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REPORT ON

**GEOTECHNICAL INVESTIGATION
NOISE BARRIER WALLS
HIGHWAY 401 HARWOOD AVENUE TO
CARRUTHERS CREEK DRIVE
TOWN OF AJAX MUNICIPALITY OF DURHAM
W.P. 124-99-00
MINISTRY OF TRANSPORTATION, ONTARIO
CENTRAL REGION, DISTRICT 6, TORONTO**

Submitted to:

Totten Sims Hubicki Associates
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May 2001



001-8019G-6

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1.0 INTRODUCTION

Golder Associates Ltd. has been retained by Totten Sims Hubicki Associates (TSH) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out a foundation investigation for the proposed Highway 401 expansion between Harwood Avenue and Carruthers Creek Drive. The project is part of the MTO plan to expand Highway 401 to a future Core / Distributor system, which requires replacement of existing and construction of proposed intersections to accommodate the Highway 401 improvements. This report presents the results of the geotechnical investigation carried out for the proposed noise barrier walls as part of the Highway 401 improvements at Harwood Avenue.

The purpose of this investigation is to determine the subsurface conditions along the proposed wall alignments by means of a limited number of boreholes, and in-situ and laboratory tests on selected samples.

Based on the plan and profiles provided to Golder by TSH, it is understood that Wall 'A' will extend from about Station 50+826.5 to 51+352.1. The noise wall will be combined with an RSS wall between about Station 51+228 and 51+352. Wall 'B' will extend from Station 60+362.0 to 60+664.9. The noise walls will generally consist of a noise barrier and a precast noise / traffic barrier, and will typically extend about 5 m above the wall grade. Except for a few sections, the grade of the wall will be near or below the existing ground surface.

2.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out between November 2 and 16, 2000 and April 17 and 20, 2001. A total of ten (10) boreholes were advanced along or just beyond the proposed wall alignments as part of the current investigation, and are identified as Boreholes 00-2, 00-11, 00-12, 00-20 to 00-24, 00-26, 00-29, and 00-30. These boreholes were supplemented with three geotechnical boreholes previously put down for the existing noise barrier wall on the north side of Highway 401 to the west of Harwood Avenue (our Report No. 971-8036, dated February 1998).

The current investigation was carried out using a truck-mounted D-90 drill rig and a track-mounted D-50 auger drill rig, both of which were supplied and operated by Master Soil Investigations Ltd of Toronto. The boreholes were advanced to depths of between 6.2 m and 12.2 m below the existing ground surface. Samples of the overburden were obtained at 0.75 m to 1.5 m intervals of depth using 50 mm outside diameter split-spoon samplers in accordance with the Standard Penetration test (SPT) procedure. Groundwater conditions in the open boreholes were observed throughout the drilling operations. Piezometers, consisting of a 0.3 m long slotted section threaded onto 12 mm diameter rigid PVC tubing, were installed in selected boreholes to permit monitoring of the groundwater levels at these locations. The boreholes were backfilled using bentonite pellets in accordance with MTO guidelines.

The fieldwork was supervised on a full-time basis by a member of our engineering staff who located the staked boreholes in the field, 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 to our laboratory in Mississauga for further examination. Index and classification tests consisting of water content determinations, Atterberg limits tests, and grain size analyses were carried out on selected samples.

The borehole locations were established in the field by TSH prior to our mobilization to the site. The elevations and northing and easting co-ordinates of the boreholes drilled for this investigation were provided to us by TSH; the locations are shown in plan on Figure 1. The northing and easting co-ordinates are referenced to the UTM NAD83 co-ordinate system and the elevations are referenced to the geodetic datum.

3.0 SUBSURFACE CONDITIONS

The detailed subsurface soil and groundwater conditions are shown on the Record of Borehole sheets, which are presented in Appendix A. The results of the in-situ and laboratory testing are shown on the Record of Borehole sheets and on Figures B-1 to B-7, which are in Appendix B.

In general, the subsoils encountered consist of up to 600 mm of topsoil, silty clay to sand fill, and silty clay to silty sand till. A 0.8 m thick organic deposit was encountered beneath the fill and overlying the till at Borehole 00-2, which is just west of the western limit of Noise Barrier 'B'.

