APPENDIX H

Carp River Floodplain Draft Geotechnical Report
September 2009

September 2009

DRAFT
GEOTECHNICAL REPORT

FLOOD PLAIN COMPENSATION AREA
RICHCRAFT PROPERTY
TERRY FOX DRIVE EXTENSION PROJECT
KANATA, ONTARIO

Submitted to:

Dillon Consulting Ltd.
5335 Canotek Road, Unit 200
Ottawa, Ontario
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Report Number: 09-1121-0027 (4000)

3 copies – Dillon Consulting Ltd.
2 copies – Golder Associates Ltd.

REPORT

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Golder Associates

September 25, 2009

Gary Holowach, P.Eng
Dillon Consulting
5335 Canotek Road, Suite 200
Ottawa, Ontario
K1J 9L4

FLOOD PLAIN COMPENSATION AREA
RICHCRAFT PROPERTY
TERRY FOX DRIVE EXTENSION PROJECT
KANATA, ONTARIO

Dear Mr. Holowach:

Please find attached our draft report on the geotechnical investigation for the proposed Carp River Flood Plain Compensation Area associated with the Terry Fox Drive Extension in Ottawa, Ontario. Please review the attached draft report and provide us with your comments at your convenience. To avoid confusion between this report and the final version, we ask that no copies be made other than those which can be tracked and either destroyed or returned to Golder Associates prior to issuance of the final report.

We trust that this report is sufficient for your present requirements. If you have any questions concerning this report, or if we can be of further service to you on this project, please call us.

Yours truly,

GOLDER ASSOCIATES LTD.

Bruce Goddard, P.E.

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Principal

BDG/TJN/cg
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1.0 INTRODUCTION

Golder Associates has been retained by Dillon Consulting Ltd. on behalf of the City of Ottawa to provide geotechnical engineering services for the proposed Terry Fox Drive expansion. Associated with the roadway construction is the compensation for flood plain area lost by the construction of the roadway through the Carp River Flood Plain. This compensation generally consists of cutting into the existing hillside and creating additional flood plain. The scope of work for this assignment was detailed in our proposal letter dated February 11, 2009.

This report presents the results of a geotechnical investigation carried out within the proposed limits of the compensation area west of the proposed extension of Terry Fox Drive from about Station 13+450 to about Station 13+800. The purpose of the geotechnical investigation was to assess the general soil and groundwater conditions within the proposed compensation area by means of a limited number of boreholes and, based on an interpretation of the factual information obtained, to provide engineering guidelines on the geotechnical design aspects of the project, including slope stability and construction considerations which could influence design decisions.

This investigation is supplemental to our 2001 investigation titled “Geotechnical Investigation, Phase II – Preliminary Design, Proposed Terry Fox Drive Extension, Richardson Side Road to March Road, Ottawa, Ontario” dated November 2003 and our 2009 investigation titled “Geotechnical Investigation, Terry Fox Drive Extension Station 12+090 (South of Richardson Side Road) to Station 17+518 (West of March Road), Kanata, Ontario” dated July 2009.

This report exclusively covers the compensation area within the Richcraft properties west of the proposed Terry Fox Drive roadway alignment. This report includes the slope stability assessment and guidelines for slope construction and associated drainage. Separate geotechnical investigations are currently in progress for the roadway and stormwater management facilities within the contract limits of Terry Fox Drive Extension. These separate investigations will be addressed in separate reports.

2.0 DESCRIPTION OF PROJECT AND SITE

Plans are being prepared to extend Terry Fox Drive from Kanata Avenue to March Road. Associated with this construction is the compensation of flood plain that will be lost by the roadway embankment construction within the Carp River Flood Plain. To compensate for this area lost, a portion of the hillside just west of the proposed roadway, from about Terry Fox Drive Station 13+450 to 13+800, will be excavated to create a new flood plain. This study investigates the subsurface conditions within the designated area for this flood plain compensation as shown the Key Plan, Figure 1 and the Borehole Location Plan, Figure 2. The total length of this compensation area is approximately 1,000 metres.

At this time only the approximate footprint of the compensation area has been provided. It has been assumed that the northern upper limit of the compensation area will be the location of the proposed crest of the new slope and the elevation of the existing ground surface at the lower limit will be the approximate bottom or south limit of the excavation. No side slope information or proposed toe of slope have been provided, therefore this study will evaluate several common slope angles to determine the stability of slopes cut at these angles. Since the area above the compensation area will be the location of future residential development, the delineation of any “Hazard Lands” or Limits of Development will also be established. Hazard Lands is defined in the City of Ottawa design guidelines as the area where no permanent structure or facility can be located due to the potential zone of slope instability.

Geologic maps produced by the Ontario Geological Survey indicate that bedrock at this proposed compensation area is quite complex. Within the existing Carp River Flood Plain, the underlying bedrock is mapped as limestone and shale of the Verulam Formation. The existing hillside is identified as the “Kanata Ridge” which consists two fault zones and several Pre-Cambrian metamorphic and igneous bedrock formations. At the area of the compensation area, the bedrock formations are mapped as paragneiss, gabbro, diorite and quartzite.

3.0 PROCEDURE

The field work for this investigation was carried in July 2009 and 21boreholes (labelled as 09-65 to 09-74A) were put down within this compensation area to provide subsurface information to aid in the evaluation of the proposed cut slope. The depth of the investigation ranged from 2.2 to 15.0 metres below the existing ground surface. Monitoring wells were installed in six boreholes for subsequent groundwater level observations.

The boreholes were advanced using track-mounted hollow stem auger machine drill rigs supplied and operated by Marathon Drilling Company Ltd. of Ottawa, Ontario. The subsurface conditions and approximate depths to strata changes were assessed at each location at the time of drilling by examination of the auger cuttings and soil samples retrieved. In boreholes, the soil strata was either sampled at regular intervals using 50 millimetre open drive sampling equipment, or where silty clay was encountered, in-situ vane testing was carried out to determine the undrained shear strength of the silty clay. At three locations where auger refusal was encounter prior to the schedule depth of the borehole, the auger refusal material was explored by means of rock coring techniques using N size rotary diamond coring equipment.

The field work was carried out by members of our technical staff who logged the boreholes and samples, directed the drilling operations, directed the in-situ testing and took custody of the samples. Detailed descriptions of the subsurface conditions encountered are provided in Appendix A.

The groundwater conditions in the monitoring well piezometers installed were measured several times to record stabilized levels. Groundwater levels measured in the boreholes are shown on the Record of Boreholes Sheets in Appendix A.

Samples of the soils encountered in the boreholes were transported to our laboratory for examination by the project engineer and for further tactile and laboratory testing. Selected samples of soil collected during the investigation were tested for moisture content, liquid and plastic limits, and particle size distribution. The results of the laboratory classification testing are provided on the Record of Borehole Sheets in Appendix A, and the particle size distribution is presented on Figure 9.

The borehole locations from this investigation were established before and after drilling using global positioning (GPS) equipment. The borehole elevations are understood to be referenced to Geodetic datum. The locations of the boreholes are shown on the Borehole Location Plan, Figure 2.

4.0 SUBSURFACE CONDITIONS

4.1 General

The subsurface conditions encountered in the probeholes and boreholes put down for this investigation are presented on the Record of Probeholes and Record of Borehole sheets in Appendix A. Subsurface conditions do vary within the compensation limits. With any geotechnical investigation, certain limitations are applied to the interpretation of available factual information on which the geotechnical analysis and recommendations were based upon. These limitations are described in detail immediately following the text of this report and form an integral part of this document. Such limitations are the logs indicate the subsurface conditions at the test hole locations only. Boundaries between zones on the logs are often not distinct, but rather are transitional and have been interpreted. The precision with which the subsurface conditions are indicated depends on the method of boring, the frequency of sampling, the method of sampling, and the uniformity of the subsurface conditions. The soil descriptions in this report are based on commonly accepted methods of classification employed in geotechnical practice. Classification and identification of soil involves judgement and Golder Associates does not guarantee descriptions as exact, but infers accuracy to the extent that is common in current geotechnical practice. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties.

In general, the eastern portion of the compensation area mainly consists of a deep deposit of sensitive silty clay and western portion of the compensation area is located further up the ”Kanata Ridge” and the overburden soils thin significantly. The overburden soils in the western portion mainly consist of sensitive silty clay overlying glacial till overlying limestone bedrock. Five cross sections of this compensation area have been established for this investigation (Figures 3 through 7) and they illustrate the changing subsurface conditions within the proposed compensation area. The following sections present the geotechnical properties and subsurface conditions for each major soil type encountered at the test locations.

4.2 Subsurface Conditions

4.2.1 Topsoil

Topsoil exists at the ground surface within this compensation area. The topsoil ranges in thickness from about 150 to 460 millimetres and averaging about 220 millimetres.

4.2.2 Sensitive Silty Clay

In east portion of the compensation area, the topsoil is generally underlain by a thick deposit of silty clay. The upper portion of this deposit has been weathered to form a stiff grey brown crust to depths typically from about 2.1 to 4.4 metres (but in localized areas may be as deep as 5.0 metres). Occasional lenses of sand were observed in the weathered crust profile. In the western portion of the compensation area, the thickness of the overburden is significantly thinner, with only discontinuous areas of unweathered grey silty clay encountered below the weathered crust. The depth of the weather crust in the western portion of the compensation area ranges from about 1.3 to 5.3 metres (but in localized areas may be as shallow as 0.4 metres or as deep as 6.4 metres).

Standard penetration tests carried out within the weathered crust gave N values ranging from 2 to 12 blows per 0.3 metres of penetration, indicating a stiff to very stiff consistency. The natural water content of the silty clay weathered crust generally increases with depth and varies from 28 to 70 percent.

The silty clay below the depth of weathering is grey in colour. In the eastern portion of the compensation area and at the lower elevations of the western portion, the grey silty clay was not fully penetrated, but was proven to a depth of 14.6 metres below the existing ground surface. In the upper elevations of the western portion of the compensation area the grey silty clay is discontinuous. Where encountered, the thickness ranges from 1.7 to 5.8 metres.

The results of in-situ vane shear testing in the grey silty clay gave undrained shear strength values ranging from 17 to greater than 80 kilopascals indicating a soft to stiff consistency. The results of Atterberg limit testing carried out on selected samples of the grey silty clay gave liquid limit values ranging from 40 to 59 percent and plasticity index values ranging from 18 to 34 percent, indicating a generally medium to high plasticity soil. The measured water content of the grey silty clay ranges from approximately 31 to 68 percent, which was generally near or in excess of the measured liquid limit.

4.2.3 Glacial Till

Glacial till was found underlying the silty clay in areas of relatively higher elevation. The glacial till consists of a heterogeneous mixture of gravel and cobbles in a matrix of silty sand with a trace of clay. In areas, such as near boreholes 09-74 and 09-83, boulders were also encountered within the glacial till. The thickness of glacial till is typical about 1.0 metre, but is as thin as 0.1 metres at some locations and as thick as 3.2 metres at other locations.

Standard penetration test N values within the glacial till ranged from 2 to greater than 50 blows per 0.3 metres of penetration, indicating a very loose to very dense state of packing. The natural water content of the selected samples ranged from 12 to 25 percent. The result of laboratory grain size distribution test carried out on a representative sample of the fines portion of the glacial till is provided on Figure 9.

4.2.4 Bedrock

Bedrock or auger refusal was encountered in most boreholes drilled at relatively higher elevations in the western portion of the compensation area. The table below provides a summary of the auger refusal depths. Auger refusal in this proposed compensation area is most likely due to bedrock contact, but could also be caused by boulders within the glacial till. At three boreholes (09-74, 09-77 and 09-81), bedrock was proven by coring.

Summary of Auger Refusals

Borehole No.	Depth (metres)	Elevation (metres)	Borehole No.	Depth (metres)	Elevation (metres)
09-72	14.96	80.94	09-80	14.63	84.74
09-74	6.96	88.92	09-81	6.71	89.64
09-76	2.16	96.60	09-83	9.52	85.42
09-77	6.22	90.20	09-84	2.18	96.99
09-78	3.96	89.89	09-84A	2.29	96.47
09-79	10.21	87.49			

Note: Elevations are Geodetic.

The type of bedrock that was encountered consists limestone of the Verulam formation. The Total Core Recovery (TCR) varied from 98 to 100 percent, but was typically 100 percent. The Solid Core Recoveries varied from 21 to 98 but were typically above 80 percent and the Rock Quality Designation (RQD) varied from 21 to 100 percent.

4.2.5 Groundwater

During the investigation, groundwater measurements were obtained for approximately one month, thus allowing the groundwater levels to stabilize. The following table provides a summary of the groundwater observations taken during the current investigation:

Borehole No.	Observed Groundwater Elevations (metres)		
	July 2, 2009	July 10, 2009	July 23, 2009
09-69	92.48	92.60	92.66
09-70	94.03	93.35	93.21
09-75	92.14	92.71	92.54
09-81	94.45	93.27	93.01
09-82	-	92.28	92.34
09-84	-	dry	dry

Note: Elevations are Geodetic.

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

5.0 DISCUSSION

5.1 General

This section of the report provides engineering guidelines on the geotechnical design aspects of the project based on our interpretation of the borehole information and project requirements. It is stressed that the information in this portion of the report is provided for the guidance of the designers and is intended for this project only. Contractors bidding on or undertaking the works should examine the factual results of the investigation, satisfy themselves as to the adequacy of the factual information for construction, and make their own interpretation of the factual data as it affects their proposed construction techniques, schedule, safety, and equipment capabilities.

The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at this site. The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off site sources are outside the terms of reference for this report and have not been investigated or addressed.

5.2 Flood Plain Compensation Area Excavation

This compensation area will require a long cut below the existing grade to compensate for the flood plain lost as a result of the construction of the roadway embankment within the Carp River Flood Plain. The stability of this excavation has been assessed. At the time of this report as mentioned earlier, only the approximate footprint of the compensation area have been determined, therefore it has been assumed that the upper northern limit of the compensation area will be the location of the crest of the new slope and the elevation at the lower southern limit will be the approximate bottom of the excavation. No side slope information or proposed toe of slope have been provided, therefore this study will evaluate several common slope angles to determine the stability at the cut slopes.

5.2.1 Excavation Stability Assessment

In general, slope failures occur when the forces (or rotational moments) generated by the weight of the soil in a slope, and the external loads, exceed the shear strength of the soil. The five main parameters involved in the engineering analysis of the stability of a slope are:

1. The geometry of the slope;
2. The geology of the slope (i.e., the composition of the various soil layers within the slope and their depth, thickness, and orientation);
3. The groundwater conditions (the groundwater levels and the hydraulic gradient/flow conditions);
4. The strength parameters for the soils; and,
5. The unit weights (i.e., densities) of the soils within the slope.

Due to the varying subsurface conditions, the stability of the proposed excavation was assessed at five selected slope cross sections. The existing slope geometry used in the analyses was established based on the survey mapping provided. The results of that mapping indicate that the existing slopes range from 8 to about 10 metres in height within the compensation area. The overall slope angle typically ranges from about 1 to 6 degrees from the horizontal. The table below summarizes the cross sections assessed in this investigation.

Carp River Stationing	Assumed Bottom Elevation of Excavation (metres)	Approximate Cut Slope Height (metres)	Cross Section and Subsurface Profile
38+300	93.4	4.6	Figure 3
38+400	93.4	6.0	Figure 4
38+500	93.4	6.4	Figure 5
38+700	93.0	4.4	Figure 6
38+800	92.75	1.4	Figure 7

Note: Elevations are Geodetic.

The general geology within each cross section used in the analyses was based primarily on the results of our field investigation. The general stratigraphy considered in the eastern portion of the compensation area (Figures 6 and 7) consists of stiff weathered silty clay crust underlain by a deep deposit of unweathered grey silty clay. The general stratigraphy considered in the western portion of the compensation area (Figures 3, 4 and 5) consists of stiff weathered silty clay crust underlain by glacial till and limestone bedrock with discontinuous grey silty clay above the glacial till.

The soil parameters used in the analyses were based on experience with similar soils in eastern Ontario, as well as, published correlations based on the results of both in-situ field and laboratory testing. Slope stability analysis was carried out for both drained (long term stability) and undrained (short term) conditions. The soil parameters used in the analyses are:

Material	Unit Weight (kN/m^3)	Drained Parameters		Undrained Parameters	
		Effective Angle of Internal Friction (degrees)	Effective Cohesion (kPa)	Angle of Internal Friction (degrees)	Cohesion (kPa)
New Roadway Embankment Fill	22	37	0	37	1
Weathered Silty Clay Crust	18	35	5	0	96
Grey Silty Clay	16	27	7	0	20 - 30
Glacial Till	21	32	0	32	0
Limestone Bedrock	Impenetrable				

The groundwater conditions used in the analyses were based on the groundwater observations taken within the monitoring wells installed within the compensation area. Typically, the groundwater flow is parallel to the existing slope face and drains towards the Carp River.

The placement of the roadway fill embankment on the existing flood plain, can impact on the stability of a slope. Therefore a cross section at Terry Fox Drive Station 13+676 or Carp River Station 38+800 was also assessed.

The stability of each slope cross section was evaluated for both long-term static conditions and rapid draw down conditions, as well as under seismic loading. Since this slope is intended to be permanent, the groundwater levels will re-establish to lower elevations, thus effective stress (i.e., drained) soil parameters were used for this assessment. Rapid draw down typically occurs just after a flood event when the flood waters have receded, but the cut slope is still saturated.

