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LOCATION QEW / ERIN MILLS PARKWAY

HIGH MAST LIGHTING & OVERHEAD SIGNS

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

Golder Associates Ltd.

2180 Meadowvale Boulevard
Mississauga, Ontario, Canada L5N 5S3
Telephone (905) 567-4444
Fax (905) 567-6561

REPORT ON

FOUNDATION INVESTIGATION FOR PROPOSED QUEEN ELIZABETH WAY (QEW) / ERIN MILLS PARKWAY SOUTHDOWN ROAD INTERCHANGE W.P. 166-86-00, DISTRICT 6, TORONTO MINISTRY OF TRANSPORTATION, ONTARIO (MTO) CENTRAL REGION

Submitted to:
Cole, Sherman & Associates
75 Commerce Valley Drive East
Thornhill, Ontario
L3T 7N9

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1.0 INTRODUCTION

Golder Associates Ltd. has been retained by Cole, Sherman & Associates (Cole, Sherman) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out a foundation investigation at the site of the proposed Queen Elizabeth Way (QEW) / Erin Mills Parkway / Southdown Road Interchange. This new interchange is to replace the existing rotary interchange which, we understand, has severe operational deficiencies. This report addresses the proposed bridge structure over the QEW and associated approach cuts. This project is designated as W.P. 166-86-00 in District 6 (Toronto).

The purpose of this investigation is to determine the subsurface conditions at the site of the proposed bridge structure by drilling boreholes, and carrying out in situ tests and laboratory tests on selected samples. Based on our interpretation of the data obtained, recommendations on the geotechnical aspects of design of the proposed works are provided. Comments are also provided on anticipated construction problems where they may affect design of the proposed bridge and approach cuts.

The proposed preliminary alignment for the QEW overpass was presented on profiles provided to us by Cole, Sherman. The General Arrangement plan showing the proposed abutment and pier layout of the overpass structure has been provided to us in digital format on August 13, 1998. The following documents have been referenced during the preparation of this report.

- Draft Pavement Design Report titled "QEW / Erin Mills Parkway – Southdown Road Interchange", G.W.P. 166-86-00, Agreement No. 9720-7411-2552, Regional Municipality of Peel, City of Mississauga, Ministry of Transportation, Ontario, Central Region, July 1998.

- Preliminary Design Report titled "QEW / Erin Mills Parkway – Southdown Road Interchange", Regional Municipality of Peel, City of Mississauga, W.P. 37-85-00, District 6 Toronto, Ministry of Transportation and Communications, Central Region, 1986.

- Department of Highways, Ontario Report titled "Shooks Hill Bridge No. I, Queen Elizabeth Way Grade Separation", Highway No. QEW, W.P. 714-A-56, Twp. # 81-194-1-A, Dist. No. 6 Toronto, Bridge Office, Toronto, Department of Highways Ontario, 1957 (GEOCRES No. 30M12-40).

- Department of Highways, Ontario Report titled "Shooks Hill Underpass - Bridge No. II", Highway No. QEW, W.P. 714-56, Twp. # 81-195-A, Dist. No. 6 Toronto, Bridge Office, Toronto, Department of Highways Ontario, 1957 (GEOCRES No. 30M12-41).

The work was carried out in general accordance with the scope of work as outlined in our proposal dated December 15, 1997 and in accordance with our Quality Control Plan for Foundation Design Services, dated February 23, 1998.

2.0 SITE DESCRIPTION

The site is located in the vicinity of the existing rotary interchange between QEW and Erin Mills Parkway / Southdown Road, and is within the MTO District 6, Toronto.

The ground surface in the interchange area generally slopes downward in an easterly direction. The QEW road grade generally follows the natural topography except where it is formed in shallow cut to the west of the Shooks Hill Bridge No. 1 ranging from Elevation 132 m at the west limit of the interchange area to Elevation 112 m at the east limit. At the immediate vicinity of the proposed bridge structure, the terrain is practically flat-lying with the ground surface ranging between Elevations 126.5 m and 127 m. The existing Shooks Hill Underpass, Bridge No. II (west of Erin Mills Parkway / Southdown Road) and its approaches were formed in cut, whereas Shooks Hill Bridge No. 1 (east of Erin Mills Parkway / Southdown Road) and its approaches were constructed as part of a fill embankment. Vegetation cover at the area of the interchange typically consists of grass, shrubs and occasional small trees.

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out on June 25 and 26, 1998 and June 29, 1998. During this time eight boreholes, numbered 1 to 8, were put down at the proposed east and west abutments, the central pier and the approaches. Boreholes 2 (132) and 5 (136) were drilled as part of the geotechnical / pavement investigation. The investigation was carried out using a track mounted B-57 drill rig supplied and operated by a specialist drilling contractor.

In the boreholes, samples of the overburden were obtained at regular 0.75 m intervals of depth using 50 mm outside diameter split-spoon samplers in accordance with the Standard Penetration

Test (SPT) procedures. The six boreholes at the proposed bridge location were advanced to between 6 m and 9 m depth below existing ground surface. Rock coring (NQ size) was carried out in all six boreholes to between 3.5 m and 6 m below bedrock surface. The two boreholes at the approach cuts were advanced to bedrock surface at between 1.7 m and 2.1 m depths. Groundwater conditions in the open boreholes were observed throughout the drilling operations. Piezometers were installed at two selected borehole locations to permit monitoring of the groundwater levels at the site.

The field work was supervised on a full-time basis by a member of our technical staff who directed the drilling, sampling and in situ testing operations, and logged the boreholes. The soil samples were identified in the field, placed in labelled containers and transported back to our laboratory in Mississauga for further examination. Rock core samples were identified and placed in wooden core boxes. Index and classification tests were carried out on selected soil samples, whereas point load tests were carried out on selected rock cores.

The borehole locations were staked out in the field by Cole, Sherman prior to our mobilization to site. The northing and easting co-ordinates and the elevations of the boreholes are shown on the Record of Borehole sheets. The boreholes for the structures are shown in plan and elevation on a Borehole Locations and Soil Strata drawing which also shows the general layout of the proposed overpass structure. We understand that all borehole elevations are referred to the Geodetic datum.

4.0 GENERAL SITE GEOLOGY AND STRATIGRAPHY

4.1 Site Geology

The site is located within the physiographic region known as the Peel Plain. The Peel Plain is generally composed of clayey soils covering the central portions of York, Peel and Halton regions (Chapman and Putnam, "The Physiography of Southern Ontario", 3rd Edition, 1984). The surface topography slopes gradually and fairly uniformly towards Lake Ontario. The native overburden at the site area is a silty clay residual soil which is underlain by bedrock comprised of shale and limestone interbeds of the Georgian Bay (Meaford-Dundas) Formation. The depth

to bedrock at this site is shallow, varying typically between 2 m and 3 m below existing ground surface.

4.2 Site Stratigraphy

The detailed subsurface soil, bedrock and groundwater conditions encountered in Boreholes 1, 3, 4, 6 to 8 are presented on the attached Record of Borehole sheets. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. Subsurface conditions will vary between and beyond the borehole locations.

Subsurface information from the two boreholes put down for the approach cuts is summarized in the following table.

Borehole Number	*Ground Surface Elevation (m)*	*Depth Below Ground Surface (m)*	*Description*
2 (132)*	126.78	0.0 – 0.4	Topsoil
		0.4 – 0.8	Sand and Silt, trace organics (FILL)
		0.8 – 1.7	Silty Sand, trace organics (FILL)
		1.7	Bedrock surface (inferred)
5 (136)*	126.52	0.0 – 1.5	Sand, trace silt, trance organics (FILL)
		1.5 – 2.4	Silty Clay, trace gravel
		2.4	Bedrock surface (inferred)

NOTE: * Borehole numbers in Golder Associates Draft Pavement Design Report, dated July 1998.

Boreholes 1 and 3 are located near the north and south extremes of the proposed west abutment, whereas Boreholes 4 and 6 are located near the north and south extremes of the proposed east abutment. Boreholes 7 and 8 are located near the north and south extremes of the proposed central pier. Boreholes 2 (132) and 5 (136) are located near the centreline of the proposed Erin Mills Parkway / Southdown Road alignment, some 55 m to the north and 90 m to the south of the QEW centreline, respectively.

In summary, the subsoils at the site consist of surficial topsoil and / or fill overlying a stratum of hard clayey silt residual soil. The overburden is underlain by interbedded shale and limestone bedrock.

A detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

4.2.1 Topsoil and Fill Materials

Topsoil ranging from 80 mm to 600 mm in thickness was encountered at Boreholes 2 (132), 3 and 8, respectively.

Fill was encountered at ground surface or immediately underlying the topsoil in all eight boreholes. The thickness of the fill varies between approximately 0.5 m and 1.5 m in Boreholes 1, 3 4 and 6, but increases to 2 m to 2.2 m in Boreholes 7 and 8. In Boreholes 2 (132) and 5 (136), the fill is 1.5 m and 1.7 m in thickness, respectively. The fill encountered in Boreholes 1, 3, 4 and 7 is comprised of clayey silt materials with some sand, gravel, organics and occasional shale and brick fragments. Sand to silty sand fill was encountered at Boreholes 2, 5 and 6 whereas both silty sand and clayey silt fill were found in Borehole 8. The cohesive fill was in a typically very stiff to occasionally hard consistency as indicated by SPT 'N' values of 16 blows to occasionally greater than 30 blows per 0.3 m penetration. The granular fill was in a compact state as indicated by 'N' values of 20 blows and 29 blows per 0.3 m penetration.

4.2.2 Silty Clay (Residual Soil)

Residual soil was encountered immediately overlying bedrock in all boreholes except Boreholes 2 and 7. The thickness of this stratum in the boreholes varies between 0.3 m and 1.6 m. This soil is comprised of silty clay materials with trace sand and gravel. Figure 1 shows the grain size distribution of a selected silty clay sample. The SPT 'N' values of greater than 30 blows per 0.3 m penetration indicated that the soil has a hard consistency throughout. Occasional limestone seams were also present within this stratum.

4.2.3 Bedrock

Continuous rock core samples were obtained in all six boreholes after reaching the bedrock surface (as established by refusal to split spoon sampling and / or augering). The bedrock at this site consists of grey, fine grained, thinly bedded shale interbedded with shaley limestone and crystalline limestone of the Georgian Bay (Meaford-Dundas) Formation. The upper 2.5 m to 3 m, or from Elevations 124 m to 121 m, of bedrock is comprised of predominantly highly to moderately weathered shale with some shaley and crystalline limestone interbeds. Below about Elevation 121 m, the bedrock becomes moderately to slightly weathered and consists of shaley limestone interbedded with crystalline limestone and shale. There are also occasional fossiliferous limestone seams, typically less than 50 mm in thickness.

Broken core zones and clay seams were identified at various elevations within the bedrock. Measured fracture indices range from 1 to 8 fractures per 0.3 m with the higher values typically associated with the upper, more shaley zones. The discontinuities are predominantly horizontal with occasional sub-vertical joints identified at zones of limestone in Borehole 4. The Rock Quality Designation (RQD) of the upper shaley rock is generally lower than 50 per cent indicating poor rock quality. The RQD values for the lower limestone typically range between approximately 50 per cent and 80 per cent indicating fair to good rock quality.