3.1 Noise Barrier 'A', Station 50+826.5 to Station 51+352

In the vicinity of Noise Barrier 'A', the subsoils consist of clayey silt to silty sand till overlain in places by varying thicknesses of fill and topsoil. Topsoil thickness along Noise Barrier 'A' varies from 0 mm to 200 mm. Fill thickness ranges from zero in Borehole 00-30, to between 0.6 m and 1.2 m in Boreholes 00-24 and 00-26 and the geotechnical borehole at Station 34+080. In the geotechnical borehole at Station 34+000 a 3.3 m thick sandy silt to silty sand fill was found below a 200 mm topsoil layer. Standard Penetration Test (SPT) 'N' values measured in the fill ranged from 2 to 22 blows per 0.3 m of penetration, indicating a very loose to compact state of packing.

A till deposit varying in composition from silty clay / clayey silt clayey silt to silty sand was encountered below the topsoil or fill down to the to the maximum depth in each borehole. SPT 'N' values measured in the clayey silt to silty sand till ranged from 8 to 115 blows per 0.3 m of penetration, indicating a loose state of packing to a hard consistency. Typically, SPT 'N' values in the till were greater than 25 blows per 0.3 m of penetration. Atterberg Limits testing on samples of the clayey silt till from Boreholes 00-23 and 00-24 indicate that liquid limit varies from 14 to 39 per cent, and plasticity index varies from 4 to 23 per cent, classifying the till as an inorganic silt to clay of low plasticity. Laboratory water content determinations on samples of the till in Boreholes 00-23 and 00-24 ranged from 8 to 26 per cent.

3.2 Noise Barrier 'B', Station 51+228 and 51+352

In the vicinity of Noise Barrier 'B', the subsoils consist of silty clay to silty sand till overlain in places by varying thicknesses of fill, topsoil, and organics in Borehole 00-2. Topsoil thickness along Noise Barrier 'B' varies from zero to 600 mm. Fill thickness ranges from zero in Boreholes 00-12 and 00-21, to between 0.8 m and 2.1 m in Boreholes 00-2, 00-11 and 00-20. SPT 'N' values measured in the fill ranged from 13 to 31 blows per 0.3 m of penetration, indicating a stiff

consistency / compact state of packing. Laboratory water content determinations on samples of the fill in Boreholes 00-2 and 00-11 ranged from 6 to 14 per cent.

In Borehole 00-2, a 0.9 m thick organic silty sand and peat deposit was found below the fill and overlying the till, from Elevation 106.3 m to 107.1 m. One SPT 'N' value measured in the organic layer was 13 blows per 0.3 m of penetration, indicating a compact state of packing. Water content in the organic layer was determined in the laboratory to be 23 per cent.

A till deposit varying in composition from clayey silt / silty clay to silty sand till was encountered below the topsoil, fill or organic layer down to the maximum depth in each borehole. SPT 'N' values measured in the silty clay to silty sand till ranged from 30 blows to over 100 blows per 0.3 m of penetration, indicating a dense to very dense state of packing / hard consistency. Typically, SPT 'N' values in the till were greater than 100 blows per 0.3 m of penetration. Atterberg Limits testing on samples of the clayey silt to silty clay portions of the till from Boreholes 00-2, 00-11 and 00-12 indicate that liquid limit varies from 19 to 22 per cent, and plasticity index varies from 6 to 9 per cent, classifying the till as an inorganic silt to inorganic clay of low plasticity. Atterberg Limits testing on samples of the silty sand to sandy silt portions of the till from Boreholes 00-2 and 00-11 indicate that the silty sand to sandy silt till is non-plastic and non-liquid. Laboratory water content determinations on samples of the till in Boreholes 00-2, 00-11 and 00-12 ranged from 5 to 16 per cent.

3.3 Groundwater Conditions

Piezometers were installed in Boreholes 00-2, 00-12, 00-24 and 00-29 along the proposed wall alignments. Details of the piezometer installations and of the water levels measured in the open boreholes at the time of drilling are shown on the attached Record of Borehole sheets. Water levels measured in the piezometers on May 4, 2001 are summarized in the following table. It should be noted that groundwater levels are expected to fluctuate seasonally, and will be higher during wet periods of the year.