The stability of the slopes was evaluated using limit equilibrium methods and the SLOPE/W software. The Morgenstern-Price method was used to compute a factor of safety. The factor of safety is defined as the ratio of the magnitude of the forces/moments tending to resist failure to the magnitude of the forces/moments tending to cause failure. Theoretically, a slope with a factor of safety of less than 1.0 will fail while one with a factor of safety of 1.0 or greater will stand. However, because the modeling is not exact and natural variations exist for all of the parameters affecting slope stability, a factor of safety of 1.5 is used to define a stable slope (for static loading conditions), or alternatively to define the acceptable set-back distance for permanent structures or valuable infrastructure from an unstable slope (i.e., the Limit of Hazard Lands). Under seismic loading and rapid draw down conditions, a minimum factor of safety of 1.1 is used.

5.2.2 Static Conditions

The results of the stability analyses carried out for both undrained and drained (i.e., static) conditions indicate that the factor of safety against global instability of slopes flatter than 3H:1V are greater than 1.5 and therefore are considered to be stable under these conditions. Undrained conditions existing during the excavation of the cut slope and are modelled as the short term case. Drained conditions exist after construction of the cut slope and are modelled as the long term case.

5.2.3 Rapid Draw Down Condition

For the rapid draw down condition, it was assumed that the flood water would reach to about Elevation 95.0 metres, which is about 0.5 metres below the finished grade of the nearby Terry Fox Drive roadway embankment. The results of the stability analyses carried out for the rapid draw down conditions indicate that the factor of safety against global instability of slopes flatter than 3H:1V are greater than 1.1 and therefore are considered to be stable under these conditions.

5.2.4 Seismic Condition (Earthquake)

The potential instability under seismic (earthquake) loading was evaluated using a simple “pseudo-static” model where a horizontal force is applied to the failure mass. This horizontal force is proportional to the weight of the failure mass and is determined using a “seismic coefficient”. In consideration of the seismicity for this area and the site conditions, a horizontal “seismic coefficient” of 0.21 was selected.

The results of the stability analyses carried out for seismic loading conditions indicate that the factor of safety against global instability of slopes flatter than 3H:1V are greater than 1.1 and therefore are considered to be stable under these conditions.

5.2.5 Limit of Development

Hazard Lands associated with unstable slopes, as defined by Ministry of Natural Resources (MNR) guidelines and provincial planning policies, are unsuitable for development with either publicly owned infrastructure or private development. In accordance with the MNR guidelines, the setback distance from the crest of unstable slopes to the Limit of Hazard Lands should include three components, as appropriate, namely:

1. A “Stable Slope Allowance”, which is determined as the limit beyond which there is an acceptable factor of safety (i.e., greater than about 1.5 static or 1.1 seismic) against slope failure.
2. An “Erosion Allowance”, to account for future movement of the slope toe, in the table land direction, as a result of erosion along the slope toe/creek bank. The magnitude of the *Erosion Allowance* depends upon the type of soil being eroded at the slope toe, the severity of the erosion, and the water course characteristics.
3. An “Access Allowance” of 6 metres, to allow a corridor by which equipment could travel to access and repair a future slope failure. This *Access Allowance* is included in the determination of the Limit of Hazard Lands wherever the development could restrict future slope access.

Side slopes 3H:1V or flatter constructed in this compensation area, have factors of safety greater than 1.5 and are considered to be stable. Therefore there is no required stable slope set back allowance.

The magnitude of the *Erosion Allowance* is described in the MNR guidelines and is a function of the soil type, state of erosion, and water course characteristics. Understanding that the compensation area will be vegetated and given that the flood plain will be subjected to almost no waterflow, we consider that there is no justification for an *Erosion Allowance*.

It is also generally the case that residential subdivision developments are considered to restrict access to the slope and therefore an *Access Allowance* of six metres should be also included in the assessment of the Limit of Hazard Lands.

As such, the required setback to the Limit of Hazard Lands or Limit of Development from the crest of the slope cross-sections including the *Access Allowance* and *Erosion Allowance* should be six metres from the crest of the proposed slope.

5.3 Excavation in Soil and Material Handling

The topsoil should first be removed from the proposed excavation area within the compensation area and the material subsequently stockpiled for re-use as growth medium to re-establish a vegetated cover within the compensation area and other areas of the project.

Where silty clay weathered crust is encountered, it should, for the most part, be re-useable as engineered fill to construct earth structures within other part of the project such as embankments, dykes, road subgrades, etc, although some moisture conditioning may be required. Laboratory tests indicate that the natural water content in the grey brown silty clay weathered crust increases with depth and varies from 25 to 40 percent, which is above its optimum water content for compaction. Handling (excavation, trucking, moving, spreading, and recompaction) of the grey brown silty clay weathered crust should therefore be possible provided there is no precipitation which would otherwise make trafficability poor and increase the water content of silty clay making it much more difficult to compact. The test results indicate that the silty clay excavated from below a depth of about 1 to 1.5 metres becomes too sensitive for reuse unless measures are taken to dry it close to the plastic limit, although it may be possible to incorporate some of the material into landscaping or noise berms. Planning should allow for wasting the grey silty clay. In general, it should be possible to excavate the soil profile where only shallow (less than about 1 metre) cuts are required, using scrapers, probably requiring some assistance from dozers, acknowledging that some difficulties with trafficability should be expected as wetter zones are encountered, and provided appropriate surface control is carried out during excavation. Excavation by hydraulic excavators should be carried out by excavating from the undisturbed ground. There is no need to use flat bladed buckets for excavating because the grooves from teeth will provide better frictional interface with the topsoil.

Cuts at higher elevations in the western sections of compensation area will be carried out through glacial till, which could be re-useable in fill embankments, road subgrades, the outer walls of embankment dams, and general fill at other portions of the project. The glacial till is often very dense and contains cobbles and boulders which, at some locations are nested. As such, the use of relatively large equipment to excavate this material would be preferable. The glacial till is a Type 3 soil. For temporary excavation into the glacial till, the sides may be cut at 1 horizontal to 1 vertical to depths of about 4 metres. Should groundwater seepage be encountered, sloughing of the cut slopes will be exacerbated.

5.4 Groundwater Control

Groundwater will likely be encountered in localized areas during excavation of the slope for the compensation area, particularly within the hillsides from the western limits of the compensation area near Station 38+150 to about Station 38+700. Figure 8 provides standard details on seep drains to collect and control the groundwater where encountered. For small seeps near the toe of slope, the rectangular drain is more appropriate, where as for larger seeps or seeps that are located mid-slope or higher, the “Y” drain is more appropriate. These drains will need to empty into a swale located at the toe of slope, which will in turn need to be graded away from the slope to provide positive drainage. These ditches may be covered with a vegetated cover if the visual aesthetics are a concern.

5.5 Well Decommission

During our field investigation, we encountered a hand dug well near borehole 09-78, along the cross section at 38+400. This well should be decommissioned in accordance with Ontario Water Resource Act, Regulation 903, Section 21 and Regulation 372 Section 21.

6.0 CONSTRUCTION CONSIDERATIONS

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

At the time of the writing of this report, only preliminary details for the proposed construction were available. Golder Associates should be retained to review the final drawings and specifications for this project prior to tendering to ensure that the guidelines in this report have been adequately interpreted.

The preliminary assessment of the Limit of Hazard Lands described in this report should provide a sufficient level of detail for developing the overall subdivision arrangement and street layout. However, these limits are specific to the cross-section locations and to the erosion conditions at each cross-section. The slopes on this site vary in height and this stability assessment should be review as the subdivision planning and design progresses.

It will likely ultimately be necessary to evaluate the stability of the slopes to sufficient detail such that the location of the Limit of Hazard Lands can be located (i.e., picketed) at the site by the geotechnical engineer and then surveyed, such as to define a boundary to development along the perimeter of the site. Some additional subsurface investigation may also be warranted, to confirm the subsurface stratigraphy and parameters used in these analyses.

This Geotechnical Report has been prepared for the sole use of Dillon Consulting Ltd. and the City of Ottawa. This Geotechnical Report should not be relied upon by other parties without the express written consent of the Golder Associates Ltd., Dillon Consulting Ltd., and the City of Ottawa.

Yours truly,

GOLDER ASSOCIATES LTD.

Bruce Goddard, P.E.	Terry Nicholas, P.Eng. Principal

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

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

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

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

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

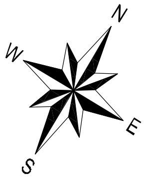
Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater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

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

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

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

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



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NOTE

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FILE No. 0911210027-4000-01.dwg

PROJECT No. 09-1121-0027 REV.

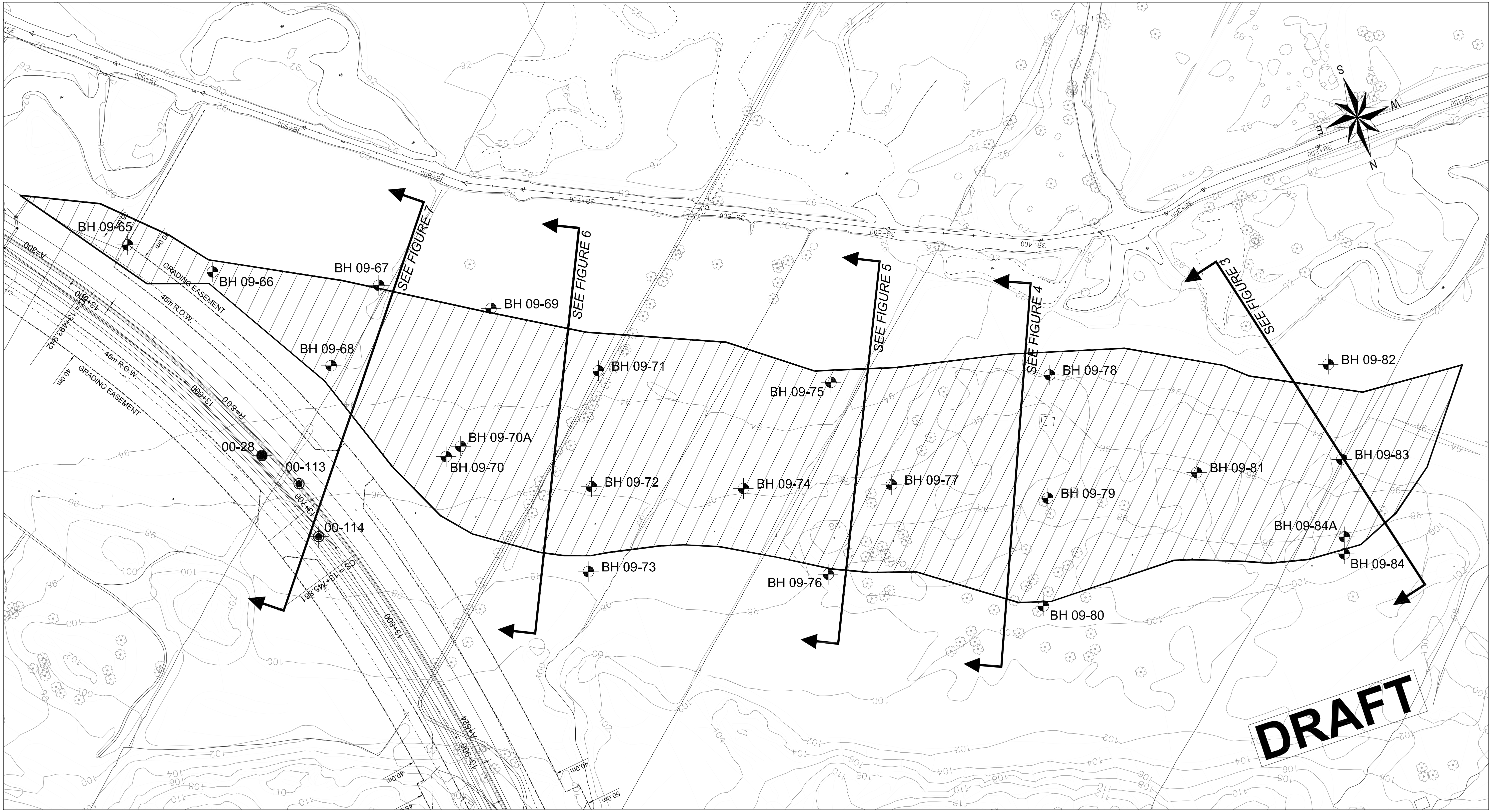
TITLE

KEY PLAN

GEOTECHNICAL INVESTIGATION
TERRY FOX DRIVE EXTENSION

FIGURE 1

PLOT DATE: September 25, 2009
FILENAME: N:\Active\2009\1121 - Geotechnical\09-1121-0027 Dillon Terry Fox Extn\ACAD\Phase 4000\0911210027-4000-01.dwg



LEGEND

⊕	APPROXIMATE BOREHOLE LOCATION IN PLAN, CURRENT INVESTIGATION
●	APPROXIMATE BOREHOLE LOCATION IN PLAN, PREVIOUS INVESTIGATION BY GOLDER ASSOCIATES LTD., REPORT No. 001-2240
◉	APPROXIMATE PROBEHOLE LOCATION IN PLAN, PREVIOUS INVESTIGATION BY GOLDER ASSOCIATES LTD., REPORT No. 001-2240
▨	LIMITS OF COMPENSATION AREA
↑↑	CROSS-SECTION LOCATION IN PLAN

REFERENCE

BASE PLAN SUPPLIED IN ELECTRONIC FORMAT BY THE CITY OF OTTAWA

NOTE

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FILE No.	0911210027-4000-02.dwg
PROJECT No.	09-1121-0027
REV.	0

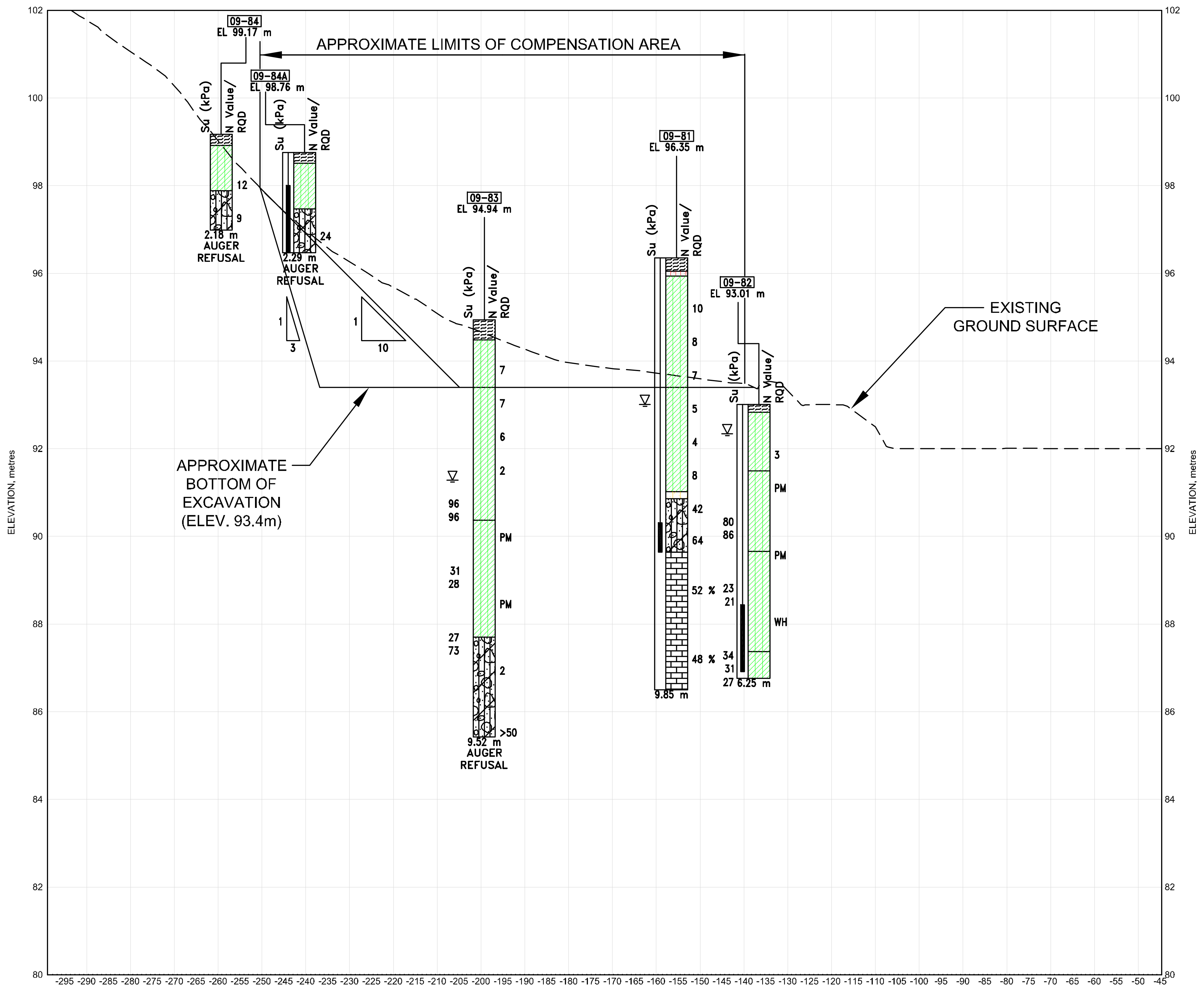
TITLE

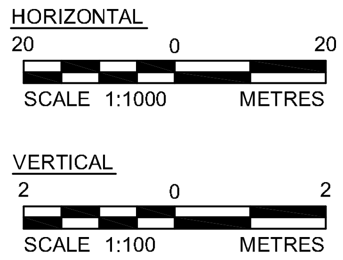
BOREHOLE LOCATION PLAN

GEOTECHNICAL INVESTIGATION
TERRY FOX DRIVE EXTENSION

FIGURE 2

PLOT DATE: September 25, 2009
FILENAME: N:\Active\2009\1121 - Geotechnical\09-1121-0027 Dillon Terry Fox Extn\ACAD\Phase 4000\0911210027-4000-02.dwg





