of Highway 410 at about Sta. 23+798 and will be located 12.5 m± away from the perimeter of the proposed foundation elements of the widened Kennedy Road underpass structure.

At the south limit of the alignment the watermain invert will be about Elev. 260.5 m± falling to Elev. 249.2 m over a horizontal distance of 12 m. The watermain will then cross under the proposed Highway 410 at Elev. 249.2 m over a horizontal distance of 66 m and will rise upwards to the north limit (over a horizontal distance of 22.3 m) to an invert elevation of Elev. 258.4 m.

Below Highway 410 the watermain will be installed in a 42.5 m long, 1200 mm diameter steel liner with invert and obvert elevations of Elev. 248.8 m and Elev. 250.0 m respectively.

On the west side of Kennedy Road a 525 mm diameter sanitary sewer will also be installed at the same elevation as the CPP watermain. This sanitary sewer will be aligned 9 m± away from the perimeter of the proposed foundation elements of the widened Kennedy Road underpass structure.

7 WATERMAINS & SEWER

7.1 General

Since the watermains and sewer installations will precede highway construction it is likely that the following construction sequence will be adopted.

- Excavate overburden soils at this site to design elevations.
- Excavate to invert elevation of watermains and sewer bedding by trenching. This will require excavations below subgrade of Highway 410 and along the face of cut slopes.
- Prepare trench bottom and install watermains and sewer.
- Place and compact select backfill material in open trench.
- Proceed with construction of other elements such as Kennedy Road underpass structure.

Based on the foregoing construction sequence and considering that the watermains and sewer will be installed before Highway 410 is constructed, other installation methods such as Jack and Bore, Directional Drilling and Pipe ramming have been eliminated. These methods only become economically viable when tunnelling under existing structures.

7.2 Open Cut Trenching

It is recommended that the watermains and sewer be installed by open cut trenching. Other methods such as Jack and bore, Directional drilling and Pipe ramming provide no advantages nor are they more economical.

7.2.1 Vertical Alignment – PVC Watermain

The invert elevation at the south limit is 264.5 m falling to Elev. 250.7 m. Towards the north limit the watermain invert will rise upwards to Elev. 262.5 m. The liner invert is Elev. 250.5 m. Based on the subsurface stratigraphy encountered at this site the trench bottom will lie in clayey silt till and sand and silt till.

Based on the boreholes drilled along this alignment, the groundwater table ranges from Elev. 255.8 m to Elev. 257.8 m and will therefore be above the depth of excavation at some sections of the alignment. This aspect must be taken into consideration when undertaking excavations at this site.

At the proposed invert level the clayey silt till is hard and the sand and silt till is very dense. These soils will provide excellent support to the pipe.

7.2.2 Vertical Alignment – CPP Watermain & Sewer

The invert elevation at the south limit is 260.5 m falling to Elev. 249.2 m. Towards the north limit the watermain invert will rise upwards to Elev. 258.4 m. The liner invert is Elev. 248.8 m. Based on the subsurface stratigraphy encountered at this site the trench bottom will lie in clayey silt till, sand and silt till and silt and sand till.

Based on the boreholes drilled along this alignment, the groundwater table ranges from Elev. 254.8 m to Elev. 257.7 m and will therefore be above the depth of excavation at some sections of the alignment. This aspect must be taken into consideration when undertaking excavations at this site.

At the proposed invert level the clayey silt till is hard and the sand and silt and silt and sand till soils are very dense. These soils will provide excellent support to the pipe.

7.2.3 Excavation

The soils described at this site are considered to be suitable for excavation using trenching and excavating equipment, such as backhoes normally used by contractors for watermain installation. Excavations should be undertaken in accordance with OPSS 514.

Till soils inherently contain cobbles and boulders and the contract documents must identify this fact to bidders. The frequency of boulders is unlikely to be high enough to prevent the use of suitable trenching and excavating equipment. However, the contract documents should include a NSSP alerting bidders to the fact that cobbles and boulders may be encountered in the soil. Suggested wording for this NSSP is included in Appendix E.

7.2.4 OHSA Soil Classification

All excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purposes of the OHSA, the native soils at this site may be classified as Type 2 soils above the water table and Type 4 soils below the water table. Excavations

above the water table may be sloped at 1.5H:1V. Provided dewatering is carried out as described below, excavations below the water table may be sloped at 2H:1V.

7.2.5 Groundwater Control

The groundwater table at this site is estimated to range between Elev. 254.8 m and Elev. 257.8 m and groundwater is likely to be encountered in the excavation along some sections of the two alignments.

The Contractor must implement such groundwater control and ground support systems as are required to install the watermains and sewer in a safe, stable, unwatered excavation. The design of the unwatering system should be the responsibility of the Contractor.

Groundwater seepage into excavations made through the sand and silt and silt and sand till deposits should be moderate and it is believed that this seepage can be controlled by gravity drainage and pumping from strategically located filtered sumps.

It should be pointed out that the granular sand and silt till and silt and silt till will be easily disturbed in the presence of water.

Laying the watermains and/or sewer and backfilling on top of heaved; disturbed soil may result in settlement that could result in damage to the pipes. Therefore, it is recommended that excavations below the water table be undertaken expeditiously in as short sections as possible. The trench bases must be inspected and approved by the Quality Verification Engineer (QVE).

7.2.6 Bedding

The bedding for the watermains, sewer and their liners must conform to the requirements of OPSD 802.030 (rigid pipe bedding, earth excavation) or OPSD 802.010 (flexible pipe embedment and backfill, earth excavation) as appropriate.

It is recommended that the bedding material consist of OPSS Granular "A".

Additional bedding requirements that may be imposed by the supplier must also be followed.

All disturbed or softened soils must be removed from the trench base before bedding material is placed.

7.2.7 Backfill

At the Highway 410 crossing, it is recommended that the trench backfill consist of Granular "B" Type I. The backfill should be compacted to a minimum of 98% of the Standard Proctor Maximum Dry Density (SPMDD) at a moisture content within ±2% of the optimum value.

Elsewhere the backfill may consist of the excavated soil compacted to 95% SPMDD at a moisture content within ±2% of the optimum value.

8 EARTH PRESSURE

The excavation walls will have to be supported using either a system of close shoring or a suitably designed trench box.

Earth pressures acting on the shoring system may be assumed to be triangular and to be governed by the characteristics of the soil being retained. Earth pressure computations must also take into account the groundwater level. Above the groundwater level, earth pressure is computed using the bulk unit weight of the retained soil. Below the groundwater level, the earth pressures are computed using the submerged unit weight of the soil. A hydrostatic pressure is also applied if the retained soil is not fully drained.

Earth pressures acting on the structure should be computed in accordance with Clause 6.9 of the CHBDC. The appropriate pressures can be computed from the expression:

$P_h = K[\gamma (h - h_w) + (\gamma' h_w) + q] + h_w\gamma_w$
P_h = horizontal pressure on the wall (kPa)
K = earth pressure coefficient (see table 8.1)
γ = bulk unit weight of retained soil (see table 8.1)
γ' = submerged unit weight of soil ($\gamma - \gamma_w$)
γ_w = unit weight of water (9.81 kN/m^3)
h = depth below surface (m)
h_w = depth below the groundwater level (m)
q = value of any surcharge (kPa)

If the shoring is internally braced at more than one level, then it is recommended that the design of the system be undertaken based on an earth pressure distribution consisting of a uniformly distributed pressure defined by the expression:

$P = 0.65\ K[\gamma h + q] + h_w\gamma_w$
K = earth pressure coefficient (see table 8.1)
γ = bulk unit weight of retained soil (see table 8.1)
γ_w = unit weight of water (9.81 kN/m^3)
h = depth below surface (m)
h_w = depth below the groundwater level (m)
q = value of any surcharge (kPa)

The appropriate values of the parameters for use in the design of structures subject to unbalanced earth pressures are given in Table 8.1 below.

Table 8.1 – Earth Pressure Coefficients

Stratum	ϕ	γ	K_a	K_o	K_p
Clayey Silt Glacial Till	28	20	0.36	0.53	2.80
Sand & Silt Till	30	20	0.33	0.50	3.00
Silt & Sand Till	30	20	0.33	0.50	3.00
Silt	28	19	0.36	0.53	2.80

The factors in the table above are "ultimate" values and require certain movements for the active and passive conditions to be mobilized. The values to use in design can be estimated from Figure C6.9.1 (a) in the Commentary to the CHBDC, 2000.

9 ALIIGNMENT CONSIDERATIONS

It is noted that excavations for the PVC watermain installation will be undertaken along an alignment approximately 10 m± east of the footprint of the proposed underpass structure. The alignment of the sanitary sewer will require excavations on the west side of Kennedy Road about 9 m± west of the footprint of the proposed underpass structure.

If excavations are undertaken within close shoring or trench boxes the founding soils below the foundation elements of the proposed underpass will be sufficiently removed from the excavation so as to be unaffected by the excavation activity.

10 CONSTRUCTION CONCERNS

During construction, the Contract Administrator should employ experienced geotechnical staff to observe construction activities related to foundation construction.

Potential construction concerns include, but are not necessarily limited to:

- the possibility of boulders being encountered during excavation.
- the potential for groundwater levels to be higher at the time of construction than those recorded in this report.
- the impact of the groundwater level on the stability of excavations in the absence of effective groundwater control.

