NRC·CNRC

Addendum / Addenda

No./No
1

Project Description / Description de projet		
M 38 Flexible Research Facility		
Solicitation No./N° de solicitation	Project No./N° de projet	W.O. No./N° d'ordre de travail
16-22072	5044	A1-006442-01
Departmental Representative / représentant ministériel		Date
Allan Smith		September 13, 2016

Notice:	**Nota**:
This addendum shall form part of the tender documents and all conditions shall apply and be read in conjunction with the original plans and specifications.	Cet addenda fait partie intégrale des dossiers d'appel; toutes les conditions énoncées doivent être lues et appliquées en conjonction avec les plans et les devis originaux.

1 See attached (2) Files in regards to the Geotechnical Survey.
The first file is from Golder dated January 2016 and the second file is Golder- McRostie dated 2008.
The 2008 file is for referance.

END / FIN

July 2008

LIMITED REPORT ON

Geotechnical Considerations NRC CO, H2 and N2 Docking and Piping Facility NRC Montreal Road Campus Blair Road Ottawa, Ontario

Submitted to:
National Research Council Canada
Building M-19
120 Montreal Road
Ottawa, Ontario
K1A 0R6

REPORT

A world of capabilities delivered locally

Report Number: 08-1121-0099

Distribution:

4 copies- National Research Council Canada
2 copies- Golder Associates Ltd.

Golder Associates

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July 23, 2008 Project No. 08-1121-0099

Mr. Bruno Vallieres, Administrative Services and Property Branch
National Research Council Canada
Building M-19
120 Montreal Road
Ottawa, Ontario
K1A 0R6

RE: NRC CO, H2 AND N2
DOCKING AND PIPING FACILITY
NRC MONTREAL ROAD CAMPUS
BLAIR ROAD
OTTAWA, ONTARIO

Dear Mr. Vallieres

Please find attached our limited report on geotechnical considerations for the proposed Docking and Piping Facility to be constructed at the NRC Montreal Road Campus, Blair Road, Ontario.

We trust that this limited report is sufficient for your present requirements. If you have any questions concerning this limited report or, if we can be of further assistance, please let us know.

Yours truly,

GOLDER ASSOCIATES LTD.

M.W. St-Louis, P.Eng.
Senior Geotechnical Engineer

T.J. Nicholas, P.Eng.
Principal

MSTL/TJN/ch

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Golder Associates: Operations in Africa, Asia, Australasia, Europe, North America and South America

Table of Contents

1.0 INTRODUCTION

This limited report addresses geotechnical consideration related to the site of the Docking and Piping Facility to be located on the NRC Montreal Road Campus, Blair Road, Ottawa (see Figure 1, Key Plan). Geotechnical studies had been prepared by McRostie Genest St-Louis (MGS) in 2002 and 2005 (reference reports SF-4553B and SF-4932). The results of the pertinent subsurface information from the above studies are included in this report for completeness.

The purpose of this assignment was to review the general soil and groundwater conditions in the area of the proposed duct bank routes for the docking and piping facility by means of an additional four (4) boreholes (08-1 to 08-4 inclusive) and fourteen (14) test pits (08-5 to 08-17 inclusive and 08-15A) and, based on an interpretation of factual information including that from past subsurface records obtained, to provide engineering guidelines on the geotechnical design aspects of the project, including construction considerations which could influence design decisions.

The reader is referred to the "Important Information and Limitations of this Report", which follows the text but forms and integral part of this document.

2.0 DESCRIPTION OF PROJECT

Plans are being prepared to construct a docking and piping facility at the NRC Montreal Road Campus (see Figure 1, Key Plan). The project will include duct banks within about 2.5 metres of the existing ground surface, foundations for a nitrogen tank that will be about 12 metres in height and 3 metres in diameter supported on three (3) legs, and 3 blast walls to be in compliance with NFP 55 requirements in the docking facility.

Geological mapping indicates that the bedrock underlying this site is sedimentary in nature and consists of limestone of the Bobcaygeon formation.

The site also falls within the Western Québec Seismic Zone (WQSZ) according to Geological Survey of Canada. The WQSZ constitutes a large area that extends from Montréal to Témiscaming, and which encompasses the Ottawa area. Within the WQSZ, recent seismic activity has been concentrated in two (2) subzones; one along the Ottawa River and another more active subzone along the Montréal-Maniwaki axis. Historical seismicity within the WQSZ from 1900 to 2000 includes the 1935 Témiscaming event which had a magnitude (i.e., a measure of the intensity of the earthquake) of 6.2 and in 1944, a Cornwall-Massena event had a magnitude of 5.6. In comparison with other seismically active areas in the world (i.e., California, Japan and New Zealand), the frequency of earthquake activity within the WQSZ is significantly lower but there still exists the potential for significant earthquake events to be generated.

Under the 2006 Ontario Building Code (OBC), a seismic hazard with a 2% probability of exceedance in 50 years has been retained for design. For the subject site, the reference (Site Class C) peak horizontal ground acceleration (PGA) is 0.42g (g = acceleration by gravity) (Adams and Halchuck, 2003).

3.0 PROCEDURE

The field work for this investigation was carried out on June 18, 2008 (test pits) and on July 3 and 4, 2008 (boreholes). At that time fourteen (14) test pits (numbered 08-5 to 08-17 inclusive and 08-15A) and four (4) boreholes (numbered 08-1 to 08-4 inclusive) were put down at the approximate locations shown on the Site Plan, Figure 2.

The test pits were excavated by a rubber tired backhoe. The test pits were advanced to depths of between 0.4 and 2.2 metres below the existing ground surface.

The boreholes were advanced using a track-mounted CME 45 hollow-stem auger drill rig supplied and operated by Marathon Drilling Company Ltd. of Ottawa, Ontario. The boreholes were advanced to depths of between 2.8 and 3.5 metres below the existing ground surface.

Within the boreholes, standard penetration tests (SPT) were carried out at regular intervals of depth and samples of the soils encountered were recovered using drive open sampling equipment. All four (4) boreholes were advanced through the overburden and into the underlying limestone bedrock. In all boreholes, the limestone bedrock was proven for a depth of between 1.5 and 1.7 metres by rotary core drilling in NQ size.

The field work was supervised by an experienced technician from our staff who directed the drilling operations, logged the test pits, the boreholes and samples, directed the in-situ testing and took custody of the soil samples and rock cores.

On completion of the drilling operations, the soil samples and rock cores were transported to our laboratory.

A standpipe was installed in boreholes 08-1 and 08-3 to determine the stabilized groundwater conditions at the site. The groundwater level in the standpipe was measure on July 9, 2008.

The borehole and test pit locations were selected by the National Research Council. Subsequently, the locations and ground surface elevations for the test pits and boreholes for this subsurface investigation were surveyed by Stantec Geomatics Ltd. The ground surface elevations supplied to Golder Associates are understood to be referenced to Geodetic datum.

4.0 SUBSURFACE CONDITIONS

4.1 General

The subsurface conditions encountered during the present 2008 investigation are shown on the Record of Borehole and Record of Test Pit sheets in Appendix A.

The subsurface information from previous studies was compiled as part of the present study and is included in Appendix B.

The subsurface conditions at this site can be generalized as consisting of surficial deposits of topsoil and fill material underlain by glacial till in turn underlain by limestone bedrock. The depth to bedrock is variable at this site.

The following sections provide a more detailed summary of the subsurface conditions encountered within the boreholes and test pits from the present and previous investigations.

4.2 Fill Material and Topsoil

Fill material and/or topsoil were encountered at the existing ground surface and found to range in thickness between 100 millimetres to about 2.15 metres (see Test Pit 08-15). The fill material generally consists of sand, gravel, topsoil, cobbles, boulders and rock blocks but at some locations also contains wood, brick, and concrete. In test pit 08-15, tires were found within the fill.

4.3 Glacial Till

A deposit of glacial till is often found between the surficial layer of fill and/or topsoil and the bedrock surface. The glacial till consists of a heterogeneous mixture of gravel, cobbles and boulders in a matrix of silty sand with a trace of some clay. There are a few locations where no glacial till was encountered and where the fill material and/or topsoil veneers the limestone bedrock.

4.4 Limestone Bedrock

Limestone bedrock underlies the fill material and the glacial till at all boreholes put down as part of the present subsurface investigation.

The bedrock surface varies from elevation 97.5 to 99.3 metres which is about 1.0 to 2.0 metres below the existing ground surface. In borehole 08-1 and 08-3, the upper layer of bedrock was weathered and was sampled using drive open soil sampling equipment over depths of 0.3 and 0.1 metres, respectively. Below this upper bedrock layer, the degree of weathering is moderate to slight.

The Total Core Recovery (TCR) varies from about 88 to 100 percent of the length drilled. The Solid Core Recovery (SCR), the percentage of core that is completely circular in section, ranges fro 67 to 98 percent. The Rock Quality Designation (RQD), the percent length of intact core longer than 100 millimetres, varies between 50 and 77 percent

4.5 Groundwater

The groundwater levels in the two (2) boreholes with standpipes sealed into the underlying limestone bedrock (boreholes 08-1 and 08-3) were measured on July 9, 2008. At that time, groundwater levels varied from about 2.5 to 2.6 metres below the existing ground surface (i.e. about elevations 97.1 to 97.7 metres).

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

5.0 PROPOSED DOCKING AND PIPING FACILITY

5.1 General

This section of the report provides limited engineering guidelines on the geotechnical aspects of the project for the service duct banks, the foundations for the nitrogen tower and the blast wall foundations portion of the project and based on our interpretation of subsurface information and project requirements and is subject to the limitations in the "Important Information and Limitations of This Report" attachment which follows the text of this report.

The professional services retained for this project include only the geotechnical aspects of subsurface conditions at the 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 project and have not been investigated nor addressed.

5.2 Excavations and Site Servicing

Excavations for the installation of site services (duct banks) will be through fill materials, topsoil, glacial till and at some locations will extend into bedrock.

No unusual problems are anticipated in trenching in the overburden using conventional hydraulic excavating equipment, although significant cobble and boulder removal could be required in the glacial till. Furthermore, large rock blocks should also be expected to be present in fill materials. Old concrete foundation walls and basement floor slabs may also be found at some locations as it is understood that buildings were demolished before the construction of the NRC Montreal Road Campus.

It is expected that the bedrock removal for the project will be carried out using drill and blast techniques. Should bedrock removal be carried out by drilling and blasting, special care will be required to prevent overblasting and fracturing of the bedrock below foundation levels.

The blasting should be controlled to limit the peak particle velocities at all adjacent structures such that blast induced damage will be avoided. This will require blast designs by a specialist in this field.

A pre-blast survey should be carried out on all surrounding structures. Selected existing interior and exterior cracks in the structure should be identified during the pre-blast survey and should be monitored for lateral or shear movements by means of glass telltales and/or movement telltales.

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

Frequency Range (Hz)	Vibration Limits (millimeters/second)
<10	5
10 to 40	5 to 50 (sliding scale)
>40	50

These limits should be practical and achievable for most of this project. In areas in close proximity to structures and services, limestone bedrock removal should be accomplished using mechanical methods such as hoe-ramming in conjunction with closely spaced line drilling to establish the limit of the excavation.

5.3 Foundations

It is considered that the proposed nitrogen tank structure and the three (3) blast walls will be founded on spread footings placed on limestone bedrock or by caissons extending into the limestone bedrock layers underlying the site.

For footing design purposes, footings placed directly on limestone bedrock, below any upper weathered zones, may be sized using an Ultimate Limit States (ULS) factored bearing resistance of 1000 kilopascals. Provided that the bedrock surface is properly cleaned of soil or any loose rock fragments at the time of construction, the settlement of footings sized using the above factored bearing resistance should be negligible, therefore, Serviceability Limit States (SLS) need not be considered.

Caissons, as an alternative foundation scheme, could be designed based on a rock socket to concrete bond value of 500 kilopascals (SLS); end bearing should be ignored. In addition, the bond (adhesion) in the upper weathered or fractured zone should also be ignored.

An advantage to the rock socketed caissons is their ability to be reinforced for both downward loading and uplift resistance.

5.4 Rock Anchors

If required, rock anchors could be provided to resist uplift loads on footing type foundations.

The anchors could consist of either grouted or mechanical anchors.

For a group of anchors or for a line of closely spaced anchors, the resistance must consider the potential overlap between the rock masses mobilized by individual anchors. Further guidance, at the final design stage, should be provided for assessing the resistance of a single anchor and the effect of a group of anchors.