SUBSURFACE STRATIGRAPHY

▤ TOPSOIL	▨ SANDY SILT
🟩 SILTY CLAY	▩ GLACIAL TILL
🟨 SILTY SAND	▦ LIMESTONE

REFERENCE

BASE PLAN SUPPLIED IN ELECTRONIC FORMAT BY THE CITY OF OTTAWA

NOTE

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PROJECT No. 09-1121-0027 REV. 0

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DATE 8 SEPT. 09
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CAD J.M.
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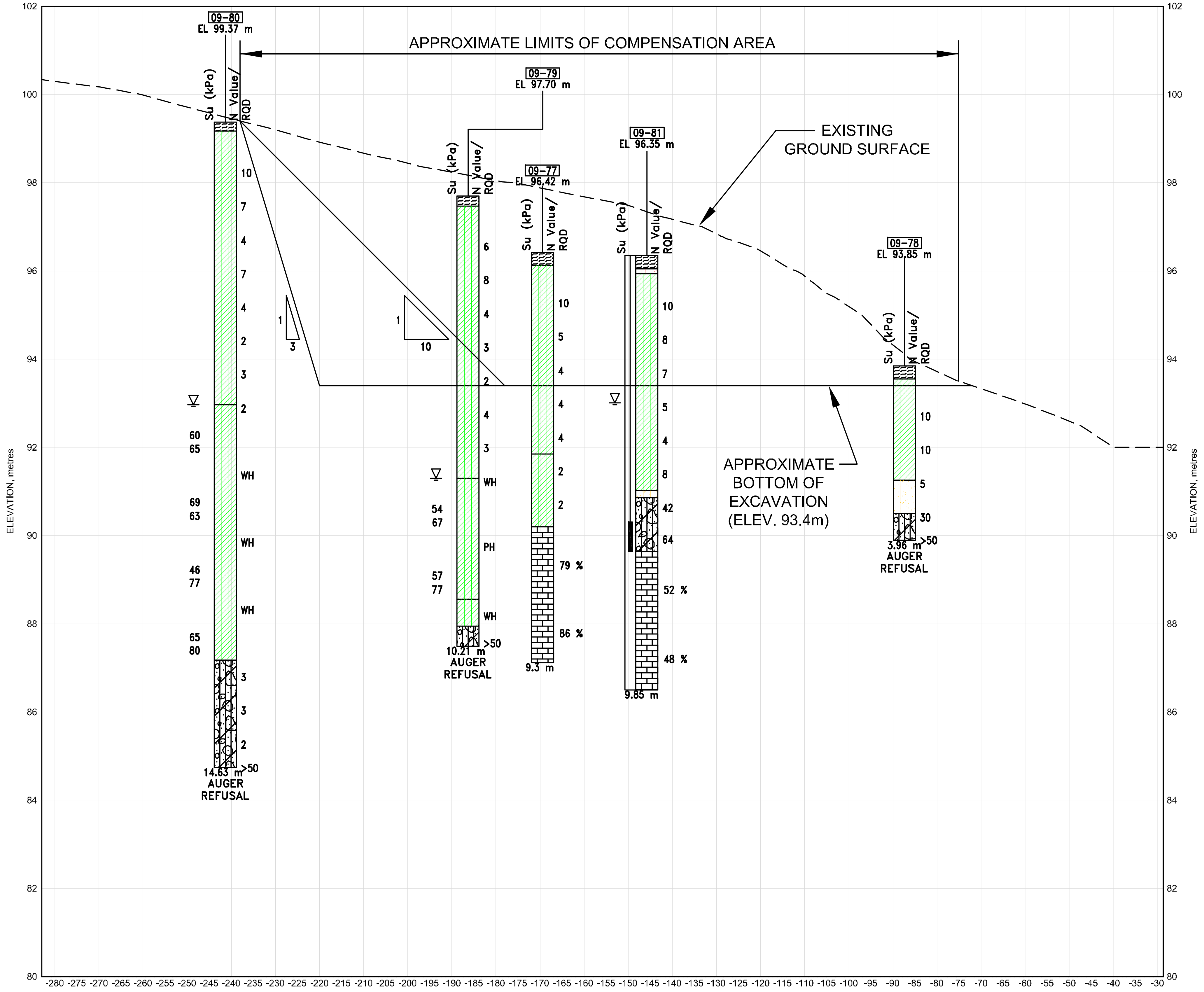
TITLE

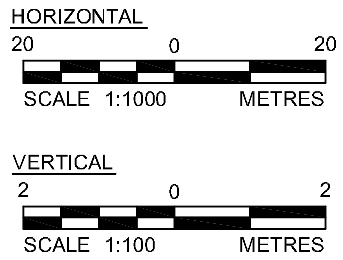
CROSS-SECTION @ STA. 38+300 AND SUMMARY OF BOREHOLE DATA

GEOTECHNICAL INVESTIGATION
TERRY FOX DRIVE EXTENSION

FIGURE 3

PLOT DATE: September 25, 2009
FILENAME: N:\Active\2009\1121 – Geotechnical\09-1121-0027 Dillon Terry Fox Extn\ACAD\Phase 4000\0911210027-4000-03.dwg





SUBSURFACE STRATIGRAPHY

▤	TOPSOIL	▨	SANDY SILT
🟩	SILTY CLAY	▩	GLACIAL TILL
▥	SILTY SAND	▦	LIMESTONE

REFERENCE

BASE PLAN SUPPLIED IN ELECTRONIC FORMAT BY THE CITY OF OTTAWA

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TITLE
CROSS-SECTION @ STA. 38+400 AND SUMMARY OF BOREHOLE DATA

GEOTECHNICAL INVESTIGATION
TERRY FOX DRIVE EXTENSION

FIGURE 4

PLOT DATE: September 25, 2009
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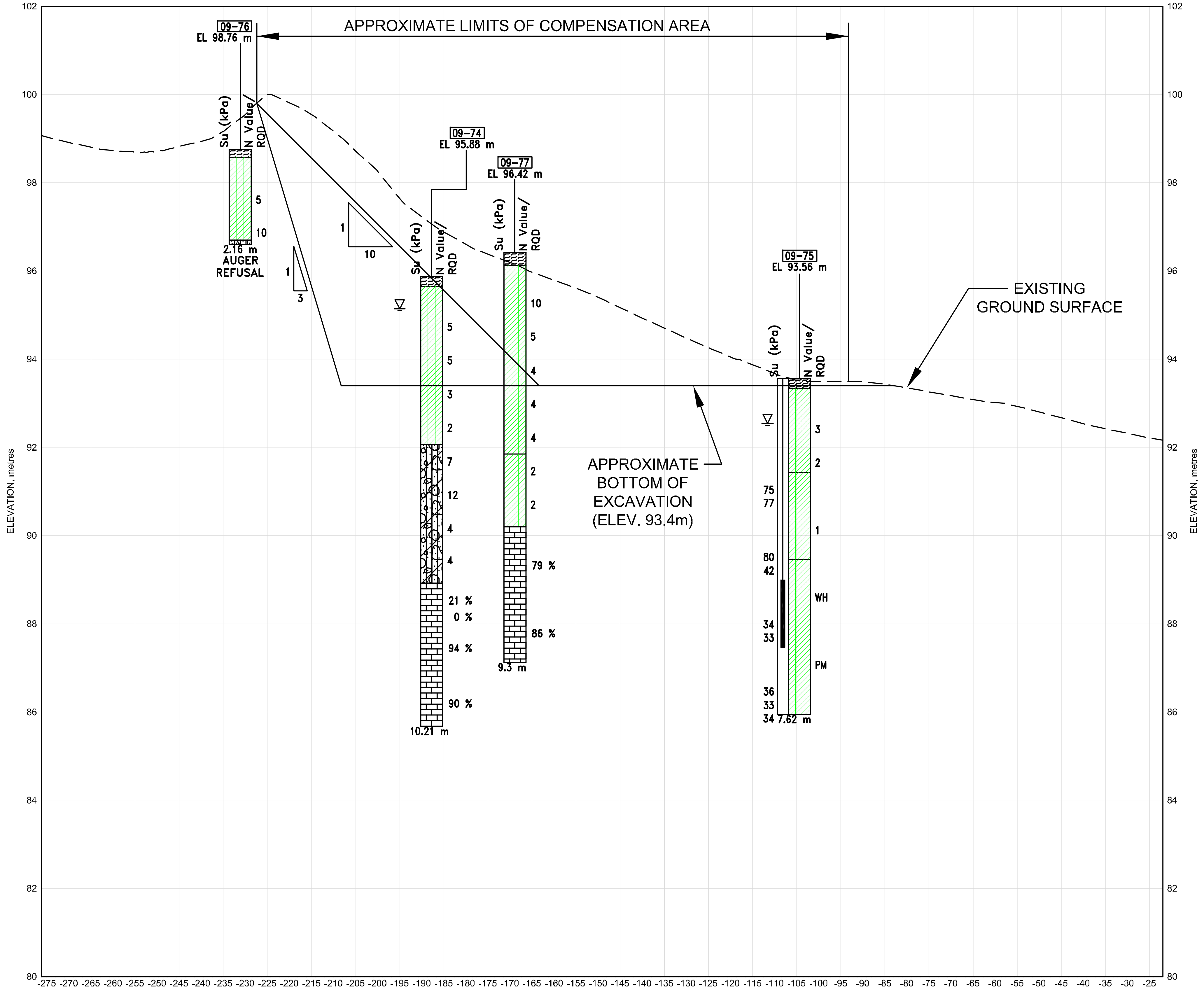

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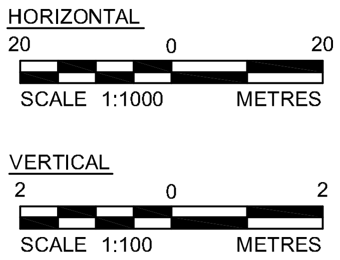

SUBSURFACE STRATIGRAPHY

▤	TOPSOIL	▨	SANDY SILT
🟩	SILTY CLAY	▩	GLACIAL TILL
🟨	SILTY SAND	▦	LIMESTONE

REFERENCE

BASE PLAN SUPPLIED IN ELECTRONIC FORMAT BY THE CITY OF OTTAWA

NOTE

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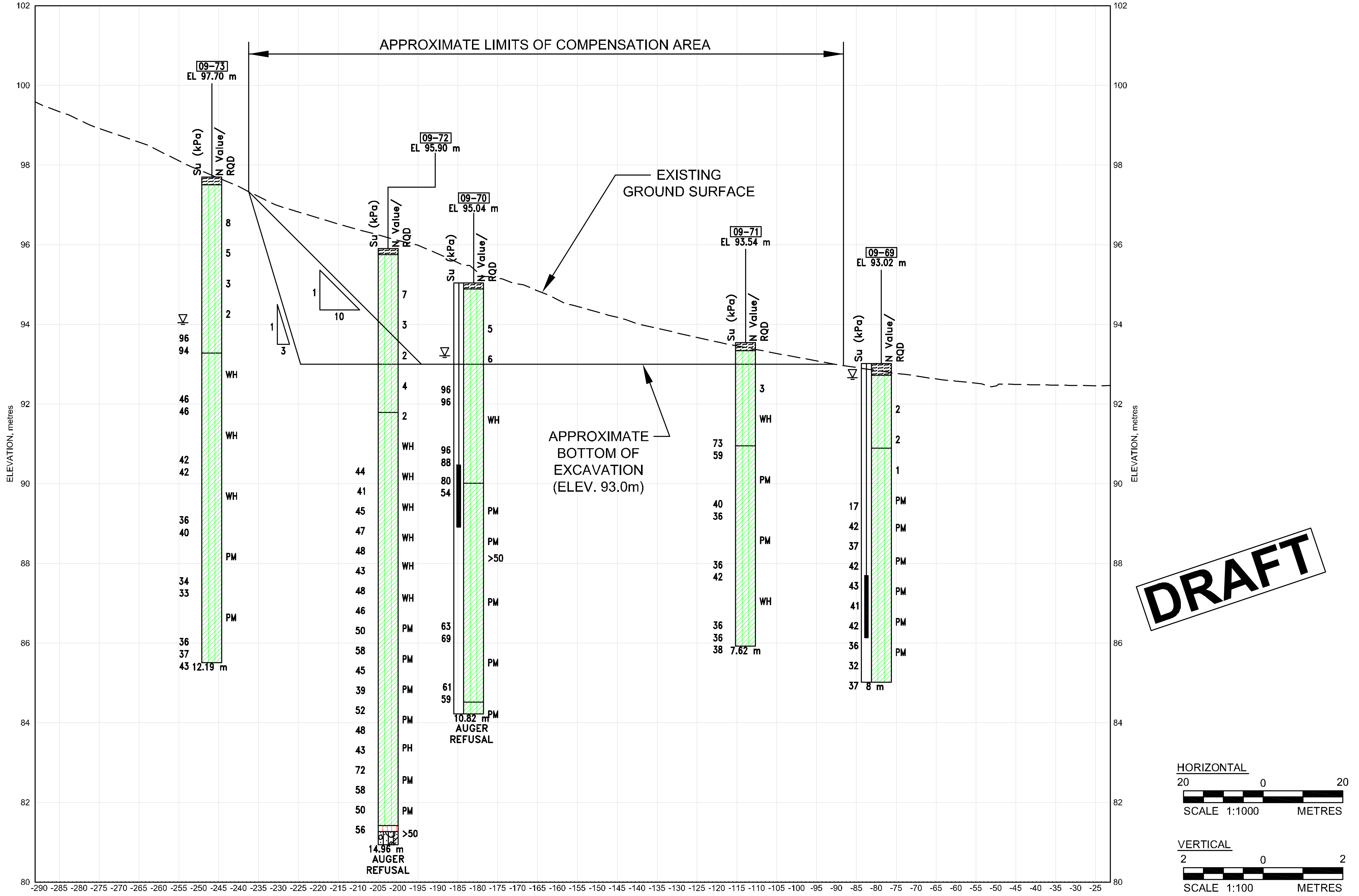
FILE No. 0911210027-4000-03.dwg
PROJECT No. 09-1121-0027 REV. 0

TITLE
CROSS-SECTION @ STA. 38+500 AND SUMMARY OF BOREHOLE DATA

GEOTECHNICAL INVESTIGATION
TERRY FOX DRIVE EXTENSION

FIGURE 5

PLOT DATE: September 25, 2009
FILENAME: N:\Active\2009\1121 - Geotechnical\09-1121-0027 Dillon Terry Fox Extn\ACAD\Phase 4000\0911210027-4000-03.dwg



SUBSURFACE STRATIGRAPHY

▤	TOPSOIL	▨	SANDY SILT
🟩	SILTY CLAY	▩	GLACIAL TILL
▥	SILTY SAND	▦	LIMESTONE

REFERENCE

BASE PLAN SUPPLIED IN ELECTRONIC FORMAT BY
THE CITY OF OTTAWA

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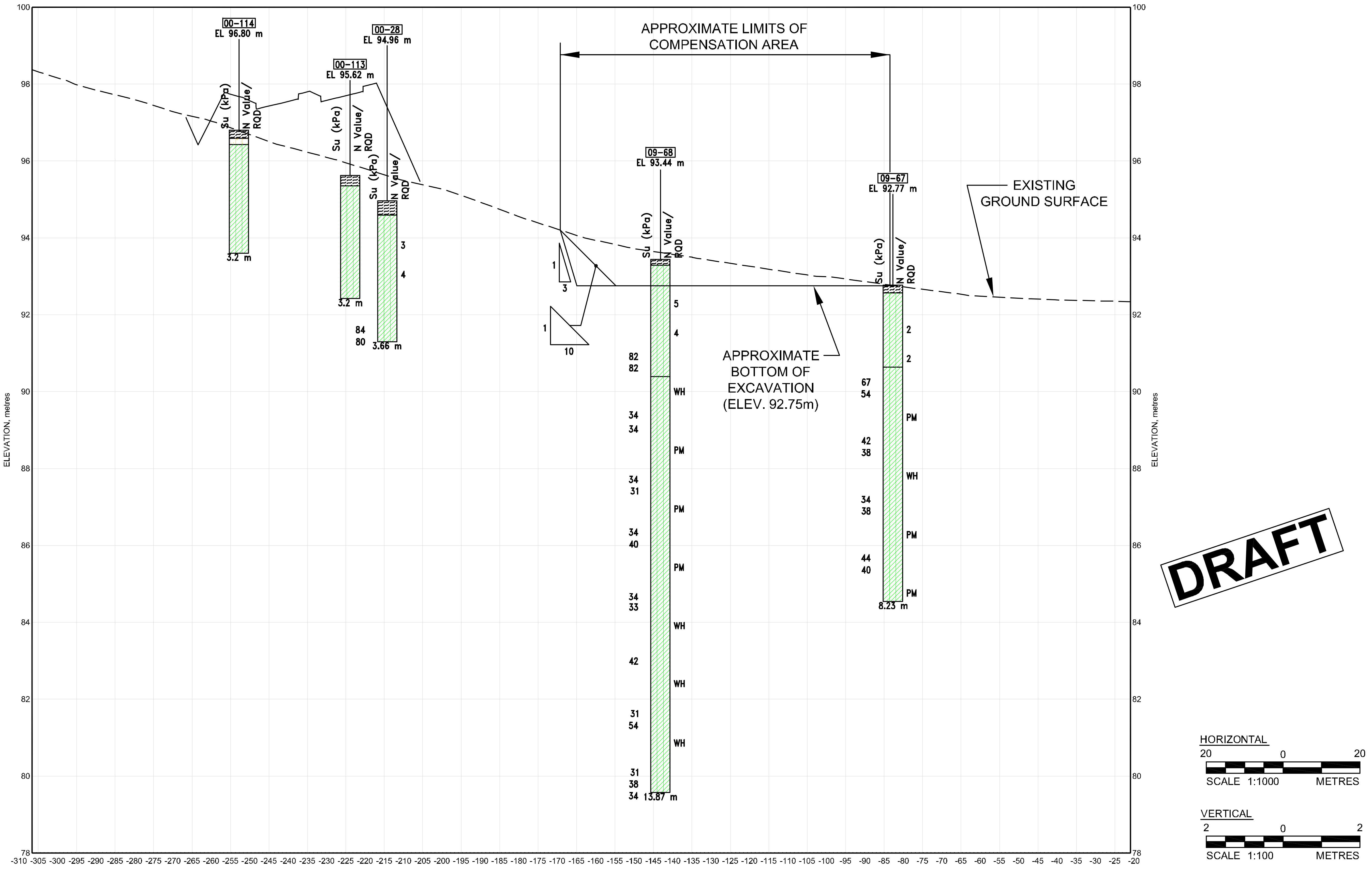
CROSS-SECTION @ STA. 38+700 AND SUMMARY OF BOREHOLE DATA