The bedrock surface depths and elevations at the borehole locations are summarized below:

Borehole		*Ground Surface Elevation (m)*	*Bedrock Surface*	
Number	*Location*		*Depth (m)*	*Elevation (m)*
Borehole 1	West Abutment (north)	126.8	2.3	124.5
Borehole 2	Approach Cut (north)	126.8	1.7	125.1
Borehole 3	West Abutment (south)	126.7	2.2	124.5
Borehole 4	East Abutment (north)	126.6	2.3	124.3
Borehole 5	Approach Cut (south)	126.5	2.4	124.1
Borehole 6	East Abutment (south)	126.6	2.3	124.3
Borehole 7	Central Pier (north)	126.6	2.3	124.3
Borehole 8	Central Pier (south)	126.7	2.2	124.4

4.3 Groundwater Conditions

Piezometers were installed in Boreholes 1 and 6 to allow monitoring of the groundwater conditions. Details of the piezometer installations and the water level measurements are shown on the attached Record of Borehole sheets. The water levels in the piezometers, as measured on July 17, 1998, were at Elevations 124.7 m and 123.4 m in Boreholes 1 and 6, respectively.

5.0 ENGINEERING RECOMMENDATIONS

5.1 General

This section of the report provides our recommendations on the geotechnical aspects of foundation design of the QEW / Erin Mills Parkway / Southdown Road, based on our interpretation of the factual information obtained during this investigation. It should be noted that the interpretation and recommendations are intended for use only by the design engineer. Where comments are made on construction they are provided only in order to highlight those aspects which could affect the design of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction method and scheduling.

The works described in this report are associated with the proposed overpass bridge and its approaches. We understand that the proposed two span bridge will allow the realigned Erin Mills Parkway / Southdown Road to be carried under the QEW. It is understood that the approaches of the Erin Mills Parkway / Southdown Road will be formed in cut with final grades in the vicinity of the bridge at about Elevation 120 m. These grades indicate that the cut will be up to 7 m below existing ground surface.

The proposed vertical alignment of the overpass structure and approaches are shown on preliminary drawings provided to us as part of the preliminary design report (see Section 1.0). The proposed abutment and pier layout of the overpass structure are shown on the General Arrangement Plan.

5.2 Bridge Foundations

The subsoils encountered in the boreholes put down during the present investigation typically consist of fill and silty clay residual soil overlying interbedded shale and limestone bedrock. The bedrock surface elevation as encountered at the bridge site is relatively consistent at this site, generally varying between Elevations 124.3 m and 124.5 m, or 2.2 m to 2.3 m below existing ground surface. The water level in the piezometers installed within bedrock was measured at between Elevations 124.7 m and 123.4 m, or 2.1 m to 3.2 m depths below existing ground surface.

Considering the shallow and consistent depth of the bedrock, it is recommended that the bridge structure be supported by spread footings founded on bedrock. A founding level at the surface of the shale bedrock (on the fractured portion) or extended deeper to the predominantly limestone portion may be assumed for design of the abutment footings. The pier footings may be founded at Elevation 119 m, or about 1 m below the design final grade of the cut. The following table summarizes the highest recommended design founding elevations based on the proposed road grades:

Abutment Location	*Reference Borehole*	*Design Founding Elevation (m) (Footing at ≥7 m from rock face)*	*Design Founding Elevation (m) (Footing at <7 m from rock face)*
West Abutment	Boreholes 1 and 3	124.5	123.5
Central Pier	Boreholes 7 and 8	119.0	119.0
East Abutment	Boreholes 4 and 6	124.3	123.3

5.2.1 Factored Geotechnical Resistance

Spread footings for the abutments, which are located at least 7 m (in plan) from the rock face and placed on properly prepared shale bedrock at the elevation as specified above, may be designed for a factored geotechnical resistance at Ultimate Limit States (ULS) of 1,000 kPa. A bearing resistance of 850 kPa at ULS may be assumed for spread footings located at less than 7 m from the rock face. Spread footings taken deeper to found on the interbedded shaley and crystalline limestone at Elevation 121.5 m may be designed for a factored geotechnical resistance of 3,000 kPa at ULS. Alternatively, closed end abutments (to be located in front of rock cuts) could be used, and the footings carried down to the interbedded shaley and crystalline limestone at the bearing resistance and founding elevation given below for the pier foundations. For the pier footing placed at or below Elevation 119.0 m, a factored geotechnical resistance at ULS of 3,000 kPa may be assumed. These values are for vertical concentric loads only. Effects of load inclination and eccentricity need to be taken into account as appropriate. Serviceability Limit States (SLS) conditions do not apply to footings placed on bedrock.

The setback of the footings from the rock face of the cut depends on the inclination of the permanent cut slopes (to be discussed further in later sections). Footings should, however, be located far enough from the face such that the footing is maintained outside the zone defined by a 0.5 horizontal to 1 vertical line drawn from the rock face at the base of the cut.

All footing excavations should be inspected prior to placing concrete to ensure that the base has been adequately cleaned and that the bedrock conditions as exposed at the founding level are consistent with the design assumptions. All loose or shattered rock within the footprint of the footings and at the footing level should be removed and replaced with concrete. To prevent deterioration of the shale, a mud mat of lean concrete should be placed immediately after excavation.

5.2.2 Horizontal Resistance

Resistance to lateral forces / sliding resistance between the concrete footings and bedrock should be calculated in accordance with Section 6-8.4.3 of the OHBDC assuming an unfactored angle of friction of 27 degrees. If necessary, sliding resistance can be supplemented by doweling into bedrock.

5.2.3 Frost Protection

All footings should be provided with a minimum of 1.2 m of earth cover for frost protection purposes.

5.3 Lateral Earth Pressures

The lateral pressures acting on the bridge abutments will depend on the type and method of placement of the backfill materials, on the nature of the soils behind the backfill and on the subsequent lateral movement of the structure. The following recommendations are made concerning the design of the abutments and the retaining walls in accordance with OHBDC:

- Select free-draining granular fill meeting the specifications of OPSS Granular A or Granular B but with less than 5 per cent passing the 200 sieve should be used as backfill behind the walls. All granular fill should be compacted in lifts of loose thickness not greater than 200 mm to 95 per cent of the material's Standard Proctor maximum dry density.

- Longitudinal drains and weep holes should be installed to provide positive drainage of the granular backfill.

- The granular fill may be placed either in a zone with width equal to at least 1.6 m behind the back of the stem (Case I) or within the wedge-shaped zone defined by a 60 degree line extending up and back from the bottom of the rear face of the footing (Case II).

- If the wall support allows lateral yielding of the stem (unrestrained structure), active earth pressures may be used in the geotechnical design of the structure. If the abutment support does not allow lateral yielding (restrained structure), at-rest pressures should be assumed for geotechnical design.

- A compaction surcharge equal to 16 kPa should be included in the lateral earth pressures for the structural design of the abutment wall in accordance with OHBDC Figure 6-7.4.3.

- For Case I, the pressures are based on the embankment fill materials and the following parameters (unfactored) may be assumed:

Soil unit weight (assuming clean earth fill)	21 kN/m^3
Coefficients of lateral earth pressure:	
'active'	0.31
'at rest'	0.47

- For Case II, the pressures are based on the granular fill as placed and the following parameters (unfactored) may be assumed:

	Granular A	**Granular B**
Soil Unit Weight	22 kN/m^3	21 kN/m^3
Coefficient of Lateral Earth Pressure		
'active'	0.27	0.31
'at rest'	0.43	0.47

It should be noted that the above design parameters assume level backfill and ground surface behind the wall. Other aspects of the abutment granular backfill requirements with respect to sub-drains and frost taper should be in accordance with OPSD-3501.00.

5.4 Excavations and Temporary Slopes

At the west and east abutments, the excavations for footing construction will be up to 3.5 m depth below existing ground surface and will extend through the fill and residual soil into the highly to moderately weathered bedrock consisting of shale with limestone interbeds. At the location of the central pier, the excavation for footing construction will extend up to 1.5 m below the final road grade which is at 7 m below existing ground surface and up to 4.5 m below the bedrock surface. Excavations to form the permanent cut and pier footing construction will extend through the overburden and the upper shale with limestone interbeds into the interbedded shaley limestone and crystalline limestone.

Conventional excavation equipment would be suitable for excavating the overburden. Temporary cuts in the overburden may be made with side slopes not steeper than one horizontal to one vertical (1H:1V). Mechanical excavation for abutment footing construction to shallow depths into the shale bedrock may be carried out with conventional hydraulic equipment equipped with rock teeth. Rock splitting equipment (hoe ram) may be required to break up intact limestone pieces. Temporary shallow excavations into the shale may be made in vertical cuts. Some ravelling of the fractured bedrock present in the upper 1 m to 2.5 m should be expected.

All excavation side slopes should conform with the requirements of the latest edition of the Occupational Heath & Safety Act.

Where the excavation is extended into less fractured bedrock for the construction of the main cut, the use of carefully controlled drill and blast excavation techniques will be required in order to ensure a neat excavation line and minimize face instabilities and long-term maintenance problems. Excavations with vertical sides may be made for the formation of the main cut. Prior to excavation, it is recommended that grouted dowels, arranged in a straight line configuration parallel to the cut, be installed to maintain face stability. Permanent cut configurations are discussed in more details in the following section.

The water levels in the piezometers installed in Boreholes 1 and 6 were at Elevations 124.7 m and 123.4 m, respectively. Water inflow into the excavations should be expected through the

upper fractured portion of the bedrock. This inflow can be handled by conventional pumping from properly filtered sumps. The sumps should be maintained outside the footing area. Surface runoff should be directed away from excavations at all times.

5.5 Permanent Cut

Permanent cuts of up to 7 m high will be formed through fill, residual soil, and bedrock consisting of predominantly shale grading into shaley limestone and limestone interbeds. The stabilized water level is determined to be within 0.5 m of the bedrock surface.

Permanent cut slopes should be formed at inclinations no steeper than 2 horizontal to 1 vertical through the overburden. To minimize the length of the bridge, two slope configurations may be considered for the rock cut under the bridge as follows:

1) The entire rock cut may be made with near vertical side slopes. If this option is adopted, the abutment footings may be located as close as practically possible to the cut, but not closer than that recommended in Section 5.2.1. Permanent rock face protection in some form of concrete facing will be required.

2) Alternatively, the upper portion of the bedrock above Elevation 121.5 m, where shale is predominant, may be cut back to an inclination of one horizontal to one vertical (1H:1V). The predominantly limestone cut below Elevation 121.5 m will be stable with near vertical faces. This configuration will require the abutment footings to be set back at least 7 m (in plan) from the edge of the cut or to lower the founding elevation. Some form of rock face / slope protection using concrete (slope paving) and / or shotcrete will be required

At locations along the approach cuts outside of the bridge length, the above two alternatives may also be considered; however, the cut through the upper shale should be inclined at 2H:1V in order to permit topsoiling and seeding.