	<i>Borehole Number</i>	<i>Depth to Groundwater (m)</i>	<i>Groundwater Elevation (m)</i>
Noise Wall 'A'	00-2	4.70	104.6
	00-12	2.60	104.6
Noise Wall 'B'	00-24	4.35	99.4
	00-29	1.10	99.5

4.0 GEOTECHNICAL RECOMMENDATIONS

This section of the report presents design parameters for the installation of the proposed noise barrier walls. The noise barrier wall alignments are as follows:

- Wall 'A' will extend from about Station 50+826.5 to 51+352.1, and
- Wall 'B' will extend from Station 60+362.0 to 60+664.9.

The alignments of the noise barrier walls as indicated by TSH are shown on Figure 1.

The noise walls will generally consist of a noise barrier and a precast noise / traffic barrier, and will typically extend about 5 m above the wall grade. Except for a few sections, the grade of the wall will be near or below the existing ground surface. It is understood that the proposed noise barrier walls will be supported on augered caissons and that typical caisson diameters used will be 0.6 m to 0.9 m. Foundation design parameters for the proposed noise barrier walls are provided in Tables 1 to 2 following the text of this report, based on the soil conditions encountered in the boreholes put down along the proposed alignments. It should be noted that, for the purposes of the design tables, the soil conditions have been simplified.

For foundation design, full passive resistance will be mobilized only where the width of soil in front of or behind the caissons is equal to or greater than eight caisson diameters. If there is sloping ground in front of the wall foundations, the magnitude of the passive resistance may be determined by interpolating between zero passive resistance at ground surface and full passive resistance at the depth where the berm slope faces are greater than eight caisson diameters away from the face of the caisson. In addition, the passive resistance in front of the caisson within the upper 1.2 m below ground surface should be neglected to account for frost action.

It should be noted that the fill soils and the native till soils will be susceptible to disturbance during caisson installation; the use of a liner and / or drilling fluid is recommended to minimize such disturbance. In addition, the Contractor's proposed excavation techniques should be able to accommodate removal or breaking up of boulders and / or other obstructions which are expected in both the fill and native soils.

We trust that this report provides the information you require at this time. If you have questions regarding the information provided, please contact the undersigned.

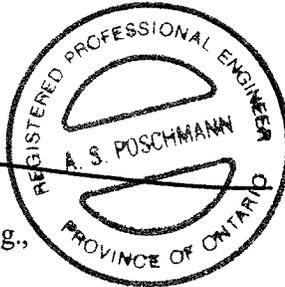
GOLDER ASSOCIATES LTD.



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Anne S. Poschmann, P.Eng.,
Principal



DJE/ASP/clg

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TABLE I

**SOIL PARAMETERS FOR FOUNDATION DESIGN
NOISE BARRIER WALL 'A'**

**Highway 401 WBL
Stations 50+826.5 to 51+228**

Location Along Wall	Reference Boreholes	Elevation Interval	Soil Stratum	Design Parameters			
				Cu (kPa)	ϕ'	γ kN/m ³	Design GWL (m)
Station 50+826.5 to 50+970	00-29, 00-30, 33+800	B. W. to Elevation 100 m	Fill (proposed)	-	30	19	98.0
		Below Elevation 100 m	Silty Sand / Silty Clay Till	-	33	20	
Station 50+970 to 51+040	34+000	B. W. to Elevation 96 m	Fill (proposed) and softened Silty Sand / Silty Clay Till	-	28	18	98.0
		Below Elevation 96 m	Silty Sand / Silty Clay Till	-	35	21	
Station 51+040 to 51+140	00-26, 34+080	B. W. to Elevation 100 m	Fill (proposed) and softened Silty Sand / Silty Clay Till	-	30	19	99.0
		Below Elevation 100 m	Silty Sand / Silty Clay Till	-	33	20	
Station 51+140 to 51+228	00-24	Below B. W.	Silty Sand / Silty Clay Till	-	35	21	99.0