GEOTECHNICAL INVESTIGATION
TERRY FOX DRIVE EXTENSION

FIGURE 6

PLOT DATE: September 25, 2009
FILENAME: N:\Active\2009\1121 - Geotechnical\09-1121-0027 Dillon Terry Fox Extn\ACAD\Phase 4000\0911210027-4000-03.dwg



SUBSURFACE STRATIGRAPHY

▤	TOPSOIL	▨	SANDY SILT
🟩	SILTY CLAY	▩	GLACIAL TILL
🟨	SILTY SAND	▦	LIMESTONE

REFERENCE

BASE PLAN SUPPLIED IN ELECTRONIC FORMAT BY THE CITY OF OTTAWA

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PROJECT No. 09-1121-0027 REV. 0

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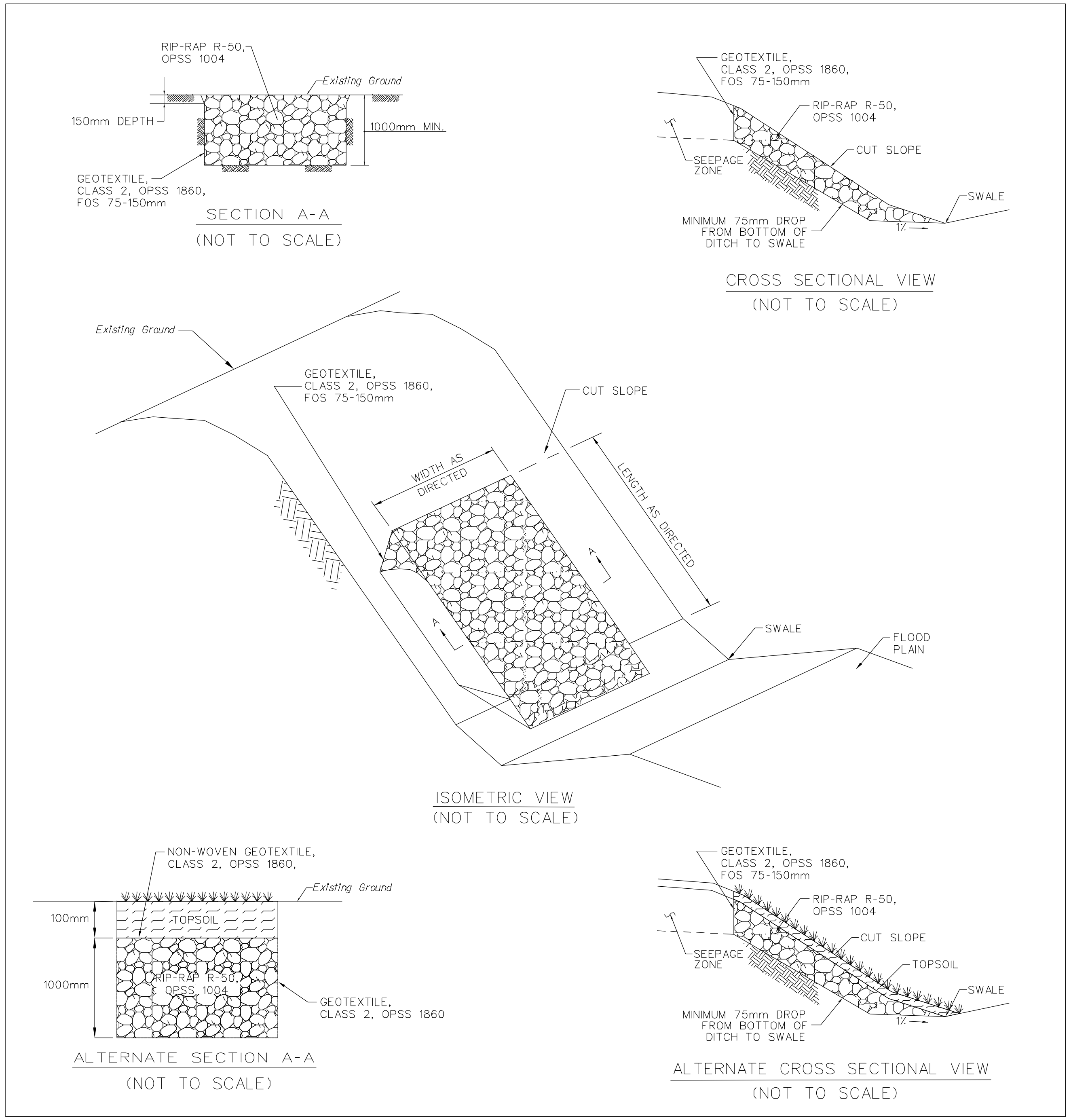
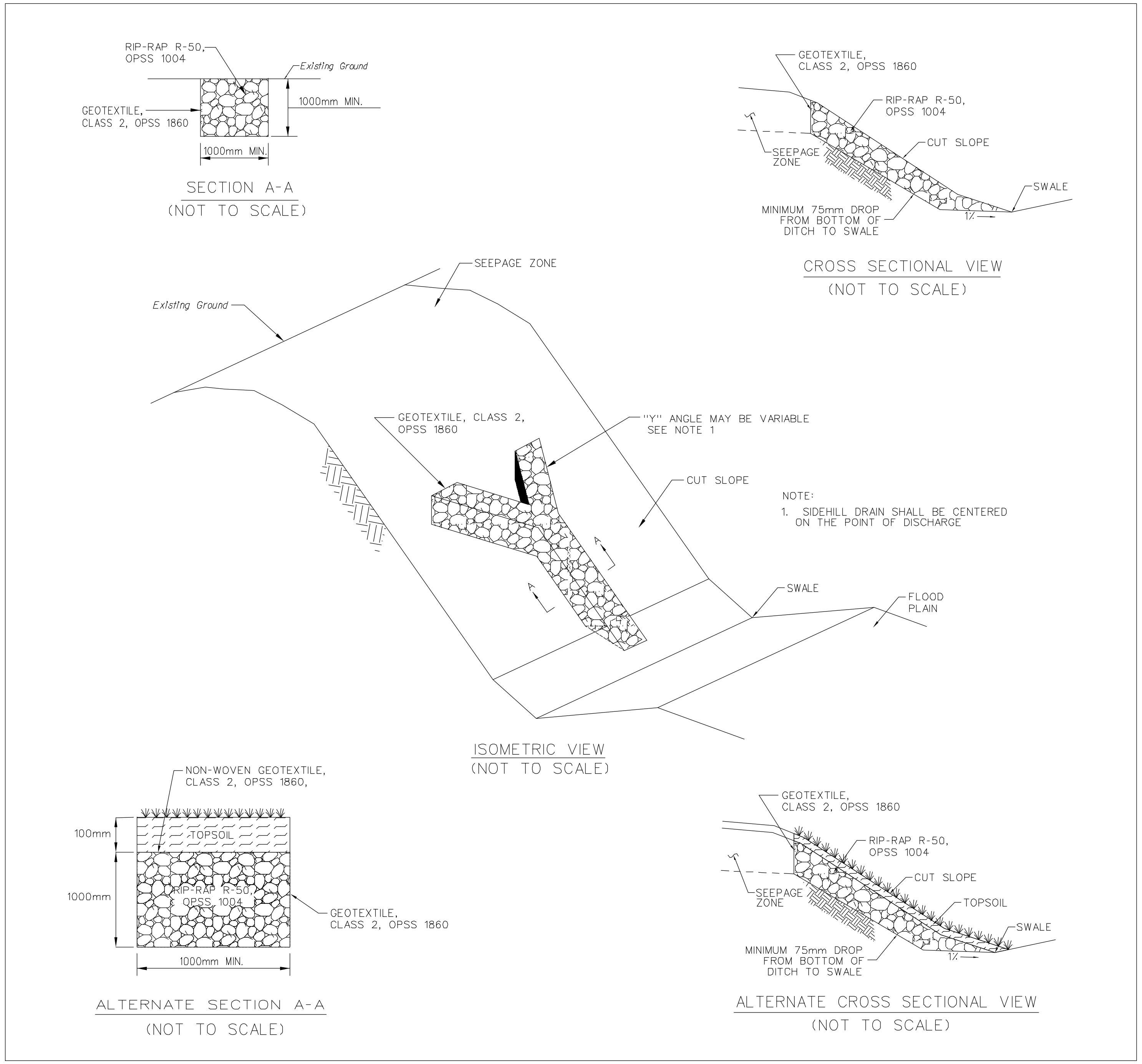
TITLE
CROSS-SECTION @ STA. 38+800 AND SUMMARY OF BOREHOLE DATA

GEOTECHNICAL INVESTIGATION
TERRY FOX DRIVE EXTENSION

FIGURE 7

PLOT DATE: September 25, 2009
FILENAME: N:\Active\2009\1121 – Geotechnical\09-1121-0027 Dillon Terry Fox Extn\ACAD\Phase 4000\0911210027-4000-03.dwg





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SCALE	NTS	TITLE	SEEP DRAIN DETAILS
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CAD	J.M.		
CHECK		GEOTECHNICAL INVESTIGATION TERRY FOX DRIVE EXTENSION	FIGURE 8
REVIEW			

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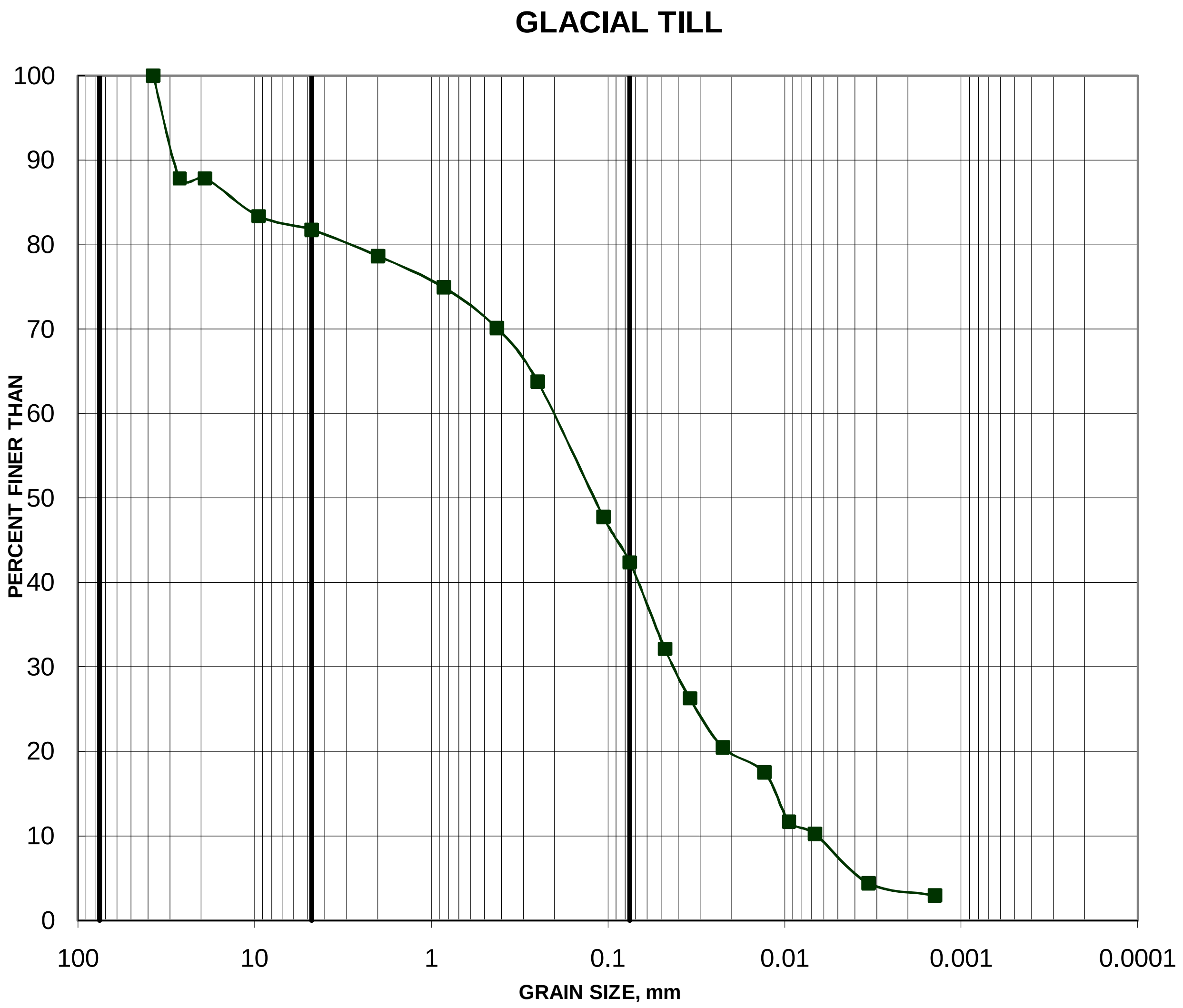
PROJECT No. 09-1121-0027 REV. 0

PLOT DATE: September 25, 2009
FILENAME: N:\Active\2009\1121 - Geotechnical\09-1121-0027 Dillon Terry Fox Extn\ACAD\Phase 4000\0911210027-4000-08.dwg

GRAIN SIZE DISTRIBUTION	Figure 9



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

Borehole	Sample	Depth (m)
■ 09-80	13	12.95-13.56

Project: 09-1121-0027 (4000)

Golder Associates

Created by: CW
Checked by: CNM

APPENDIX A

List of Abbreviations and Symbols

Lithological and Geotechnical Rock Description Terminology

Record of Probeholes and Borehole Sheets

LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO	Drive open
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample
DT	Dual Tube sample

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:
The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open Sampler for a distance of 300 mm (12 in.)
DD- Diamond Drilling

Dynamic Penetration Resistance; N_d:
The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive Uncased a 50 mm (2 in.) diameter, 60^0 cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

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

Peizo-Cone Penetration Test (CPT):
An electronic cone penetrometer with a 60^0 conical tip and a projected end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded Electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Cohesionless Soils

Density Index **(Relative Density)**	**N** Blows/300 mm Or Blows/ft.
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils

Consistency	**C_u or S_u** Kpa	Psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	Over 200	Over 4,000

IV. SOIL TESTS

w	water content
w_p	plastic limited
w_1	liquid limit
C	consolidaiton (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	modified Proctor compaction test
SPC	standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane test (LV-laboratory vane test)
γ	unit weight

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

LIST OF SYMBOLS

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

I. GENERAL

π	= 3.1416
ln x, natural logarithm of x	
$\log_{10}$ x or log x, logarithm of x to base 10	
g	Acceleration due to gravity
t	time
F	factor of safety
V	volume
W	weight

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

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

* Density symbol is p. Unit weight symbol is γ where γ=pg(i.e. mass density x acceleration due to gravity)

(a) Index Properties (cont'd.)

w	water content
w_1	liquid limit
w_p	plastic limit
I_p	plasticity Index=(w_1-w_p)
w_s	shrinkage limit
I_L	liquidity index=$(w-w_p)/I_p$
I_c	consistency index=$(w_1-w)/I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index-$(e_{max}-e)/(e_{max}-e_{min})$ (formerly relative density)

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (overconsolidated range)
C_s	swelling index
C_a	coefficient of secondary consolidation
m_v	coefficient of volume change
c_v	coefficient of consolidation
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation pressure
OCR	Overconsolidation ratio=σ'_p/σ'_{vo}

(d) Shear Strength

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

Notes: 1. τ=c'σ' tan |'
2. Shear strength=(Compressive strength)/2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING STATE

Fresh: no visible sign of weathering

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

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

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

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

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

BEDDING THICKNESS

Description	**Bedding Plane Spacing**
Very thickly bedded	>2 m
Thickly bedded	0.6 m to 2m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	<6 mm

JOINT OR FOLIATION SPACING

Description	**Spacing**
Very wide	>3 m
Wide	1 – 3 m
Moderately close	0.3 – 1 m
Close	50 – 300 mm
Very close	<50 mm

GRAIN SIZE

Term	**Size***
Very Coarse Grained	>60 mm
Coarse Grained	2 – 60 mm
Medium Grained	60 microns - 2mm
Fine Grained	2 – 60 microns
Very Fine Grained	<2 microns

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

O:\ Templates\Rock Description Terminology

CORE CONDITION

Total Core Recovery

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

Solid Core Recovery (SCR)

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

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varies from 0% for completely broken core 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to (W.R.T.) Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90^0 angle is horizontal.