5.6 Subgrade Preparation

In order to achieve the recommended design bearing pressure, it is important that all material at the founding level, which is loosened during excavation, be removed from the base of the excavation. The upper portions of the shale bedrock are highly fractured and therefore careful cleaning will be required. It is recommended that all foundation excavations be inspected by experienced

geotechnical personnel prior to any concrete placement to ensure that the base has been adequately prepared.

It is recommended that, in order to minimize the effects of weathering of the bedrock surface, a skim coat of lean concrete be placed over the base of the excavation immediately after the foundation elevation is reached and the base approved.

GOLDER ASSOCIATES LTD.

S. Pang, P.Eng.
Project Engineer

A.S. Poschmann, P.Eng.
Principal

F.J. Heffernan, P.Eng.
Consultant

SP/ASP/FJH/clg
WORD S/FINALDAT/OTHPRJT/981-8004/8004IR1

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.).

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° 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

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

III. SOIL DESCRIPTION

(a) Cohesionless Soils

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

(b) Cohesive Soils

Consistency	c_u, s_u kPa	c_u, s_u 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 limit
w_l	liquid limit
C	consolidation (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 to 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 ($D_R = \rho_s/\rho_w$) (formerly G_s)
e void ratio
n porosity
S degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density x acceleration due to gravity)

(a) Index Properties (con't.)

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)

(c) 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

(d) Consolidation (one-dimensional)

C_c compression index (normally consolidated range)
C_r recompression index (overconsolidated range)
C_S swelling index
C_α 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 $=\sigma'_p/\sigma'_{vo}$

(e) Shear Strength

τ_p, τ_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 ($\phi = 0$ 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

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING STATE

Fresh: no visible sign of weathering.

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

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

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

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

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

BEDDING THICKNESS

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

JOINT OR FOLIATION SPACING

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

GRAIN SIZE

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

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

CORE CONDITION

Total Core Recovery

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

Solid Core Recovery (SCR)

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

Rock Quality Designation (RQD)

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

DISCONTINUITY DATA

Fracture Index

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

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

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

Description and Notes

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

Abbreviations

B - Bedding	P - Polished
FO - Foliation/Schistosity	S - Slickensided
CL - Cleavage	SM - Smooth
SH - Shear Plane/Zone	R - Ridged/Rough
VN - Vein	ST - Stepped
F - Fault	PL - Planar
CO - Contact	FL - Flexured
J - Joint	UE - Uneven
FR - Fracture	W - Wavy
MF - Mechanical Fracture	C - Curved
ll - Parallel To	
⊾ - Perpendicular To	

Form...G.A.-R-3

W.P. 166-86-00

DIST. 6; HWY. QEW

LOCATION: N 4820492.256; E 292818.885

RECORD OF BOREHOLE BH1

BORING DATE: JUNE 29/98

SHEET 1 OF 2

DATUM: GEODETIC

PROJECT: 981-8004

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	HYDRAULIC CONDUCTIVITY, k, cm/s	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		126.84				SHEAR STRENGTH Cu, kPa: nat V - +, rem V - ⊕, Q - ●, U - ○	WATER CONTENT, PERCENT: Wp, W, Wl (10 20 30 40)		
0	B-57 TRACK MOUNT DRILL SOLID STEM AUGERS	Clayey Silt, some sand, trace gravel, trace organics, some shale fragments Very stiff Mottled brown to brown Moist (Fill)		0.00	1	50 DO	22				BENTONITE SEAL
1		Silty Clay, trace sand and gravel Hard Grey Moist (Residual Soil)		125.26	2	50 DO	70		o		NATIVE BACKFILL
2		Shale Highly to completely weathered Grey Dry (Bedrock)		1.58 124.55	3	50 DO	65		o		▽
			—	2.29	4	50 DO	50/ .13				
		REFUSAL TO SPLIT SPOON SAMPLER ADVANCE BOREHOLE CONTINUED FOR BEDROCK CORING DETAILS, SEE SHEET 2.		2.42							
3											
4											
5											
6											
7											
8											
9											
10		CONTINUED ON NEXT PAGE									

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: JY

CHECKED: SP

W.P. 166-88-00
DIST. 6; HWY. QEW
LOCATION: N 4820492.256E 292818.885

RECORD OF BOREHOLE: BH1

DRILLING DATE: JUNE 29/98
DRILL RIG: B-57 TRACK MOUNT
DRILLING CONTRACTOR: MASTER SOILS

SHEET 2 OF 2
DATUM: GEODETIC
PROJECT: 981-8004

FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN
F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED
SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR
FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED
BC-BROKEN CORE MB-MECH. BREAK B-BEDDING

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min.)	FLUSH / % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES / WATER LEVELS / INSTRUMENTATION
0		CONTINUED FROM PREVIOUS PAGE		126.84 0.00												
1																
2		CONTINUED FROM SHEET 1		124.42												
		Borehole advanced by augering to 2.8m depth prior to coring.		2.42 124.04												
3	NQ CORING	highly to moderately weathered, fine grained, thinly bedded, grey SHALE, with some SHALEY LIMESTONE and crystalline LIMESTONE interbeds.		2.80	1								Clay seam (2.8m to 2.9m) Broken Core (2.8m to 3.3m)			
4					2											FILTER SAND
5													Broken Core (5.2m to 5.3m)			
6		Moderately becoming slightly weathered, grey SHALEY LIMESTONE interbedded with crystalline LIMESTONE; some SHALE bedding partings. Crystalline limestone interbeds are generally less than 75mm in thickness except at the following approximate elevations. 121.0m - 230mm 119.5m - 200mm One 50mm thick fossiliferous limestone seam at Elev. 119.7m.		121.34 5.50	3											
7													Broken Core (6.6m to 6.8m)			
8	JUNE 30/98				4											
		END OF BOREHOLE		118.56 8.28												Water level in piezometer at Elev. 124.7m on July 17/98.
9																
10																

DEPTH SCALE:
1 to 50

Golder Associates

LOGGED: JY
DATE: AUGUST 17/98
CHECKED: SP

W.P. 166-86-00

DIST. 6; HWY. QEW

LOCATION: N 4820456.987; E 292848.497

RECORD OF BOREHOLE BH3

BORING DATE: JUNE 29/98

SHEET 1 OF 2

DATUM: GEODETIC

PROJECT: 981-8004

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	HYDRAULIC CONDUCTIVITY, k, cm/s	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	B-57 TRACK MOUNT DRILL, SOLID STEM AUGERS	GROUND SURFACE		126.72				SHEAR STRENGTH Cu, kPa: nat V - +, rem V - ⊕; Q - ●, U - ○	WATER CONTENT, PERCENT: Wp, W, Wl (10, 20, 30, 40)		
		Topsoil		0.00							
		Clayey Silt, some sand, trace gravel, trace rootlets and organics Very stiff Brown Moist (Fill)		0.08	1	50 DO	22				
				126.03							
1				0.69	2	50 DO	60/ .15				
		Silty Clay, trace sand and gravel Hard Grey Moist (Residual Soil)			3	50 DO	55/ .13				
2		Shale Highly to completely weathered Grey Dry		124.49 2.23							
		(Bedrock)		124.15 2.57	4	50 DO	60/ .13				
3		REFUSAL TO SPLIT SPOON SAMPLER ADVANCE. BOREHOLE CONTINUED. FOR BEDROCK CORING DETAILS, SEE SHEET 2.									
4		NOTE: Resistance to auger advance between 2.23m and 2.44m - inferred limestone layer.									
5											
6											
7											
8											
9											
10		CONTINUED ON NEXT PAGE									

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: JY

CHECKED: SP

W.P. 166-86-00
DIST. 6; HWY. QEW
LOCATION: N 4820456.987E 292848.497

RECORD OF BOREHOLE: BH3

DRILLING DATE: JUNE 25/98
DRILL RIG: B-57 TRACK MOUNT
DRILLING CONTRACTOR: MASTER SOILS

SHEET 2 OF 2
DATUM: GEODETIC
PROJECT: 981-8004

FR-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R -ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W -WAVY B -BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C -CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min.)	FLUSH / COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA DIP w.r.t. CORE AXIS	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
		CONTINUED FROM PREVIOUS PAGE		126.72												
0				0.00												
1																
2		CONTINUED FROM SHEET 1		124.15												
		Borehole advanced by augering to 3.05m depth prior to coring.		2.57												
3				123.67									Clay seam (3.1m to 3.2m)			
	NQ CORING	Highly to moderately weathered, fine grained, thinly bedded, grey SHALE with some SHALEY LIMESTONE and crystalline LIMESTONE interbeds. Crystalline limestone interbeds are generally less than 75mm in thickness except at the following approx. elevation.		3.05	1								Broken core (3.0m to 4.3m)			
4		123.3m - 200mm			2											
5		Moderately to slightly weathered, grey SHALEY LIMESTONE interbedded with crystalline LIMESTONE. Crystalline limestone interbeds are generally less than 75mm in thickness except at the following elevation.		121.42												
	JUNE 25/98	121.3m - 180mm		5.30	3											
6		END OF BOREHOLE		120.68 6.04												
7																
8																
9																
10																

DEPTH SCALE:
1 to 50

Golder Associates

LOGGED: JY
DATE: AUGUST 17/98
CHECKED: SP

W.P. 166-86-00

DIST. 6; HWY. QEW

LOCATION: N 4820527.296; E 292844.282

RECORD OF BOREHOLE BH4

BORING DATE: JUNE 29/98

SHEET 1 OF 2

DATUM: GEODETIC

PROJECT: 981-8004

BORING METHOD: B-57 TRACK MOUNT DRILL, SOLID STEM AUGERS

DEPTH SCALE METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m
0	GROUND SURFACE		126.60			
	Clayey Silt, some sand, trace gravel, trace rootlets and organics. Very stiff Brown Moist (Fill)		0.00 125.91 0.69	1	50 DO	16
1	Silty Clay, trace sand, trace gravel, limestone seam at 1.5m depth Hard Mottled grey and brown Moist (Residual Soil)			2 3	50 DO 50 DO	69 200 /03
2	Shale Highly to completely weathered Grey Dry (Bedrock)		124.31 2.29 124.09	4	50 DO	50/ .08
	REFUSAL TO SPLIT SPOON SAMPLER ADVANCE. BOREHOLE CONTINUED. FOR BEDROCK CORING DETAILS, SEE SHEET 2.		2.51			
3						
4						
5						
6						
7						
8						
9						
10	CONTINUED ON NEXT PAGE					

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

SHEAR STRENGTH Cu, kPa — nat V - + Q - ● rem V - ⊕ U - ○

HYDRAULIC CONDUCTIVITY, k, cm/s

WATER CONTENT, PERCENT — Wp W Wl (10 20 30 40)