NOTES: B. W. = Base of Wall
 Cu = Undrained Shear Strength of Soil
 ϕ' = Effective Angle of Friction of Soil
 γ = Bulk Unit Weight of Soil

TABLE 2

**SOIL PARAMETERS FOR FOUNDATION DESIGN
NOISE BARRIER WALL 'B'**

**Highway 401 WBL
Stations 60+362 to 60+665**

Location Along Wall	Reference Boreholes	Elevation Interval	Soil Stratum	Design Parameters			
				Cu (kPa)	ϕ'	γ kN/m ³	Design GWL (m)
Station 60+362 to 60+400	00-2	B. W. to Elevation 106 m	Fill (existing) and organics	-	28	18	104.5
		Below Elevation 106 m	Silty Sand / Silty Clay Till	-	38	21	
Station 60+400 to 60+435	00-12	Below B.W.	Silty Sand / Silty Clay Till	-	38	21	104.5
		B. W. to Elevation 105 m (existing ground surface)	Fill (proposed)	-	30	19	104.0
Station 60+482.5 to 60+590	00-20	Below Elevation 105 m	Silty Sand / Silty Clay Till	-	38	21	
		Below B.W.	Silty Sand / Silty Clay Till	-	35	21	102.0
Station 60+590 to 60+665	00-11	B. W. to Elevation 103 m	Fill (proposed) and softened silty clay till	-	30	19	100.0
		Below Elevation 102 m	Silty Sand / Silty Clay Till	-	38	21	

NOTES: B.W. = Base of Wall
 Cu = Undrained Shear Strength of Soil
 ϕ' = Effective Angle of Friction of Soil
 γ = Bulk Unit Weight of Soil