Description and Notes

An abbreviated description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

B –	Bedding	Ca-	Calcite
FO-	Foliation/Schistosity	P-	Polished
CL -	Cleavage	S-	Slickensided
SH -	Shear Plane/Zone	SM-	Smooth
VN-	Vein	R-	Ridged/Rough
F -	Fault	ST-	Stepped
CO-	Contact	PL-	Planar
J -	Joint	FL-	Flexured
FR-	Fracture	UE-	Uneven
MF -	Mechanical	W-	Wavy
A-	Angular	C-	Curved
BP-	Bedding Plane	H-	Hackly
BL-	Blast Induced	SL-	Sludge Coated
II	Parallel To	TCA-	To Core Axis
	Perpendicular To	STR-	Stress Induced

RECORD OF PROBEHOLES

Probehole Number (Elevation)	**Depth** (metres)	**Description**
00-113	0.00 - 0.27	TOPSOIL
(Elev. 95.62)	0.27 - 3.20	Grey brown SILTY CLAY (Weathered Crust)
	3.20	End of probehole
00-114	0.00 - 0.21	TOPSOIL
(Elev. 96.80)	0.21 - 0.37	Brown SILTY SAND
	0.37 - 3.20	Grey brown SILTY CLAY, occasional sand seams (Weathered Crust)
	3.20	End of probehole

PROJECT: 001-2240

RECORD OF BOREHOLE: 00-28

SHEET 1 OF 1

LOCATION: SEE SITE PLAN

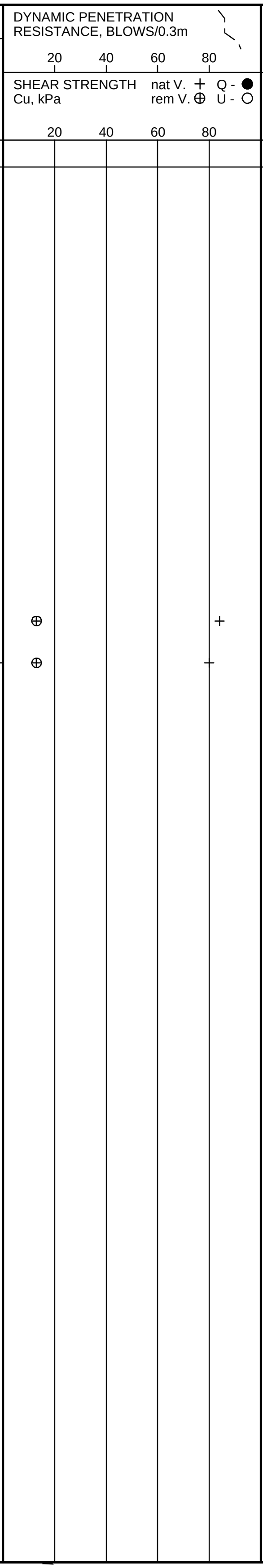
BORING DATE: DEC 20, 2001

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	SOIL PROFILE STRATA PLOT	SOIL PROFILE ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH Cu, kPa	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		94.96							
0	POWER AUGER 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							
		Very stiff to stiff grey brown SILTY CLAY (Weathered Crust)		94.59 0.37							
1					1	50 DO	3				
2					2	50 DO	4				
3											
		END OF BOREHOLE		91.30 3.66							
4											
5											
6											
7											
8											
9											
10											



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

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

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.J.S.

CHECKED: T.J.N.

PROJECT: 09-1121-0027

RECORD OF BOREHOLE: 09-65

SHEET 1 OF 1

LOCATION: See Site Plan

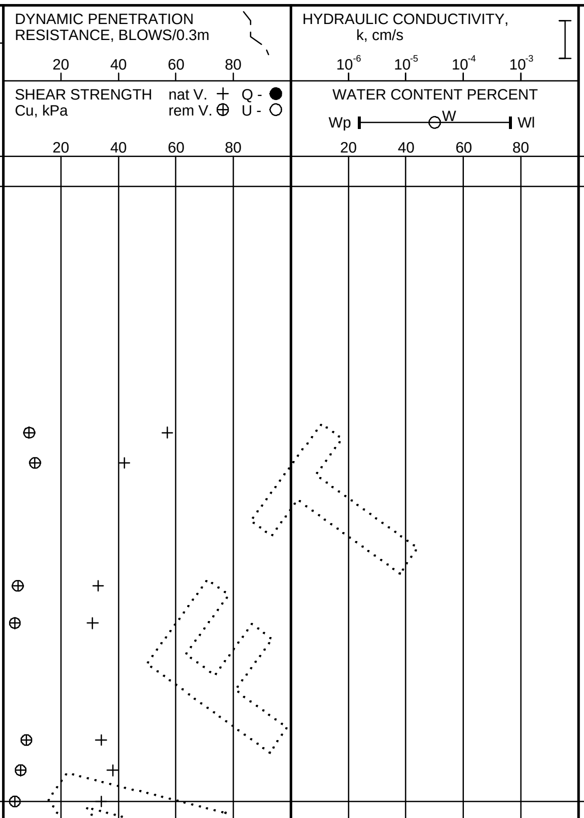
BORING DATE: June 23, 2009

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		92.48					
0	Power Auger 200mm Diam. (Hollow Stem)	Brown silty sand (TOPSOIL)			1	GRAB			
		Stiff grey brown SILTY CLAY, trace sand (Weathered Crust)		0.15					
1				91.26	2	50 DO	4		∇
		Grey brown SILTY SAND							
		Grey brown CLAYEY SILT		1.37	3	50 DO	WH		
2				90.35					
		Stiff to firm grey SILTY CLAY		2.13					
3					4	50 DO	PM		
4									
5					5	50 DO	WH		
6				86.38					
		End of Borehole		6.10					W.L. in open hole at 1.22m depth below ground surface upon completion of drilling
7									
8									
9									
10									
11									
12									
13									
14									
15									



DEPTH SCALE

1 : 75

Golder Associates

LOGGED: J.A.C.

CHECKED: ________

PROJECT: 09-1121-0027

RECORD OF BOREHOLE: 09-66

SHEET 1 OF 1

LOCATION: See Site Plan

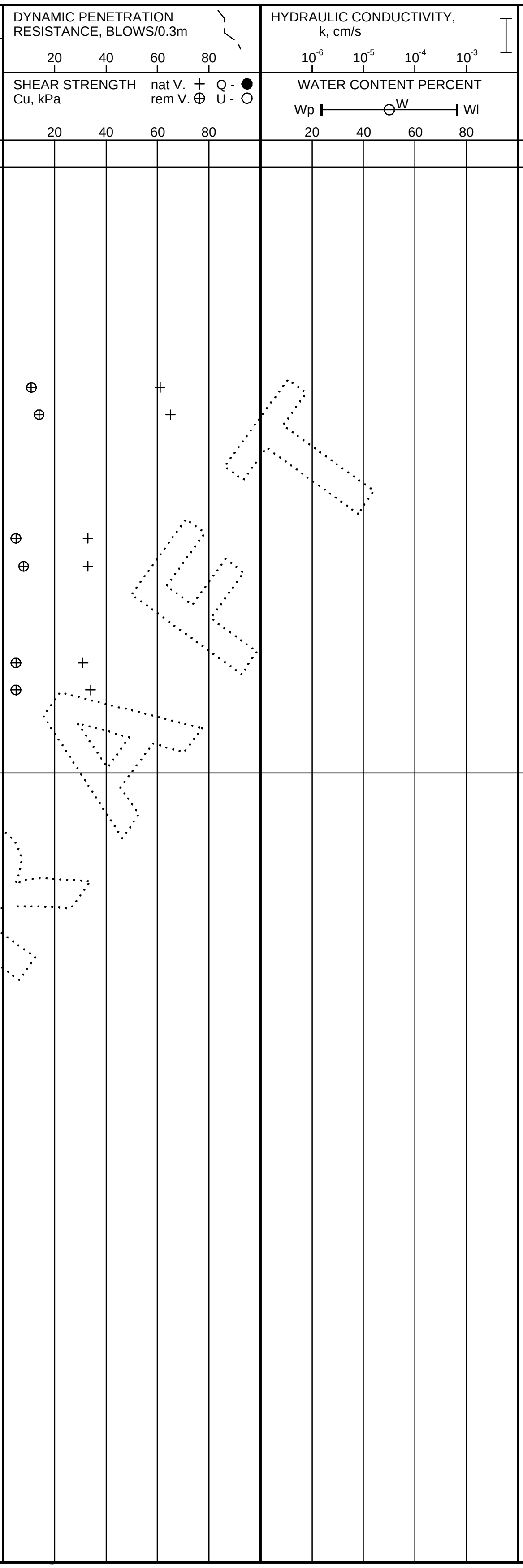
BORING DATE: June 22, 2009

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		92.62					
0	Power Auger 200mm Diam. (Hollow Stem)	Brown sandy silt (TOPSOIL)			1	GRAB			
		Stiff grey brown SILTY CLAY, with occasional thin sand seams (Weathered Crust)		0.15					
1					2	50 DO	3		
					3	50 DO	2		
2		Stiff to firm grey SILTY CLAY, trace shells		90.49 2.13					
3					4	50 DO	WH		
5					5	50 DO	PM		
6					6	50 DO	PM		
7		End of Borehole		85.91 6.71					
8									
9									
10									
11									
12									
13									
14									
15									



DEPTH SCALE

1 : 75

Golder Associates

LOGGED: J.A.C.

CHECKED: ________

PROJECT: 09-1121-0027

RECORD OF BOREHOLE: 09-67

SHEET 1 OF 1

LOCATION: See Site Plan

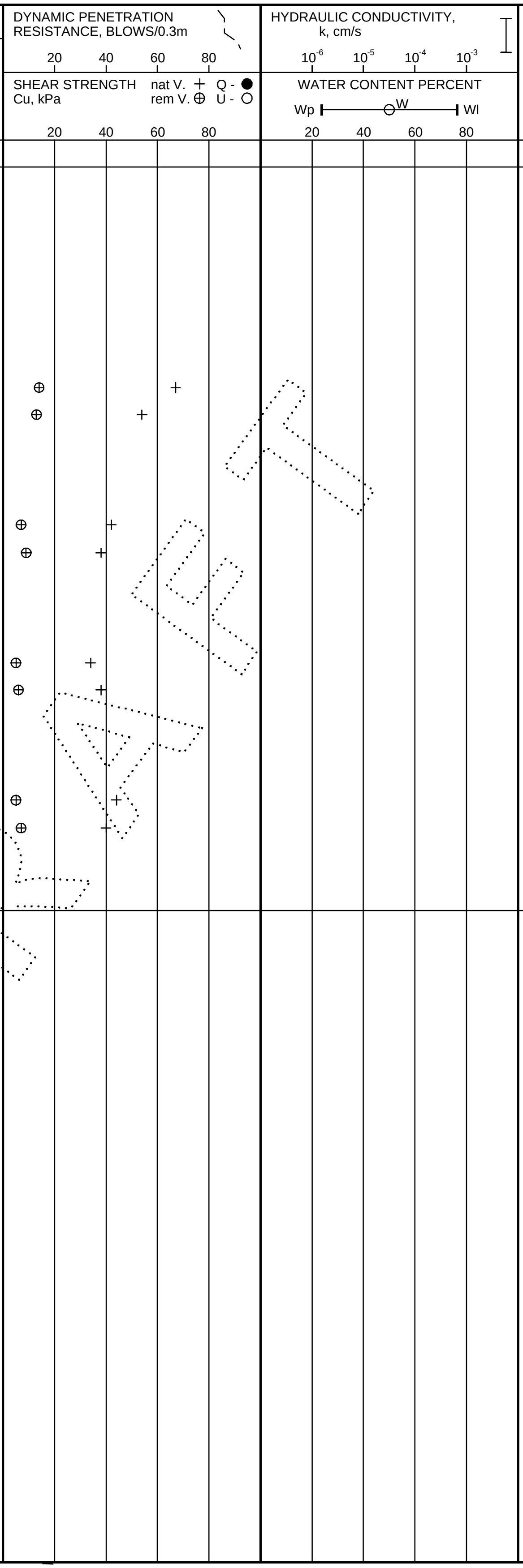
BORING DATE: June 22, 2009

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m
		Ground Surface		92.77			
0	Power Auger 200mm Diam. (Hollow Stem)	Brown sandy silt (TOPSOIL)		92.57	1	GRAB	
		Stiff grey brown SILTY CLAY, some sand seams (Weathered Crust)		0.20			
1					2	50 DO	2
					3	50 DO	2
2		Stiff to firm grey SILTY CLAY		90.64 2.13			
3					4	50 DO	PM
5					5	50 DO	WH
6					6	50 DO	PM
8					7	50 DO	PM
		End of Borehole		84.54 8.23			



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: J.A.C.

CHECKED: ________

PROJECT: 09-1121-0027

RECORD OF BOREHOLE: 09-68

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 23, 2009

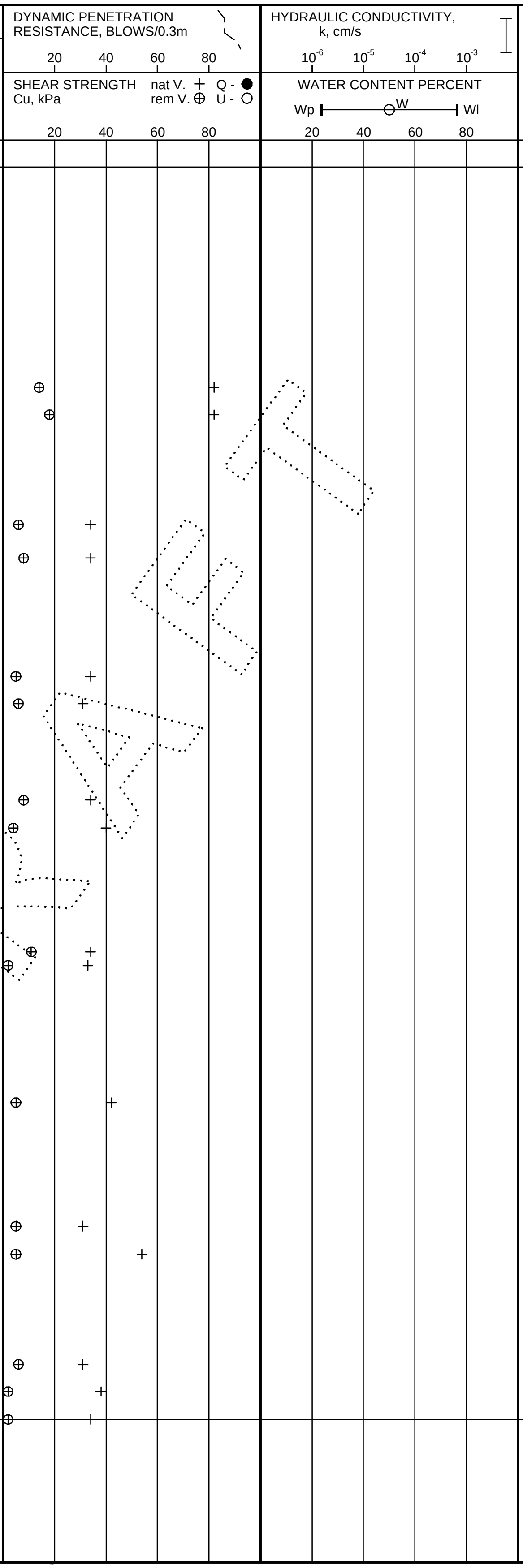
DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

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

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.3m
	Ground Surface		93.44			
0	Dark brown sandy silt, trace organic matter (TOPSOIL)			1	GRAB	
	Stiff grey brown SILTY CLAY (Weathered Crust)	▨	0.15			
1				2	50 DO	5
2				3	50 DO	4
3	Firm grey SILTY CLAY	▨	90.39 3.05	4	50 DO	WH
5				5	50 DO	PM
6				6	50 DO	PM
8				7	50 DO	PM
9				8	50 DO	WH
11				9	50 DO	WH
12				10	50 DO	WH
14	End of Borehole		79.57 13.87			



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: J.A.C.