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APPENDIX A

Record of Borehole Sheets

Terraprobe Limited

LIMITATIONS AND RISK

Procedures

The soil conditions were confirmed at the borehole locations only and conditions may vary between and beyond the boreholes. The boundaries between the various strata as shown on the logs are based on non-continuous sampling. These boundaries represent an inferred transition between the various strata, rather than a precise plane of stratigraphic change.

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.

It must be recognized that there are special risks whenever engineering or related disciplines are applied to identify subsurface conditions. Even 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. The conditions that Terraprobe has interpreted to exist between sampling points can differ from those that actually exist.

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 that could affect construction costs, techniques, equipment and scheduling. Contractors bidding on or undertaking work on the project should 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, cognizant of the risks implicit in the subsurface investigation activities.

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. Groundwater levels are particularly susceptible to seasonal fluctuations.

The design advice is 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 designers in the design phase of the project. If there are changes to the project scope and development features, or there is any additional information relevant to the interpretations made of the subsurface information, the geotechnical design parameters and comments relating to constructibility issues and quality control may not be relevant or complete for the revised project. Terraprobe should be retained to review the implications of such changes with respect to the contents of this report

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg. FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 – 12	12 – 25	25 – 50	50 – 100	100 – 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 – 5	5 – 10	10 – 30	30 – 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY IS:

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

JOINTING AND BEDDING:

SPACING	50mm	50 – 300mm	0.3m – 1m	1m – 3m	>3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ε	%	LINEAR STRAIN
$\varepsilon_1, \varepsilon_2, \varepsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
C_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	- °	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	- °	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = c_u / τ_r

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1,%	VOID RATIO	e_{min}	1,%	VOID RATIO IN DENSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1,%	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m^3	DENSITY OF WATER				D	mm	GRAIN DIAMETER
γ_w	kN/m^3	UNIT WEIGHT OF WATER	w	1,%	WATER CONTENT	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	S_r	%	DEGREE OF SATURATION	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_L	%	LIQUID LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_P	%	PLASTIC LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	w_S	%	SHRINKAGE LIMIT	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_P	%	PLASTICITY INDEX = $(w_L - w_P)$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $(w - w_P)/I_P$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	I_C	1	CONSISTENCY INDEX = $(w_L - w)/I_P$	j	kN/m^3	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL	e_{max}	1,%	VOID RATIO IN LOOSEST STATE			

RECORD OF BOREHOLE No T1

1 OF 2

METRIC

W.P. _____ LOCATION Co-ords. 4,845,380.7 N; 278,989.4 E. ORIGINATED BY J.C.

DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY D.B

DATUM Geodetic DATE 08.11.06 CHECKED BY R.A.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS
263.9	Ground Surface					
0.0 / 263.2	FILL - Clayey Silt, trace to some sand, trace gravel, with rootlets, stiff, brown, damp		1	SS	9	
0.7	CLAYEY SILT sandy, trace gravel, hard, brown, damp to moist (GLACIAL TILL)		2	SS	37	
			3	SS	59	
			4	SS	68	
			5	SS	35	
			6	SS	80	
256.9 / 7.0	SAND AND SILT trace clay, trace gravel, very dense, brown, damp to moist (GLACIAL TILL)		7	SS	100/ 8cm	
	grey		8	SS	100/ 13cm	
253.9 / 10.0	CLAYEY SILT sandy, trace to some gravel, hard, grey, damp (GLACIAL TILL)		9	SS	125/ 23cm	
			10	SS	99/ 23cm	
			11	SS	86	

ELEVATION SCALE: 263, 262, 261, 260, 259, 258, 257, 256, 255, 254, 253, 252, 251, 250, 249

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%) 10 20 30

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

ONTARIO MOT 1-06-1346 K SEWERS.GPJ ONTARIO MOT GDT 30/11/06

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No T1 2 OF 2 METRIC

W.P. _____ LOCATION Co-ords. 4,845,380.7 N; 278,989.4 E. ORIGINATED BY J.C.

DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY D.B.

DATUM Geodetic DATE 08.11.06 CHECKED BY R.A.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE; 20 40 60 80 100)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	CLAYEY SILT sandy, trace to some gravel, hard, grey, damp		12	SS	80		248		O		
247.7 / 16.2	(GLACIAL TILL) *(continued)*										
	SILT AND SAND trace clay, trace gravel, very dense, grey, moist (GLACIAL TILL)		13	SS	93/ 23cm		247		O		
246.7 / 17.2	**End of Borehole**										

Piezometer Installation consists of 19mm diameter, schedule 40 PVC pipe with a 4.5m slotted screen.

Water Level Readings:

Date	Depth(m)	Elevation(m)
20/11/06	8.4	255.5

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No T2

1 OF 2

METRIC

W.P. _____ LOCATION Co-ords. 4,845,393.1 N; 279,008.1 E. ORIGINATED BY A.Z

DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY D.B.

DATUM Geodetic DATE 10.11.06 CHECKED BY R.A

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
264.5	Ground Surface										
264.2 / 0.3	250mm TOPSOIL, black										
263.8 / 0.7	FILL - Clayey Silt, trace to some sand, trace gravel, with rootlets, firm to stiff, brown, damp to moist		1	SS	8		264		○		
	CLAYEY SILT sandy, trace gravel, hard, brown, damp (GLACIAL TILL)		2	SS	54		263		○		
			3	SS	78		262		○		
			4	SS	75		261		○		
			5	SS	59		260		○		
	and sand, grey		6	SS	50/ 13cm		259		○		
257.5 / 7.0	SAND AND SILT trace clay, trace gravel, very dense, grey, damp (GLACIAL TILL)		7	SS	130/ 8cm		258		○		
			8	SS	100/ 13cm		257		○		
			9	SS	100/ 13cm		256		○		
253.0 / 11.5	CLAYEY SILT trace to some sand, trace gravel, hard, grey, damp to moist (GLACIAL TILL)		10	SS	80/ 15cm		255		○		No Sample Recovery
			11	SS	110/ 8cm		254		○		
							253				
							252				
							251		○		
							250				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No T2 2 OF 2 METRIC

W.P. _____ LOCATION Co-ords. 4,845,393.1 N; 279,008.1 E. ORIGINATED BY A.Z

DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY D.B.

DATUM Geodetic DATE 10.11.06 CHECKED BY R.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
248.8	CLAYEY SILT trace to some sand, trace gravel, hard, grey, damp to moist (GLACIAL TILL)		12	SS	92		249				
15.7	End of Borehole										
	Piezometer Installation consists of 19mm diameter, schedule 40 PVC pipe with a 3.0m slotted screen.										
	Water Level Readings: Date Depth(m) Elevation(m) 20/11/06 6.7 257.8										

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No T3

1 OF 2

METRIC

W.P. _____ LOCATION Co-ords. 4,845,304.8 N; 279,055.5 E. ORIGINATED BY J.C.

DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY D.B.

DATUM Geodetic DATE 08.11.06 CHECKED BY R.A.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
265.4	Ground Surface										
265.0	150mm TOPSOIL, black										
0.2	FILL - Clayey Sill, trace to some sand, trace gravel, with rootlets, stiff, brown, damp		1	SS	9		265				
264.7											
0.7	CLAYEY SILT some sand, trace gravel, very sliff to hard, brown, damp to moist (GLACIAL TILL)		2	SS	43		264				
			3	SS	63		263				
			4	SS	75		262				
			5	SS	54		261				
	---- grey		6	SS	26		260				
			7	SS	83	▼	259				
256.8							258				
8.6	SAND AND SILT trace clay, trace gravel, very dense, brown, damp to moist (GLACIAL TILL)		8	SS	50/ 8cm		257				
			9	SS	100/ 15cm		256				
			10	SS	150/ 13cm		255				
			11	SS	150/ 10cm		254				
250.9							253				
14.5							252				
							251				

Continued Next Page

$+^3, \times^3$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No T3 2 OF 2 METRIC

W.P. _____ LOCATION Co-ords 4,845,304.8 N; 279,055.5 E ORIGINATED BY J.C

DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY D.B

DATUM Geodetic DATE 08.11.06 CHECKED BY R.A.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	CLAYEY SILT sandy, trace gravel, hard, grey, damp to moist		12	SS	140/ 13cm		250		○		
249.3	(GLACIAL TILL) *(continued)*										
16.1	SILT trace clay, very dense, grey, damp						249				
248.3			13	SS	100/ 15cm				○		
17.1	End of Borehole										

Piezometer Installation consists of 19mm diameter, schedule 40 PVC pipe with a 4.5m slotted screen.

Water Level Readings:

Date	Depth(m)	Elevation(m)
20/11/06	7.7	257.7

+ ³, × ³: Numbers refer to Sensitivity ○ ³% STRAIN AT FAILURE

RECORD OF BOREHOLE No T4

1 OF 2

METRIC

W.P. _____ LOCATION Co-ords. 4,845,316.0 N; 279,083.7 E ORIGINATED BY A.Z

DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY D.B

DATUM Geodetic DATE 10.11.06 CHECKED BY R.A.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
266.4	Ground Surface										
266.0	200mm TOPSOIL, black										
0.2	FILL - Clayey Silt, trace sand, trace gravel, trace organics, stiff, brown, moist		1	SS	13		266		○		
265.3			2	SS	46		265		○		
1.1	CLAYEY SILT some sand, trace gravel, hard, brown, damp to moist (GLACIAL TILL)		3	SS	95		264		○		
			4	SS	92/ 28cm		263		○		
			5	SS	62/ 15cm		262				No Sample Recovery
	grey		6	SS	87		261		○		
			7	SS	64		260		○		
			8	SS	50/ 15cm		259				
256.3							258		○		
10.1	SAND AND SILT trace clay, trace gravel, very dense, grey, damp (GLACIAL TILL)		9	SS	150/ 8cm	▼	257		○		
			10	SS	110/ 10cm		256		○		
253.4							255		○		
13.0	CLAYEY SILT sandy, trace gravel, hard, grey, damp to moist (GLACIAL TILL)		11	SS	110/ 13cm		254		○		
							253		○		
							252				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No T4 2 OF 2 METRIC

W.P. _____ LOCATION Co-ords. 4,845,316.0 N; 279,083.7 E ORIGINATED BY A.Z

DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY D.B.