DIST. HWY.
 CONT No.
 WP No. 124-99-00



HWY 401 HARWOOD AVENUE
 TO CARRUTHERS CREEK
 NOISE BARRIER WALLS
 BOREHOLE LOCATION PLAN

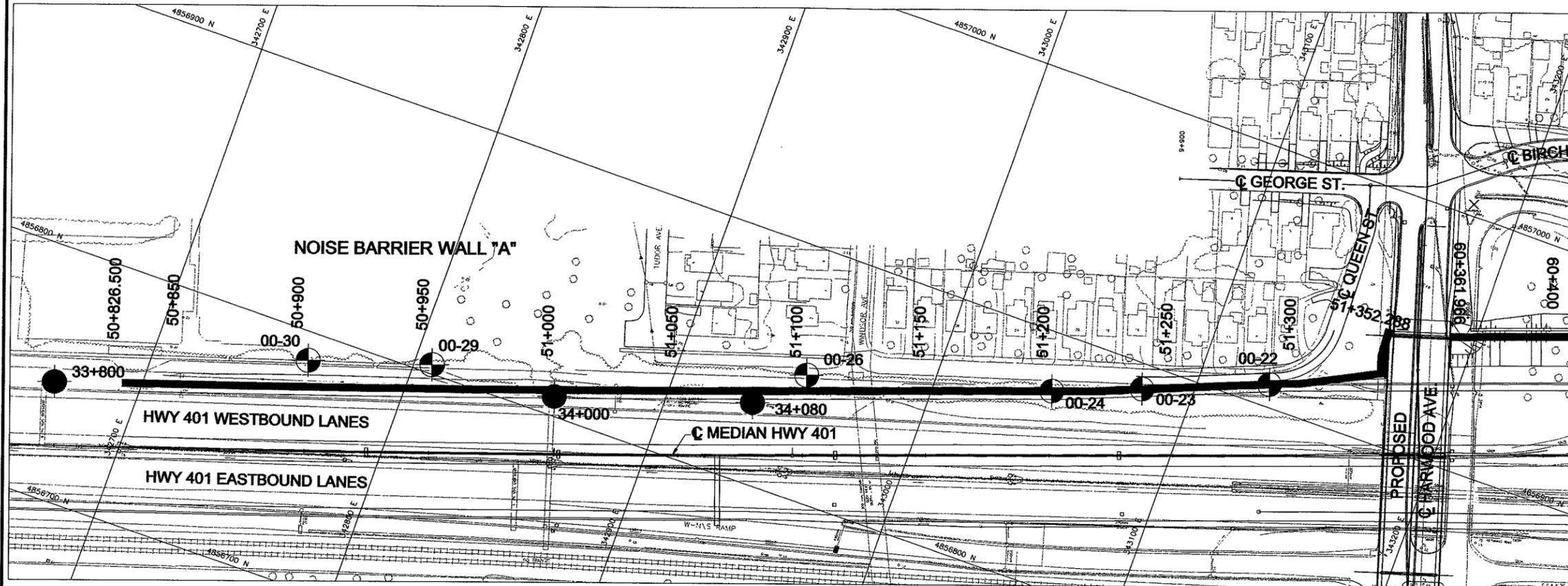
SHEET



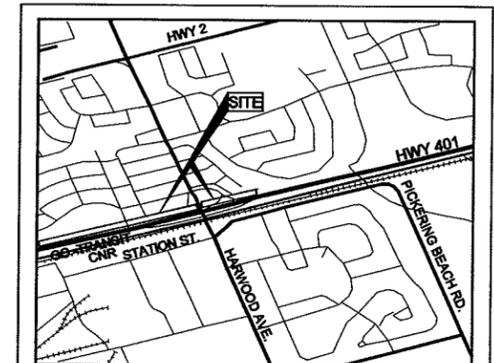
Golder Associates Ltd.
 MISSISSAUGA, ONTARIO, CANADA