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: JY

CHECKED: SP

W.P. 166-86-00
DIST. 6; HWY. QEW
LOCATION: N 4820527.296E 292844.282

RECORD OF BOREHOLE: BH4

DRILLING DATE: JUNE 29/98
DRILL RIG: B-57 TRACK MOUNT
DRILLING CONTRACTOR: MASTER SOILS

SHEET 2 OF 2
DATUM: GEODETIC
PROJECT: 981-8004

FR-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R -ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W -WAVY B -BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C -CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min.)	FLUSH / % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA DIP w.r.t. CORE AXIS	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
		CONTINUED FROM PREVIOUS PAGE		126.60												
0				0.00												
1																
2		CONTINUED FROM SHEET 1		124.16												
		Borehole advanced by augering to 2.69m depth prior to coring.		2.44 123.91												
3	NQ CORING	Highly to moderately weathered, fine grained, thinly bedded, grey SHALE, with some SHALEY LIMESTONE and crystalline LIMESTONE interbeds. Crystalline limestone interbeds are generally less than 75mm in thickness except at the following approx. elevations. 123.7m - 150mm One 50mm thick fossiliferous limestone seam at Elev. 121.4m.		2.69	1								Clay seam (2.9m to 3.0m) Broken Core (2.7m to 4.6m) Clay seam (3.6m) Sub-vertical joint (4.2m to 4.3m) Clay seam (4.6m to 4.7m)			
4					2											
5																
6	JUNE 29/98	Moderately to slightly weathered, grey SHALEY LIMESTONE interbedded with crystalline LIMESTONE, some SHALE bedding partings. Crystalline limestone interbeds are generally less than 75mm in thickness except at the following approx. elevation. 121.3m - 100mm 120.9m - 180mm		121.10 5.50 119.74	3								Sub-vertical joint (6.8m to 6.9m) Broken Core (6.7m to 6.9m)			
7		END OF BOREHOLE		6.86												
8																
9																
10																

DEPTH SCALE:
1 to 50

Golder Associates

LOGGED: JY
DATE: AUGUST 17/98
CHECKED: SP

W.P. 166-86-00
DIST. 6; HWY. QEW
LOCATION: N 4820492.124; E 292873.795

RECORD OF BOREHOLE BH6

BORING DATE: JUNE 26/98

SHEET 1 OF 2
DATUM: GEODETIC
PROJECT: 981-8004

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	HYDRAULIC CONDUCTIVITY, k, cm/s	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		126.60				SHEAR STRENGTH Cu, kPa: nat V - + Q - ● ; rem V - ⊕ U - ○	WATER CONTENT, PERCENT: Wp W Wl (10 20 30 40)		
0	B-57 TRACK MOUNT DRILL SOLID STEM AUGERS	Silty Sand, some gravel, trace clay, trace organics and brick fragments Compact Brown Moist (Fill)		0.00	1	SS DO	20				BENTONITE SEAL
1					2	SS DO	29		○		NATIVE BACKFILL
				125.23							
		Silty Clay, trace sand and gravel Hard Grey Moist (Residual Soil)		1.37	3	SS DO	65		○	MH	
2				124.31	4	SS DO	50/ 0.0				
		REFUSAL TO SPLIT SPOON SAMPLER ADVANCE. BOREHOLE CONTINUED. FOR BEDROCK CORING DETAILS, SEE SHEET 2.		2.29							
3											
4											
5											
6											
7											
8											
9											
10		CONTINUED ON NEXT PAGE									

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: JY
CHECKED: SP

W.P. 166-86-00
DIST. 6; HWY. QEW
LOCATION: N 4820492.124E 292873.795

RECORD OF BOREHOLE: BH6

SHEET 2 OF 2
DRILLING DATE: JUNE 26/98
DRILL RIG: B-57 TRACK MOUNT
DRILLING CONTRACTOR: MASTER SOILS
DATUM: GEODETIC
PROJECT: 981-6004

FR-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R -ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W -WAVY B -BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C -CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	FLUSH / COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES / WATER LEVELS / INSTRUMENTATION
0		CONTINUED FROM PREVIOUS PAGE		126.60												
				0.00												
1																
2		CONTINUED FROM SHEET 1		124.31												
		Borehole advanced by augering to 2.84m depth prior to coring.		2.29												
				123.76												
3	NQ CORING	Highly to moderately weathered, fine grained, thinly bedded, grey SHALE, with some SHALEY LIMESTONE and crystalline LIMESTONE interbeds. Crystalline limestone interbeds are genrally 75mm in thickness except at the following elevations. 123.2m - 100mm One 50mm thick fossiliferous limestone seam at Elev. 123.1m.		2.84	1								Broken Core (2.8m to 3.4m)			
4					2								Broken Core (3.7m to 4.3m)			NATIVE BACKFILL
5				121.30												
		Moderately becoming slightly weathered, grey SHALEY LIMESTONE interbedded with light grey crystalline LIMESTONE, some SHALE bedding partings. Crystalline limestone interbeds are generally less than 75mm in thickness except at the following approx. elevations. 121.1m - 600mm 119.5m - 150mm 119.1m - 180mm		5.30	3											
6																
7					4											
8	JUNE 26/98															FILTER SAND
					5											
9				117.66												
		END OF BOREHOLE		8.94												Water level in piezometer at Elev. 123.4m on July 17/98.
10																

DEPTH SCALE:
1 to 50

Golder Associates

LOGGED: JY
DATE: AUGUST 17/98
CHECKED: SP

W.P. 166-86-00
DIST. 6; HWY. QEW
LOCATION: N 4820509.007; E 292831.262

RECORD OF BOREHOLE BH7

BORING DATE: JUNE 29/98

SHEET 1 OF 2
DATUM: GEODETIC
PROJECT: 981-8004

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	SHEAR STRENGTH Cu, kPa (nat V - +, rem V - ⊕, Q - ●, U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s	WATER CONTENT, PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		126.61									
0	B-57 TRACK MOUNT DRILL, SOLID STEM AUGERS	Clayey Silt, some sand, trace gravel, trace rootlets and organics Very stiff Brown Moist (Fill)		0.00 125.92 0.69	1	50 DO	25						
1		Clayey Silt, trace sand and gravel, some oxidized stains Very stiff Mottled brown becoming grey Moist (Fill)			2	50 DO	24				○		
		Shale Highly to completely weathered Grey Dry (Bedrock)			3	50 DO	28				○		
2				124.32 2.29	4	50 DO	65/ .15						
		REFUSAL TO SPLIT SPOON SAMPLER ADVANCE. BOREHOLE CONTINUED. FOR BEDROCK CORING DETAILS, SEE SHEET 2.		2.44									
3													
4													
5													
6													
7													
8													
9													
10		CONTINUED ON NEXT PAGE											

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: JY
CHECKED: SP

W.P. 166-86-00
DIST. 6; HWY. QEW
LOCATION: N 4890509.007E 292831.262

RECORD OF BOREHOLE: BH7

SHEET 2 OF 2
DRILLING DATE: JUNE 25/98
DRILL RIG: B-57 TRACK MOUNT
DRILLING CONTRACTOR: MASTER SOILS
DATUM: GEODETIC
PROJECT: 981-8004

FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN
F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED
SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR
FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED
BC-BROKEN CORE MB-MECH. BREAK B-BEDDING

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min.)	FLUSH / COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
		CONTINUED FROM PREVIOUS PAGE		126.61												
0				0.00												
1																
2		CONTINUED FROM SHEET 1		124.17												
	NQ CORING	Borehole advanced by augering to 2.74m depth prior to coring.		2.44 123.87												
3		Highly to moderately weathered, fine grained, thinly bedded, grey SHALE, with some SHALEY LIMESTONE and crystalline LIMESTONE interbeds.		2.74	1								Broken Core (2.7m to 3.3m)			
4					2								Broken Core (4.0m to 4.3m) Broken Core (4.6m to 4.9m)			
5		Moderately to slightly weathered, grey SHALEY LIMESTONE interbedded with crystalline LIMESTONE. Crystalline limestone interbeds are generally less than 75mm in thickness except at the following approx. elevations. 120.4m - 150mm		121.61 5.00									Broken Core (5.2m to 5.4m)			
6	JUNE 25/98				3											
		END OF DRILLHOLE		119.85 6.76												
7																
8																
9																
10																

DEPTH SCALE:
1 to 50

Golder Associates

LOGGED: JY
DATE: AUGUST 17/98
CHECKED: SP

W.P. 166-86-00
DIST. 6; HWY. QEW
LOCATION: N 4820477.170; E 292862.790

RECORD OF BOREHOLE BH8

BORING DATE: JUNE 25/98

SHEET 1 OF 2
DATUM: GEODETIC
PROJECT: 981-8004

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	HYDRAULIC CONDUCTIVITY, k, cm/s	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	B-57 TRACK MOUNT DRILL, SOLID STEM AUGERS	GROUND SURFACE		126.67				SHEAR STRENGTH Cu, kPa: nat V - +, rem V - ⊕; Q - ●, U - ○	WATER CONTENT, PERCENT: Wp, W, Wl (10, 20, 30, 40)		
		Topsoil		0.00 / 126.42							
		Silty Sand, some gravel, trace clay, tarce organics and brick fragments Compact Brown Moist (Fill)		0.25 / 125.91 / 0.78	1	50 DO	20				
1					2	50 DO	41		○		
		Clayey Silt, trace sand and gravel, trace organics Hard Brown to grey Moist (Fill)			3	50 DO	58				
2		Clayey Silt, some sand and gravel Hard Grey Moist (Residual Soil)		124.67 / 2.00 / 124.44 / 2.23							
		Shale Highly to completely weathered Grey Dry (Bedrock)		124.08 / 2.59	4	50 DO	50/.15				
3		REFUSAL TO SPLIT SPOON SAMPLER ADVANCE. BOREHOLE CONTINUED. FOR BEDROCK CORING DETAILS, SEE SHEET 2.									
4											
5											
6											
7											
8											
9											
10		CONTINUED ON NEXT PAGE									

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: JY
CHECKED: SP

W.P. 166-86-00

DIST. 6; HWY. QEW

LOCATION: N 4820477.170E 292862.790

RECORD OF BOREHOLE: BH8

DRILLING DATE: JUNE 26/98

DRILL RIG: B-57 TRACK MOUNT

DRILLING CONTRACTOR: MASTER SOILS

SHEET 2 OF 2

DATUM: GEODETIC

PROJECT: 981-8004

FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN | F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED | SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR | FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED | BC-BROKEN CORE MB-MECH. BREAK B-BEDDING

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min.)	FLUSH / % RETURN / COLOUR	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
0		CONTINUED FROM PREVIOUS PAGE		126.67												
				0.00												
1																
2																
		CONTINUED FROM SHEET 1		124.17												
		Bedrock advanced by augering to 2.74m depth prior to coring.		2.50 123.93												
3	NQ CORING			2.74									Broken Core (2.7m to 3.0m)			
		Highly to moderately weathered, fine grained, thinly bedded, grey SHALE, with some SHALEY LIMESTONE and crystalline LIMESTONE interbeds. Crystalline limestone interbeds are generally less than 75mm in thickness except at the following approx. elevations.			1								Broken Core) (3.3m to 4.3m)			
4		123.5m - 150mm														
					2											
5				121.37									Clay seam (5.0m to 5.2m)			
	JUNE 26/98	Moderately weathered, grey SHALEY LIMESTONE interbedded with crystalline LIMESTONE, some SHALE bedding partings.		5.30	3											
6				120.57												
		END OF BOREHOLE		6.10												
7																
8																
9																
10																