DATUM Geodetic DATE 10.11.06 CHECKED BY R.A.

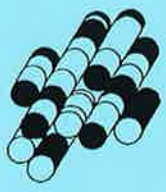
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	CLAYEY SILT sandy, trace gravel, hard, grey, damp to moist (GLACIAL TILL) *(continued)*		12	SS	100/15cm		251		○		
							250		○		
249.4			13	SS	60/5cm						
17.0	End of Borehole Piezometer Installation consists of 19mm diameter, schedule 40 PVC pipe with a 3.0m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) 20/11/06 10.5 255.9										

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

APPENDIX B

Record of Borehole Sheets (Previous Investigations)

Terraprobe Limited



RECORD OF BOREHOLE No K2

1 OF 1

METRIC

W.P. _____ LOCATION Co-ords. 4,845,371.3 N; 279,022.3 E. ORIGINATED BY A.S.

DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY J.B.

DATUM Geodetic DATE 11.11.02 CHECKED BY J.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
265.4	Ground Surface										
0.0 / 264.9	**Fill** - Sand, some gravel, damp, compact, brown		1	SS	10		265				
0.6 / 264.7	**FILL** - Clayey Silt, some sand, trace gravel, moist, stiff, brown										
0.7	**CLAYEY SILT** sandy, trace gravel, damp to moist, very stiff to hard, brown (GLACIAL TILL)		2	SS	25		264				
			3	SS	34		263				
			4	SS	47						
			5	SS	41		262				
			6	SS	54		261				
	stiff, grey						260				
			7	SS	11		259				0 31 57 12
	hard						258				
257.4 / 8.0			8	SS	100/ 23cm						
	SAND AND SILT trace clay, trace gravel, damp, very dense, brown (GLACIAL TILL)		9	SS	100/ 13cm		257				
	grey						256				3 62 (35)
			10	SS	100/ 8cm		255				8 44 40 8
253.2 / 12.2	End of Borehole		11	SS	100/ 14cm		254				

Piezometer installation consists of 19mm diameter, schedule 40 PVC pipe with a 3.0m slotted screen.

Water Level Readings:

Date	Height(m)	Elevation(m)
Nov.25.02	9.6	255.8

$+^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No K2A

1 OF 2

METRIC

W.P. _____ LOCATION Co-ords. 4,845,371.3 N; 279,022.3 E. ORIGINATED BY H.A.

DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY D.B.

DATUM Geodetic DATE 27.10.05 CHECKED BY R.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
265.3 0.0	Augered to 12.1m, refer to BH K2 for inferred soil stratigraphy						265				
							264				
							263				
							262				
							261				
							260				
							259				
							258				
							257				
							256				
							255				
							254				
253.2 12.1	**SAND AND SILT** trace clay, trace gravel, damp, very dense, grey (GLACIAL TILL)		1	SS	194	▽	253		○		** Sampler Wet
252.1 13.2	**CLAYEY SILT** trace sand, trace to some gravel, damp, hard, grey (GLACIAL TILL)		2	SS	63		252		○		
							251				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No K2A

2 OF 2 **METRIC**

W.P. _____ LOCATION Co-ords. 4,845,371.3 N; 279,022.3 E. ORIGINATED BY H.A.

DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY D.B.

DATUM Geodelic DATE 27.10.05 CHECKED BY R.A.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	CLAYEY SILT trace sand, trace to some gravel, damp, hard, grey (GLACIAL TILL) *(continued)*		3	SS	53		250				
248.9 16.4	**SILT AND SAND** trace to some gravel, trace clay, damp to moist, very dense, grey (GLACIAL TILL)		4	SS	71		249				
			5	SS	54		248				
			6	SS	100/ 10cm		247				
			7	SS	170		246				
243.2 22.1	**SILT** trace clay, trace sand, moist to wet, very dense, grey		8	SS	73		245				
			9	SS	100/ 15cm		244				
			10	SS	70		243				
238.9 26.4	End of Borehole						242				
	* Water level at 12.2m (unstabilized) and hole open to 13.1m upon completion of drilling.						241				
							240				
							239				

$+^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MOT 1-06-1346 K SEWERS.GPJ ONTARIO MOT.GDT 30/11/06

RECORD OF BOREHOLE No K3

1 OF 1 **METRIC**

W.P. _____ LOCATION Co-ords. 4,845,349.7 N; 279,029.2 E. ORIGINATED BY A.S.

DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY J.B.

DATUM Geodetic DATE 11.12.02 CHECKED BY J.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
265.7	Ground Surface										
0.0 / 265.2	**FILL** - Sand and Gravel, damp, loose, brown		1	SS	8		265				34 57 7 2
265.0 / 0.7	**FILL** - Clayey Silt, some sand, trace gravel, moist, firm, brown		2	SS	14						
	CLAYEY SILT trace sand to sandy, trace gravel, damp to moist, stiff to 1.4m, very stiff to hard below, brown (GLACIAL TILL)		3	SS	24		264				
			4	SS	33		263				4 32 46 18
			5	SS	49		262				
			6	SS	72		261				
	grey						260				
			7	SS	23		259				1 5 75 19
			8	SS	86		258				
257.2 / 8.5	**SAND AND SILT** trace gravel, damp, very dense, grey (GLACIAL TILL)		9	SS	100/ 8cm		257				
			10	SS	100/ 13cm	▽	256				
							255				7 45 (48)
253.5 / 12.2	End of Borehole * Wet cave at 11.7m upon completion of drilling.		11	SS	100/ 14cm		254				

$+^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MOT 1-06-1346 K SEWERS.GPJ ONTARIO MOT.GDT 30/11/06

RECORD OF BOREHOLE No K3A

1 OF 2

METRIC

W.P. _____ LOCATION Co-ords. 4,845,349.6 N; 279,029.2 E ORIGINATED BY M.K

DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY D.B.

DATUM Geodetic DATE 27.10.05 CHECKED BY R.A.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
265.2											
0.0	Augered to 12.1m, refer to BH K3 for inferred soil stratigraphy.						265				
							264				
							263				
							262				
							261				
							260				
							259				
							258				
							257				
							256				
	Increased resistance to augering at 9.7m (Elev. 255.5m), inferred cobbles.						255				
							254				
253.1											
12.1	**SAND AND SILT** trace gravel, trace clay, damp, very dense, grey		1	SS	100/ 13CM		253		o		
252.2	(GLACIAL TILL)										
13.0	**CLAYEY SILT** trace to some sand, trace gravel, damp, hard, grey					▽	252				
	(GLACIAL TILL)		2	SS	61				o		** Sampler Wet
250.5							251				
14.7											

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No K3A 2 OF 2 METRIC

W.P. _____ LOCATION Co-ords. 4,845,349.6 N; 279,029.2 E. ORIGINATED BY M.K

DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY D.B.

DATUM Geodetic DATE 27.10.05 CHECKED BY R.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	SILT AND SAND trace gravel, trace clay, damp, very dense, grey *(continued)*		3	SS	59		250		○		6 35 50 9
	becoming sandy and gravelly		4	SS	134		249 248		○		21 52 23 4
246.4			5	SS	66		247		○		
18.8	End of Borehole										

* Water level at 13.4m (unstabilized) and hole open to 16.7m upon completion of drilling.

+ ^{3}, × ^{3}: Numbers refer to Sensitivity ○ $^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No K4

1 OF 1

METRIC

W.P. _____ LOCATION Co-ords. 4,845,354.9 N; 279,038.2 E. ORIGINATED BY A.S.

DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY J.B.

DATUM Geodetic DATE 11.12.02 CHECKED BY J.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
265.8	Ground Surface										
0.0 / 265.1	**FILL** - Sand and Gravel, damp, dense, brown		1	SS	37				○		
0.7	**CLAYEY SILT** sandy, trace gravel, damp to moist, stiff to 1.4m, very stiff to hard below, brown (GLACIAL TILL)		2	SS	10		265		○		
			3	SS	30		264		○		
			4	SS	35		263		○ ⊢		9 29 42 20
			5	SS	59				○		
			6	SS	50		262		○		
	grey		7	SS	21		261		○		
			8	SS	64		260		○		
257.3 / 8.5	**SAND AND SILT** trace clay, trace gravel, dry to damp, very dense, grey (GLACIAL TILL)		9	SS	100/ 8cm		259		○		
			10	SS	100/ 13cm		258		○		
							257		○		
							256		○		
							255		○		
253.6 / 12.2	End of Borehole * Borehole dry (unstabilized) and hole open to full depth upon completion of drilling.		11	SS	100/ 13cm		254		○		8 41 42 9

+ ³, × ³: Numbers refer to Sensitivity ○ ³% STRAIN AT FAILURE

ONTARIO MOT 1-06-1346 K SEWERS.GPJ ONTARIO MOT.GDT 30/11/06

RECORD OF BOREHOLE No K4A 1 OF 2 METRIC

W.P. _____ LOCATION Co-ords. 4,845,354.9 N; 279,038.2 E. ORIGINATED BY M.K.

DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY D.B.

DATUM Geodetic DATE 27.10.05 CHECKED BY R.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
265.8 0.0	Augering to 12.1m, refer to BH K4 for inferred soil straligraphy.						265				
							264				
							263				
							262				
							261				
							260				
							259				
							258				
							257				
							256				
							255				
							254				
253.7 12.1	**SAND AND SILT** trace clay, trace gravel, damp, very dense, grey (GLACIAL TILL)		1	SS	155		253		○		** Sampler Wet
			2	SS	162		252		○		
251.2 14.6							251				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No K4A 2 OF 2 METRIC

W.P. _____ LOCATION Co-ords. 4,845,354.9 N; 279,038.2 E. ORIGINATED BY M.K.

DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY D.B.

DATUM Geodetic DATE 27.10.05 CHECKED BY R.A.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	CLAYEY SILT some sand, trace gravel, damp to moist, hard, grey (GLACIAL TILL) *(continued)*		3	SS	72		250		○		
248.9											
16.9	**SILT AND SAND** trace to some gravel, damp, very dense, grey (GLACIAL TILL)		4	SS	100/ 80MM	▽	249		○ ○		
							248				
247.0			5	SS	91				○		
18.8	End of Borehole * Water level at 17.2m (unstabilized) and hole open to 18.1m upon completion of drilling										

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MOT 1-06-1346 K SEWERS.GPJ ONTARIO MOT GDT 30/11/06

RECORD OF BOREHOLE No K5

1 OF 1

METRIC

W.P. _____ LOCATION Co-ords. 4,845,333.1 N; 279,045.1 E. ORIGINATED BY A.S.

DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY J.B.

DATUM Geodetic DATE 11.11.02 CHECKED BY J.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
266.0	Ground Surface										
0.0 / 265.6	FILL - Sand and Gravel, damp, compact, brown		1	SS	11						
0.4 / 265.3	FILL - Clayey Silt, some sand, trace gravel, occasional topsoil inclusions, damp to moist, stiff, brown										
0.7	**CLAYEY SILT** sandy, trace gravel, damp, very stiff to hard, brown (GLACIAL TILL)		2	SS	17		265				
			3	SS	34		264				
			4	SS	35						
			5	SS	45		263				5 30 46 19
			6	SS	47		262				
	grey		7	SS	26		261				
			8	SS	55		260				
257.5 / 8.5	**SAND AND SILT** trace gravel, trace clay, dry to damp, very dense, grey (GLACIAL TILL)		9	SS	100/ 8cm		259				
			10	SS	100/ 5cm		258				
							257				5 47 40 8
							256				
							255				
253.8 / 12.2	End of Borehole		11	SS	100/ 10cm		254				

Piezometer Installation consists of 19mm diameter, schedule 40 PVC pipe with a 3.0m slotted screen.

Water Level Readings:

Date	Height(m)	Elevation(m)
Nov.25.02	11.2	254.8

+ ^{3}, × ^{3}: Numbers refer to Sensitivity ○ $^{3\%}$ STRAIN AT FAILURE

ONTARIO MOT 1-06-1346 K SEWERS.GPJ ONTARIO MOT.GDT 30/11/06

RECORD OF BOREHOLE No K5A 1 OF 2 METRIC

W.P. _____ LOCATION Co-ords. 4,845,333.065 N; 279,045.1 E. ORIGINATED BY H.A.

DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY D.B.

DATUM Geodetic DATE 27.10.05 CHECKED BY R.A.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
266.0 / 0.0	Augering to 12.1m, refer to BH K5 for inferred soil straligraphy.						265, 264, 263, 262, 261, 260, 259, 258, 257, 256, 255, 254, 253, 252				
253.9 / 12.1	**SAND AND SILT** trace clay, trace gravel, damp, very dense, grey (GLACIAL TILL)		1	SS	100/ 15cm	▽			○		** Sampler Wet
			2	SS	100/ 15cm				○		
251.5 / 14.5											

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity ○ $^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No K5A 2 OF 2 METRIC

W.P. _____ LOCATION Co-ords. 4,845,333.065 N; 279,045.1 E. ORIGINATED BY H.A.

DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY D.B.

DATUM Geodetic DATE 27.10.05 CHECKED BY R.A.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE; 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	CLAYEY SILT sandy, trace gravel, damp to moist, hard, grey (GLACIAL TILL) *(continued)*		3	SS	115		250		○		10 25 52 13
			4	SS	85		249		○		
			5	SS	41		248		○		
							247				
246.0			6	SS	100/ 15cm		246		○		
20.0	**SILT AND SAND** trace clay, trace gravel, damp to moist, very dense, grey (GLACIAL TILL)		7	SS	100/ 15cm		245		○		6 41 45 8
243.8							244				
22.2	**SILT** trace clay, trace sand, moist to wet, very dense, grey		8	SS	74		243		○		
							242				
			9	SS	100/ 15cm		241		○		0 1 91 8
			10	SS	156		240		○		
							239				
238.3			11	SS	100/ 15cm				○		
27.7	End of Borehole										

* Water level at 10.0m (unstabilized) and hole open to 14.9m upon completion of drilling.

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

APPENDIX C

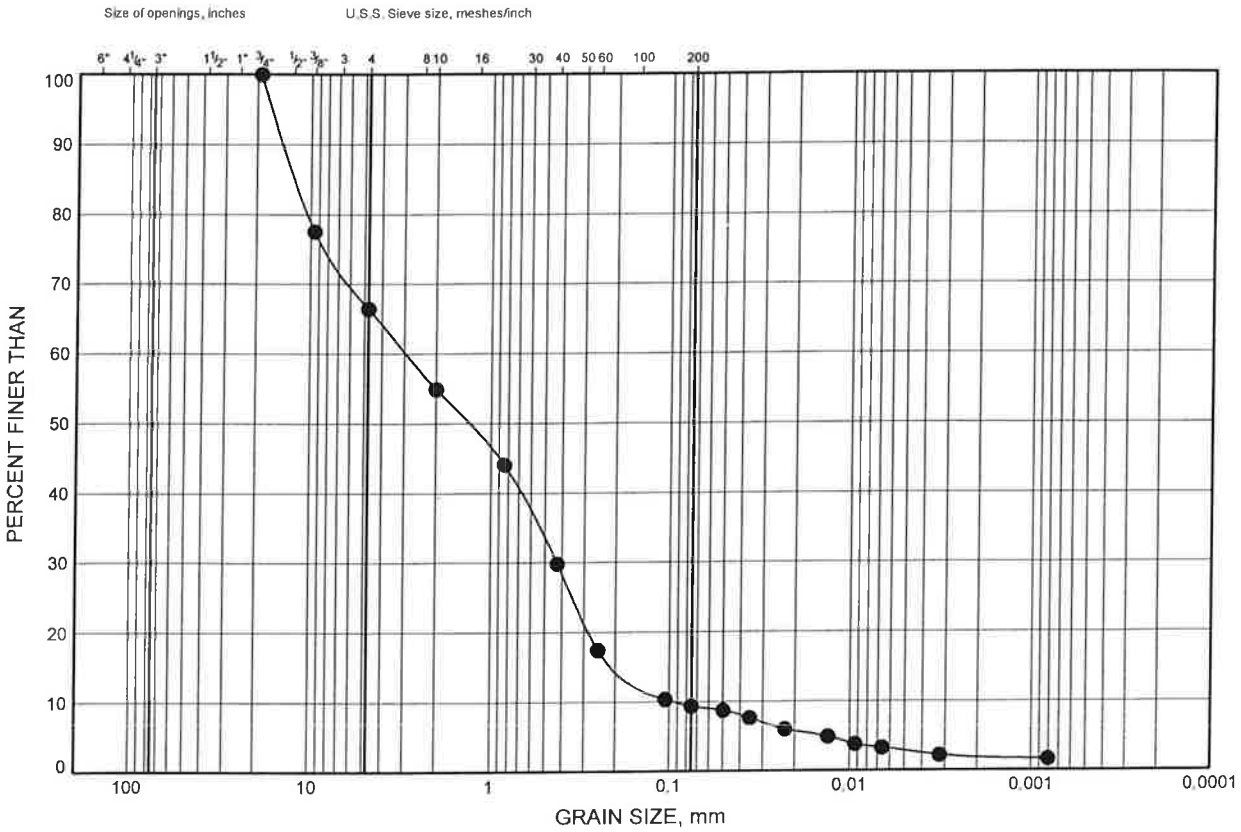
Laboratory Test Results (Previous Investigations)

Terraprobe Limited

GRAIN SIZE DISTRIBUTION

FIGURE C1

Sand and Gravel (Fill)



COBBLE SIZE	GRAVEL		SAND			SILT and CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	K3	0.3	265.4

Date November 2006

Project 1-06-1346 (K)