5.5 Frost Protection

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

For footings founded on competent bedrock, the requirement for 1.5 or 1.8 metres of earth cover could be waived where it could be shown by check drilling during construction that the bedrock below footing level does not contain any joints filled with frost-susceptible soil.

5.6 Duct Bank Route

The concrete encased duct bank should be made to bear on the bedrock surface or within the bedrock over the entire route for this project in order to prevent conditions of differential support and potential settlement where soil supported.

Excavation of the limestone bedrock would be required at some locations where bedrock is shallow. Lean concrete infill would be required in localized areas where the bedrock surface is somewhat deeper.

5.7 Seismic Site Response Classification

The 2006 OBC contains an updated seismic analysis and design methodology which uses a seismic site response classification system defined by the shear stiffness of the upper 30 metres of ground of interest. Seismic response is now defined by uniform hazard spectra (UHS) corresponding to design earthquake with a probability of exceedance of 2% in 50 years. There are six site classes (from A to F), decreasing in soil stiffness from A (hard rock) to E (soft soil); Site Class F denotes problematic soils for which a site-specific evaluation is required. The site class is used to obtain soil factors (F_a and F_v) used to modify the UHS to account for the effects of site-specific soil conditions on the seismic response of the site to the design earthquake.

To support a site class designation, a shear wave velocity of 700 metres per second was assigned to the limestone bedrock, based on actual measurements in similar bedrock formations. Interpreting the data available indicates that a Site Class C designation would be appropriate. It may be possible to achieve a higher Site Class designation by obtaining site specific shear wave velocities.

5.8 Corrosion and Cement Type

As part of several studies performed by McRostie Genest St.-Louis (MGS) at the NRC Montreal Road Campus over the years, groundwater samples were collected and submitted for chemical analysis related to potential corrosion of buried ferrous elements and sulphate attack on buried concrete elements.

There has not been a history of potential problems with corrosion of exposed ferrous elements or sulphate attack on buried concrete elements.

Based on the past performance of older existing foundations exposed at the time of recent additions to the NRC Montreal Road Campus, concrete made with Type GU Portland cement should be acceptable for substructures.

6.0 ADDITIONAL CONSIDERATIONS

All foundation areas and duct bank trenches should be inspected by experienced geotechnical personnel prior to concreting to ensure that the limestone bedrock having adequate bearing capacity has been reached and that the bearing surfaces have been properly prepared including the removal of fractured bedrock by overblasting.

At the time of writing this report, only conceptual details of the proposed docking and piping facility were available.

We trust that this limited report that only cover the geotechnical aspects within the latter is sufficient for your present requirements. If you have any questions concerning this report or require additional geotechnical recommendations, please call us.

Report Signature Page

GOLDER ASSOCIATES LTD.

Michel St-Louis, P.Eng.
Senior Geotechnical Engineer

Terry J. Nicholas, P.Eng
Principal

MSTL/TJN/sr

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IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

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

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

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

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

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

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

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

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

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

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

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

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

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

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

SPECIAL NOTE
THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT

Golder Associates
Ottawa, Ontario

SCALE	1:25,000
DATE	14 July '08
DESIGN	J.E.M.
CADD	J.E.M.
CHECK	
REVIEW	

FILE No. 0811210099-01.dwg
PROJECT No. 08-1121-0099 REV. 0

TITLE

KEY PLAN

GEOTECHNICAL INVESTIGATION - NRC CO, H_2 & N_2
DOCKING FACILITY, MONTREAL ROAD, OTTAWA, ONTARIO

FIGURE 1

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Drawing file: 0811210099-01.dwg Jul 14, 2008 - 2:28pm

PLOT DATE: July 22, 2008
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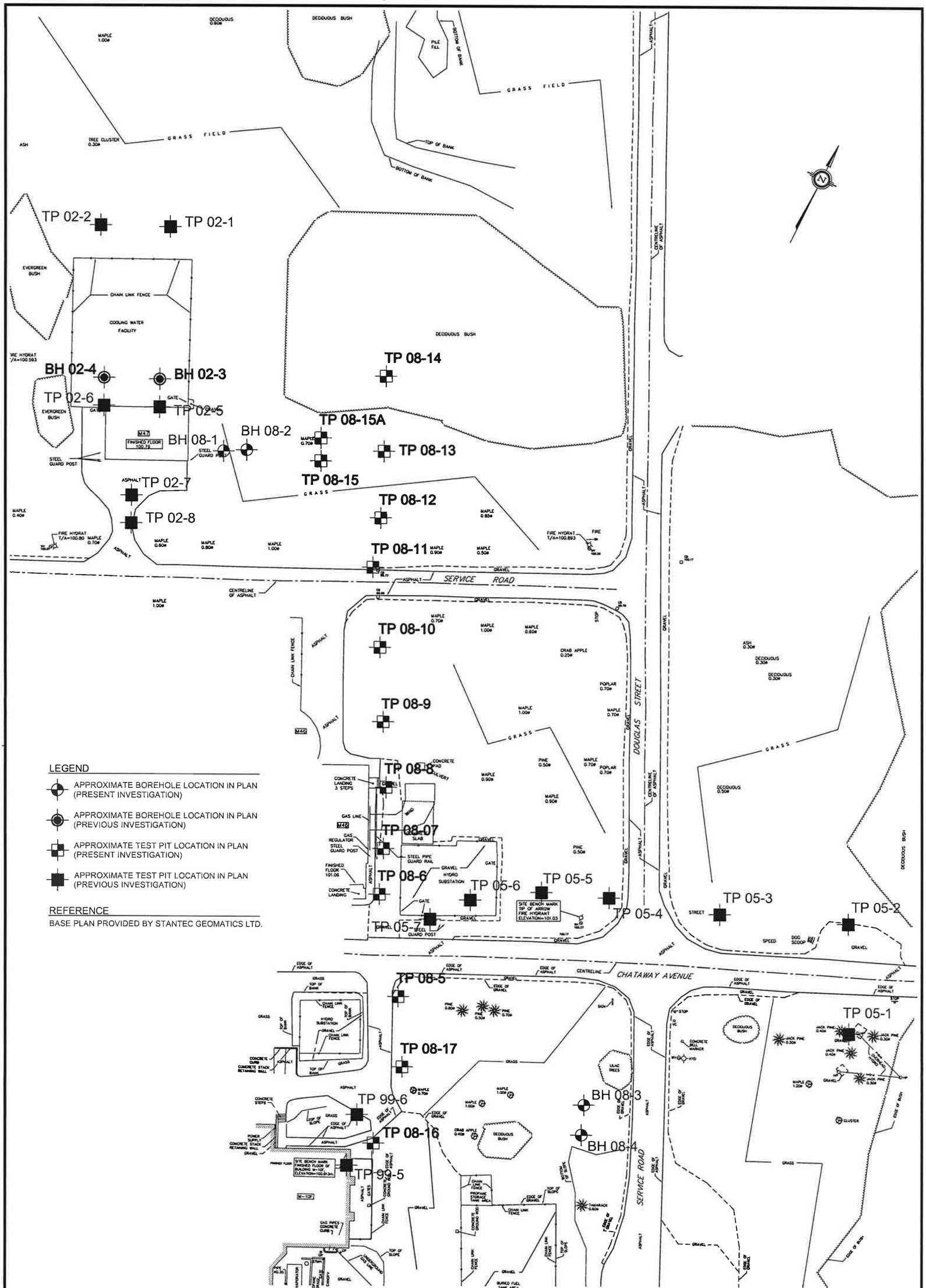

LEGEND

- APPROXIMATE BOREHOLE LOCATION IN PLAN (PRESENT INVESTIGATION)
- APPROXIMATE BOREHOLE LOCATION IN PLAN (PREVIOUS INVESTIGATION)
- APPROXIMATE TEST PIT LOCATION IN PLAN (PRESENT INVESTIGATION)
- APPROXIMATE TEST PIT LOCATION IN PLAN (PREVIOUS INVESTIGATION)

REFERENCE

BASE PLAN PROVIDED BY STANTEC GEOMATICS LTD.

Golder Associates
Ottawa, Ontario

SCALE	1:750
DATE	Jul. 14, 2008
DESIGN	M.ST-L
CAD	J.E.M.
CHECK	
REVIEW	

FILE No. 0811210099-02.dwg
PROJECT No. 08-1121-0099 REV.

TITLE

SITE PLAN

GEOTECHNICAL INVESTIGATION - NRC CO, H_2 & N_2 DOCKING FACILITY
MONTREAL ROAD, OTTAWA, ONTARIO

FIGURE 2

APPENDIX A

Abbreviations and Symbols
Record of Borehole and Test Pit 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

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	$C_{u2}S_u$ 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_l	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_l	liquid limit
w_p	plastic limit
I_p	plasticity Index=(w_l-w_p)
w_s	shrinkage limit
I_L	liquidity index=($w-w_p$)/I_p
I_c	consistency index=(w_l-w)/I_p
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index-(e_{max}-e)/(e_{max}-e_{min}) (formerly relative density)

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

C_c	çompression 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. $\tau=c'\sigma'\tan\phi'$

2. Shear strength=(Compressive strength)/2

PROJECT: 08-1121-0099

RECORD OF BOREHOLE: BH 08-1

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: 4 July 2008

DATUM:

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. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		100.26									
0	Power Auger 200 mm Diam. (Hollow Stem)	Brown sand and gravel, some cobbles and boulders (FILL)		0.00									Native Backfill and Silica Sand
				99.44	1A	DO	31						
1		Grey brown SILTY SAND, some gravel		99.25		DO	50 31						
		Weathered Grey LIMESTONE BEDROCK		1.01									
2	Rotary Drill NQ Core				2	NQ RC	DD	TCR (%) 100; SCR (%) 83; RQD (%) 50					Bentonite Seal; Silica Sand; Slot Screen
				97.43									
3		End of Borehole		2.83									W.L. in screen at elev. 97.73 m on July 9, 2008
4													
5													
6													
7													
8													
9													
10													

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: J.D.

CHECKED: TyS

BOREHOLE 0811210099.GPJ HYDROGEO.GDT 14/7/08

PROJECT: 08-1121-0099

RECORD OF BOREHOLE: BH 08-2

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: July 3, 2008

DATUM:

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	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) (10 20 30 40)	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		100.26							
0	Power Auger 200 mm Diam. (Hollow Stem)	FILL and GLACIAL TILL, with cobbles and boulders		0.00	1	GRAB	-				
					2	NQ RC	DD				
1				99.16	3	50 DO	30				
	Rotary Drill NQ Core	Weathered Grey LIMESTONE BEDROCK		1.10	4	NQ RC	DD	T.C.R. (%) 92; S.C.R. (%) 82; R.Q.D. (%) 77			
2					5	NQ RC	DD	T.C.R. (%) 88; S.C.R. (%) 67; R.Q.D. (%) 52			
				97.49							
		End of Borehole		2.77							
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: J.D.

CHECKED:

BOREHOLE 0811210099.GPJ HYDROGEO.GDT 7/22/08

PROJECT: 08-1121-0099

RECORD OF BOREHOLE: BH 08-3

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: July 3, 2008

DATUM:

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) (10 20 30 40)	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface		99.67							
	Power Auger 200 mm Diam. (Hollow Stem)	Loose brown sand and gravel, some cobbles and boulders (FILL)		0.00							
				98.71	1	50 DO	13				
1		Compact grey brown SILTY SAND, some gravel, cobbles, boulders, trace clay (GLACIAL TILL)		0.90	1A	50 DO	13				Native Backfill and Silica Sand
				98.15							
	Rotary Drill NQ Core	Weathered grey LIMESTONE BEDROCK, some mud seams		1.52	2	50 DO	30				
2								TCR (%) 100	SCR (%) 98	RQD (%) 73	Bentonite Seal
					3	NQ RC	DD				Silica Sand
3											Slot Screen
				90.20							
		End of Borehole		3.47							
4											W.L. in screen at elev. 97.05 m on July 9, 2008
5											
6											
7											
8											
9											
10											

BOREHOLE 0811210099.GPJ HYDROGEO.GDT 7/22/08

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: J.D.