DEPTH SCALE:

1 to 50

Golder Associates

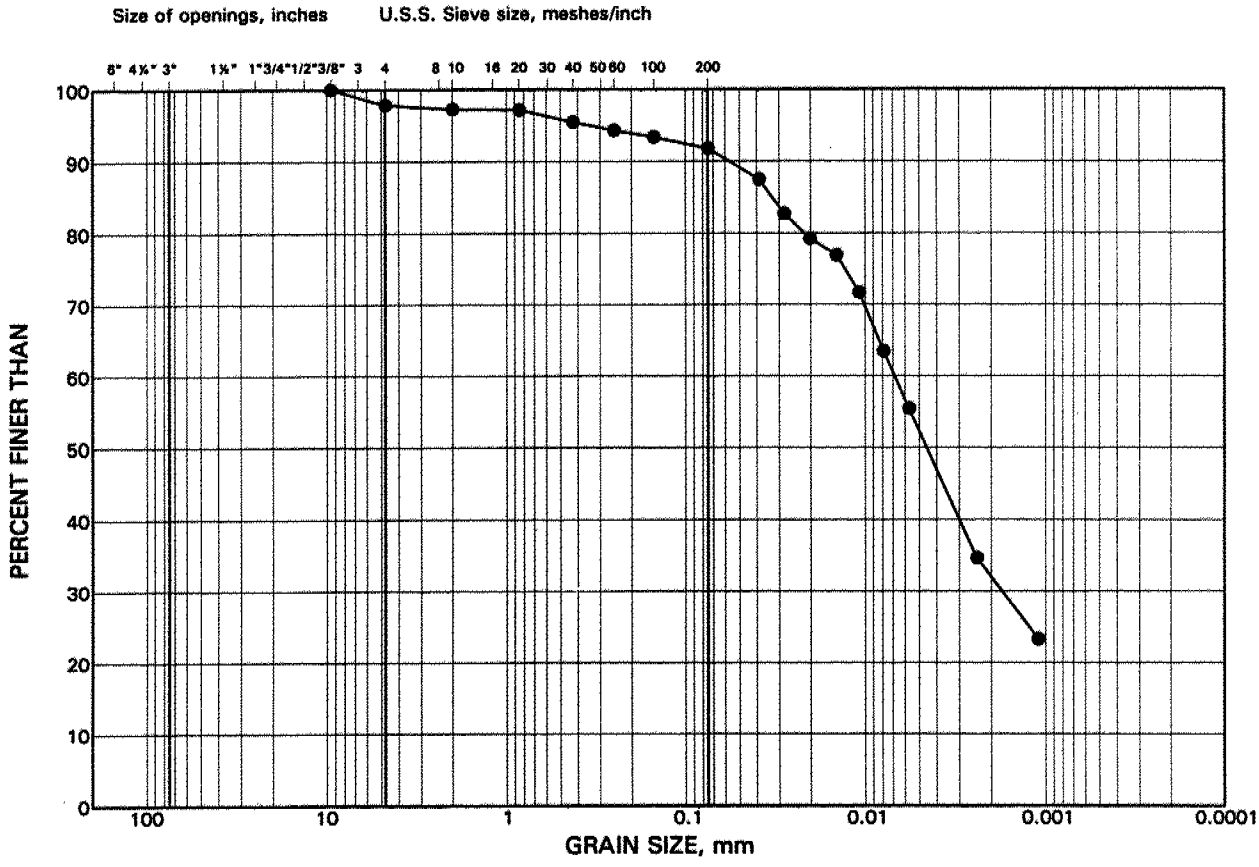
LOGGED: JY

DATE: AUGUST 17/98

CHECKED: SP

GRAIN SIZE DISTRIBUTION
SILTY CLAY, trace sand and gravel

FIGURE 1



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	6	3	124.8

Project 981-8004

Golder Associates

OVERSIZE DRAWING(S)

GEOCRES No 30M12-239

Golder Associates Ltd.

2180 Meadowvale Boulevard
Mississauga, Ontario, Canada L5N 5S3
Telephone (905) 567-4444
Fax (905) 567-6561

REPORT ON

FOUNDATION INVESTIGATION HIGH MAST LIGHTING AND OVERHEAD SIGNAGE W.P. 166-86-00 QUEEN ELIZABETH WAY (QEW) / ERIN MILLS PARKWAY – SOUTHDOWN ROAD INTERCHANGE

Submitted to:

Cole, Sherman & Associates
75 Commerce Valley Drive East
Thornhill, Ontario
L3T 7N9

DISTRIBUTION:

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2 Copies - Golder Associates Ltd., Mississauga, Ontario

August 1998

981-8004A

TABLE OF CONTENTS

1.0 INTRODUCTION

This report presents the results of the foundation investigation carried out for the proposed high mast lighting and overhead signage foundations as part of the Queen Elizabeth Way (QEW) / Erin Mills Parkway – Southdown Road Interchange project. The investigation and analysis has been carried out in accordance with the Terms of Reference for the work and the Ontario Highway Bridge Design Code, Third Edition.

2.0 SITE DESCRIPTION

The site is located at the existing rotary interchange of Erin Mills Parkway – Southdown Road with the QEW in Mississauga, Ontario. The study area for the high mast lighting and overhead signage covers all four quadrants of the proposed interchange. The terrain at the site typically slopes gently downwards in an easterly direction. The existing Shooks Hill Underpass, Bridge No. II (west of Erin Mills Parkway / Southdown Road) and its approaches were formed in cut, whereas Shooks Hill Bridge No. 1 (east of Erin Mills Parkway / Southdown Road) and its approaches were constructed as part of a fill embankment. Vegetation cover at the area of the interchange typically consists of grass, shrubs and occasional small trees.

3.0 INVESTIGATION PROCEDURES

The field work was carried out on July 01 and 02, 1998 at which time seven boreholes were put down within the study area at the locations shown on the attached Figure 1. The boreholes were extended using a track mounted drill rig supplied and operated by a specialist drilling contractor. Soil samples were obtained at regular (0.75 m) intervals of depth as part of the Standard Penetration Test using 50 mm diameter split spoon samplers. The boreholes were extended up to 3 m below the bedrock surface by augering and split spoon sampling.

All ten HML locations, for both options, were surveyed by Cole, Sherman prior to the start of the field work. Boreholes 101 to 104 were put down at four selected locations of the proposed high mast light (HML) poles. Boreholes 105 to 107 were put down at the locations of the three proposed overhead signs, which are to be constructed adjacent to the existing signs. Additional information was obtained from several boreholes put down as part of the geotechnical /

pavement investigation, and one borehole put down as part of the foundation investigation for the bridge structure.

Surveyed northing, easting coordinates and ground surface elevations for Boreholes 101 (208 / 216) and 103 (212), as provided by Cole, Sherman, are shown on the Record of Borehole sheets. Coordinates and elevations shown for Boreholes 102 (209 / 217) and 104 (213 / 220) are changed to reflect slight modification of the drilled locations. For Boreholes 105 to 107, the coordinates are estimated values based on the digital base plan and field location information.

4.0 SUBSURFACE CONDITIONS

In general, the subsoils encountered at the site consist of surficial topsoil and / or fill materials overlying silty clay residual soil and / or silty sand. Bedrock was proven at all borehole locations with the bedrock surface ranging from 0.7 m to 3.0 m in depth. The bedrock typically consists of a 0.3 m to 0.4 m thick limestone cap overlying shale of the Georgian Bay formation. The open boreholes were either dry or had observed water levels of 1.5 m to 2.5 m in depths upon completion of drilling. The following table summarizes the subsurface conditions encountered in the boreholes:

Borehole Number	*Ground Surface Elevation (m)*	*Northing / Easting*	*Depth (m)*	*Stratigraphy / Comments*
101	125.4	4820654.502 N 292777.277 E	0.0 - 0.1 0.1 - 1.5 1.5 - 4.7 4.7	Topsoil Firm to stiff, brown to grey, clayey silt to silty clay, trace sand FILL. "N" = 8 @ 0.2 m; "N" = 10 @ 0.8 m Weathered, grey shale with limestone interbeds BEDROCK. "N" > 50 @ 1.5 m and 4.5 m End of borehole; water level at 1.5 m depth in open borehole upon completion of drilling.
102	123.9	4820725.315 N 292909.799 E	0.0 - 0.6 0.6 - 2.3 2.3 - 5.3 5.3	Loose, brown, silty sand FILL. "N" = 8 @ 0.2 m. Hard, grey, silty clay, trace sand and gravel RESIDUAL SOIL. "N" > 50 @ 0.8 m; and 1.5 m. Weathered, grey shale with limestone interbeds BEDROCK, "N" > 50 @ 3.0 m End of borehole; water level at 2.5 m depth in open borehole upon completion of drilling.
103	125.7	4820371.497 N 292866.788 E	0.0 - 0.2 0.2 - 1.4 1.4 - 1.8 1.8 - 4.7 4.7	Topsoil Very stiff, mottled brown, silty clay, trace sand and gravel FILL. "N" = 24 @ 0.8 m. Hard, grey silty clay, trace sand and gravel RESIDUAL SOIL. "N" > 50 @ 4.5 m. Weathered, grey shale with limestone interbeds BEDROCK End of borehole.

Borehole Number	Ground Surface Elevation (m)	Northing / Easting	Depth (m)	Stratigraphy / Comments
104	127.7	4820301.797 N 292719.988 E	0.0 - 0.7 0.7 - 1.4 1.4 - 4.6 4.6	Dense, silty sand, some gravel FILL. "N" = 32 @ 0.2 m Hard, grey, silty clay, trace sand and gravel RESIDUAL SOIL. "N" = 85 @ 0.8 m; "N" > 50 @ 1.5 m Weathered, grey shale with limestone interbeds BEDROCK. "N" > 60 @ 1.5 m and 4.5 m End of borehole; open borehole dry upon completion of drilling.
105	-	4820697.854 N (approximate) 292729.138 E (approximate)	0.0 - 1.4 1.4 - 2.1 2.1 - 5.2 5.2	Very stiff, clayey silt, trace sand and gravel FILL. "N" = 28 @ 0.2 m, "N" = 18 @ 0.8 m. Very stiff to hard, mottled grey and brown, silty clay, trace sand and gravel RESIDUAL SOIL. "N" = 30 @ 1.5 m. Weathered, grey shale with limestone interbeds BEDROCK. "N" > 60 @ 5.2 m. End of borehole; water level in open borehole at 2.6 m depth upon completion of drilling.
106	-	4820584.513 N (approximate) 293075.549 E (approximate)	0.0 - 1.4 1.4 - 2.3 2.3 to 5.3 5.3	Loose to compact, brown, sandy silt FILL. "N" = 8 @ 0.2 m; "N" = 14 @ 0.8 m. Compact, brown, silty sand, trace gravel. "N" = 23 @ 1.5 m. Weathered, grey shale with limestone interbeds BEDROCK "N" > 60 @ 5.3 m End of borehole; open borehole dry upon completion of drilling.
107	-	4820367.023 N (approximate) 292936.691 E (approximate)	0.0 - 0.7 0.7 - 3.8 3.8	Stiff, brown, clayey silt, some gravel FILL. "N" = 14 @ 0.2 m. Weathered, grey shale with limestone interbeds BEDROCK "N" > 60 @ 0.8 m, 1. m and 3.7 m. End of borehole.