CHECKED: ________

PROJECT: 09-1121-0027

RECORD OF BOREHOLE: 09-69

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 24, 2009

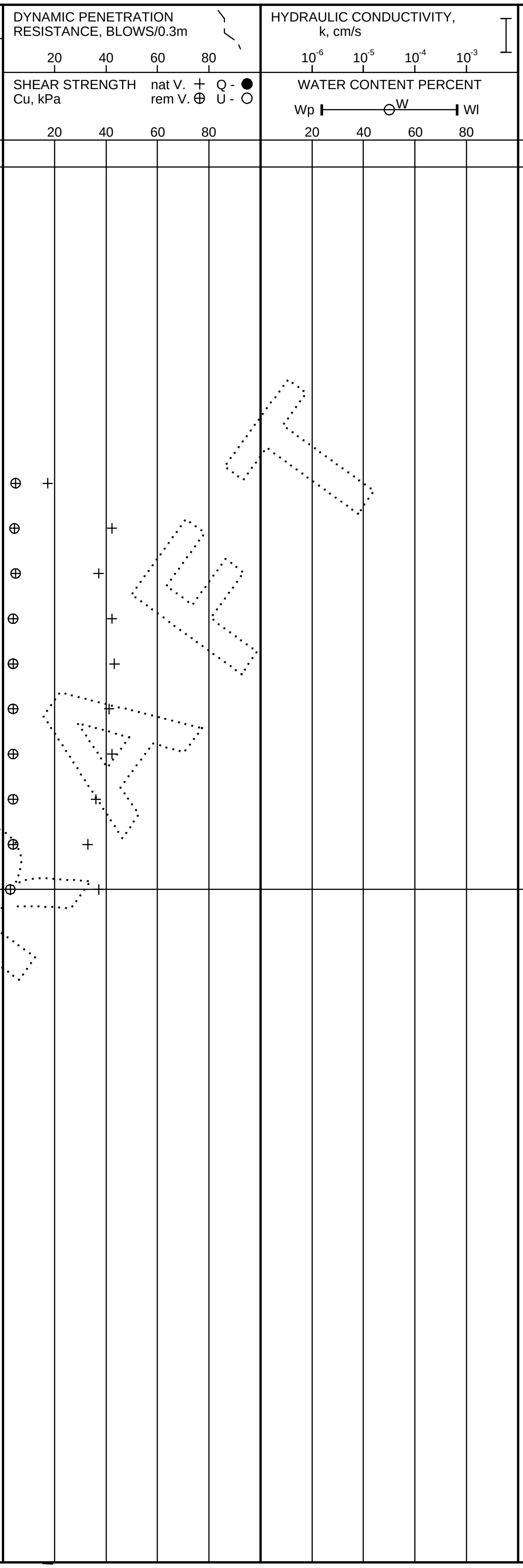
DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

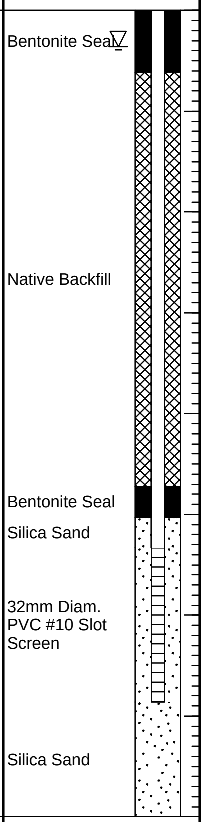
PENETRATION TEST HAMMER, 64kg; DROP, 760mm

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

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
0	Ground Surface	93.02			
	Dark brown sandy silt, trace organic matter (TOPSOIL)	92.72 0.30	1	GRAB	
	Stiff grey brown SILTY CLAY, some sand seams (Weathered Crust)				
1			2	50 DO	2
2			3	50 DO	2
	Firm grey SILTY CLAY	90.89 2.13			
			4	50 DO	1
3			5	50 DO	PM
4			6	50 DO	PM
5			7	50 DO	PM
			8	50 DO	PM
6			9	50 DO	PM
7			10	50 DO	PM
8	End of Borehole	85.02 8.00			



PIEZOMETER OR STANDPIPE INSTALLATION



W.L. in screen at Elev. 92.66m on July 23, 2009

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: J.A.C.

CHECKED: ________

PROJECT: 09-1121-0027

RECORD OF BOREHOLE: 09-70

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 24, 2009

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

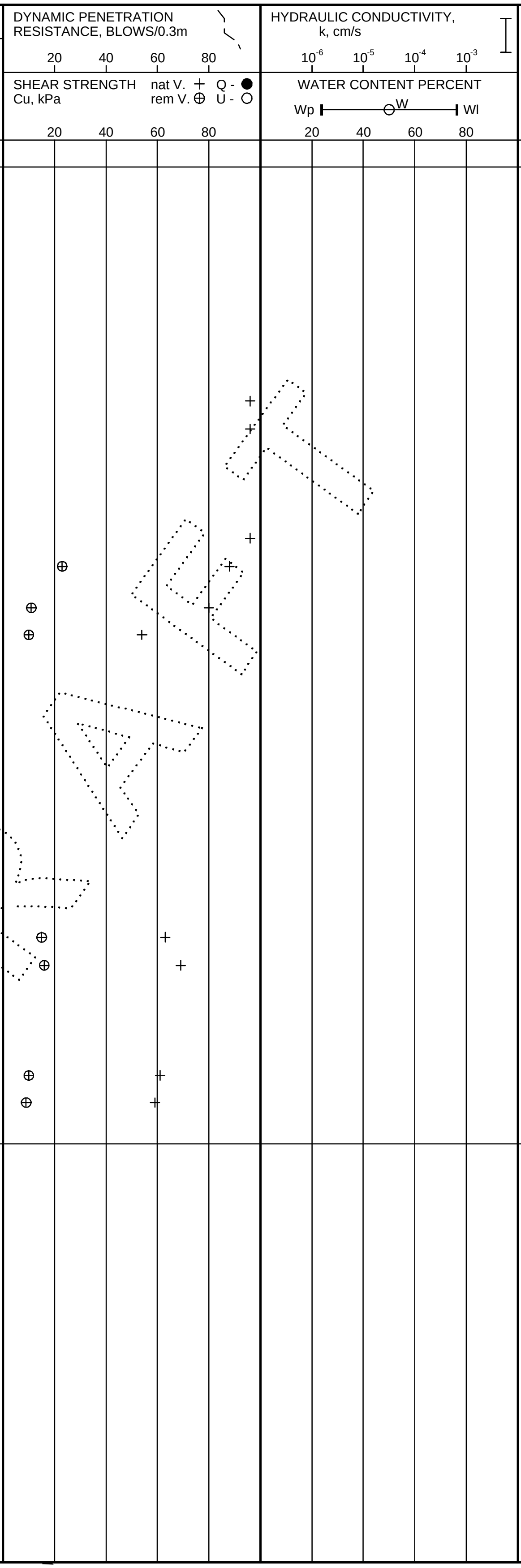
BORING METHOD: Power Auger, 200mm Diam. (Hollow Stem)

SOIL PROFILE

DESCRIPTION	ELEV. DEPTH (m)
Ground Surface	95.04
Dark brown silty sand, trace organic matter (TOPSOIL)	0.15
Very stiff to stiff grey brown SILTY CLAY (Weathered Crust)	
Stiff grey SILTY CLAY	90.01 5.03
Stiff grey SILTY CLAY, some sand, trace gravel	84.52 10.52
End of Borehole Auger Refusal	84.22 10.82

SAMPLES

NUMBER	TYPE	BLOWS/0.3m
1	GRAB	
2	50 DO	5
3	50 DO	6
4	50 DO	WH
5	50 DO	PM
6	50 DO	PM
7	50 DO	>50
8	50 DO	PM
9	50 DO	PM
10	50 DO	PM



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

Native Backfill
Bentonite Seal
Native Backfill
Bentonite Seal
Silica Sand
32mm Diam. PVC #10 Slot Screen
Silica Sand
Bentonite Seal
Cave
Bentonite Seal

W.L. in screen at Elev. 93.21m on July 23, 2009

DEPTH SCALE
1 : 75

LOGGED: J.A.C./D.G.

CHECKED: ________

PROJECT: 09-1121-0027

RECORD OF BOREHOLE: 09-71

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 26, 2009

DATUM: Geodetic

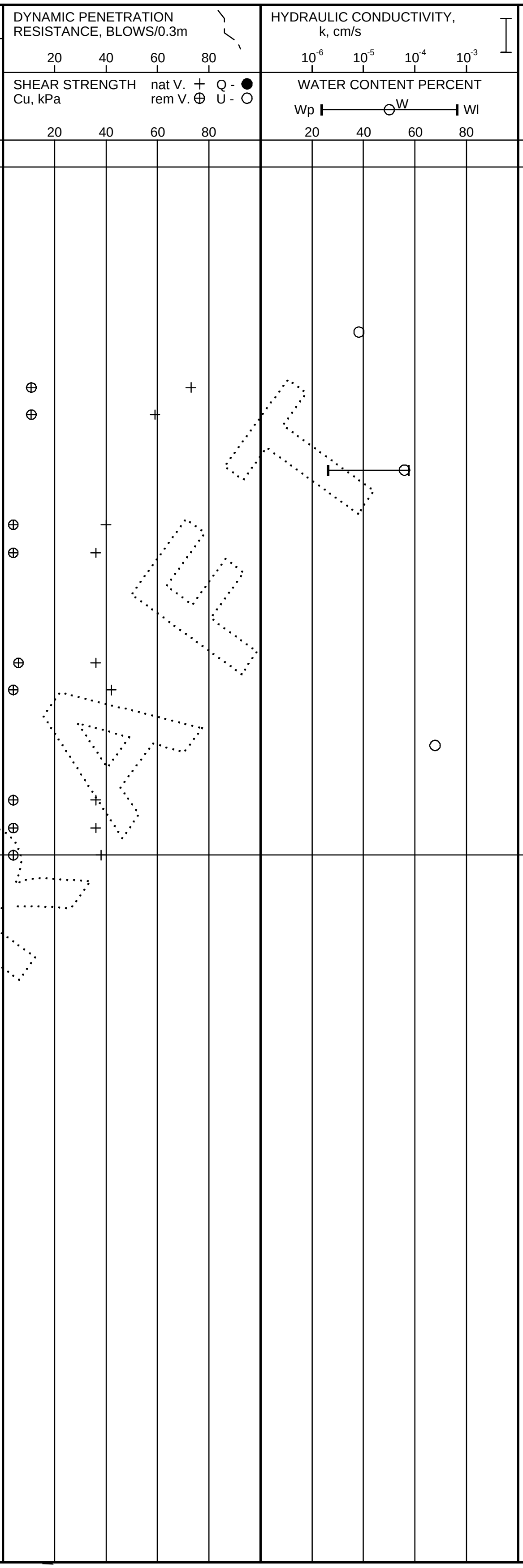
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

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

SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)
Ground Surface		93.54
Dark brown sandy silt, trace organic matter (TOPSOIL)		93.34 0.20
Stiff grey brown SILTY CLAY, trace sand (Weathered Crust)		
Stiff to firm grey SILTY CLAY		90.95 2.59
End of Borehole		85.92 7.62

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	GRAB	
2	50 DO	3
3	50 DO	WH
4	50 DO	PM
5	50 DO	PM
6	50 DO	WH



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: J.A.C.

CHECKED: ________

PROJECT: 09-1121-0027

RECORD OF BOREHOLE: 09-72

SHEET 1 OF 2

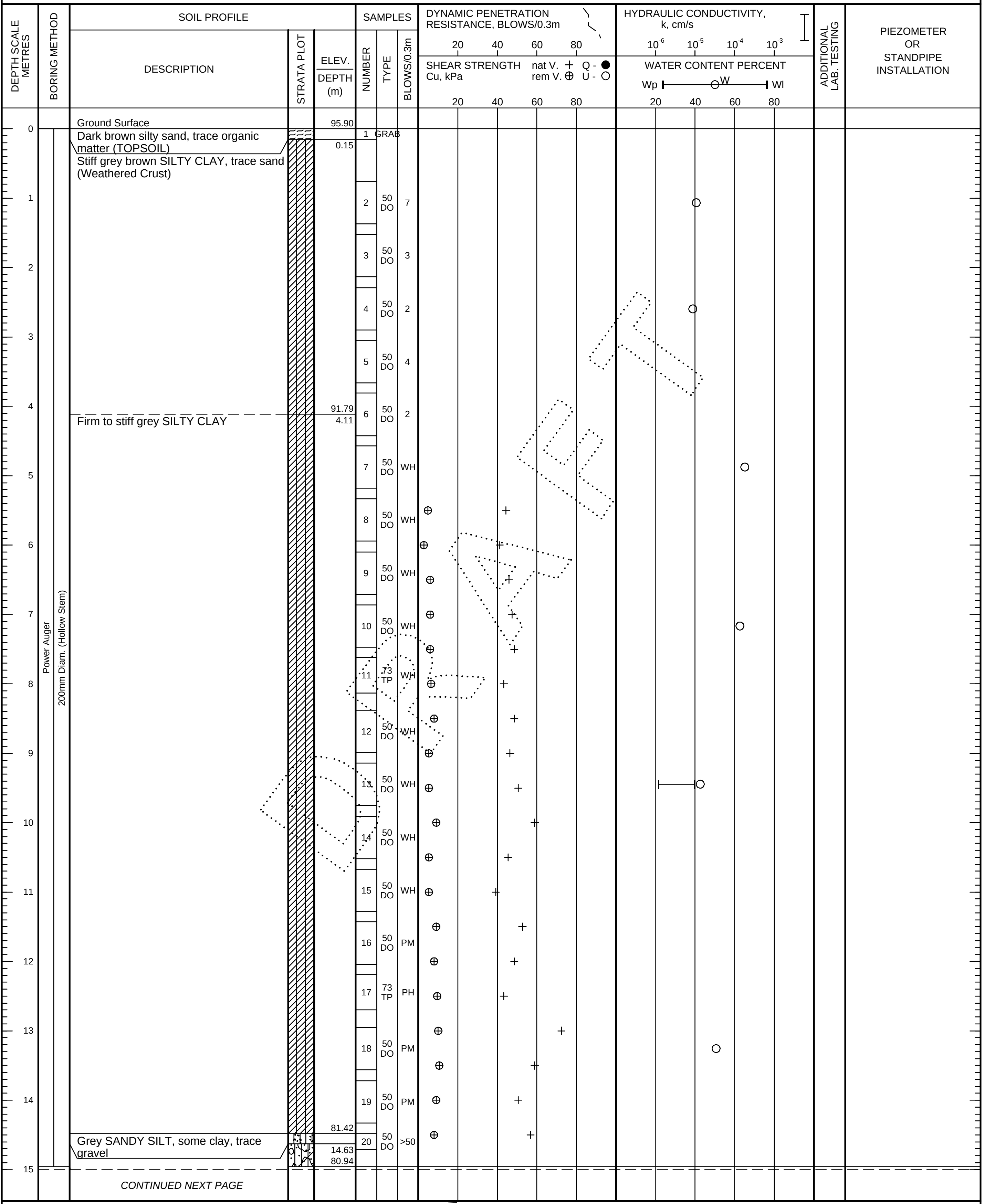
LOCATION: See Site Plan

BORING DATE: June 25, 2009

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm



DESCRIPTION	ELEV. DEPTH (m)
Ground Surface	95.90
Dark brown silty sand, trace organic matter (TOPSOIL)	0.15
Stiff grey brown SILTY CLAY, trace sand (Weathered Crust)	
Firm to stiff grey SILTY CLAY	91.79 4.11
Grey SANDY SILT, some clay, trace gravel	81.42 14.63 80.94

NUMBER	TYPE	BLOWS/0.3m
1	GRAB	
2	50 DO	7
3	50 DO	3
4	50 DO	2
5	50 DO	4
6	50 DO	2
7	50 DO	WH
8	50 DO	WH
9	50 DO	WH
10	50 DO	WH
11	73 TP	WH
12	50 DO	WH
13	50 DO	WH
14	50 DO	WH
15	50 DO	WH
16	50 DO	PM
17	73 TP	PH
18	50 DO	PM
19	50 DO	PM
20	50 DO	>50

CONTINUED NEXT PAGE

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: J.A.C.

CHECKED: ________

PROJECT: 09-1121-0027

RECORD OF BOREHOLE: 09-72

SHEET 2 OF 2

LOCATION: See Site Plan

BORING DATE: June 25, 2009

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
15		Very dense grey SILTY SAND, some gravel, trace clay (GLACIAL TILL) End of Borehole Auger Refusal		14.96							
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											

BOREHOLE 09-1121-0027-1100 (SOILCORE).GPJ HYDROGEO.GDT 9/25/09

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: J.A.C.

CHECKED: ________

PROJECT: 09-1121-0027

RECORD OF BOREHOLE: 09-73

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 29, 2009

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

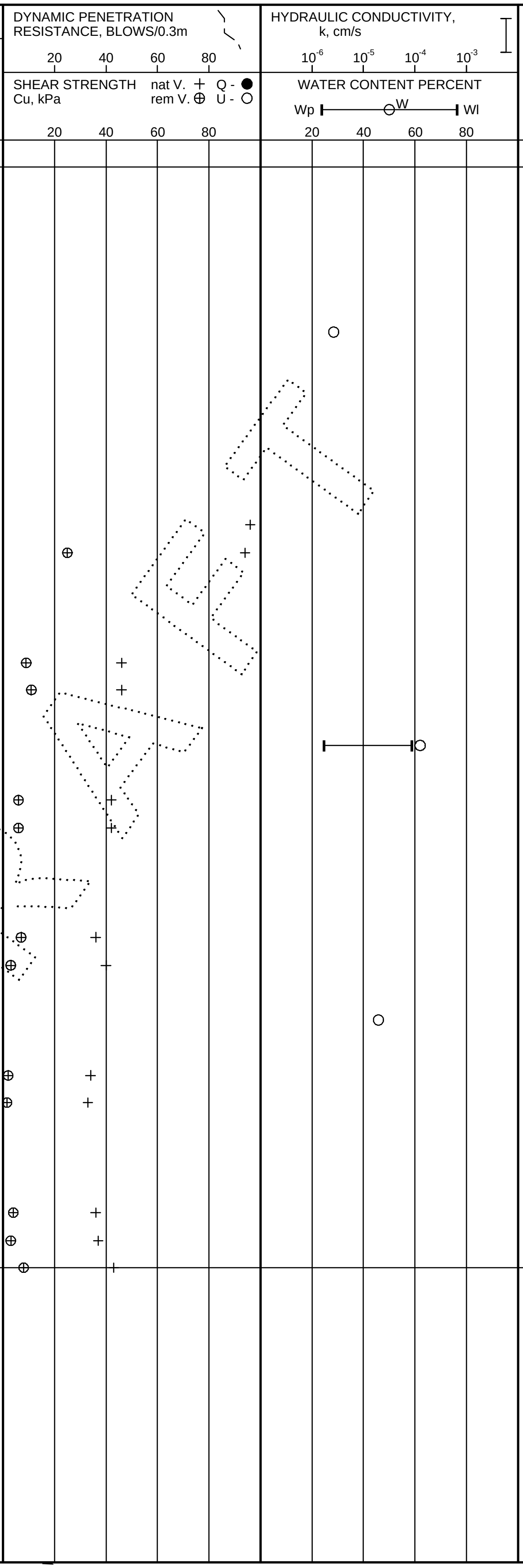
PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES: 0 – 15

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

SOIL PROFILE	
DESCRIPTION	ELEV. DEPTH (m)
Ground Surface	97.70
Brown sandy silt, with organic matter (TOPSOIL)	97.50 0.20
Very stiff grey brown SILTY CLAY, with fine sand seams (Weathered Crust)	
Firm grey SILTY CLAY	93.28 4.42
End of Borehole	85.51 12.19

SAMPLES		
NUMBER	TYPE	BLOWS/0.3m
1	50 DO	8
2	50 DO	5
3	50 DO	3
4	50 DO	2
5	50 DO	WH
6	50 DO	WH
7	50 DO	WH
8	50 DO	PM
9	50 DO	PM



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

W.L. in open hole at 3.66m depth below ground surface upon completion of drilling

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: D.G.