Prep'd DB

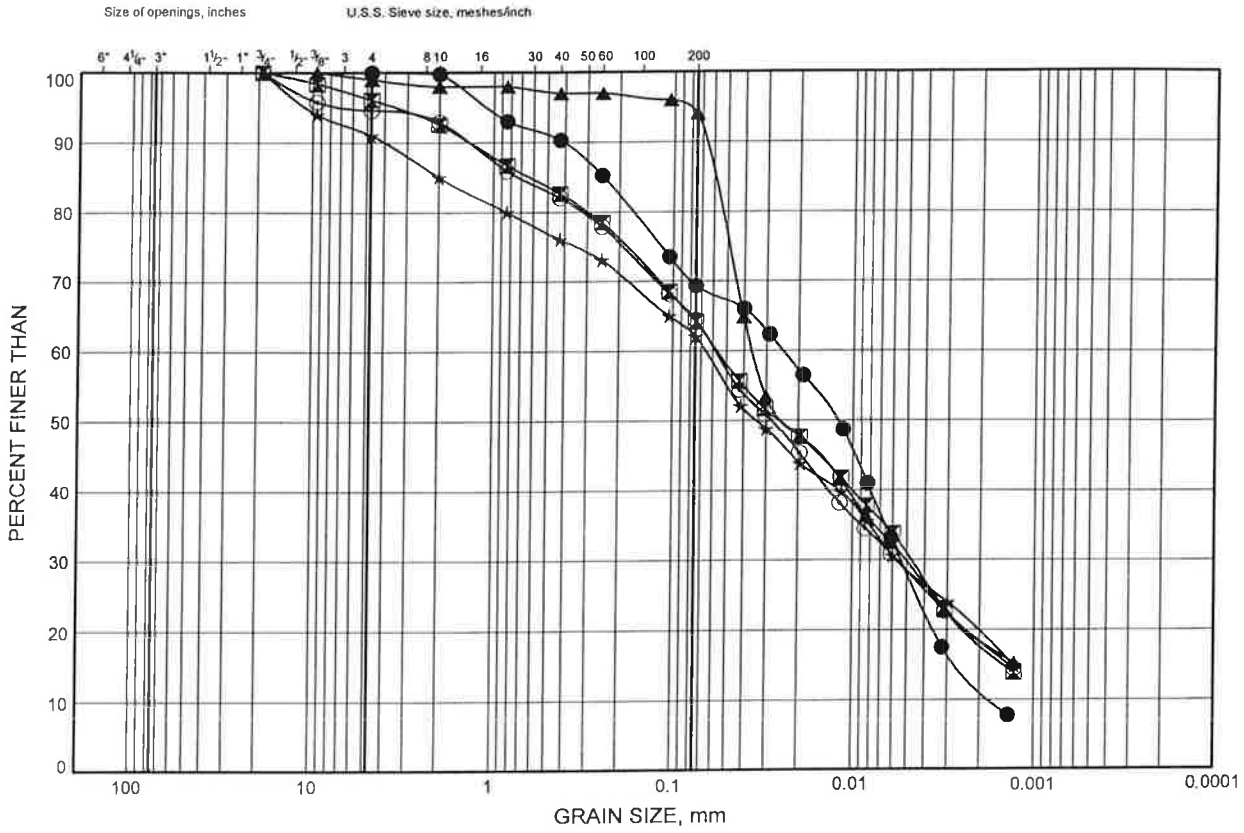
Chkd. RA

GSD 1-06-1346 K SEWERS.GPJ 30/11/06

GRAIN SIZE DISTRIBUTION

FIGURE C2

Upper Clayey Silt Till



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	K2	6.3	259.1
⊠	K3	2.5	263.2
▲	K3	6.3	259.4
★	K4	2.5	263.3
⊙	K5	3.2	262.8

Date November 2006

Project 1-06-1346 (K)

Prep'd DB

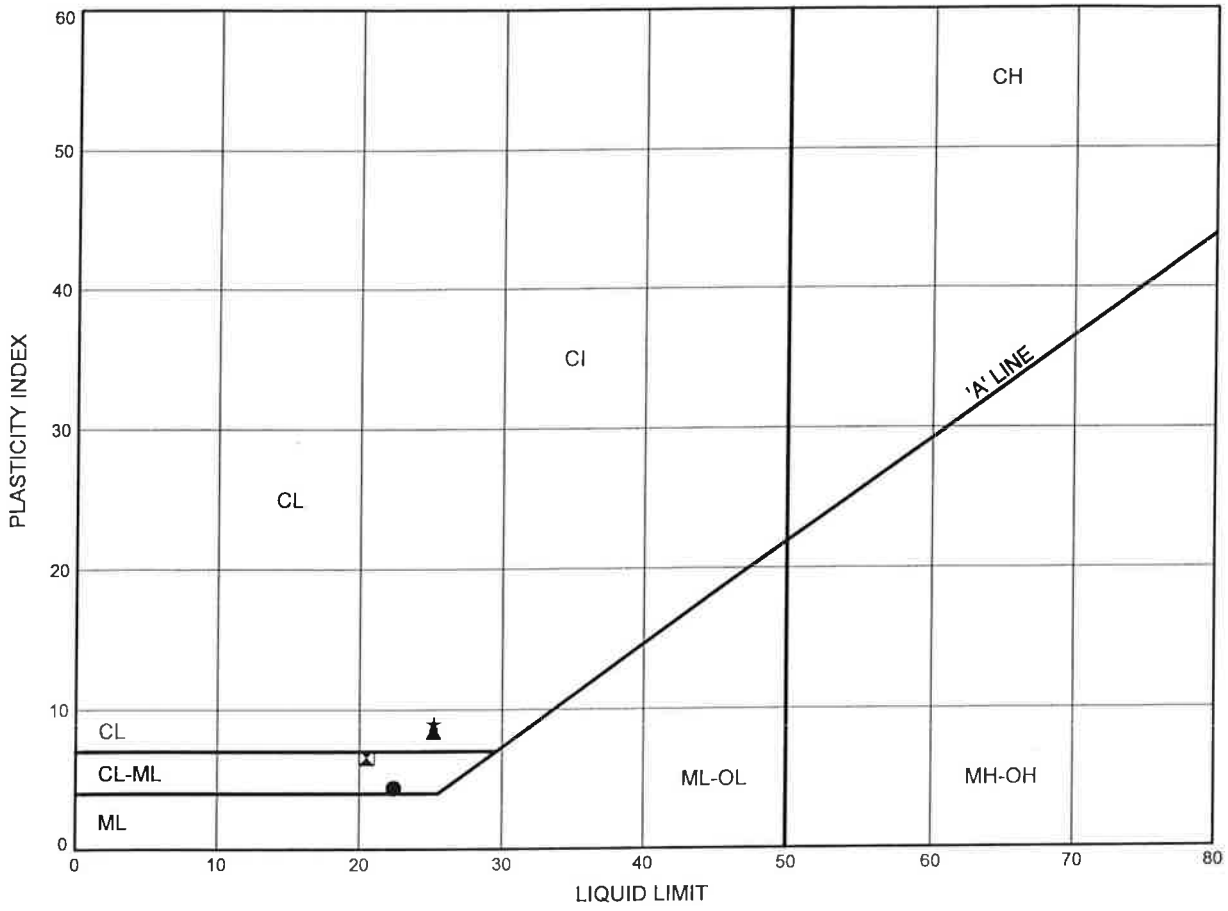
Chkd. RA

GSD 1-06-1346 K SEWERS.GPJ 30/11/06

ATTERBERG LIMITS TEST RESULTS

FIGURE C3

Upper Clayey Silt Till



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	K2	6.3	259.1
⊠	K3	6.3	259.4
▲	K4	2.5	263.3
★	K5	3.2	262.8

Date November 2006

Project 1-06-1346 (K)