CHECKED:

PROJECT: 08-1121-0099

RECORD OF BOREHOLE: BH 08-4

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: 3 July 2008

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	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. +, rem V. ⊕, Q - ●, U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		99.44							
0	Power Auger 200 mm Diam. (Hollow Stem)	Loose brown sand and gravel, some cobbles and boulders (FILL)		0.00							
				98.59							
1		Compact grey brown SILTY SAND, some gravel, cobbles, boulders, trace clay (GLACIAL TILL)		0.85	1A 1	GRAB 50 DO	- 12				
					2	50 DO	60				
				97.49							
2	Rotary Drill NQ Core	Weathered grey LIMESTONE BEDROCK, some mud seams		1.95							
					3	NQ RC	DD	T.C.R. (%) 100 S.C.R. (%) 94 R.Q.D. (%) 71			
3				95.97							
		End of Borehole		3.47							
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: J.D.

CHECKED:

BOREHOLE 0811210099.GPJ HYDROGEO.GDT 14/7/08

TABLE 1

RECORD OF TEST PITS

Test Pit Number	Depth (Metres)	Description
TP 08-5	0.00 – 0.30	FILL – Brown SAND, GRAVEL and TOPSOIL
(Elevation	0.30 – 1.55	Brown SANDY TILL
100.55 m)	1.55	End of test pit. Refusal on BEDROCK.
TP 08-6	0.00 – 0.20	FILL – Crushed Limestone
(Elevation	0.20 – 0.35	Light brown fine SAND
100.44 m)	0.35 – 1.52	Medium dense brown SANDY TILL
	1.52	End of test pit. Refusal on BEDROCK.
TP 08-7	0.00 – 0.20	FILL – Crushed LIMESTONE
(Elevation	0.20 – 1.30	FILL – Brown SAND, BOULDERS, GRAVEL, pieces of WOOD and BRICK
100.39 m)	1.30 – 1.90	Brown SANDY TILL
	1.90	End of test pit. Refusal on BEDROCK.
TP 08-8	0.00 – 0.25	FILL – Crushed LIMESTONE
(Elevation	0.25 – 0.80	FILL – Brown SAND, GRAVEL, and pieces of BRICK
100.31 m)	0.80 – 1.50	Brown SANDY TILL
	1.50	End of test pit. Refusal on BEDROCK.
TP 08-9	0.00 – 1.00	FILL – Black TOPSOIL, SAND, GRAVEL, and BRICK
(Elevation	1.00	End of test pit. Refusal on BEDROCK.
100.11 m)		
TP 08-10	0.00 – 0.30	Black TOPSOIL
(Elevation	0.30 – 0.70	Brown SANDY TILL
99.89 m)	0.70	End of test pit. Refusal on BEDROCK.
TP 08-11	0.00 – 0.60	FILL – SAND, GRAVEL and BRICK
(Elevation	0.60 – 1.00	WEATHERED BEDROCK
99.77 m)	1.00	End of test pit. Refusal on BEDROCK.

TABLE 1 (continued)

TP 08-12	0.00 – 0.30	Black TOPSOIL and pieces of WEATHERED ROCK
(Elevation	0.30 – 0.50	WEATHERED BEDROCK
100.06 m)	0.50	End of test pit. Refusal on BEDROCK.
TP 08-13	0.00 – 0.15	Black TOPSOIL
(Elevation	0.15 – 0.65	Brown SANDY TILL
100.21 m)	0.65 – 0.80	WEATHERED BEDROCK
	0.80	End of test pit. Refusal on BEDROCK.
TP 08-14	0.00 – 0.30	Black TOPSOIL
(Elevation	0.30 – 0.45	WEATHERED BEDROCK
100.53 m)	0.45	End of test pit. Refusal on BEDROCK.
TP 08-15	0.00 – 0.30	Black TOPSOIL
(Elevation	0.30 – 2.15	FILL – SAND, GRAVEL, pieces of CONCRETE, BRICK,
100.18 m)		TIRES
	2.15	End of test pit. Refusal on BEDROCK.
TP 08-15A	0.00 – 0.20	Black TOPSOIL
(Elevation	0.20 – 0.35	WEATHERED BEDROCK
100.18 m)	0.35	End of test pit. Refusal on BEDROCK.
TP 08-16	0.00 – 0.60	FILL – Crushed LIMESTONE
(Elev.	0.60 – 1.70	Light brown SANDY TILL
100.67 m)	1.70	End of test pit. Refusal on BEDROCK.
TP 08-17	0.00 – 0.30	FILL – Crushed LIMESTONE
(Elev.	0.30 – 0.80	Dark brown SAND and GRAVEL
100.77 m)	0.80 – 2.20	Light brown SANDY TILL
	2.20	End of test pit. Refusal on BEDROCK.

APPENDIX B

Boreholes and Test Pits from Previous Studies

NRC – NEW ELECTRICAL SUB-STATION	B.M.(ELEV 100.20m)geodetic: Floor at	TEST PIT NO: 05-1
	building M-10 at door No. 11	PROJECT NO: E-8890
START DATE: 05/09/02		ELEVATION: 97.54 m

SAMPLE TYPE ■ REMOULDED ⁄ SHELBY TUBE ☒ SPLIT-SPOON ▤ PROBING ▯▯ NO RECOVERY ▮ CORE

DEPTH(m)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	■ VANE Cu (kPa) ■ 80 160 240 320 ▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320 PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(m)
0.0	sides stable			TOPSOIL and ROOTS		
				97.24		97.0
				medium dense sandy TILL		
	no water seepage					
1.0				Bottom of test pit on possible rock 96.74		96.0
2.0						95.0
3.0						94.0
4.0						

McROSTIE GENEST ST-LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 0.8 m
REVIEWED BY: E.S.	COMPLETE: 05/09/02
Fig. No: 2	Page 1 of 1

05/09/20 08:02AM (STD-SHTP)

NRC – NEW ELECTRICAL SUB-STATION	B.M.(ELEV 100.20m) geodetic: Floor at	TEST PIT NO: 05–2
	building M–10, at door No.11	PROJECT NO: E–8890
START DATE: 05/09/02		ELEVATION: 98.02 m

SAMPLE TYPE ■ REMOULDED ⁄ SHELBY TUBE ☒ SPLIT-SPOON ▤ PROBING ▯▯ NO RECOVERY ▮ CORE

DEPTH(m)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	■ VANE Cu (kPa) ■ 80 160 240 320 ▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320 PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(m)
0.0	sides stable			FILL – crushed limestone		98.0
				97.67 medium dense sandy TILL		
	no water seepage			Bottom of test pit on possible rock 97.42		
1.0						97.0
2.0						96.0
3.0						95.0
4.0						

McROSTIE GENEST ST–LOUIS Ottawa, Canada	LOGGED BY: JML	COMPLETION DEPTH: 0.6 m
	REVIEWED BY: E.S.	COMPLETE: 05/09/02
	Fig. No: 3	Page 1 of 1

05/09/20 08:02AM (STD-SHTP)

NRC – NEW ELECTRICAL SUB-STATION	B.M.(ELEV 100.20m) geodetic; Floor of	TEST PIT NO: 05-3
	building M-10 at door No.11	PROJECT NO: E-8890
START DATE: 05/09/02		ELEVATION: 99.43 m

SAMPLE TYPE ■ REMOULDED ⧸ SHELBY TUBE ☒ SPLIT-SPOON ▤ PROBING ▥ NO RECOVERY ▮ CORE

DEPTH(m)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	■ VANE Cu (kPa) ■ 80 160 240 320 ▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320 PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(m)
0.0	sides stable			TOPSOIL		
				99.23		99.0
				medium dense sandy TILL		
	no water seepage					
				Bottom of test pit on possible rock 98.63		
1.0						98.0
2.0						97.0
3.0						96.0
4.0						

McROSTIE GENEST ST-LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 0.8 m
REVIEWED BY: E.S.	COMPLETE: 05/09/02
Fig. No: 4	Page 1 of 1

05/09/20 08:02AM (STD-SHTP)

NRC – NEW ELECTRICAL SUB-STATION	B.M.(ELEV 100.20m)geodetic: Floor of	TEST PIT NO: 05-4
	building M-10 at door No. 11	PROJECT NO: E-8890
START DATE: 05/09/02		ELEVATION: 100.34 m

SAMPLE TYPE ■ REMOULDED ⁄ SHELBY TUBE ☒ SPLIT-SPOON ▤ PROBING ▯▯ NO RECOVERY ▮ CORE

DEPTH(m)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	■ VANE Cu (kPa) ■ 80 160 240 320 ▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320 PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(m)
0.0	sides stable			TOPSOIL		
				100.14		100.0
				medium dense sandy TILL		
1.0						99.0
	no water seepage			Bottom of test pit on possible rock 98.94		
2.0						98.0
3.0						97.0
4.0						

McROSTIE GENEST ST-LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 1.4 m
REVIEWED BY: E.S.	COMPLETE: 05/09/02
Fig. No: 5	Page 1 of 1

05/09/20 08:02AM (STD-SHTP)

NRC – NEW ELECTRICAL SUB-STATION	B.M.(ELEV 100.20m)geodetic; Floor of	TEST PIT NO: 05-5
	building M-10 at door No.11	PROJECT NO: E-8890
START DATE: 05/09/02		ELEVATION: 100.41 m

SAMPLE TYPE ■ REMOULDED ⧸ SHELBY TUBE ☒ SPLIT-SPOON ▤ PROBING ▥ NO RECOVERY ▮ CORE

DEPTH(m)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	■ VANE Cu (kPa) ■ 80 160 240 320 ▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320 PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(m)
0.0	sides stable			TOPSOIL		
				100.16		100.0
				medium dense sandy TILL		
1.0						
	no water seepage					
				Bottom of test pit on possible rock 99.06		99.0
2.0						
						98.0
3.0						
						97.0
4.0						

McROSTIE GENEST ST-LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 1.35 m
REVIEWED BY: E.S.	COMPLETE: 05/09/02
Fig. No: 6	Page 1 of 1

05/09/20 08:02AM (STO-SHTP)

NRC – NEW ELECTRICAL SUB-STATION	B.M.(ELEV 100.20m) geodetic: Floor of	TEST PIT NO: 05-6
	building M-10 at door No.11	PROJECT NO: E-8890
START DATE: 05/09/02		ELEVATION: 100.31 m

SAMPLE TYPE ■ REMOULDED ⁄ SHELBY TUBE ☒ SPLIT-SPOON ▤ PROBING ▥ NO RECOVERY ▮ CORE

DEPTH(m)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	■ VANE Cu (kPa) ■ 80 160 240 320 ▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320 PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(m)
0.0	sides stable			TOPSOIL		100.0
				100.01		
1.0				medium dense sandy TILL		99.0
	no water seepage					
2.0				Bottom of test pit on possible rock 98.51		98.0
3.0						97.0
4.0						

McROSTIE GENEST ST-LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 1.8 m
REVIEWED BY: E.S.	COMPLETE: 05/09/02
Fig. No: 7	Page 1 of 1

05/09/20 08:02AM (STD-SHTP)

NRC – NEW ELECTRICAL SUB-STATION	B.M.(ELEV 100.20m)geodetic; Floor of	TEST PIT NO: 05-7
	building M-10 at door No.11	PROJECT NO: E-8890
START DATE: 05/09/02		ELEVATION: 100.37 m

SAMPLE TYPE ■ REMOULDED ⁄ SHELBY TUBE ☒ SPLIT-SPOON ▤ PROBING ▯▯ NO RECOVERY ▮ CORE

DEPTH(m)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	■ VANE Cu (kPa) ■ 80 160 240 320 ▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320 PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(m)
0.0	sides stable			TOPSOIL		
				100.07		100.0
1.0				medium dense sandy TILL		99.0
	no water seepage					
				Bottom of test pit on possible rock 98.87		
2.0						98.0
3.0						97.0
4.0						

McROSTIE GENEST ST-LOUIS Ottawa, Canada	LOGGED BY: JML	COMPLETION DEPTH: 1.5 m
	REVIEWED BY: E.S.	COMPLETE: 05/09/02
	Fig. No: 8	Page 1 of 1

05/09/20 08:03AM (STD-SHTP)

MONTREAL RD. NRC M-10 & COOLING TOWER	B.M.(ELEV 328.75FT.)geodetic: Floor of	TEST PIT NO: 02-1
NATIONAL RESEARCH COUNCIL CANADA	bldg. M-10 at door No. 11	PROJECT NO: E-8230
START DATE: 02/04/22		ELEVATION: 327.61 ft