Further subsurface information was obtained from the results of three boreholes put down during the geotechnical / pavement investigation for this project, and from a borehole put down for the proposed bridge structure. The approximate borehole locations are shown on the attached Figure 1. The borehole information is summarized in the following table.

Borehole Number	*Ground Surface Elevation (m)*	*Depth Below Ground Surface (m)*	*Description*
GP107*	120.06	0.0 – 0.2	Asphalt
		0.2 – 0.4	Concrete
		0.4 – 2.3	Sand to silty sand
		2.3	BEDROCK (inferred)
GP122*	125.05	0.0 – 0.2	Asphalt
		0.2 – 0.4	Concrete
		0.4 – 0.6	Sand
		0.6 – 1.5	Silty clay
		1.5	BEDROCK (inferred)
GP149*	127.33	0.0 – 0.1	Topsoil
		0.1 – 0.8	Sand and silt
		0.8 – 3.0	Silty clay
		3.0	BEDROCK (inferred)
1**	126.8	0.0 – 1.6	Clayey silt FILL
		1.6 – 2.3	Silty clay RESIDUAL SOIL
		2.3 – 8.3	Weathered grey shale with limestone interbeds.
		8.3	End of borehole; water level in piezometer at 2.2 m depth.

NOTE: * Borehole numbers from geotechnical / pavement report.
** Borehole number from bridge foundation report.

The subsurface conditions at the HML locations can be inferred from the results of the boreholes closest to each proposed HML; the boreholes put down specifically at the proposed HML locations and boreholes put down during the geotechnical / pavement and foundation investigations. Conditions at the overhead signage locations can be obtained from Boreholes 105 to 107 specifically drilled at these locations.

Grinding of the augers during drilling through the bedrock was noted indicating the presence of limestone interlayers within the shale. A limestone layer of about 0.3 m to 0.4 m thick was encountered in six of the seven boreholes put down for the HML / signage locations. It was possible to advance the auger to up to 3 m into the bedrock at all of these locations.

5.0 GEOTECHNICAL RECOMMENDATIONS

Reference should be made to Special Provision No. 631F02ERS – Construction Specification for Concrete Footings for High Mast Poles.

The following parameters may be assumed for the design of the HML foundations based on the simplified stratigraphy.

High Mast Lighting & Signage Location Designation	*Approximate Northing / Easting*	*Strata*	*Depth (m)*	*Design Parameters*				
				Cu	*c'*	*ϕ'*	*γ*	*K_p*
S1	4820697.854 N 292729.138 E	Fill	0.0 - 1.0	-	-	28	19	2.8
		Silty Clay	1.0 - 2.2	100	-	31	21	3.1
209 / 217	4820725.315 N 292909.799 E	Shale bedrock	>2.2	-	10	40	23	4.6
208 / 216	4820654.502 N 292777.277 E	Fill	0.0 – 1.5	-	-	28	19	2.8
		Shale bedrock	>1.5	-	10	40	23	4.6
211	4820529.322 N 292903.990 E	Fill	0.0 - 0.7	-	-	28	19	2.8
		Silty Clay	0.7 - 1.5	100	-	31	21	3.1
213 / 220	4820301.797 N 292719.988 E	Shale bedrock	>1.5	-	10	40	23	4.6
S2	4820584.513 N 293075.549 E							
210	4820650.175 N 293003.987 E	Fill/Sand	0.0 - 2.3	-	-	28	19	2.8
		Shale bedrock	>2.3	-	10	40	23	4.6
218	4820612.349 N 292975.977 E							
207	4820445.095 N 292776.743 E	Sand	0.0 - 0.8	-	-	28	19	2.8
		Silty Clay	0.8 - 3.0	75	-	30	20	3.0
		Shale bedrock	>3.0	-	10	40	23	4.6
212	4820371.497 N 292866.788 E	Topsoil	0.0 - 0.2	-	-	-	16	-
		Fill	0.2 - 1.4	-	-	28	19	2.8
219	4820370.520 N 292889.370 E	Silty Clay	1.4 - 1.8	150	-	32	21	3.2
		Shale bedrock	>1.8	-	10	40	23	4.6
S3	4820367.023 N 292936.691 E	Fill	0.0 – 0.7	-	-	28	19	2.8
		Shale Bedrock	>0.7	-	10	40	23	4.6
215	4820490.049 N 292810.877 E	Fill	0.0 – 1.6	-	-	28	19	2.8
		Silty Clay	1.6 – 2.3	150	-	32	21	3.2
		Shale bedrock	2.3	-	10	40	23	4.6

c_u - undrained shear strength, kPa
c' - effective cohesion, kPa
ϕ' - effective angle of friction, degrees
γ - bulk unit weight, kN/m^3
K_p - passive lateral earth pressure coefficient

The unfactored passive lateral earth pressure, P_p, distribution along the caisson acting over depth, d in m, may be calculated using the following expression and the parameters given above:

$$P_p = K_p \gamma \ d + 2\, c' \sqrt{K_p}$$

The groundwater level as encountered in the boreholes is generally coincident with the surface of the bedrock. As such, the effective unit weight of the shale bedrock should be used and may be taken as 13 kN/m^3.

Where an undrained shear strength, c_u, is provided, the undrained capacity for the length of the socket within the silty clay residual soil may be calculated assuming ϕ' of zero and an unfactored passive lateral pressure distribution equivalent to 2 times the undrained shear strength.

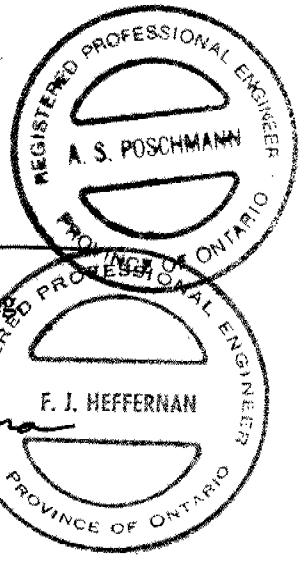
The unfactored lateral resistance should be calculated assuming an equivalent pile width equal to 3 times the caisson diameter. A resistance factor of 0.5 should be applied to the lateral resistance as calculated to obtain the factored lateral geotechnical resistance.

The groundwater level should be assumed at 2 m depth below ground surface. The passive resistance in front of the caisson within the upper 1.2 m below ground surface should be neglected in the design of the foundations to account for frost action.

Sockets for the HML and signage foundations will primarily be formed in bedrock. It is noted that refusal to further auger advance and / or split spoon penetration during drilling through the bedrock was encountered in all boreholes drilled during the present investigation. Augering through the bedrock for caisson construction will be relatively difficult given the anticipated limestone cap and layering within the shale bedrock. As such, the caisson may have to be advanced using tricone or churn drilling techniques to break through the hard layers. The contractors' method of caisson construction should allow for penetration of the limestone layers and break-up and removal of cobbles and boulders, where encountered.

Yours truly,

GOLDER ASSOCIATES LTD.



S. Pang, P.Eng.
Project Engineer

A.S. Poschmann, P.Eng.
Principal

F.J. Heffernan, P.Eng.
Consultant

SP/ASP/FJH/sp/clg
WORD S/FINAL.DAT/OTHPRJT/9818004A/8004HR2

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.).

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° 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

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

III. SOIL DESCRIPTION

(a) Cohesionless Soils

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

(b) Cohesive Soils

Consistency	c_u, s_u kPa	c_u, s_u 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 limit
w_l	liquid limit
C	consolidation (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 to 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 ($D_R = \rho_s/\rho_w$) (formerly G_s)
e void ratio
n porosity
S degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density x acceleration due to gravity)

(a) Index Properties (con't.)

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)

(c) 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

(d) Consolidation (one-dimensional)

C_c compression index (normally consolidated range)
C_r recompression index (overconsolidated range)
C_S swelling index
C_α 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 $= \sigma'_p/\sigma'_{vo}$

(e) Shear Strength

τ_p, τ_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 ($\phi = 0$ 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

W.P. 166-86-00

DIST. 6; HWY: QEW

LOCATION: N 4820654.502; E 292777.277

RECORD OF BOREHOLE BH101

BORING DATE: JULY 1/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-8004A

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; SHEAR STRENGTH Cu, kPa (nat V +, rem V ⊕, Q ●, U ○)	HYDRAULIC CONDUCTIVITY, k, cm/s; WATER CONTENT, PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	B-57 TRACK MOUNT DRILL SOLID STEM AUGERS	GROUND SURFACE		125.37							
		TOPSOIL		0.00							
		Clayey Silt, trace sand Firm Dark brown Dry (Fill)		0.08	1	50 DO	8		W: ○		
				124.76 0.61							
1		Silty Clay, trace sand Stiff Grey Moist (Fill)			2	50 DO	10		W: ○		
				123.85 1.52	3	50 DO	50/ .08				▽
2		Shale with limestone interbeds (limestone from 1.5m to 1.8m) Weathered Grey (Bedrock)									Water level in open borehole at Elev.123.9m upon completion of drilling.
3											
4				120.72	4	50 DO	60/ .08				
		END OF BOREHOLE		4.65							
5											
6											
7											
8											
9											
10											

WATER CONTENT, PERCENT: Wp 10, W 20, Wl 30, 40

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: JY

CHECKED: SP

W.P. 166-86-00

DIST. 6; HWY: QEW

LOCATION: N 4820722.315; E 292909.799

RECORD OF BOREHOLE BH102

BORING DATE: JULY 1/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-6004A

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 / SHEAR STRENGTH Cu, kPa (nat V - +, rem V - ⊕)	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT, PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	B-57 TRACK MOUNT DRILL, SOLID STEM AUGERS	GROUND SURFACE		123.90							
		Silty Sand, trace organics Loose Brown Moist (Fill)		0.00	1	50 DO	8				
				123.29 0.61							
1		Silty Clay, trace sand and gravel, some shale fragments Hard Grey Moist (Residual Soil)			2	50 DO	50/.15				
					3	50 DO	50/0.0				
2				121.64							
		Shale with limestone interbeds (limestone 2.3m to 2.7m) Weathered Grey (Bedrock)		2.26	4	50 DO	60/.03				Water level in open borehole at Elev.122.5m upon completion of drilling.
3											
4											
5				118.57							
		END OF BOREHOLE		5.33							
6											
7											
8											
9											
10											