Prep'd DB

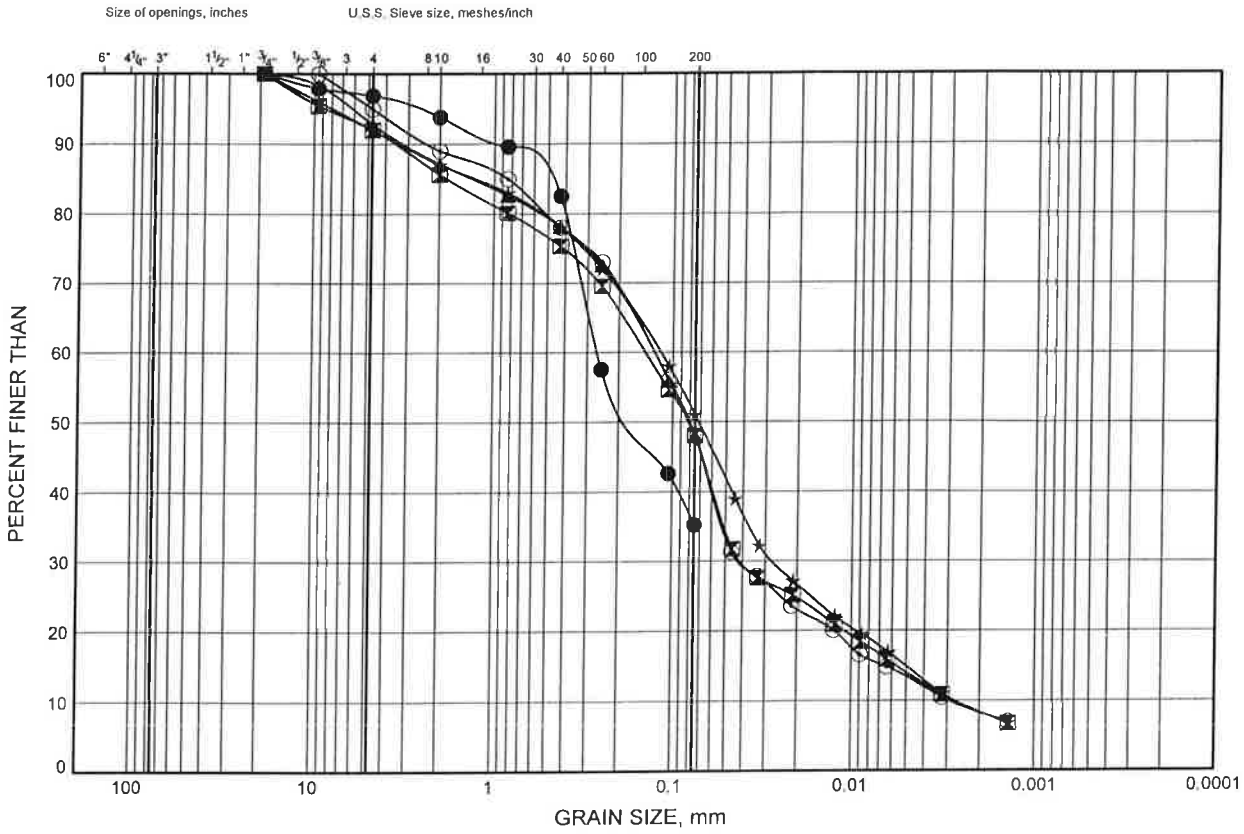
Chkd. RA

ALTR 1-06-1346 K SEWERS.GPJ 30/11/06

GRAIN SIZE DISTRIBUTION

FIGURE C4

Sand and Silt Till



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	K2	9.2	256.2
⊠	K2	10.7	254.7
▲	K3	10.8	254.9
★	K4	12.1	253.7
⊙	K5	9.1	256.9

Date November 2006

Project 1-06-1346 (K)

Prep'd DB

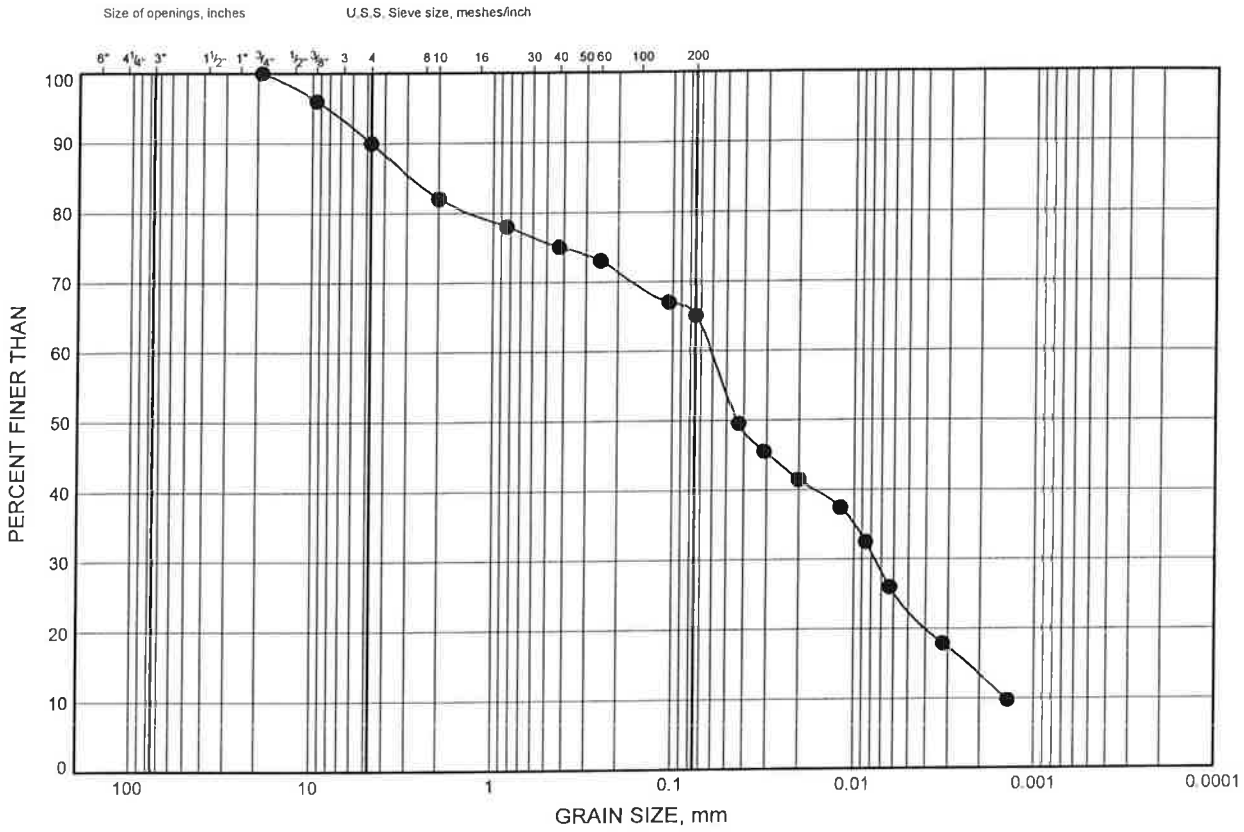
Chkd. RA

GSD 1-06-1346 K SEWERS.GPJ 30/11/06

GRAIN SIZE DISTRIBUTION

FIGURE C5

Lower Clayey Silt Till



COBBLE SIZE	GRAVEL		SAND			FINE GRAINED
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	K5A	15.4	250.6

Date November 2006

Project 1-06-1346 (K)

Prep'd DB

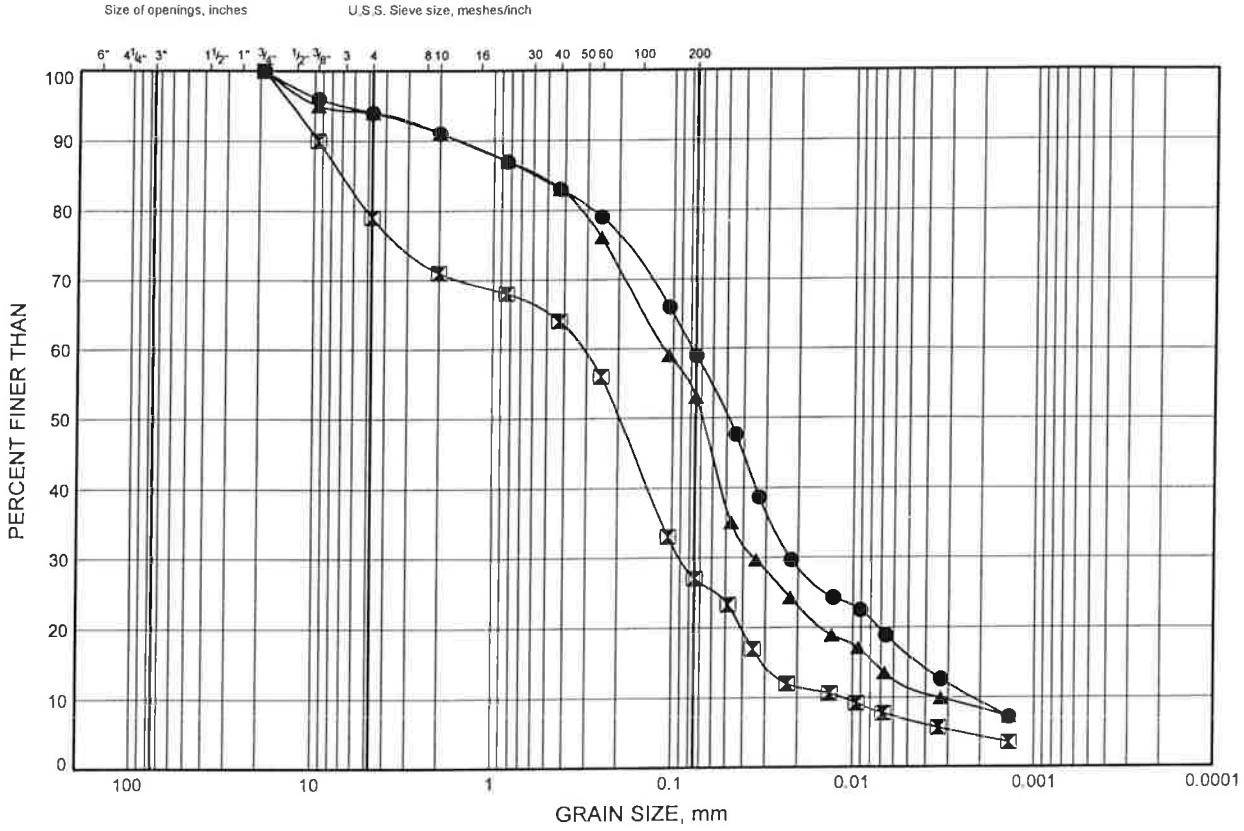
Chkd. RA

GSD 1-06-1346 K SEWERS.GPJ 30/11/06

GRAIN SIZE DISTRIBUTION

FIGURE C6

Silt and Sand Till



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	K3A	15.4	249.8
⊠	K3A	17.0	248.2
▲	K5A	21.5	244.5

Date November 2006

Project 1-06-1346 (K)