CHECKED: ________

PROJECT: 09-1121-0027

RECORD OF BOREHOLE: 09-74

SHEET 1 OF 1

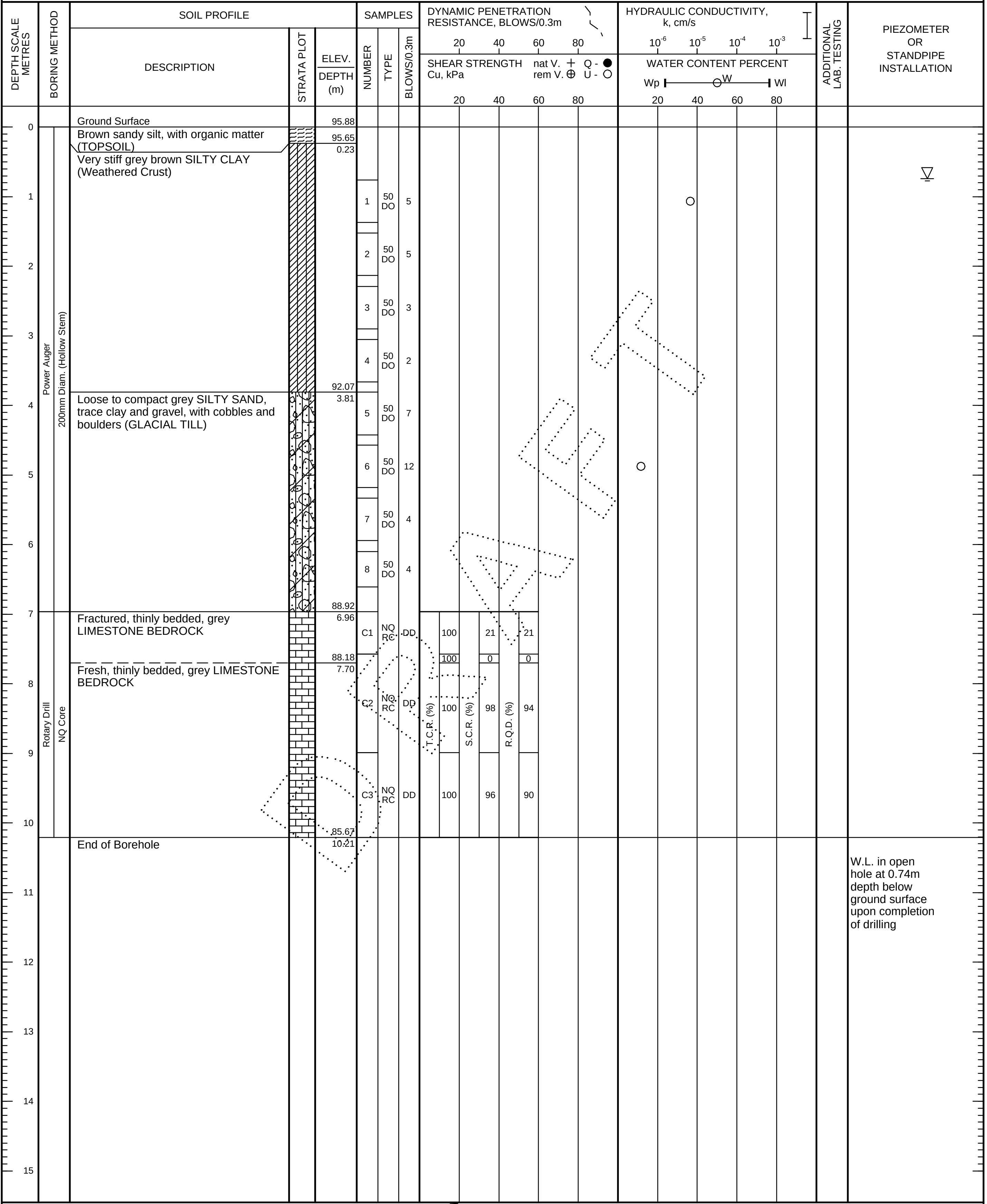
LOCATION: See Site Plan

BORING DATE: June 29, 2009

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm



BORING METHOD	DESCRIPTION	ELEV. DEPTH (m)
	Ground Surface	95.88
Power Auger 200mm Diam. (Hollow Stem)	Brown sandy silt, with organic matter (TOPSOIL)	95.65 0.23
	Very stiff grey brown SILTY CLAY (Weathered Crust)	92.07 3.81
	Loose to compact grey SILTY SAND, trace clay and gravel, with cobbles and boulders (GLACIAL TILL)	88.92 6.96
Rotary Drill NQ Core	Fractured, thinly bedded, grey LIMESTONE BEDROCK	88.18 7.70
	Fresh, thinly bedded, grey LIMESTONE BEDROCK	85.67 10.21
	End of Borehole	

NUMBER	TYPE	BLOWS/0.3m	T.C.R. (%)	S.C.R. (%)	R.Q.D. (%)
1	50 DO	5			
2	50 DO	5			
3	50 DO	3			
4	50 DO	2			
5	50 DO	7			
6	50 DO	12			
7	50 DO	4			
8	50 DO	4			
C1	NQ RC	DD	100	21	21
			100	0	0
C2	NQ RC	DD	100	98	94
C3	NQ RC	DD	100	96	90

∇

W.L. in open hole at 0.74m depth below ground surface upon completion of drilling

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: D.G.

CHECKED: ________

PROJECT: 09-1121-0027

RECORD OF BOREHOLE: 09-75

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 30, 2009

DATUM: Geodetic

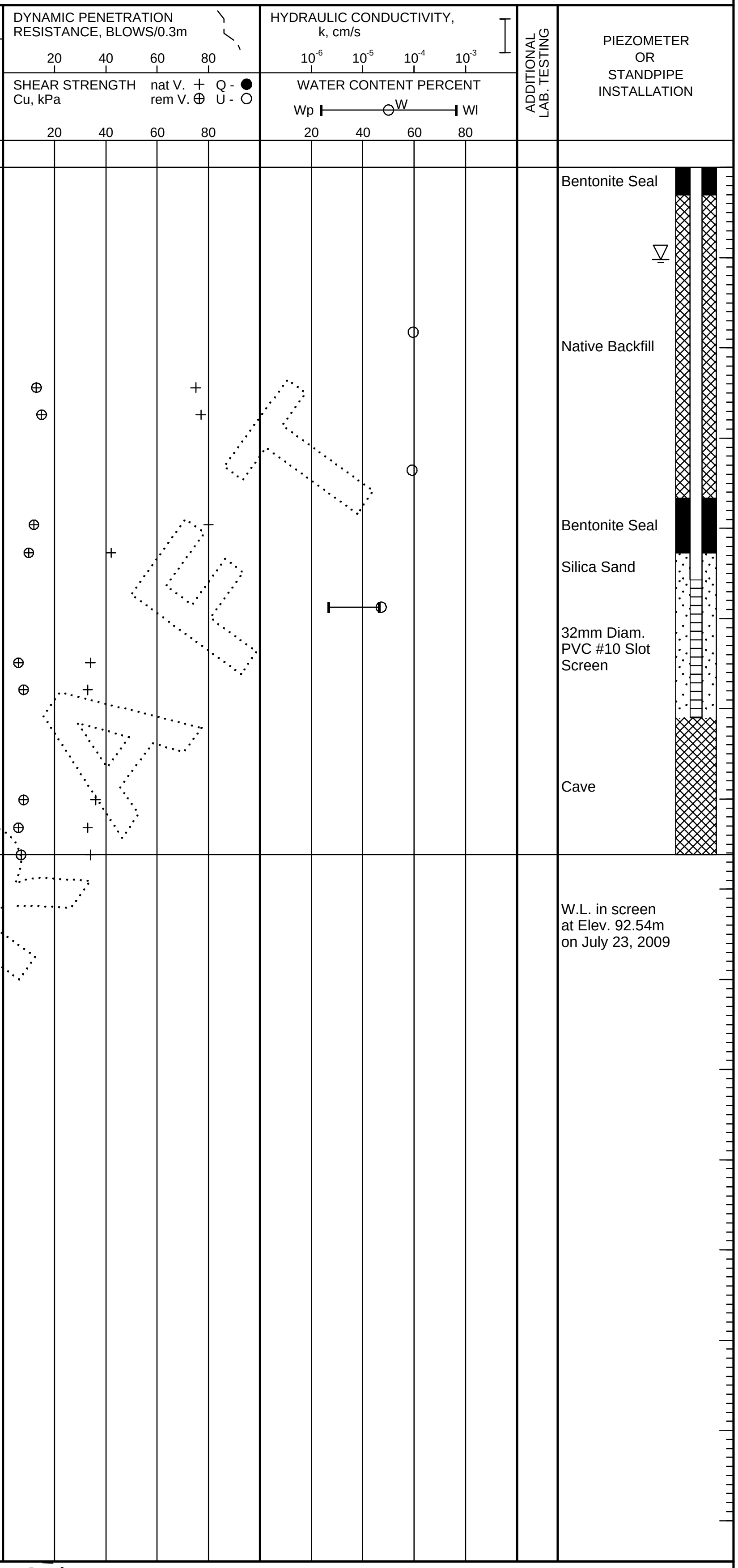
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

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

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
Ground Surface	93.56
Brown sandy silt, with organic matter (TOPSOIL)	93.33 0.23
Very stiff grey brown SILTY CLAY (Weathered Crust)	
Stiff to firm grey SILTY CLAY	91.43 2.13
End of Borehole	85.94 7.62

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	50 DO	3
2	50 DO	2
3	50 DO	1
4	50 DO	WH
5	50 DO	PM



Bentonite Seal

Native Backfill

Bentonite Seal

Silica Sand

32mm Diam. PVC #10 Slot Screen

Cave

W.L. in screen
at Elev. 92.54m
on July 23, 2009

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: D.G.

CHECKED: ________

PROJECT: 09-1121-0027

RECORD OF BOREHOLE: 09-76

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 30, 2009

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface	98.76							
0	Power Auger 200mm Diam. (Hollow Stem)	Brown sandy silt, with organic matter (TOPSOIL)	98.58 0.18							
		Very stiff grey brown SILTY CLAY (Weathered Crust)								
1				1	50 DO	5				
				2	50 DO	10				
2		Grey brown SILTY SAND, some gravel, trace clay (GLACIAL TILL)	96.70 2.16							
		End of Borehole Auger Refusal								Borehole dry upon completion of drilling
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: D.G.

CHECKED: ________

PROJECT: 09-1121-0027

RECORD OF BOREHOLE: 09-77

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 30, 2009

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.3m	T.C.R. (%)	S.C.R. (%)	R.Q.D. (%)
		Ground Surface	96.42						
0	Power Auger 200mm Diam. (Hollow Stem)	Brown sandy silt, trace organic matter (TOPSOIL)		1	GRAB				
		Stiff grey brown SILTY CLAY (Weathered Crust)	96.12 0.30						
1				2	50 DO	10			
2				3	50 DO	5			
				4	50 DO	4			
3				5	50 DO	4			
4				6	50 DO	4			
		Stiff grey brown SILTY CLAY, some sand and gravel seams	91.85 4.57						
5				7	50 DO	2			
				8	50 DO	2			
6	Rotary Drill NQ Core	Fresh, thinly bedded, grey LIMESTONE BEDROCK	90.20 6.22						
7				C1	NQ RC	DD	100	95	79
8				C2	NQ RC	DD	98	92	86
9		End of Borehole	87.12 9.30						
10									
11									
12									
13									
14									
15									

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

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

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

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

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE

1 : 75

LOGGED: J.A.C.

CHECKED: ________

PROJECT: 09-1121-0027

RECORD OF BOREHOLE: 09-78

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 30, 2009

DATUM: Geodetic

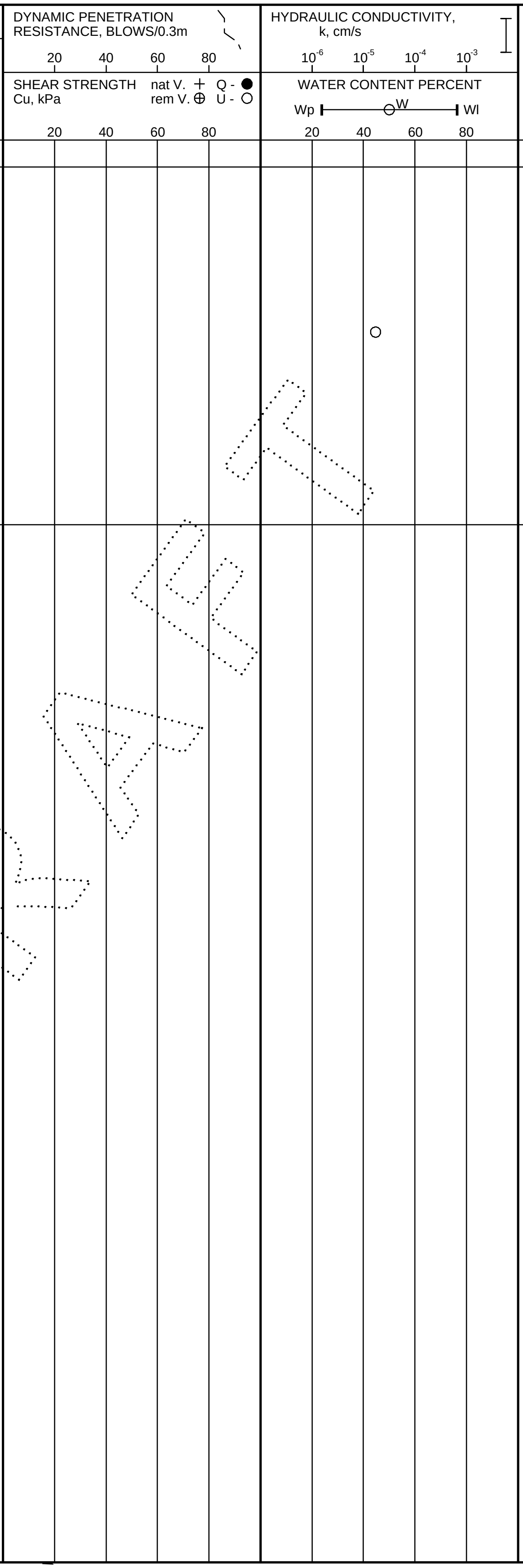
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

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

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
Ground Surface	93.85
Brown sandy silt, trace gravel and organic matter (TOPSOIL)	93.55 0.30
Stiff grey brown SILTY CLAY, some sand seams (Weathered Crust)	91.26 2.59
Loose grey brown SILTY SAND, trace gravel and clay	90.50 3.35
Grey brown SILTY SAND and GRAVEL, trace clay (GLACIAL TILL)	89.89 3.96
End of Borehole Auger Refusal	

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	GRAB	
2	50 DO	10
3	50 DO	10
4	50 DO	5
5	50 DO	30
6	50 DO	>50



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: J.A.C.
CHECKED: ________

PROJECT: 09-1121-0027

RECORD OF BOREHOLE: 09-79

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: July 1, 2009

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

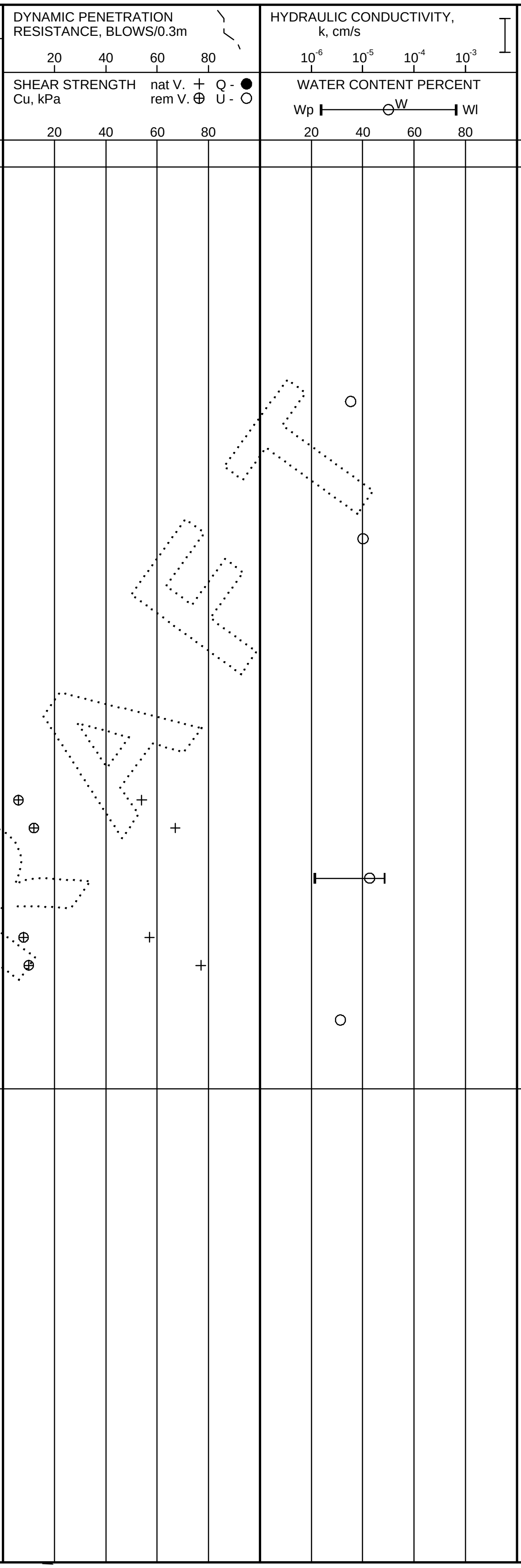
BORING METHOD: Power Auger 200mm Diam. (Hollow Stem)

SOIL PROFILE

DESCRIPTION	ELEV. DEPTH (m)
Ground Surface	97.70
Brown sandy silt, with organic matter (TOPSOIL)	97.47 0.23
Very stiff grey brown SILTY CLAY (Weathered Crust)	
Stiff grey SILTY CLAY	91.30 6.40
Stiff grey SILTY CLAY, with fine grey sand layers	88.56 9.14
Loose grey SILTY SAND, some gravel, trace clay (GLACIAL TILL)	87.95 9.75
End of Borehole Auger Refusal	87.49 10.21

SAMPLES

NUMBER	TYPE	BLOWS/0.3m
1	50 DO	6
2	50 DO	8
3	50 DO	4
4	50 DO	3
5	50 DO	2
6	50 DO	4
7	50 DO	3
8	50 DO	WH
9	73 TP	PH
10	50 DO	WH
11	50 DO	>50



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

∇

W.L. in open hole at 6.40m depth below ground surface upon completion of drilling

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: D.G.