HYDRAULIC CONDUCTIVITY, k, cm/s

WATER CONTENT, PERCENT: Wp — W — Wl; 10 20 30 40

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: JY

CHECKED: SP

W.P. 166-86-00
DIST. 6; HWY: QEW
LOCATION: N 4820371.497; E 292866.788

RECORD OF BOREHOLE BH103

BORING DATE: JULY 1/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8004A

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; SHEAR STRENGTH Cu, kPa (nat V - +, rem V - ⊕, Q - ●, U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s; WATER CONTENT, PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	B-57 TRACK MOUNT DRILL, SOLID STEM AUGERS	GROUND SURFACE		125.68							
		TOPSOIL		0.00							
		Silty Clay, trace sand and gravel, trace organics, some oxidized stains Very stiff Mottled brown Moist (Fill)		0.15	1	50 DO	*				
1					2	50 DO	24				
				124.31							
		Silty Clay, trace sand and gravel Hard Grey Moist (Residual Soil)		1.37	3	50 DO	50/.15				
2				123.90 1.78							
3		Shale with limestone interbeds (limestone from 1.8m to 2.1m) Weathered Grey (Bedrock)									
4					4	50 DO	60/.15				
				120.96 4.72							
5		END OF BOREHOLE *Note: Blow counts not recorded									
6											
7											
8											
9											
10											

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: JY
CHECKED: SP

W.P. 166-86-00

DIST. 6; HWY: QEW

LOCATION: N 4820298.797; E 292719.988

RECORD OF BOREHOLE BH104

BORING DATE: JULY 1/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-8004A

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	HYDRAULIC CONDUCTIVITY, k, cm/s	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	B-57 TRACK MOUNT DRILL, SOLID STEM AUGERS	GROUND SURFACE		127.70				SHEAR STRENGTH Cu, kPa: nat V - +, rem V - ⊕; Q - ●, U - ○	WATER CONTENT, PERCENT: Wp, W, Wl (10, 20, 30, 40)		
		Silty Sand, some gravel Dense Brown Dry (Fill)		0.00	1	50 DO	32		○		
				127.01							
1		Silty Clay, trace sand and gravel, some shale fragments Hard Grey Moist (Residual Soil)		0.69	2	50 DO	85		○		
				126.35							
				1.35	4	50 DO	60/ .05				
2		Shale with limestone interbeds (limestone from 1.4m to 1.8m) Weathered Grey (Bedrock)									Open borehole dry upon completion of drilling.
3											
4											
				123.13		50 DO	60/ 0.0				
		END OF BOREHOLE REFUSAL TO SPLIT SPOON SAMPLER ADVANCE.		4.57							
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: JY

CHECKED: SP

W.P. 166-86-00
DIST. 6; HWY: QEW
LOCATION: N 4820697.854; E 292729.138

RECORD OF BOREHOLE BH105

BORING DATE: JULY 1/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8004A

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH Cu, kPa (nat V - +, rem V - ⊕, Q - ●, U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT, PERCENT (Wp, W, Wl; 10, 20, 30, 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	B-57 TRACK MOUNT DRILL, SOLID STEM AUGERS	GROUND SURFACE									
		Clayey Silt, trace sand and gravel, trace organics Very stiff Brown Moist (Fill)		0.00	1	50 DO	28				
1					2	50 DO	18				
		Silty Clay, trace sand and gravel Very stiff to hard Mottled grey and brown Grey (Residual Soil)		1.37	3	50 DO	30				
2				2.13							
3		Shale with limestone interbeds (limestone from 2.1m to 2.4m) Weathered Grey (Bedrock)									Water level in open borehole at 2.6m depth upon completion of drilling.
4											
5						50 DO	60/.03				
		END OF BOREHOLE		5.21							
6											
7											
8											
9											
10											

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: JY
CHECKED: SP

W.P. 166-86-00

DIST. 6; HWY: QEW

LOCATION: N 4820584.513; E 293075.549

RECORD OF BOREHOLE BH106

BORING DATE: JULY 1/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-8004A

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	HYDRAULIC CONDUCTIVITY, k, cm/s	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE						SHEAR STRENGTH Cu, kPa: nat V - + Q - ● ; rem V - ⊕ U - ○	WATER CONTENT, PERCENT: Wp 10 — W 20 30 — Wl 40		
0	B-57 TRACK MOUNT DRILL, SOLID STEM AUGERS	Sandy Silt, trace organics and rootlets Loose to compact Brown Moist (Fill)		0.00	1	50 DO	8				
1					2	50 DO	14				
		Silty Sand, trace gravel Compact Brown Moist		1.37	3	50 DO	23				
2											Open borehole dry upon completion of drilling.
3		Shale with limestone interbeds (limestone from 2.3m to 3.0m) Weathered Grey (Bedrock)		2.29							
4											
5						50 DO	60/ 0.0				
		END OF BOREHOLE REFUSAL TO SPLIT SPOON SAMPLER ADVANCE.		5.33							
6											
7											
8											
9											
10											

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: JY

CHECKED: SP

W.P. 166-86-00
DIST. 6; HWY: QEW
LOCATION: N 4820367.023; E 292936.961

RECORD OF BOREHOLE BH107

BORING DATE: JULY 2/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8004A

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	HYDRAULIC CONDUCTIVITY, k, cm/s	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE									
0	B-57 TRACK MOUNT DRILL, SOLID STEM AUGERS	Clayey Silt, some gravel, some organics, trace rootlets Stiff Brown Moist (Fill)		0.00	1	50 DO	14				
				0.71	2	50 DO	60/.15				
1		Shale with limestone interbeds Weathered Grey (Bedrock)			3	50 DO	60/.15				
2											
3					4	50 DO	60/.15				
4		END OF BOREHOLE		3.81							
5											
6											
7											
8											
9											
10											

SHEAR STRENGTH Cu, kPa — nat V - + rem V - ⊕ — Q - ● U - ○

WATER CONTENT, PERCENT — Wp — W — Wl — 10 20 30 40

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: JY
CHECKED: SP

W.P. 166-86-00
DIST. 6; HWY. QEW
LOCATION: N 4820492.256; E 292818.885

RECORD OF BOREHOLE BH1

BORING DATE: JUNE 29/98

SHEET 1 OF 2
DATUM: GEODETIC
PROJECT: 981-8004

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; SHEAR STRENGTH Cu, kPa (nat V - +, rem V - ⊕, Q - ●, U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s; WATER CONTENT, PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		126.84							
0	B-57 TRACK MOUNT DRILL, SOLID STEM AUGERS	Clayey Silt, some sand, trace gravel, trace organics, some shale fragments Very stiff Mottled brown to brown Moist (Fill)		0.00	1	50 DO	22				BENTONITE SEAL
1		Silty Clay, trace sand and gravel Hard Grey Moist (Residual Soil)		125.26	2	50 DO	70		○		NATIVE BACKFILL
		Shale Highly to completely weathered Grey Dry (Bedrock)		1.58 124.55	3	50 DO	65		○		
2			—	2.29	4	50 DO	50/ .13				▽
		REFUSAL TO SPLIT SPOON SAMPLER ADVANCE BOREHOLE CONTINUED FOR BEDROCK CORING DETAILS, SEE SHEET 2.		2.42							
3											
4											
5											
6											
7											
8											
9											
10		CONTINUED ON NEXT PAGE									

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: JY
CHECKED: SP

W.P. 166-86-00
DIST. 6: HWY. QEW
LOCATION: N 4820492.256E 292818.885

RECORD OF BOREHOLE: BH1

DRILLING DATE: JUNE 29/98
DRILL RIG: B-57 TRACK MOUNT
DRILLING CONTRACTOR: MASTER SOILS

SHEET 2 OF 2
DATUM: GEODETIC
PROJECT: 981-8004

FR-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R -ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W -WAVY B -BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C -CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min.)	FLUSH	COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA DIP w.r.t. CORE AXIS	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
		CONTINUED FROM PREVIOUS PAGE		126.84													
0				0.00													
1																	
2		CONTINUED FROM SHEET 1		124.42													
	NQ CORING	Borehole advanced by augering to 2.8m depth prior to coring.		2.42 124.04													
3		highly to moderately weathered, fine grained, thinly bedded, grey SHALE, with some SHALEY LIMESTONE and crystalline LIMESTONE interbeds.		2.80	1									Clay seam (2.8m to 2.9m) Broken Core (2.8m to 3.3m)			FILTER SAND
4					2												
5				121.34										Broken Core (5.2m to 5.3m)			
6		Moderately becoming slightly weathered, grey SHALEY LIMESTONE interbedded with crystalline LIMESTONE; some SHALE bedding partings. Crystalline limestone interbeds are generally less than 75mm in thickness except at the following approximate elevations. 121.0m - 230mm 119.5m - 200mm One 50mm thick fossiliferous limestone seam at Elev. 119.7m.		5.50	3									Broken Core (6.6m to 6.8m)			
7					4												
8	JUNE 30/98			118.56													
		END OF BOREHOLE		8.28													Water level in piezometer at Elev. 124.7m on July 17/98.
9																	
10																	