Prep'd DB

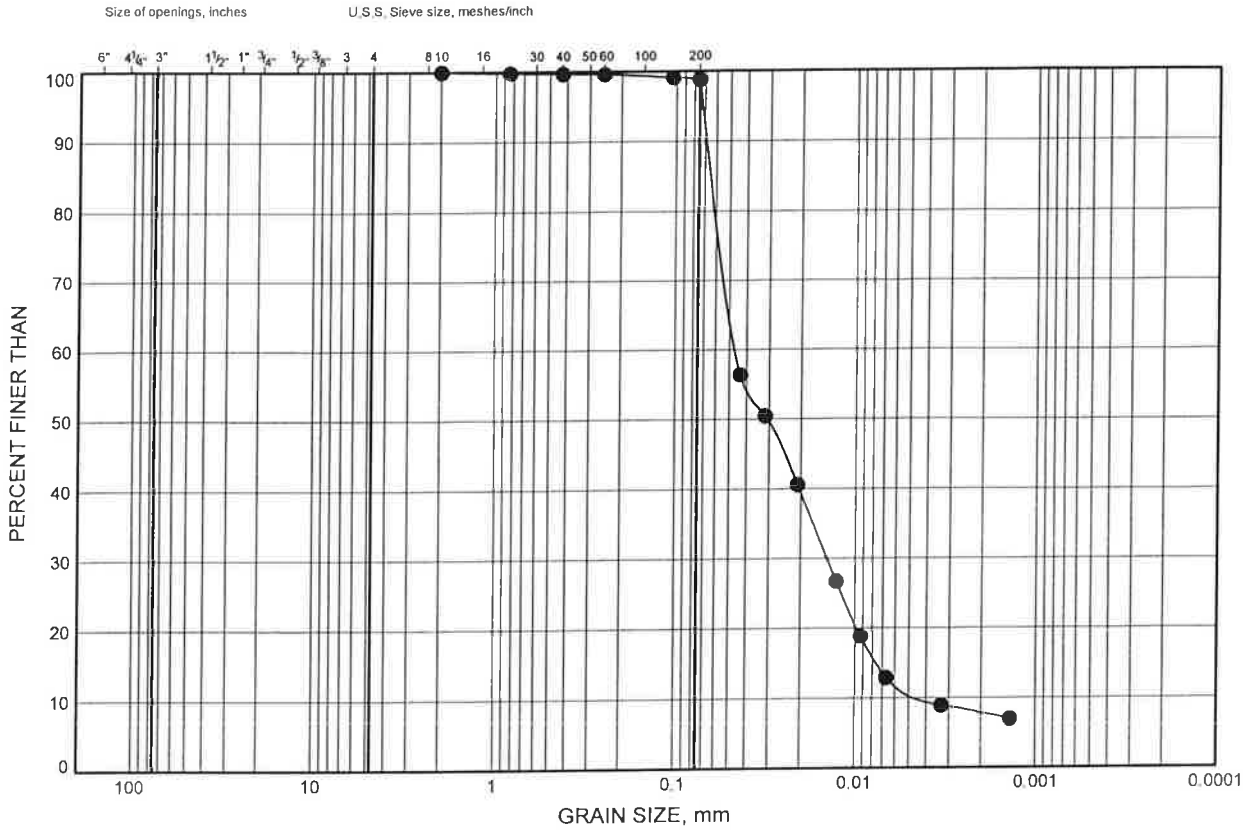
Chkd. RA

GSD 1-06-1346 K SEWERS.GPJ 30/11/06

GRAIN SIZE DISTRIBUTION

FIGURE C7

Silt



COBBLE SIZE	GRAVEL		SAND			FINE GRAINED
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	K5A	24.6	241.4

Date November 2006

Project 1-06-1346 (K)

Prep'd DB

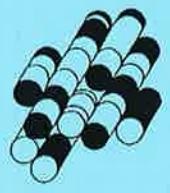
Chkd. RA

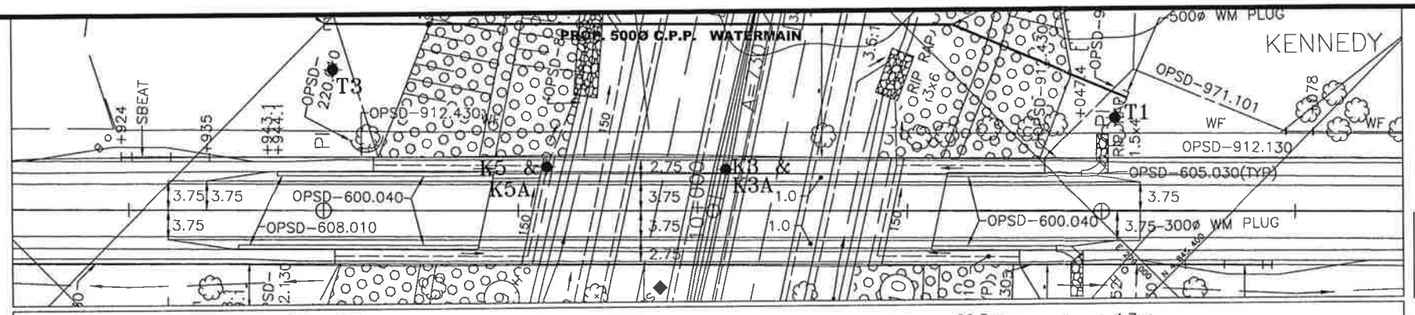
GSD 1-06-1346 K SEWERS.GPJ 30/11/06

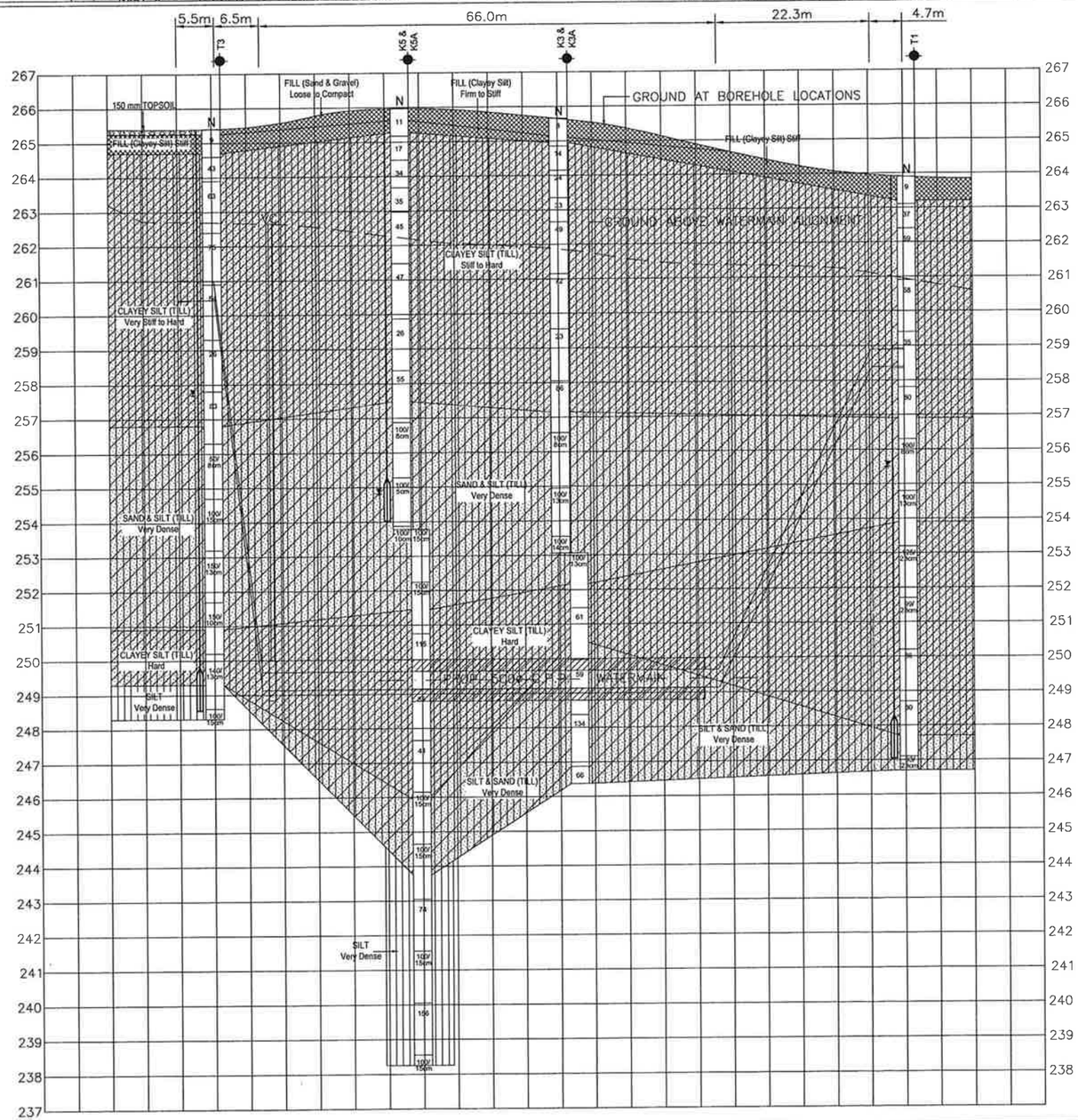
APPENDIX D

Drawing titled
"Borehole Locations and Soil Strata"

Terraprobe Limited







Plan

20m 10m 0 10m 20m

Profile ℄ Watermain

20m 10m 0 10m 20m HORIZ

4m 2m 0 2m 4m VERT

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETERS UNLESS OTHERWISE SHOWN