SAMPLE TYPE ■ REMOULDED ⁄ SHELBY TUBE ☒ SPLIT-SPOON ▤ PROBING ▯▯ NO RECOVERY ▮ CORE

DEPTH(ft)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	■ VANE Cu (kPa) ■ 80 160 240 320 ▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320 PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(ft)
0.0	sides stable			TOPSOIL		327.0
				327.19 FILL pieces of broken rock in sand & gravel		
1.0						326.0
2.0				325.86 clayey SAND		325.0
3.0						324.0
4.0						323.0
5.0				medium dense sandy TILL 323.03		322.0
	no water seepage			Bottom of pit on probable rock 322.11		
6.0						321.0
7.0						320.0
8.0						319.0
9.0						318.0
10.0						317.0
11.0						316.0
12.0						

McROSTIE GENEST ST-LOUIS Ottawa, Canada	LOGGED BY: JML	COMPLETION DEPTH: 5.5 ft
	REVIEWED BY: E.S.	COMPLETE: 02/04/22
	Fig. No: 2	Page 1 of 1

02/04/30 11:12AM (ST-SHIMP)

MONTREAL RD. NRC M-10 & COOLING TOWER	B.M.(ELEV 328.75FT.)geodetic: Floor of	TEST PIT NO: 02-2
NATIONAL RESEARCH COUNCIL CANADA	bldg. M-10 at door No. 11	PROJECT NO: E-8230
START DATE: 02/04/22		ELEVATION: 327.16 ft

SAMPLE TYPE: REMOULDED | SHELBY TUBE | SPLIT-SPOON | PROBING | NO RECOVERY | CORE

DEPTH(ft)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	VANE Cu (kPa) 80 160 240 320 / VANE Cu REMOULDED (kPa) 80 160 240 320 / PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(ft)
0.0	sides stable			TOPSOIL 326.83		327.0
1.0						326.0
2.0				FILL large pieces of broken rock up to 2.5'x2.5'x 1.0' in sand and gravel with pieces of tin and steel rebar		325.0
3.0						324.0
4.0	no water seepage			Bottom of pit on probable rock 323.16		323.0
5.0						322.0
6.0						321.0
7.0						320.0
8.0						319.0
9.0						318.0
10.0						317.0
11.0						316.0
12.0						315.0

McROSTIE GENEST ST-LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 4 ft
REVIEWED BY: E.S.	COMPLETE: 02/04/22
Fig. No: 3	Page 1 of 1

02/04/30 09:53AM (ST-SHIMP)

MONTREAL RD. NRC M-10 & COOLING TOWER	B.M.(ELEV 328.75FT.)geodetic: Floor of	BOREHOLE NO: 02-3
NATIONAL RESEARCH COUNCIL CANADA	bldg. M-10 at door No. 11	PROJECT NO: E-8230
START DATE: 02/04/26		ELEVATION: 328.76 ft

SAMPLE TYPE: REMOULDED-AUGER | SHELBY TUBE | SPLIT-SPOON | NW-CASING | NO RECOVERY | NQ CORE

DEPTH(ft)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	% CORE RECOVERY	SOIL / ROCK DESCRIPTION	ELEVATION(ft)
0.0					FILL topsoil, sand and gravel	328.0
1.0						
2.0	3/6" 12/2"		1		FILL 327.26 topsoil, sand, gravel and wood	327.0
3.0	split barrel refusal				326.09	326.0
4.0				85	LIMESTONE	325.0
5.0						324.0
6.0					323.34 LIMESTONE	323.0
7.0						322.0
8.0	WL			83	Water level April 29/02 elev 320.34'	321.0
9.0						320.0
10.0						319.0
11.0					318.34 LIMESTONE	318.0
12.0						317.0
13.0				98		316.0
14.0						315.0
15.0						314.0
16.0					313.34 LIMESTONE	313.0
17.0				100		312.0
18.0						311.0
19.0					Bottom of hole 310.34	310.0
20.0						309.0
21.0						308.0
22.0						307.0
23.0						306.0
24.0						305.0
25.0						304.0

VANE Cu (kPa) 80 160 240 320
▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320
PLASTIC M.C. LIQUID
20 40 60 80

McROSTIE GENEST ST-LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 18.42 ft
REVIEWED BY: E.S.	COMPLETE: 02/04/26
Fig. No: 4	Page 1 of 1

02/05/01 02:02PM (NQ-IMP)

MONTREAL RD. NRC M-10 & COOLING TOWER	B.M.(ELEV 328.75FT.)geodetic: Floor of	BOREHOLE NO: 02-4
NATIONAL RESEARCH COUNCIL CANADA	bldg. M-10 at door No. 11	PROJECT NO: E-8230
START DATE: 02/04/26		ELEVATION: 328.41 ft

SAMPLE TYPE: REMOULDED-AUGER | SHELBY TUBE | SPLIT-SPOON | NW-CASING | NO RECOVERY | NQ CORE

DEPTH(ft)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	% CORE RECOVERY	SOIL / ROCK DESCRIPTION	ELEVATION(ft)
0.0					TOPSOIL	328.0
1.0	6/6" 20/6"		1		topsoil, sand and gravel	327.0
2.0	split barrel refusal				FILL 327.41	326.0
3.0					topsoil, sand, gravel sandy TILL 326.41	325.0
4.0						324.0
5.0				100	LIMESTONE 324.16	323.0
6.0					323.16 LIMESTONE	322.0
7.0	WL					321.0
8.0				80	Water level April 29/02 elev 320.99'	320.0
9.0						319.0
10.0					318.16	318.0
11.0					LIMESTONE	317.0
12.0						316.0
13.0				100		315.0
14.0						314.0
15.0					313.16	313.0
16.0					LIMESTONE	312.0
17.0				100		311.0
18.0					Bottom of hole 310.33	310.0
19.0						309.0
20.0						308.0
21.0						307.0
22.0						306.0
23.0						305.0
24.0						304.0
25.0						

VANE Cu (kPa) 80 160 240 320
▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320
PLASTIC M.C. LIQUID
20 40 60 80

McROSTIE GENEST ST-LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 18.08 ft
REVIEWED BY: E.S.	COMPLETE: 02/04/26
Fig. No: 5	Page 1 of 1

02/05/01 01:43PM (NQ-IMP)

MONTREAL RD. NRC M-10 & COOLING TOWER	B.M.(ELEV 328.75FT.)geodetic: Floor of	TEST PIT NO: 02-5
NATIONAL RESEARCH COUNCIL CANADA	bldg. M-10 at door No. 11	PROJECT NO: E-8230
START DATE: 02/04/22		ELEVATION: 328.93 ft

SAMPLE TYPE ■ REMOULDED ⧸ SHELBY TUBE ⊠ SPLIT-SPOON ▤ PROBING ▯▯ NO RECOVERY ▮ CORE

DEPTH(ft)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	■ VANE Cu (kPa) ■ 80 160 240 320 ▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320 PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(ft)
0.0	sides stable			FILL large pieces of broken rock up to (2.5'x2.5'x1.0') in sand and gravel		328.0
1.0						
2.0						327.0
3.0	no water seepage			medium dense sandy TILL 326.43		326.0
4.0				Bottom of pit on probable rock 325.76		325.0
5.0						324.0
6.0						323.0
7.0						322.0
8.0						321.0
9.0						320.0
10.0						319.0
11.0						318.0
12.0						317.0

McROSTIE GENEST ST-LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 3.25 ft
REVIEWED BY: E.S	COMPLETE: 02/04/22
Fig. No: 6	Page 1 of 1

02/04/30 11:12AM (ST-SHIMP)

MONTREAL RD. NRC M-10 & COOLING TOWER	B.M.(ELEV 328.75FT.)geodetic: Floor of	TEST PIT NO: 02-6
NATIONAL RESEARCH COUNCIL CANADA	bldg. M-10 at door No. 11	PROJECT NO: E-8230
START DATE: 02/04/22		ELEVATION: 328.77 ft

SAMPLE TYPE ■ REMOULDED ⁄ SHELBY TUBE ☒ SPLIT-SPOON ▤ PROBING ▥ NO RECOVERY ▮ CORE

DEPTH(ft)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	ELEVATION(ft)
0.0	sides stable			TOPSOIL	
				328.19	328.0
1.0				FILL rock blocks in sand and gravel	
				326.77	327.0
2.0				medium dense sandy TILL	
3.0	no water seepage			Bottom of pit on 325.77 probable rock	326.0
4.0					325.0
5.0					324.0
6.0					323.0
7.0					322.0
8.0					321.0
9.0					320.0
10.0					319.0
11.0					318.0
12.0					317.0

■ VANE Cu (kPa) ■ 80 160 240 320
▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320
PLASTIC M.C. LIQUID 20 40 60 80

McROSTIE GENEST ST-LOUIS Ottawa, Canada	LOGGED BY: JML	COMPLETION DEPTH: 3 ft
	REVIEWED BY: E.S.	COMPLETE: 02/04/22
	Fig. No: 7	Page 1 of 1

02/04/30 09:53AM (ST-SHIMP)

MONTREAL RD. NRC M-10 & COOLING TOWER	B.M.(ELEV 328.75FT.)geodetic: Floor of	TEST PIT NO: 02-7
NATIONAL RESEARCH COUNCIL CANADA	bldg. M-10 at door No. 11	PROJECT NO: E-8230
START DATE: 02/04/22		ELEVATION: 328.36 ft

SAMPLE TYPE ■ REMOULDED ⁄ SHELBY TUBE ☒ SPLIT-SPOON ▤ PROBING ▯▯ NO RECOVERY ▮ CORE

DEPTH(ft)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	■ VANE Cu (kPa) ■ 80 160 240 320 ▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320 PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(ft)
0.0	sides stable			FILL topsoil with a trace of brick		328.0
1.0				327.69 FILL large pieces of broken rock up to (2.5'x2.5'x1.0') in sand and gravel with traces of concrete and metal		327.0
2.0						326.0
3.0						325.0
4.0						324.0
5.0						323.0
6.0	no water seepage			Bottom of pit on probable rock 322.36		322.0
7.0						321.0
8.0						320.0
9.0						319.0
10.0						318.0
11.0						317.0
12.0						316.0

McROSTIE GENEST ST-LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 6 ft
REVIEWED BY: E.S.	COMPLETE: 02/04/22
Fig. No: 8	Page 1 of 1

02/04/30 09:53AM (ST-SHIMP)

MONTREAL RD. NRC M-10 & COOLING TOWER	B.M.(ELEV 328.75FT.)geodetic: Floor of	TEST PIT NO: 02-8
NATIONAL RESEARCH COUNCIL CANADA	bldg. M-10 at door No. 11	PROJECT NO: E-8230
START DATE: 02/04/22		ELEVATION: 328.08 ft

SAMPLE TYPE ■ REMOULDED ▨ SHELBY TUBE ▩ SPLIT-SPOON ▤ PROBING ▯ NO RECOVERY ▮ CORE

DEPTH(ft)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	■ VANE Cu (kPa) ■ 80 160 240 320 ▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320 PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(ft)
0.0	sides stable			TOPSOIL		328.0
				327.41		
1.0				FILL large pieces of broken rock up to (2.5'x2.5'x1.0') in sandy soil and traces of brick		327.0
2.0						326.0
3.0				medium dense sandy TILL 325.08		325.0
4.0	no water seepage			Bottom of pit on probable rock 324.08		324.0
5.0						323.0
6.0						322.0
7.0						321.0
8.0						320.0
9.0						319.0
10.0						318.0
11.0						317.0
12.0						316.0

McROSTIE GENEST ST-LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 4 ft
REVIEWED BY: E.S.	COMPLETE: 02/04/22
Fig. No: 9	Page 1 of 1

02/04/30 09:54AM (ST-SHIMP)

McROSTIE GENEST ST-LOUIS & Associates Ltd. Consulting Engineers OTTAWA, CANADA	TEST PIT RECORD	Test Pit No. 99-6
	Date :	JUNE 11, 1999

N.R.C. BLDG. M-10 ADDITION
MONTREAL ROAD

ELEV. 329.23	DEPTH in feet	DESCRIPTION	REMARKS
		TOPSOIL	sides stable
328.41	0.82		
328.23	-- 1 --	BOULDERS up to 1.6' O in dense sandy TILL	
327.23	-- 2 --		
326.23	-- 3 --		
325.62	3.61	Bottom of pit on probable rock	no water seepage

Plate No.
8

McROSTIE GENEST ST-LOUIS & Associates Ltd. Consulting Engineers OTTAWA, CANADA	TEST PIT RECORD	Test Pit No. 99-5
	Date :	JUNE 11, 1999

N.R.C. BLDG. M-10 ADDITION
MONTREAL ROAD

ELEV. 328.54	DEPTH in feet	DESCRIPTION	REMARKS
			sides stable
		FILL crushed limestone	
327.54	-- 1 --		
327.23	1.31		
		dense sandy TILL	
326.54	-- 2 --		
325.54	-- 3 --		
325.26	3.28		no water seepage
		Bottom of pit on probable rock	

Plate No.
7

Golder Associates

July 23, 2008 Project No. 08-1121-0099

Mr. Bruno Vallieres, Administrative Services and Property Branch
National Research Council Canada
Building M-19
120 Montreal Road
Ottawa, Ontario
K1A 0R6

RE: NRC CO, H2 AND N2
DOCKING AND PIPING FACILITY
NRC MONTREAL ROAD CAMPUS
BLAIR ROAD
OTTAWA, ONTARIO

Dear Mr. Vallieres

Please find attached our limited report on geotechnical considerations for the proposed Docking and Piping Facility to be constructed at the NRC Montreal Road Campus, Blair Road, Ontario.