CHECKED: ________

PROJECT: 09-1121-0027

RECORD OF BOREHOLE: 09-80

SHEET 1 OF 1

LOCATION: See Site Plan

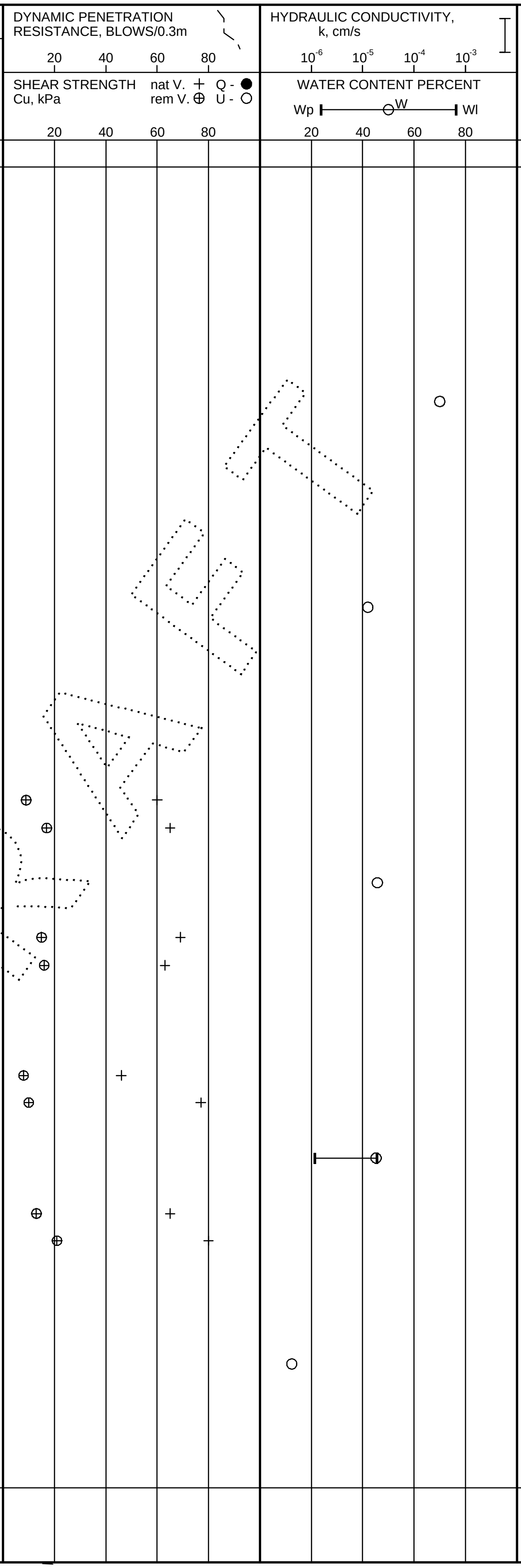
BORING DATE: June 30, 2009

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		99.37					
0	Power Auger 200mm Diam. (Hollow Stem)	Brown sandy silt, with organic matter (TOPSOIL)		99.17 0.20					
		Very stiff grey brown SILTY CLAY (Weathered Crust)							
1					1	50 DO	10		
2					2	50 DO	7		
					3	50 DO	4		
3					4	50 DO	7		
4					5	50 DO	4		
5					6	50 DO	2		
					7	50 DO	3		
6		Stiff grey SILTY CLAY		92.97 6.40	8	50 DO	2		∇
8					9	50 DO	WH		
9					10	50 DO	WH		
11					11	50 DO	WH		
12		Loose grey SILTY SAND, some clay, trace gravel (GLACIAL TILL)		87.18 12.19	12	50 DO	3		
13					13	50 DO	3	M	W.L. in open hole at 6.40m depth below ground surface upon completion of drilling
14					14	50 DO	2		
				84.74	15	50 DO	>50		
15		End of Borehole Auger Refusal		14.63					



DEPTH SCALE

1 : 75

Golder Associates

LOGGED: D.G.

CHECKED: ________

PROJECT: 09-1121-0027

RECORD OF BOREHOLE: 09-81

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 30, 2009

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	ELEV. DEPTH (m)
		Ground Surface	96.35
0	Power Auger 200mm Diam. (Hollow Stem)	Brown silty sand, trace organic matter (TOPSOIL)	96.05
		Brown SANDY SILT	
		Stiff grey brown SILTY CLAY, with sand and gravel seams at depth (Weathered Crust)	0.41
5		Grey brown SILTY SAND, some gravel	91.02
		Dense to very dense grey SILTY SAND, some gravel, trace clay (GLACIAL TILL)	90.86 5.49
7	Rotary Drill NQ Core	Fresh, thinly bedded, grey LIMESTONE BEDROCK	89.64 6.71
10		End of Borehole	86.50 9.85

SAMPLES: NUMBER	TYPE	BLOWS/0.3m	T.C.R. (%)	S.C.R. (%)	R.Q.D. (%)
1	GRAB				
2	GRAB				
3	50 DO	10			
4	50 DO	8			
5	50 DO	7			
6	50 DO	5			
7	50 DO	4			
8	50 DO	8			
9	50 DO	42			
10	50 DO	64			
C1	NQ RC	DD	100	79	52
C2	NQ RC	DD	100	85	48

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

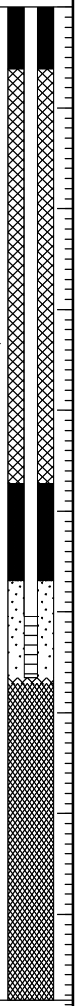
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80

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

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

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



Bentonite Seal

Native Backfill

∇

Bentonite Seal

Silica Sand

32mm Diam. PVC #10 Slot Screen

Bentonite Seal

W.L. in screen at Elev. 93.01m on July 23, 2009

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: D.G.

CHECKED: ________

PROJECT: 09-1121-0027

RECORD OF BOREHOLE: 09-82

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: July 3, 2009

DATUM: Geodetic

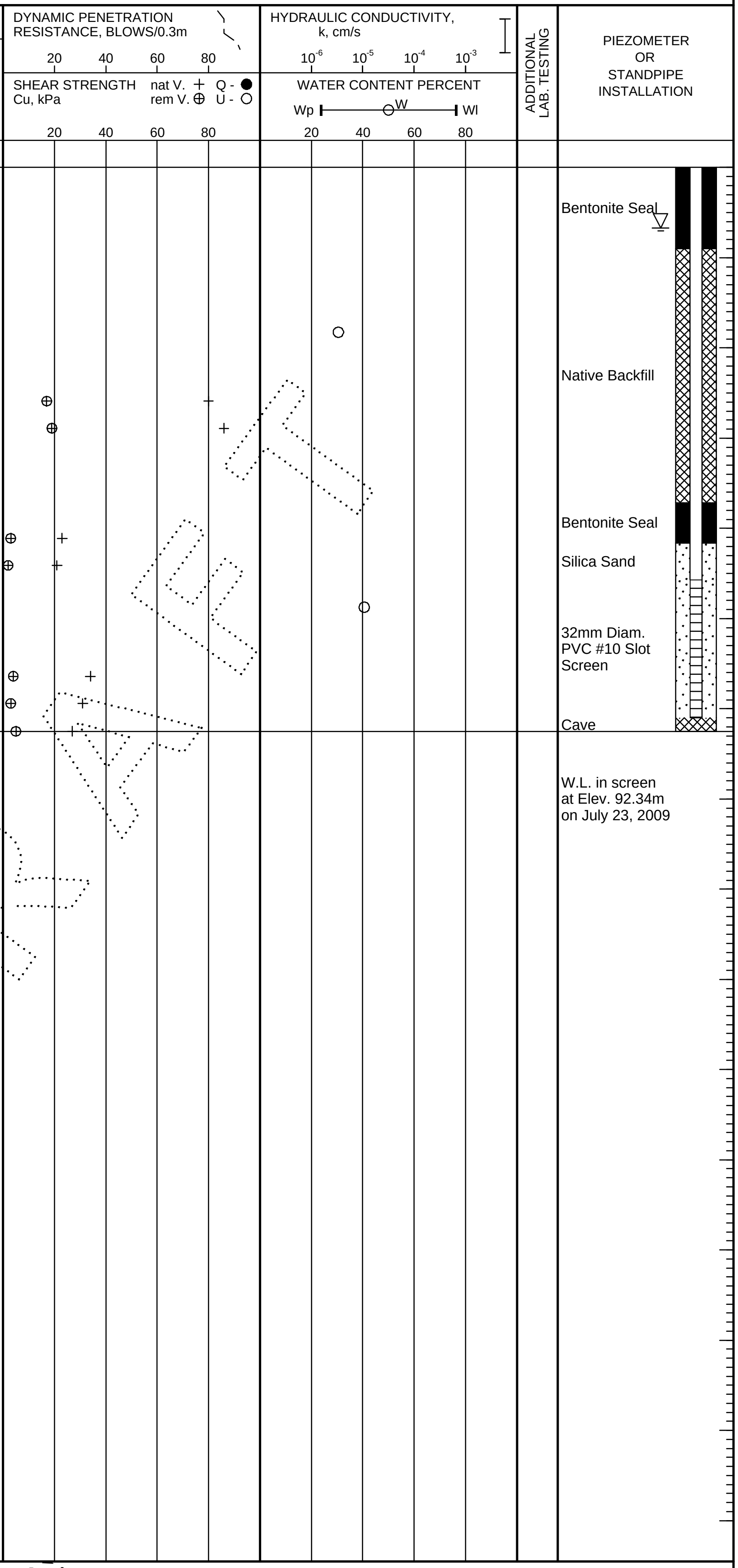
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

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

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
Ground Surface	93.01
Dark brown sandy silt (TOPSOIL)	92.83
Stiff grey brown SILTY CLAY, some sand (Weathered Crust)	0.18
	91.49
Stiff grey brown SILTY CLAY (Weathered Crust)	1.52
	89.66
Soft grey SILTY CLAY	3.35
	87.37
Firm grey SILTY CLAY	5.64
	86.76
End of Borehole	6.25

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	50 DO	3
2	50 DO	PM
3	50 DO	PM
4	50 DO	WH



W.L. in screen at Elev. 92.34m on July 23, 2009

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: D.W.M.

CHECKED: ________

PROJECT: 09-1121-0027

RECORD OF BOREHOLE: 09-83

SHEET 1 OF 1

LOCATION: See Site Plan

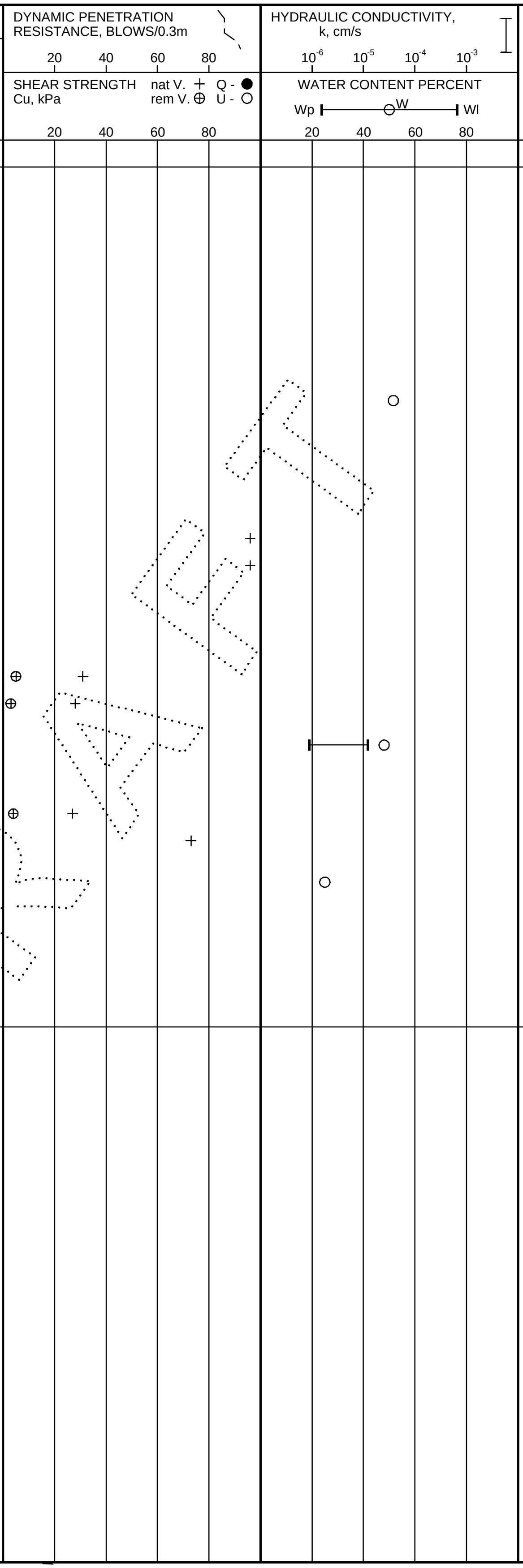
BORING DATE: July 2, 2009

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m
		Ground Surface		94.94			
0	Power Auger 200mm Diam. (Hollow Stem)	Dark brown sandy silt (TOPSOIL)		0.00			
		Very stiff brown SILTY CLAY, trace to some sand (Weathered Crust)		94.48 0.46			
1					1	50 DO	7
2					2	50 DO	7
3					3	50 DO	6
					4	50 DO	2
4		Firm grey SILTY CLAY		90.37 4.57			
5					5	50 DO	PM
6					6	50 DO	PM
7		Very loose to compact grey brown SILTY SAND, trace to some gravel, trace clay, occasional cobble (GLACIAL TILL)		87.70 7.24			
8					7	50 DO	2
9					8	50 DO	>50
		End of Borehole Auger Refusal		85.42 9.52			
10							
11							
12							
13							
14							
15							



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

∇

W.L. in open
hole at 3.66m
depth below
ground surface
upon completion
of drilling

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: D.W.M.

CHECKED: ________

PROJECT: 09-1121-0027

RECORD OF BOREHOLE: 09-84

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: July 6, 2009

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		99.17							
0	Power Auger 200mm Diam. (Hollow Stem)	Dark brown silty sand (TOPSOIL)									
		Very stiff brown SILTY CLAY, trace sand (Weathered Crust)		98.92 0.25							
1					1	50 DO	12				
		Loose brown SILTY SAND, trace gravel (GLACIAL TILL)		97.88 1.29							
					2	50 DO	9				
2		End of Borehole Auger Refusal		96.99 2.18							
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: D.W.M.

CHECKED: ________

PROJECT: 09-1121-0027

RECORD OF BOREHOLE: 09-84A

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: July 6, 2009

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80; SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}; WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		98.76							
0	Power Auger 200mm Diam. (Hollow Stem)	Dark brown silty sand (TOPSOIL)		98.51 0.25							Bentonite Seal
1		Brown SILTY CLAY, trace sand (Weathered Crust)		97.47 1.29							Silica Sand
2		Compact brown SILTY SAND, trace gravel (GLACIAL TILL)		96.47 2.29	1	50 DO	24				32mm Diam. PVC #10 Slot Screen
3		End of Borehole Auger Refusal									Well screen dry on July 23, 2009
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: D.W.M.

CHECKED: ________

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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