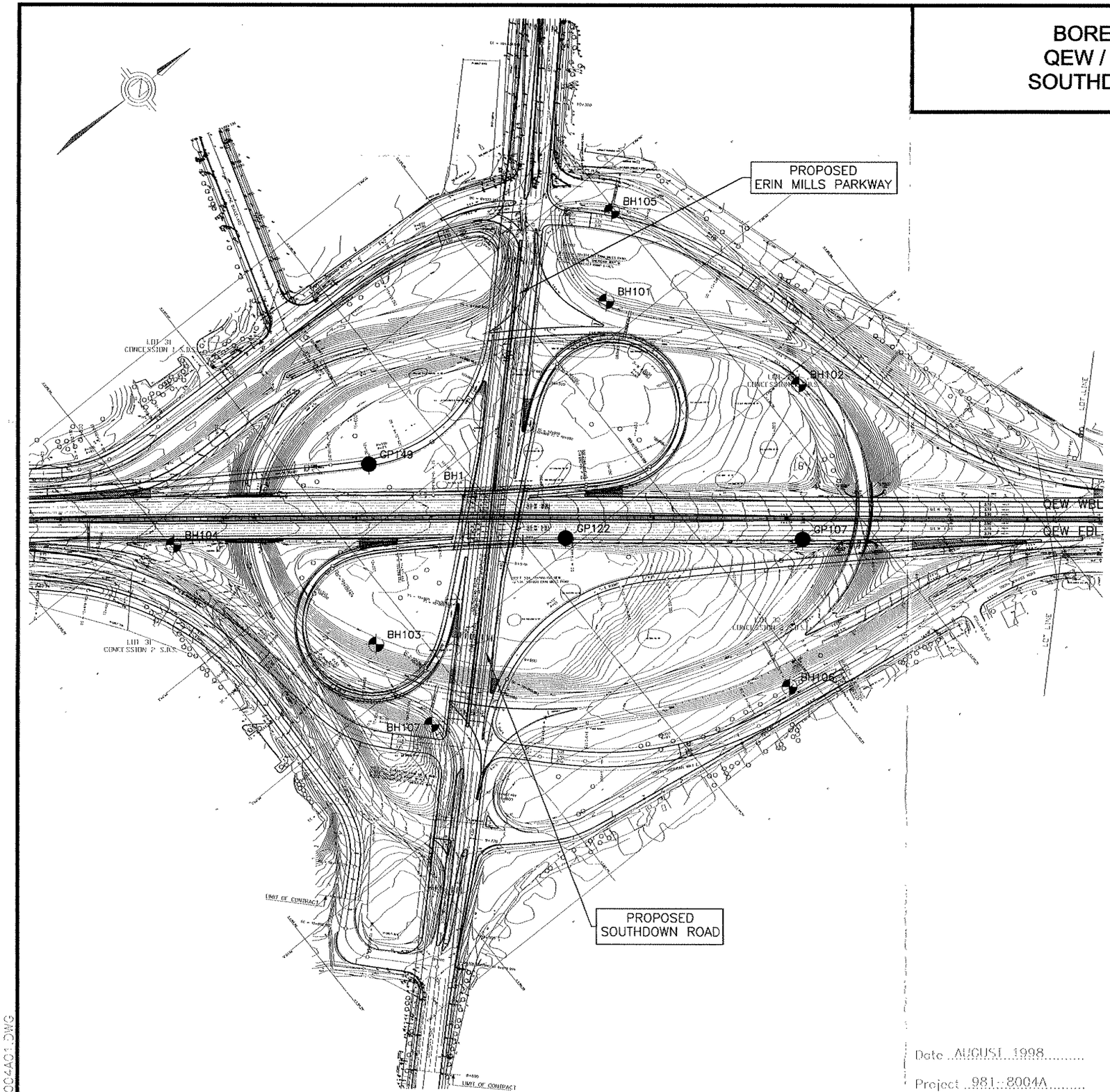
DEPTH SCALE:
1 to 50

Golder Associates

LOGGED: JY
DATE: AUGUST 17/98
CHECKED: SP

BOREHOLE LOCATION PLAN
QEW / ERIN MILLS PARKWAY - SOUTHDOWN RD. INTERCHANGE

FIGURE 1



LEGEND

BH101 — BOREHOLE LOCATION IN PLAN (CURRENT INVESTIGATION)

GP149 — BOREHOLE LOCATION IN PLAN (GEOTECNICAL/PAVEMENT DESIGN REPORT FOR PROPOSED INTERCHANGE, GOLDER ASSOCIATES REPORT No. 981-8004, DATED JULY 1998)

BH1 — BOREHOLE LOCATION IN PLAN (FOUNDATION INVESTIGATION REPORT FOR PROPOSED BRIDGE, GOLDER ASSOCIATES REPORT No. 981-8004, DATED AUGUST 1998)

REFERENCE

BASE PLAN SUPPLIED IN DIGITAL FORMAT BY COLE SHERMAN AND ASSOCIATES.

0 25 50 75 100(metres)

SCALE 1 : 3000

Date AUGUST 1998

Project 981-8004A

Golder Associates

Drawn PS

Chkd SP

N8004A01.DWG

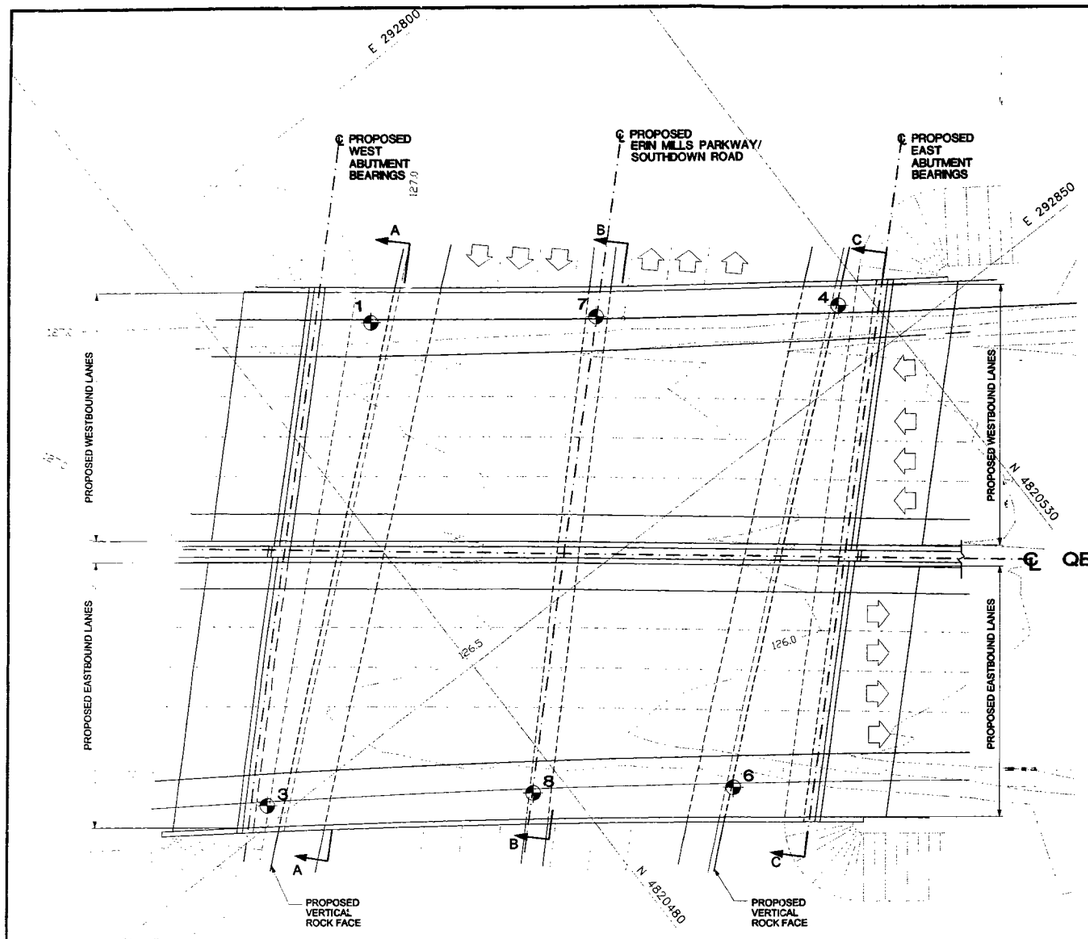
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

DIST. 6 HWY. QEW
CONT. No.
WP No. 166-86-00

QEW OVERPASS AT ERIN MILLS PARKWAY
BOREHOLE LOCATIONS & SOIL STRATA

SHEET

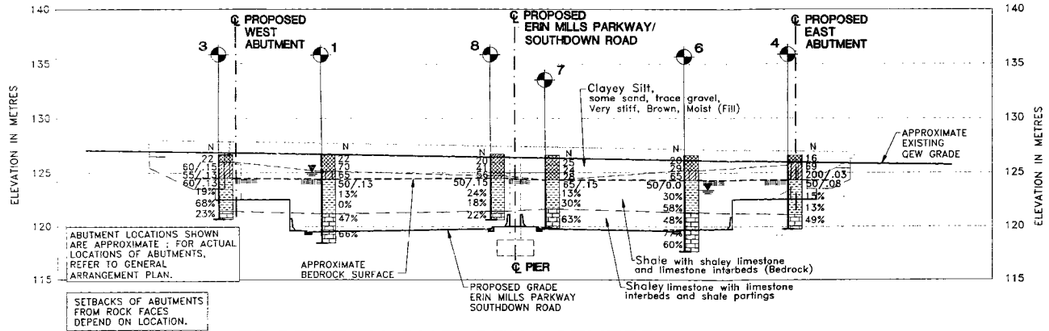
Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



ABUTMENT LOCATIONS SHOWN ARE APPROXIMATE ; FOR ACTUAL LOCATIONS OF ABUTMENTS, REFER TO GENERAL ARRANGEMENT PLAN.

PLAN

0 5 10 15 20 30 METRES
SCALE

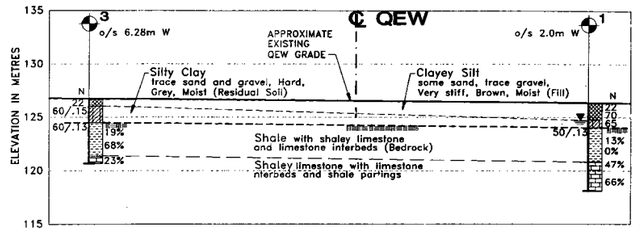


ABUTMENT LOCATIONS SHOWN ARE APPROXIMATE ; FOR ACTUAL LOCATIONS OF ABUTMENTS, REFER TO GENERAL ARRANGEMENT PLAN.

SETBACKS OF ABUTMENTS FROM ROCK FACES DEPEND ON LOCATION.

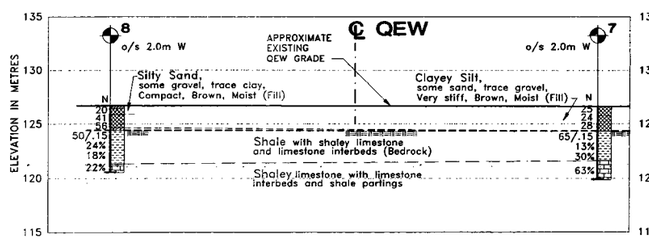
PROFILE ALONG QEW CENTRELINE

0 5 10 15 20 30 METRES
SCALE



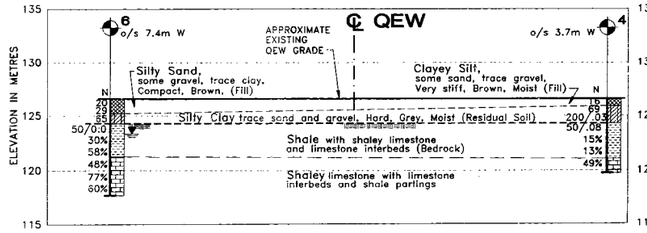
SECTION A-A

0 5 10 15 20 30 METRES
SCALE



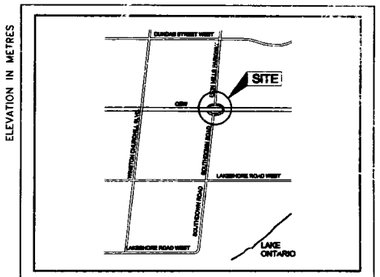
SECTION B-B

0 5 10 15 20 30 METRES
SCALE



SECTION C-C

0 5 10 15 20 30 METRES
SCALE



KEY PLAN

1 0 1 2 3 4 kilometre
SCALE, km

LEGEND

- Borehole
- N — Blows/0.3m (Std. Pen. Test, 475 j/blow)
- Cone — Blows/0.3m (60° Cone, 475 j/blow)
- WL ON JULY 17, 1998.
- 90% — Rock Quality Designation (RQD).

No.	ELEVATION	LOCATION NORTHING	LOCATION EASTING
1	126.84	4820492.256	292818.885
3	126.72	4820456.987	292848.497
4	126.60	4820527.296	292844.282
6	126.60	4820492.124	292873.795
7	126.61	4820509.007	292831.262
8	126.67	4820477.170	292862.790

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

NOTE : The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Offices, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.

NO.	DATE	BY	REVISION

Geocres No.

HWY. QEW		PROJECT NO.: 981-8004	DIST. 6
SUBM'D. SP	CHKD: SP	DATE: 1998 08 18	SITE
DRAWN: PS/JFC	CHKD. ASP	APPD.	DWG.

E:\USERS\JOB\ACDOC\981-8004\N000\001.DWG