We trust that this limited report is sufficient for your present requirements. If you have any questions concerning this limited report or, if we can be of further assistance, please let us know.

Yours truly,

GOLDER ASSOCIATES LTD.

M.W. St-Louis, P.Eng.
Senior Geotechnical Engineer

T.J. Nicholas, P.Eng.
Principal

MSTL/TJN/ch

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Table of Contents

1.0 INTRODUCTION

This limited report addresses geotechnical consideration related to the site of the Docking and Piping Facility to be located on the NRC Montreal Road Campus, Blair Road, Ottawa (see Figure 1, Key Plan). Geotechnical studies had been prepared by McRostie Genest St-Louis (MGS) in 2002 and 2005 (reference reports SF-4553B and SF-4932). The results of the pertinent subsurface information from the above studies are included in this report for completeness.

The purpose of this assignment was to review the general soil and groundwater conditions in the area of the proposed duct bank routes for the docking and piping facility by means of an additional four (4) boreholes (08-1 to 08-4 inclusive) and fourteen (14) test pits (08-5 to 08-17 inclusive and 08-15A) and, based on an interpretation of factual information including that from past subsurface records obtained, to provide engineering guidelines on the geotechnical design aspects of the project, including construction considerations which could influence design decisions.

The reader is referred to the "Important Information and Limitations of this Report", which follows the text but forms and integral part of this document.

2.0 DESCRIPTION OF PROJECT

Plans are being prepared to construct a docking and piping facility at the NRC Montreal Road Campus (see Figure 1, Key Plan). The project will include duct banks within about 2.5 metres of the existing ground surface, foundations for a nitrogen tank that will be about 12 metres in height and 3 metres in diameter supported on three (3) legs, and 3 blast walls to be in compliance with NFP 55 requirements in the docking facility.

Geological mapping indicates that the bedrock underlying this site is sedimentary in nature and consists of limestone of the Bobcaygeon formation.

The site also falls within the Western Québec Seismic Zone (WQSZ) according to Geological Survey of Canada. The WQSZ constitutes a large area that extends from Montréal to Témiscaming, and which encompasses the Ottawa area. Within the WQSZ, recent seismic activity has been concentrated in two (2) subzones; one along the Ottawa River and another more active subzone along the Montréal-Maniwaki axis. Historical seismicity within the WQSZ from 1900 to 2000 includes the 1935 Témiscaming event which had a magnitude (i.e., a measure of the intensity of the earthquake) of 6.2 and in 1944, a Cornwall-Massena event had a magnitude of 5.6. In comparison with other seismically active areas in the world (i.e., California, Japan and New Zealand), the frequency of earthquake activity within the WQSZ is significantly lower but there still exists the potential for significant earthquake events to be generated.

Under the 2006 Ontario Building Code (OBC), a seismic hazard with a 2% probability of exceedance in 50 years has been retained for design. For the subject site, the reference (Site Class C) peak horizontal ground acceleration (PGA) is 0.42g (g = acceleration by gravity) (Adams and Halchuck, 2003).

3.0 PROCEDURE

The field work for this investigation was carried out on June 18, 2008 (test pits) and on July 3 and 4, 2008 (boreholes). At that time fourteen (14) test pits (numbered 08-5 to 08-17 inclusive and 08-15A) and four (4) boreholes (numbered 08-1 to 08-4 inclusive) were put down at the approximate locations shown on the Site Plan, Figure 2.

The test pits were excavated by a rubber tired backhoe. The test pits were advanced to depths of between 0.4 and 2.2 metres below the existing ground surface.

The boreholes were advanced using a track-mounted CME 45 hollow-stem auger drill rig supplied and operated by Marathon Drilling Company Ltd. of Ottawa, Ontario. The boreholes were advanced to depths of between 2.8 and 3.5 metres below the existing ground surface.

Within the boreholes, standard penetration tests (SPT) were carried out at regular intervals of depth and samples of the soils encountered were recovered using drive open sampling equipment. All four (4) boreholes were advanced through the overburden and into the underlying limestone bedrock. In all boreholes, the limestone bedrock was proven for a depth of between 1.5 and 1.7 metres by rotary core drilling in NQ size.

The field work was supervised by an experienced technician from our staff who directed the drilling operations, logged the test pits, the boreholes and samples, directed the in-situ testing and took custody of the soil samples and rock cores.

On completion of the drilling operations, the soil samples and rock cores were transported to our laboratory.

A standpipe was installed in boreholes 08-1 and 08-3 to determine the stabilized groundwater conditions at the site. The groundwater level in the standpipe was measure on July 9, 2008.

The borehole and test pit locations were selected by the National Research Council. Subsequently, the locations and ground surface elevations for the test pits and boreholes for this subsurface investigation were surveyed by Stantec Geomatics Ltd. The ground surface elevations supplied to Golder Associates are understood to be referenced to Geodetic datum.

4.0 SUBSURFACE CONDITIONS

4.1 General

The subsurface conditions encountered during the present 2008 investigation are shown on the Record of Borehole and Record of Test Pit sheets in Appendix A.

The subsurface information from previous studies was compiled as part of the present study and is included in Appendix B.

The subsurface conditions at this site can be generalized as consisting of surficial deposits of topsoil and fill material underlain by glacial till in turn underlain by limestone bedrock. The depth to bedrock is variable at this site.

The following sections provide a more detailed summary of the subsurface conditions encountered within the boreholes and test pits from the present and previous investigations.

4.2 Fill Material and Topsoil

Fill material and/or topsoil were encountered at the existing ground surface and found to range in thickness between 100 millimetres to about 2.15 metres (see Test Pit 08-15). The fill material generally consists of sand, gravel, topsoil, cobbles, boulders and rock blocks but at some locations also contains wood, brick, and concrete. In test pit 08-15, tires were found within the fill.

4.3 Glacial Till

A deposit of glacial till is often found between the surficial layer of fill and/or topsoil and the bedrock surface. The glacial till consists of a heterogeneous mixture of gravel, cobbles and boulders in a matrix of silty sand with a trace of some clay. There are a few locations where no glacial till was encountered and where the fill material and/or topsoil veneers the limestone bedrock.

4.4 Limestone Bedrock

Limestone bedrock underlies the fill material and the glacial till at all boreholes put down as part of the present subsurface investigation.

The bedrock surface varies from elevation 97.5 to 99.3 metres which is about 1.0 to 2.0 metres below the existing ground surface. In borehole 08-1 and 08-3, the upper layer of bedrock was weathered and was sampled using drive open soil sampling equipment over depths of 0.3 and 0.1 metres, respectively. Below this upper bedrock layer, the degree of weathering is moderate to slight.

The Total Core Recovery (TCR) varies from about 88 to 100 percent of the length drilled. The Solid Core Recovery (SCR), the percentage of core that is completely circular in section, ranges fro 67 to 98 percent. The Rock Quality Designation (RQD), the percent length of intact core longer than 100 millimetres, varies between 50 and 77 percent

4.5 Groundwater

The groundwater levels in the two (2) boreholes with standpipes sealed into the underlying limestone bedrock (boreholes 08-1 and 08-3) were measured on July 9, 2008. At that time, groundwater levels varied from about 2.5 to 2.6 metres below the existing ground surface (i.e. about elevations 97.1 to 97.7 metres).

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

5.0 PROPOSED DOCKING AND PIPING FACILITY

5.1 General

This section of the report provides limited engineering guidelines on the geotechnical aspects of the project for the service duct banks, the foundations for the nitrogen tower and the blast wall foundations portion of the project and based on our interpretation of subsurface information and project requirements and is subject to the limitations in the "Important Information and Limitations of This Report" attachment which follows the text of this report.

The professional services retained for this project include only the geotechnical aspects of subsurface conditions at the 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 project and have not been investigated nor addressed.

5.2 Excavations and Site Servicing

Excavations for the installation of site services (duct banks) will be through fill materials, topsoil, glacial till and at some locations will extend into bedrock.

No unusual problems are anticipated in trenching in the overburden using conventional hydraulic excavating equipment, although significant cobble and boulder removal could be required in the glacial till. Furthermore, large rock blocks should also be expected to be present in fill materials. Old concrete foundation walls and basement floor slabs may also be found at some locations as it is understood that buildings were demolished before the construction of the NRC Montreal Road Campus.

It is expected that the bedrock removal for the project will be carried out using drill and blast techniques. Should bedrock removal be carried out by drilling and blasting, special care will be required to prevent overblasting and fracturing of the bedrock below foundation levels.

The blasting should be controlled to limit the peak particle velocities at all adjacent structures such that blast induced damage will be avoided. This will require blast designs by a specialist in this field.

A pre-blast survey should be carried out on all surrounding structures. Selected existing interior and exterior cracks in the structure should be identified during the pre-blast survey and should be monitored for lateral or shear movements by means of glass telltales and/or movement telltales.

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

Frequency Range (Hz)	Vibration Limits (millimeters/second)
<10	5
10 to 40	5 to 50 (sliding scale)
>40	50

These limits should be practical and achievable for most of this project. In areas in close proximity to structures and services, limestone bedrock removal should be accomplished using mechanical methods such as hoe-ramming in conjunction with closely spaced line drilling to establish the limit of the excavation.

5.3 Foundations

It is considered that the proposed nitrogen tank structure and the three (3) blast walls will be founded on spread footings placed on limestone bedrock or by caissons extending into the limestone bedrock layers underlying the site.

For footing design purposes, footings placed directly on limestone bedrock, below any upper weathered zones, may be sized using an Ultimate Limit States (ULS) factored bearing resistance of 1000 kilopascals. Provided that the bedrock surface is properly cleaned of soil or any loose rock fragments at the time of construction, the settlement of footings sized using the above factored bearing resistance should be negligible, therefore, Serviceability Limit States (SLS) need not be considered.

Caissons, as an alternative foundation scheme, could be designed based on a rock socket to concrete bond value of 500 kilopascals (SLS); end bearing should be ignored. In addition, the bond (adhesion) in the upper weathered or fractured zone should also be ignored.

An advantage to the rock socketed caissons is their ability to be reinforced for both downward loading and uplift resistance.

5.4 Rock Anchors

If required, rock anchors could be provided to resist uplift loads on footing type foundations.

The anchors could consist of either grouted or mechanical anchors.

For a group of anchors or for a line of closely spaced anchors, the resistance must consider the potential overlap between the rock masses mobilized by individual anchors. Further guidance, at the final design stage, should be provided for assessing the resistance of a single anchor and the effect of a group of anchors.

5.5 Frost Protection

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

For footings founded on competent bedrock, the requirement for 1.5 or 1.8 metres of earth cover could be waived where it could be shown by check drilling during construction that the bedrock below footing level does not contain any joints filled with frost-susceptible soil.

5.6 Duct Bank Route

The concrete encased duct bank should be made to bear on the bedrock surface or within the bedrock over the entire route for this project in order to prevent conditions of differential support and potential settlement where soil supported.

Excavation of the limestone bedrock would be required at some locations where bedrock is shallow. Lean concrete infill would be required in localized areas where the bedrock surface is somewhat deeper.