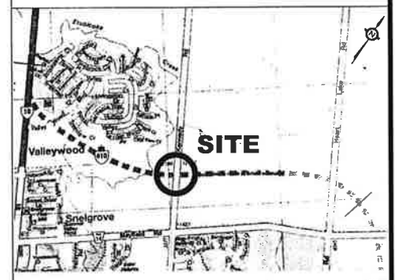
CONT No
WP No 105-00-01

SHEET

HIGHWAY 410-PHASE III
KENNEDY ROAD WATERMAINS & SEWER
BOREHOLE LOCATIONS AND SOIL STRATA

Giffels
An Ingenium Group Company

Terraprobe
Consulting Geotechnical & Environmental Engineering
Construction Materials Engineering, Inspection & Testing



KEY PLAN

LEGEND

●	Bore Hole
⊕	Dynamic Cone Penetration Test (Cone)
⊕	Bore Hole & Cone
'N'	Blows/0.3m (Std Pen Test, 475 J/blow)
CONE	Blows/0.3m (60° Cone, 475 J/blow)
▼	WL at Time of Investigation
▼	WL in Piezometer 2006, 11 & 2002, 11
	Piezometer
90%	Rock Quality Designation
A/R	Auger Refusal

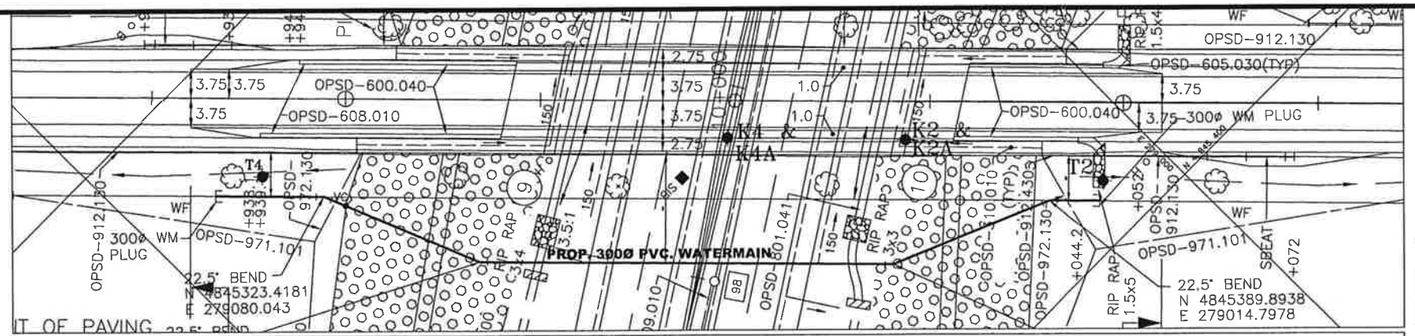
No	ELEVATION	COORDINATES	
		NORTHING	EASTING
T1	263.9	4845380.7	278989.3
K3	265.7	4845349.7	279029.2
K3A	265.2	4845349.6	279029.2
K5	266	4845333.1	279045.1
K5A	266	4845333.1	279045.1
T3	265.4	4845304.7	279055.5

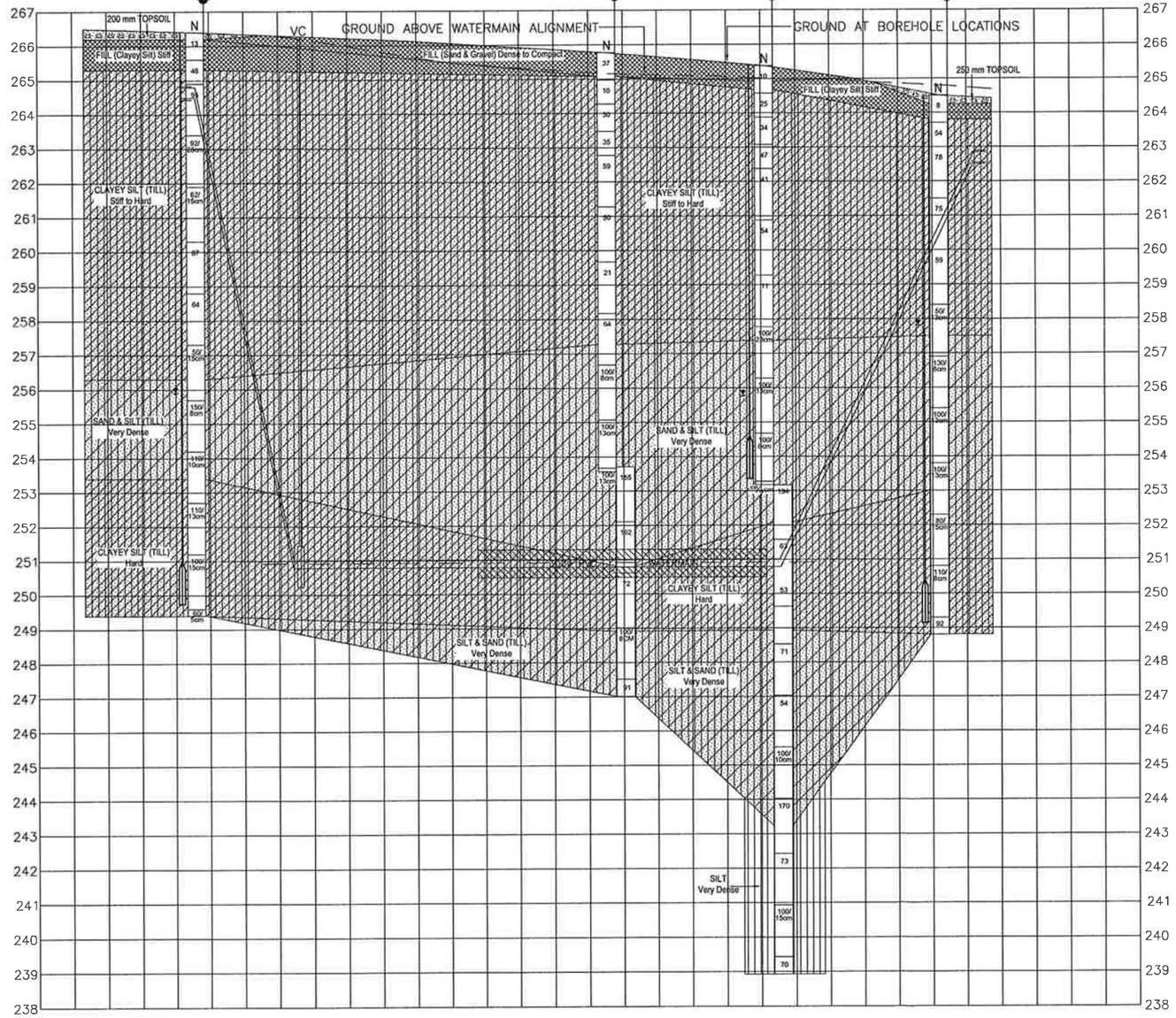
NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore holes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

DESIGN	R.A	CODE	–	LOAD	DATE NOV.2006
DRAWN	JDM	CHK	R.A	SITE:	STRUCT DWG 1





Plan

20m 10m 0 10m 20m

Profile ℄ Watermain

20m 10m 0 10m 20m HORIZ

4m 2m 0 2m 4m VERT

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETERS UNLESS OTHERWISE SHOWN

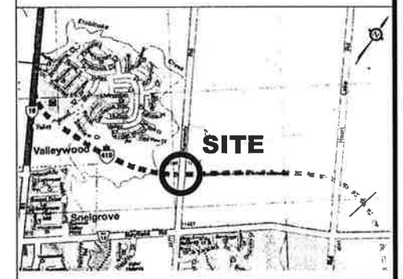
CONT No
WP No 105-00-01

SHEET

HIGHWAY 410-PHASE III
KENNEDY ROAD WATERMAINS & SEWER
BOREHOLE LOCATIONS
AND SOIL STRATA

Giffels
An Ingenium Group Company

Terraprobe
Consulting Geotechnical & Environmental Engineering
Construction Materials Engineering, Inspection & Testing



KEY PLAN

LEGEND

	Bore Hole
	Dynamic Cone Penetration Test (Cone)
	Bore Hole & Cone
'N'	Blows/0.3m (Std Pen Test, 475 J/blow)
CONE	Blows/0.3m (60° Cone, 475 J/blow)
	WL at Time of Investigation
	WL in Piezometer 2006, 11 & 2002, 11
	Piezometer
90%	Rock Quality Designation
A/R	Auger Refusal

No	ELEVATION	COORDINATES	
		NORTHING	EASTING
T2	264.5	4845393.1	279008.1
K2	265.4	4845371.3	279022.3
K2A	265.3	4845371.3	279022.3
K4	265.8	4845354.9	279038.2
K4A	265.8	4845354.9	279038.2
T4	266.4	4845316.0	279083.7

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore holes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

DESIGN R.A	CODE	-	LOAD	DATE	NOV.2006
DRAWN JDM	CHK R.A	SITE:		STRUCT	DWG 2

APPENDIX E

Suggested NSSP Wording

TERRAPROBE LIMITED

In this report reference is made to the following Provincial Standard

- OPSS 514, November 2005.

The contract documents should contain a NSSP containing the following wording:

Cobbles and Boulders

"The Contractor is informed that the soils at this site may contain cobbles and boulders that may impede the progress of trenching. The soil conditions are described in the Foundation Investigation Report prepared for this site. Reference should be made to this report for a description of the soil conditions"

Groundwater & Dewatering

"The Contractor is informed that excavations along the watermains and sewer alignments will encounter groundwater at some sections of the alignments. Reference should be made to the Foundation Investigation Report for a description of the encountered conditions. The Contractor must satisfy himself regarding the groundwater levels likely to prevail at the time of construction and be prepared to implement appropriate dewatering procedures".