5.7 Seismic Site Response Classification

The 2006 OBC contains an updated seismic analysis and design methodology which uses a seismic site response classification system defined by the shear stiffness of the upper 30 metres of ground of interest. Seismic response is now defined by uniform hazard spectra (UHS) corresponding to design earthquake with a probability of exceedance of 2% in 50 years. There are six site classes (from A to F), decreasing in soil stiffness from A (hard rock) to E (soft soil); Site Class F denotes problematic soils for which a site-specific evaluation is required. The site class is used to obtain soil factors (F_a and F_v) used to modify the UHS to account for the effects of site-specific soil conditions on the seismic response of the site to the design earthquake.

To support a site class designation, a shear wave velocity of 700 metres per second was assigned to the limestone bedrock, based on actual measurements in similar bedrock formations. Interpreting the data available indicates that a Site Class C designation would be appropriate. It may be possible to achieve a higher Site Class designation by obtaining site specific shear wave velocities.

5.8 Corrosion and Cement Type

As part of several studies performed by McRostie Genest St.-Louis (MGS) at the NRC Montreal Road Campus over the years, groundwater samples were collected and submitted for chemical analysis related to potential corrosion of buried ferrous elements and sulphate attack on buried concrete elements.

There has not been a history of potential problems with corrosion of exposed ferrous elements or sulphate attack on buried concrete elements.

Based on the past performance of older existing foundations exposed at the time of recent additions to the NRC Montreal Road Campus, concrete made with Type GU Portland cement should be acceptable for substructures.

6.0 ADDITIONAL CONSIDERATIONS

All foundation areas and duct bank trenches should be inspected by experienced geotechnical personnel prior to concreting to ensure that the limestone bedrock having adequate bearing capacity has been reached and that the bearing surfaces have been properly prepared including the removal of fractured bedrock by overblasting.

At the time of writing this report, only conceptual details of the proposed docking and piping facility were available.

We trust that this limited report that only cover the geotechnical aspects within the latter is sufficient for your present requirements. If you have any questions concerning this report or require additional geotechnical recommendations, please call us.

Report Signature Page

GOLDER ASSOCIATES LTD.

Michel St-Louis, P.Eng.
Senior Geotechnical Engineer

Terry J. Nicholas, P.Eng
Principal

MSTL/TJN/sr

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IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

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

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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.

SPECIAL NOTE
THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT

Golder Associates
Ottawa, Ontario

SCALE	1:25,000
DATE	14 July '08
DESIGN	J.E.M.
CADD	J.E.M.
CHECK	
REVIEW	

FILE No. 0811210099-01.dwg
PROJECT No. 08-1121-0099 REV. 0

TITLE

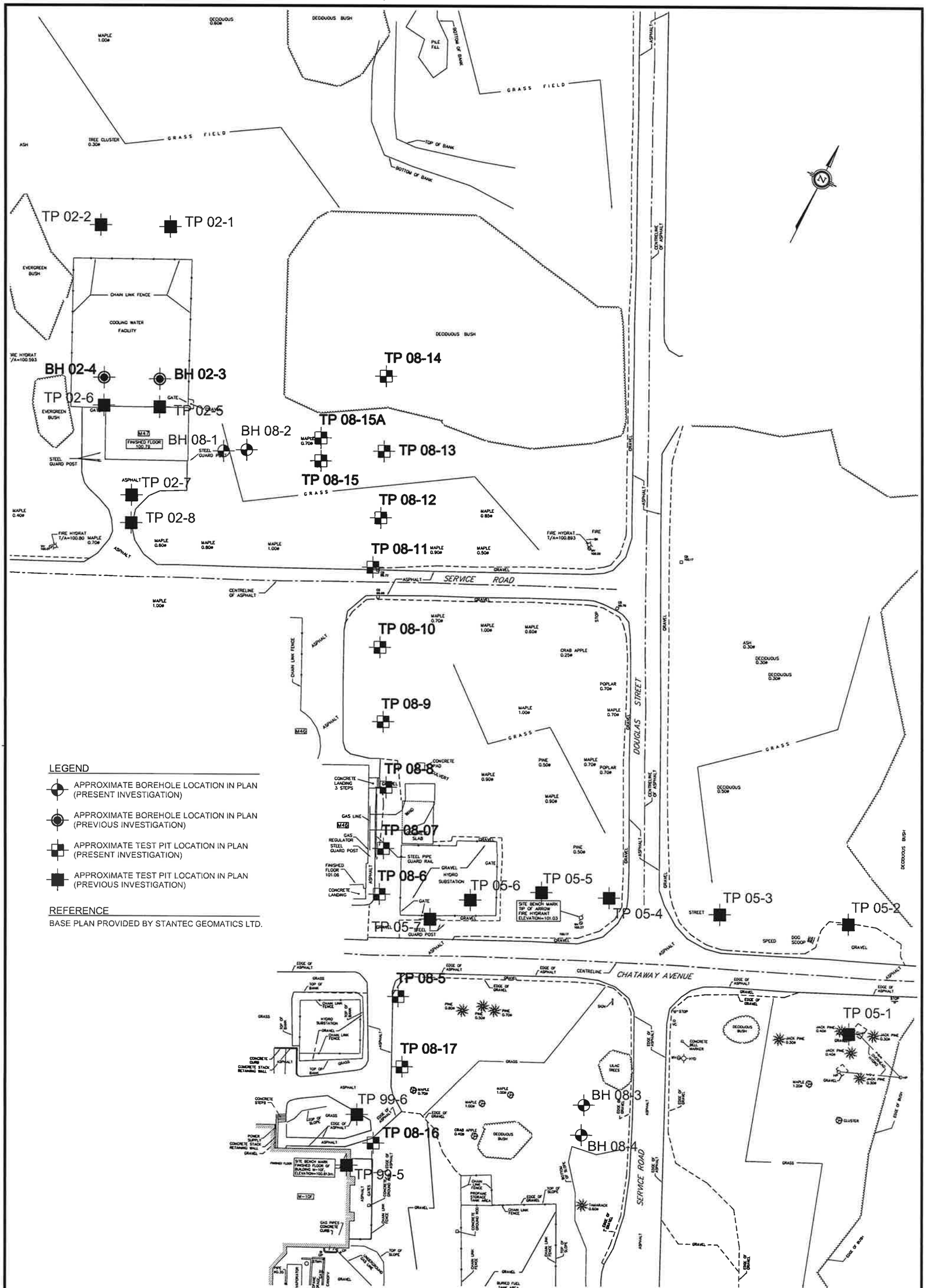
KEY PLAN

GEOTECHNICAL INVESTIGATION - NRC CO, H_2 & N_2
DOCKING FACILITY, MONTREAL ROAD, OTTAWA, ONTARIO

FIGURE 1

FILENAME: N:\Active\2008\1121 - Geotechnical\08-1121-0099\ACAD\0811210099-01.dwg
Drawing file: 0811210099-01.dwg Jul 14, 2008 - 2:28pm

PLOT DATE: July 22, 2008
FILENAME: N:\Active\2008\1121 - Geotechnical\08-1121-0099\ACAD\0811210099-02.dwg



LEGEND

- APPROXIMATE BOREHOLE LOCATION IN PLAN (PRESENT INVESTIGATION)
- APPROXIMATE BOREHOLE LOCATION IN PLAN (PREVIOUS INVESTIGATION)
- APPROXIMATE TEST PIT LOCATION IN PLAN (PRESENT INVESTIGATION)
- APPROXIMATE TEST PIT LOCATION IN PLAN (PREVIOUS INVESTIGATION)

REFERENCE

BASE PLAN PROVIDED BY STANTEC GEOMATICS LTD.

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Ottawa, Ontario

SCALE	1:750
DATE	Jul. 14, 2008
DESIGN	M.ST-L
CAD	J.E.M.
CHECK	
REVIEW	

FILE No. 0811210099-02.dwg
PROJECT No. 08-1121-0099 REV.

TITLE

SITE PLAN

GEOTECHNICAL INVESTIGATION - NRC CO, H_2 & N_2 DOCKING FACILITY
MONTREAL ROAD, OTTAWA, ONTARIO

FIGURE 2

APPENDIX A

Abbreviations and Symbols
Record of Borehole and Test Pit 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

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	$C_{u2}S_u$ 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_l	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_l	liquid limit
w_p	plastic limit
I_p	plasticity Index=(w_l-w_p)
w_s	shrinkage limit
I_L	liquidity index=($w-w_p$)/I_p
I_c	consistency index=(w_l-w)/I_p
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index-(e_{max}-e)/(e_{max}-e_{min}) (formerly relative density)

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

C_c	çompression 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. $\tau=c'\sigma'\tan\phi'$

2. Shear strength=(Compressive strength)/2

PROJECT: 08-1121-0099

RECORD OF BOREHOLE: BH 08-1

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: 4 July 2008

DATUM:

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. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		100.26									
0	Power Auger 200 mm Diam. (Hollow Stem)	Brown sand and gravel, some cobbles and boulders (FILL)		0.00									Native Backfill and Silica Sand
				99.44	1A	DO	31						
1		Grey brown SILTY SAND, some gravel		99.25		DO	50 31						
		Weathered Grey LIMESTONE BEDROCK		1.01									
2	Rotary Drill NQ Core				2	NQ RC	DD	TCR (%) 100; SCR (%) 83; RQD (%) 50					Bentonite Seal; Silica Sand; Slot Screen
				97.43									
3		End of Borehole		2.83									W.L. in screen at elev. 97.73 m on July 9, 2008
4													
5													
6													
7													
8													
9													
10													

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: J.D.

CHECKED: TyS

BOREHOLE 0811210099.GPJ HYDROGEO.GDT 14/7/08

PROJECT: 08-1121-0099

RECORD OF BOREHOLE: BH 08-2

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: July 3, 2008

DATUM:

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	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) (10 20 30 40)	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		100.26							
0	Power Auger 200 mm Diam. (Hollow Stem)	FILL and GLACIAL TILL, with cobbles and boulders		0.00	1	GRAB	-				
					2	NQ RC	DD				
1				99.16	3	50 DO	30				
	Rotary Drill NQ Core	Weathered Grey LIMESTONE BEDROCK		1.10	4	NQ RC	DD	T.C.R. (%) 92; S.C.R. (%) 82; R.Q.D. (%) 77			
2					5	NQ RC	DD	T.C.R. (%) 88; S.C.R. (%) 67; R.Q.D. (%) 52			
				97.49							
		End of Borehole		2.77							
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: J.D.

CHECKED:

BOREHOLE 0811210099.GPJ HYDROGEO.GDT 7/22/08

PROJECT: 08-1121-0099

RECORD OF BOREHOLE: BH 08-3

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: July 3, 2008

DATUM:

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) (10 20 30 40)	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface		99.67							
	Power Auger 200 mm Diam. (Hollow Stem)	Loose brown sand and gravel, some cobbles and boulders (FILL)		0.00							
				98.71	1	50 DO	13				
1		Compact grey brown SILTY SAND, some gravel, cobbles, boulders, trace clay (GLACIAL TILL)		0.90	1A	50 DO	13				Native Backfill and Silica Sand
				98.15							
	Rotary Drill NQ Core	Weathered grey LIMESTONE BEDROCK, some mud seams		1.52	2	50 DO	30				
2								TCR (%) 100	SCR (%) 98	RQD (%) 73	Bentonite Seal
					3	NQ RC	DD				Silica Sand
3											Slot Screen
				90.20							
		End of Borehole		3.47							
4											W.L. in screen at elev. 97.05 m on July 9, 2008
5											
6											
7											
8											
9											
10											

BOREHOLE 0811210099.GPJ HYDROGEO.GDT 7/22/08

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: J.D.

CHECKED:

PROJECT: 08-1121-0099

RECORD OF BOREHOLE: BH 08-4

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: 3 July 2008

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	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. +, rem V. ⊕, Q - ●, U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		99.44							
0	Power Auger 200 mm Diam. (Hollow Stem)	Loose brown sand and gravel, some cobbles and boulders (FILL)		0.00							
				98.59							
1		Compact grey brown SILTY SAND, some gravel, cobbles, boulders, trace clay (GLACIAL TILL)		0.85	1A 1	GRAB 50 DO	- 12				
					2	50 DO	60				
				97.49							
2	Rotary Drill NQ Core	Weathered grey LIMESTONE BEDROCK, some mud seams		1.95							
					3	NQ RC	DD	T.C.R. (%) 100 S.C.R. (%) 94 R.Q.D. (%) 71			
3				95.97							
		End of Borehole		3.47							
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: J.D.

CHECKED:

BOREHOLE 0811210099.GPJ HYDROGEO.GDT 14/7/08

TABLE 1

RECORD OF TEST PITS

Test Pit Number	Depth (Metres)	Description
TP 08-5	0.00 – 0.30	FILL – Brown SAND, GRAVEL and TOPSOIL
(Elevation	0.30 – 1.55	Brown SANDY TILL
100.55 m)	1.55	End of test pit. Refusal on BEDROCK.
TP 08-6	0.00 – 0.20	FILL – Crushed Limestone
(Elevation	0.20 – 0.35	Light brown fine SAND
100.44 m)	0.35 – 1.52	Medium dense brown SANDY TILL
	1.52	End of test pit. Refusal on BEDROCK.
TP 08-7	0.00 – 0.20	FILL – Crushed LIMESTONE
(Elevation	0.20 – 1.30	FILL – Brown SAND, BOULDERS, GRAVEL, pieces of WOOD and BRICK
100.39 m)	1.30 – 1.90	Brown SANDY TILL
	1.90	End of test pit. Refusal on BEDROCK.
TP 08-8	0.00 – 0.25	FILL – Crushed LIMESTONE
(Elevation	0.25 – 0.80	FILL – Brown SAND, GRAVEL, and pieces of BRICK
100.31 m)	0.80 – 1.50	Brown SANDY TILL
	1.50	End of test pit. Refusal on BEDROCK.
TP 08-9	0.00 – 1.00	FILL – Black TOPSOIL, SAND, GRAVEL, and BRICK
(Elevation	1.00	End of test pit. Refusal on BEDROCK.
100.11 m)		
TP 08-10	0.00 – 0.30	Black TOPSOIL
(Elevation	0.30 – 0.70	Brown SANDY TILL
99.89 m)	0.70	End of test pit. Refusal on BEDROCK.
TP 08-11	0.00 – 0.60	FILL – SAND, GRAVEL and BRICK
(Elevation	0.60 – 1.00	WEATHERED BEDROCK
99.77 m)	1.00	End of test pit. Refusal on BEDROCK.

TABLE 1 (continued)

TP 08-12	0.00 – 0.30	Black TOPSOIL and pieces of WEATHERED ROCK
(Elevation	0.30 – 0.50	WEATHERED BEDROCK
100.06 m)	0.50	End of test pit. Refusal on BEDROCK.
TP 08-13	0.00 – 0.15	Black TOPSOIL
(Elevation	0.15 – 0.65	Brown SANDY TILL
100.21 m)	0.65 – 0.80	WEATHERED BEDROCK
	0.80	End of test pit. Refusal on BEDROCK.
TP 08-14	0.00 – 0.30	Black TOPSOIL
(Elevation	0.30 – 0.45	WEATHERED BEDROCK
100.53 m)	0.45	End of test pit. Refusal on BEDROCK.
TP 08-15	0.00 – 0.30	Black TOPSOIL
(Elevation	0.30 – 2.15	FILL – SAND, GRAVEL, pieces of CONCRETE, BRICK,
100.18 m)		TIRES
	2.15	End of test pit. Refusal on BEDROCK.
TP 08-15A	0.00 – 0.20	Black TOPSOIL
(Elevation	0.20 – 0.35	WEATHERED BEDROCK
100.18 m)	0.35	End of test pit. Refusal on BEDROCK.
TP 08-16	0.00 – 0.60	FILL – Crushed LIMESTONE
(Elev.	0.60 – 1.70	Light brown SANDY TILL
100.67 m)	1.70	End of test pit. Refusal on BEDROCK.
TP 08-17	0.00 – 0.30	FILL – Crushed LIMESTONE
(Elev.	0.30 – 0.80	Dark brown SAND and GRAVEL
100.77 m)	0.80 – 2.20	Light brown SANDY TILL
	2.20	End of test pit. Refusal on BEDROCK.

APPENDIX B

Boreholes and Test Pits from Previous Studies

NRC – NEW ELECTRICAL SUB-STATION	B.M.(ELEV 100.20m)geodetic: Floor at	TEST PIT NO: 05-1
	building M-10 at door No. 11	PROJECT NO: E-8890
START DATE: 05/09/02		ELEVATION: 97.54 m

SAMPLE TYPE ■ REMOULDED ⁄ SHELBY TUBE ☒ SPLIT-SPOON ▤ PROBING ▯▯ NO RECOVERY ▮ CORE

DEPTH(m)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	■ VANE Cu (kPa) ■ 80 160 240 320 ▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320 PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(m)
0.0	sides stable			TOPSOIL and ROOTS		
				97.24		97.0
				medium dense sandy TILL		
	no water seepage					
1.0				Bottom of test pit on possible rock 96.74		96.0
2.0						95.0
3.0						94.0
4.0						

McROSTIE GENEST ST-LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 0.8 m
REVIEWED BY: E.S.	COMPLETE: 05/09/02
Fig. No: 2	Page 1 of 1

05/09/20 08:02AM (STD-SHTP)

NRC – NEW ELECTRICAL SUB-STATION	B.M.(ELEV 100.20m) geodetic: Floor at	TEST PIT NO: 05–2
	building M–10, at door No.11	PROJECT NO: E–8890
START DATE: 05/09/02		ELEVATION: 98.02 m

SAMPLE TYPE ■ REMOULDED ⁄ SHELBY TUBE ☒ SPLIT-SPOON ▤ PROBING ▯▯ NO RECOVERY ▮ CORE

DEPTH(m)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	■ VANE Cu (kPa) ■ 80 160 240 320 ▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320 PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(m)
0.0	sides stable			FILL – crushed limestone		98.0
				97.67 medium dense sandy TILL		
	no water seepage			Bottom of test pit on possible rock 97.42		
1.0						97.0
2.0						96.0
3.0						95.0
4.0						

McROSTIE GENEST ST–LOUIS Ottawa, Canada	LOGGED BY: JML	COMPLETION DEPTH: 0.6 m
	REVIEWED BY: E.S.	COMPLETE: 05/09/02
	Fig. No: 3	Page 1 of 1

05/09/20 08:02AM (STD-SHTP)

NRC – NEW ELECTRICAL SUB-STATION	B.M.(ELEV 100.20m) geodetic; Floor of	TEST PIT NO: 05-3
	building M-10 at door No.11	PROJECT NO: E-8890
START DATE: 05/09/02		ELEVATION: 99.43 m

SAMPLE TYPE ■ REMOULDED ⧸ SHELBY TUBE ☒ SPLIT-SPOON ▤ PROBING ▥ NO RECOVERY ▮ CORE

DEPTH(m)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	■ VANE Cu (kPa) ■ 80 160 240 320 ▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320 PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(m)
0.0	sides stable			TOPSOIL		
				99.23		99.0
				medium dense sandy TILL		
	no water seepage					
				Bottom of test pit on possible rock 98.63		
1.0						98.0
2.0						97.0
3.0						96.0
4.0						

McROSTIE GENEST ST-LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 0.8 m
REVIEWED BY: E.S.	COMPLETE: 05/09/02
Fig. No: 4	Page 1 of 1

05/09/20 08:02AM (STD-SHTP)

NRC – NEW ELECTRICAL SUB-STATION	B.M.(ELEV 100.20m)geodetic: Floor of	TEST PIT NO: 05-4
	building M-10 at door No. 11	PROJECT NO: E-8890
START DATE: 05/09/02		ELEVATION: 100.34 m

SAMPLE TYPE ■ REMOULDED ⁄ SHELBY TUBE ☒ SPLIT-SPOON ▤ PROBING ▯▯ NO RECOVERY ▮ CORE

DEPTH(m)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	■ VANE Cu (kPa) ■ 80 160 240 320 ▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320 PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(m)
0.0	sides stable			TOPSOIL		
				100.14		100.0
				medium dense sandy TILL		
1.0						99.0
	no water seepage			Bottom of test pit on possible rock 98.94		
2.0						98.0
3.0						97.0
4.0						

McROSTIE GENEST ST-LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 1.4 m
REVIEWED BY: E.S.	COMPLETE: 05/09/02
Fig. No: 5	Page 1 of 1

05/09/20 08:02AM (STD-SHTP)

NRC – NEW ELECTRICAL SUB-STATION	B.M.(ELEV 100.20m)geodetic; Floor of	TEST PIT NO: 05-5
	building M-10 at door No.11	PROJECT NO: E-8890
START DATE: 05/09/02		ELEVATION: 100.41 m

SAMPLE TYPE ■ REMOULDED ⧸ SHELBY TUBE ☒ SPLIT-SPOON ▤ PROBING ▥ NO RECOVERY ▮ CORE

DEPTH(m)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	■ VANE Cu (kPa) ■ 80 160 240 320 ▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320 PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(m)
0.0	sides stable			TOPSOIL		
				100.16		100.0
				medium dense sandy TILL		
1.0						
	no water seepage					
				Bottom of test pit on possible rock 99.06		99.0
2.0						
						98.0
3.0						
						97.0
4.0						

McROSTIE GENEST ST-LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 1.35 m
REVIEWED BY: E.S.	COMPLETE: 05/09/02
Fig. No: 6	Page 1 of 1

05/09/20 08:02AM (STO-SHTP)

NRC – NEW ELECTRICAL SUB-STATION	B.M.(ELEV 100.20m) geodetic: Floor of	TEST PIT NO: 05-6
	building M-10 at door No.11	PROJECT NO: E-8890
START DATE: 05/09/02		ELEVATION: 100.31 m

SAMPLE TYPE ■ REMOULDED ⁄ SHELBY TUBE ☒ SPLIT-SPOON ▤ PROBING ▥ NO RECOVERY ▮ CORE

DEPTH(m)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	■ VANE Cu (kPa) ■ 80 160 240 320 ▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320 PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(m)
0.0	sides stable			TOPSOIL		100.0
				100.01		
1.0				medium dense sandy TILL		99.0
	no water seepage					
2.0				Bottom of test pit on possible rock 98.51		98.0
3.0						97.0
4.0						

McROSTIE GENEST ST-LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 1.8 m
REVIEWED BY: E.S.	COMPLETE: 05/09/02
Fig. No: 7	Page 1 of 1

05/09/20 08:02AM (STD-SHTP)

NRC – NEW ELECTRICAL SUB-STATION	B.M.(ELEV 100.20m)geodetic; Floor of	TEST PIT NO: 05-7
	building M-10 at door No.11	PROJECT NO: E-8890
START DATE: 05/09/02		ELEVATION: 100.37 m

SAMPLE TYPE ■ REMOULDED ⁄ SHELBY TUBE ☒ SPLIT-SPOON ▤ PROBING ▯▯ NO RECOVERY ▮ CORE

DEPTH(m)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	■ VANE Cu (kPa) ■ 80 160 240 320 ▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320 PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(m)
0.0	sides stable			TOPSOIL		
				100.07		100.0
1.0				medium dense sandy TILL		99.0
	no water seepage					
				Bottom of test pit on possible rock 98.87		
2.0						98.0
3.0						97.0
4.0						

McROSTIE GENEST ST-LOUIS Ottawa, Canada	LOGGED BY: JML	COMPLETION DEPTH: 1.5 m
	REVIEWED BY: E.S.	COMPLETE: 05/09/02
	Fig. No: 8	Page 1 of 1

05/09/20 08:03AM (STD-SHTP)

MONTREAL RD. NRC M-10 & COOLING TOWER	B.M.(ELEV 328.75FT.)geodetic: Floor of	TEST PIT NO: 02-1
NATIONAL RESEARCH COUNCIL CANADA	bldg. M-10 at door No. 11	PROJECT NO: E-8230
START DATE: 02/04/22		ELEVATION: 327.61 ft

SAMPLE TYPE ■ REMOULDED ⁄ SHELBY TUBE ☒ SPLIT-SPOON ▤ PROBING ▯▯ NO RECOVERY ▮ CORE

DEPTH(ft)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	■ VANE Cu (kPa) ■ 80 160 240 320 ▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320 PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(ft)
0.0	sides stable			TOPSOIL		327.0
				327.19 FILL pieces of broken rock in sand & gravel		
1.0						326.0
2.0				325.86 clayey SAND		325.0
3.0						324.0
4.0						323.0
5.0				medium dense sandy TILL 323.03		322.0
	no water seepage			Bottom of pit on probable rock 322.11		
6.0						321.0
7.0						320.0
8.0						319.0
9.0						318.0
10.0						317.0
11.0						316.0
12.0						

McROSTIE GENEST ST-LOUIS Ottawa, Canada	LOGGED BY: JML	COMPLETION DEPTH: 5.5 ft
	REVIEWED BY: E.S.	COMPLETE: 02/04/22
	Fig. No: 2	Page 1 of 1

02/04/30 11:12AM (ST-SHIMP)

MONTREAL RD. NRC M-10 & COOLING TOWER	B.M.(ELEV 328.75FT.)geodetic: Floor of	TEST PIT NO: 02-2
NATIONAL RESEARCH COUNCIL CANADA	bldg. M-10 at door No. 11	PROJECT NO: E-8230
START DATE: 02/04/22		ELEVATION: 327.16 ft

SAMPLE TYPE: REMOULDED | SHELBY TUBE | SPLIT-SPOON | PROBING | NO RECOVERY | CORE

DEPTH(ft)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	VANE Cu (kPa) 80 160 240 320 / VANE Cu REMOULDED (kPa) 80 160 240 320 / PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(ft)
0.0	sides stable			TOPSOIL 326.83		327.0
1.0						326.0
2.0				FILL large pieces of broken rock up to 2.5'x2.5'x 1.0' in sand and gravel with pieces of tin and steel rebar		325.0
3.0						324.0
4.0	no water seepage			Bottom of pit on probable rock 323.16		323.0
5.0						322.0
6.0						321.0
7.0						320.0
8.0						319.0
9.0						318.0
10.0						317.0
11.0						316.0
12.0						315.0

McROSTIE GENEST ST-LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 4 ft
REVIEWED BY: E.S.	COMPLETE: 02/04/22
Fig. No: 3	Page 1 of 1

02/04/30 09:53AM (ST-SHIMP)

MONTREAL RD. NRC M-10 & COOLING TOWER	B.M.(ELEV 328.75FT.)geodetic: Floor of	BOREHOLE NO: 02-3
NATIONAL RESEARCH COUNCIL CANADA	bldg. M-10 at door No. 11	PROJECT NO: E-8230
START DATE: 02/04/26		ELEVATION: 328.76 ft

SAMPLE TYPE: REMOULDED-AUGER | SHELBY TUBE | SPLIT-SPOON | NW-CASING | NO RECOVERY | NQ CORE

DEPTH(ft)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	% CORE RECOVERY	SOIL / ROCK DESCRIPTION	ELEVATION(ft)
0.0					FILL topsoil, sand and gravel	328.0
1.0						
2.0	3/6" 12/2"		1		FILL 327.26 topsoil, sand, gravel and wood	327.0
3.0	split barrel refusal				326.09	326.0
4.0				85	LIMESTONE	325.0
5.0						324.0
6.0					323.34 LIMESTONE	323.0
7.0						322.0
8.0	WL			83	Water level April 29/02 elev 320.34'	321.0
9.0						320.0
10.0						319.0
11.0					318.34 LIMESTONE	318.0
12.0						317.0
13.0				98		316.0
14.0						315.0
15.0						314.0
16.0					313.34 LIMESTONE	313.0
17.0				100		312.0
18.0						311.0
19.0					Bottom of hole 310.34	310.0
20.0						309.0
21.0						308.0
22.0						307.0
23.0						306.0
24.0						305.0
25.0						304.0

VANE Cu (kPa) 80 160 240 320
▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320
PLASTIC M.C. LIQUID
20 40 60 80

McROSTIE GENEST ST-LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 18.42 ft
REVIEWED BY: E.S.	COMPLETE: 02/04/26
Fig. No: 4	Page 1 of 1

02/05/01 02:02PM (NQ-IMP)

MONTREAL RD. NRC M-10 & COOLING TOWER	B.M.(ELEV 328.75FT.)geodetic: Floor of	BOREHOLE NO: 02-4
NATIONAL RESEARCH COUNCIL CANADA	bldg. M-10 at door No. 11	PROJECT NO: E-8230
START DATE: 02/04/26		ELEVATION: 328.41 ft

SAMPLE TYPE: REMOULDED-AUGER | SHELBY TUBE | SPLIT-SPOON | NW-CASING | NO RECOVERY | NQ CORE

DEPTH(ft)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	% CORE RECOVERY	SOIL / ROCK DESCRIPTION	ELEVATION(ft)
0.0					TOPSOIL	328.0
1.0	6/6" 20/6"		1		topsoil, sand and gravel	327.0
2.0	split barrel refusal				FILL 327.41	326.0
3.0					topsoil, sand, gravel sandy TILL 326.41	325.0
4.0						324.0
5.0				100	LIMESTONE 324.16	323.0
6.0					323.16 LIMESTONE	322.0
7.0	WL					321.0
8.0				80	Water level April 29/02 elev 320.99'	320.0
9.0						319.0
10.0					318.16	318.0
11.0					LIMESTONE	317.0
12.0						316.0
13.0				100		315.0
14.0						314.0
15.0					313.16	313.0
16.0					LIMESTONE	312.0
17.0				100		311.0
18.0					Bottom of hole 310.33	310.0
19.0						309.0
20.0						308.0
21.0						307.0
22.0						306.0
23.0						305.0
24.0						304.0
25.0						

VANE Cu (kPa) 80 160 240 320
▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320
PLASTIC M.C. LIQUID
20 40 60 80

McROSTIE GENEST ST-LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 18.08 ft
REVIEWED BY: E.S.	COMPLETE: 02/04/26
Fig. No: 5	Page 1 of 1

02/05/01 01:43PM (NQ-IMP)

MONTREAL RD. NRC M-10 & COOLING TOWER	B.M.(ELEV 328.75FT.)geodetic: Floor of	TEST PIT NO: 02-5
NATIONAL RESEARCH COUNCIL CANADA	bldg. M-10 at door No. 11	PROJECT NO: E-8230
START DATE: 02/04/22		ELEVATION: 328.93 ft

SAMPLE TYPE ■ REMOULDED ⧸ SHELBY TUBE ⊠ SPLIT-SPOON ▤ PROBING ▯▯ NO RECOVERY ▮ CORE

DEPTH(ft)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	■ VANE Cu (kPa) ■ 80 160 240 320 ▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320 PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(ft)
0.0	sides stable			FILL large pieces of broken rock up to (2.5'x2.5'x1.0') in sand and gravel		328.0
1.0						
2.0						327.0
3.0	no water seepage			medium dense sandy TILL 326.43		326.0
4.0				Bottom of pit on probable rock 325.76		325.0
5.0						324.0
6.0						323.0
7.0						322.0
8.0						321.0
9.0						320.0
10.0						319.0
11.0						318.0
12.0						317.0

McROSTIE GENEST ST-LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 3.25 ft
REVIEWED BY: E.S	COMPLETE: 02/04/22
Fig. No: 6	Page 1 of 1

02/04/30 11:12AM (ST-SHIMP)

MONTREAL RD. NRC M-10 & COOLING TOWER	B.M.(ELEV 328.75FT.)geodetic: Floor of	TEST PIT NO: 02-6
NATIONAL RESEARCH COUNCIL CANADA	bldg. M-10 at door No. 11	PROJECT NO: E-8230
START DATE: 02/04/22		ELEVATION: 328.77 ft

SAMPLE TYPE ■ REMOULDED ⁄ SHELBY TUBE ☒ SPLIT-SPOON ▤ PROBING ▥ NO RECOVERY ▮ CORE

DEPTH(ft)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	ELEVATION(ft)
0.0	sides stable			TOPSOIL	
				328.19	328.0
1.0				FILL rock blocks in sand and gravel	
				326.77	327.0
2.0				medium dense sandy TILL	
3.0	no water seepage			Bottom of pit on 325.77 probable rock	326.0
4.0					325.0
5.0					324.0
6.0					323.0
7.0					322.0
8.0					321.0
9.0					320.0
10.0					319.0
11.0					318.0
12.0					317.0

■ VANE Cu (kPa) ■ 80 160 240 320
▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320
PLASTIC M.C. LIQUID 20 40 60 80

McROSTIE GENEST ST-LOUIS Ottawa, Canada	LOGGED BY: JML	COMPLETION DEPTH: 3 ft
	REVIEWED BY: E.S.	COMPLETE: 02/04/22
	Fig. No: 7	Page 1 of 1

02/04/30 09:53AM (ST-SHIMP)

MONTREAL RD. NRC M-10 & COOLING TOWER	B.M.(ELEV 328.75FT.)geodetic: Floor of	TEST PIT NO: 02-7
NATIONAL RESEARCH COUNCIL CANADA	bldg. M-10 at door No. 11	PROJECT NO: E-8230
START DATE: 02/04/22		ELEVATION: 328.36 ft

SAMPLE TYPE ■ REMOULDED ⁄ SHELBY TUBE ☒ SPLIT-SPOON ▤ PROBING ▯▯ NO RECOVERY ▮ CORE

DEPTH(ft)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	■ VANE Cu (kPa) ■ 80 160 240 320 ▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320 PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(ft)
0.0	sides stable			FILL topsoil with a trace of brick		328.0
1.0				327.69 FILL large pieces of broken rock up to (2.5'x2.5'x1.0') in sand and gravel with traces of concrete and metal		327.0
2.0						326.0
3.0						325.0
4.0						324.0
5.0						323.0
6.0	no water seepage			Bottom of pit on probable rock 322.36		322.0
7.0						321.0
8.0						320.0
9.0						319.0
10.0						318.0
11.0						317.0
12.0						316.0

McROSTIE GENEST ST-LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 6 ft
REVIEWED BY: E.S.	COMPLETE: 02/04/22
Fig. No: 8	Page 1 of 1

02/04/30 09:53AM (ST-SHIMP)

MONTREAL RD. NRC M-10 & COOLING TOWER	B.M.(ELEV 328.75FT.)geodetic: Floor of	TEST PIT NO: 02-8
NATIONAL RESEARCH COUNCIL CANADA	bldg. M-10 at door No. 11	PROJECT NO: E-8230
START DATE: 02/04/22		ELEVATION: 328.08 ft

SAMPLE TYPE ■ REMOULDED ▨ SHELBY TUBE ▩ SPLIT-SPOON ▤ PROBING ▯ NO RECOVERY ▮ CORE

DEPTH(ft)	SMALL PEN. SPT (kPa) (N)	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	■ VANE Cu (kPa) ■ 80 160 240 320 ▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320 PLASTIC M.C. LIQUID 20 40 60 80	ELEVATION(ft)
0.0	sides stable			TOPSOIL		328.0
				327.41		
1.0				FILL large pieces of broken rock up to (2.5'x2.5'x1.0') in sandy soil and traces of brick		327.0
2.0						326.0
3.0				medium dense sandy TILL 325.08		325.0
4.0	no water seepage			Bottom of pit on probable rock 324.08		324.0
5.0						323.0
6.0						322.0
7.0						321.0
8.0						320.0
9.0						319.0
10.0						318.0
11.0						317.0
12.0						316.0

McROSTIE GENEST ST-LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 4 ft
REVIEWED BY: E.S.	COMPLETE: 02/04/22
Fig. No: 9	Page 1 of 1

02/04/30 09:54AM (ST-SHIMP)

McROSTIE GENEST ST-LOUIS & Associates Ltd. Consulting Engineers OTTAWA, CANADA	TEST PIT RECORD	Test Pit No. 99-6
	Date :	JUNE 11, 1999

N.R.C. BLDG. M-10 ADDITION
MONTREAL ROAD

ELEV. 329.23	DEPTH in feet	DESCRIPTION	REMARKS
		TOPSOIL	sides stable
328.41	0.82		
328.23	-- 1 --	BOULDERS up to 1.6' O in dense sandy TILL	
327.23	-- 2 --		
326.23	-- 3 --		
325.62	3.61	Bottom of pit on probable rock	no water seepage

Plate No.
8

McROSTIE GENEST ST-LOUIS & Associates Ltd. Consulting Engineers OTTAWA, CANADA	TEST PIT RECORD	Test Pit No. 99-5
	Date :	JUNE 11, 1999

N.R.C. BLDG. M-10 ADDITION
MONTREAL ROAD

ELEV. 328.54	DEPTH in feet	DESCRIPTION	REMARKS
			sides stable
		FILL crushed limestone	
327.54	-- 1 --		
327.23	1.31		
		dense sandy TILL	
326.54	-- 2 --		
325.54	-- 3 --		
325.26	3.28		no water seepage
		Bottom of pit on probable rock	

Plate No.
7