METRIC

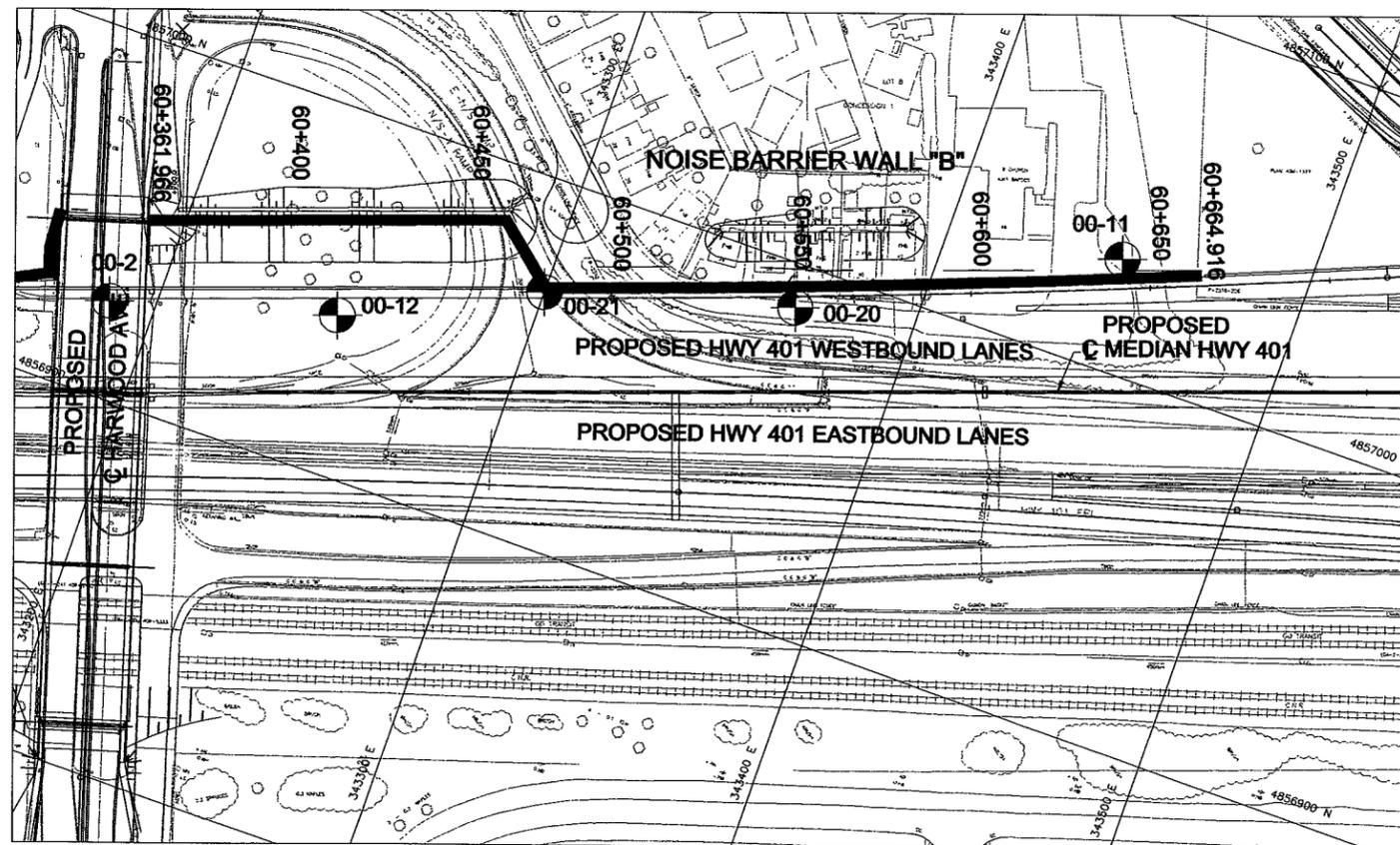
DIMENSIONS ARE IN METRES
 AND/OR MILLIMETRES
 UNLESS OTHERWISE SHOWN



NOISE BARRIER WALL "A"
 STA. 50+826.5 to 51+352.1



KEY PLAN

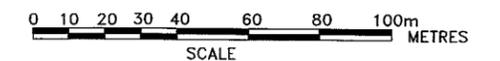


NOISE BARRIER WALL "B"
 STA. 60+361.966 to 60+664.916

LEGEND

- Borehole - Current Golder Associates Ltd. Investigation
- Borehole - Previous Golder Associates Ltd. Investigation (Report No. 971-8036 dated February 1998)

No.	ELEVATION	LOCATION	
		NORTHING	EASTING
00-2	109.3	4856926.6	343187.5
00-11	103.3	4857031.3	343448.7
00-12	107.2	4856943.6	343247.9
00-20	106.1	4856988.0	343367.0
00-21	105.3	4856968.9	343300.0
00-23	104.2	4856890.0	343080.0
00-24	103.7	4856877.0	343046.0
00-26	100.6	4856849.8	342950.2
00-29	100.6	4856803.6	342807.0
00-30	100.0	4856788.8	342759.7
33+800		4856747.0	342666.8
34+000		4856807.8	342857.3
34+080		4856832.1	342933.5



NO.	DATE	BY	REVISION

Geocres No.			
HWY. 401	PROJECT NO. 001-8019G-6	DIST. 6	
SUBM'D.	CHKD.	DATE: MAY 2001	SITE:
DRAWN: JFC	CHKD.	APPD.	DWG. 1

May 2001

001-8019G-6

APPENDIX A
RECORDS OF BOREHOLES

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
 SS Split-spoon
 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

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

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.)

(b) Cohesive Soils

Consistency	c_u, 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

Dynamic Cone 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)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² 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.

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 test¹
 CIU consolidated isotropically undrained triaxial test with porewater pressure measurement¹
 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 (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 = σ'_p / σ'_{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 = $\tan \delta$
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

PROJECT 001-8019F

RECORD OF BOREHOLE No 00-2

1 OF 1

METRIC

W.P. 124-99-00

LOCATION N 4856927; E 343187

ORIGINATED BY PKS

DIST 6 HWY 401

BOREHOLE TYPE 108mm Solid Stem Augers

COMPILED BY DKB

DATUM Geodetic

DATE Nov. 16/00

CHECKED BY ASP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20 40 60 80 100	20 40 60 80 100	20 40 60	20 40 60	20 40 60						
109.3	GROUND SURFACE															
0.0	Topsoil															
0.1	Silty Sand to Sand, some silt, some gravel Dense to compact Grey brown Moist (Fill)		1	SS	31											
107.8			2	SS	29											
1.5	Clayey Silt, some sand and gravel Stiff Brown Moist (Fill)		3	SS	13											
107.1			4	SS	13											
2.2	Organic Silty Sand and Peat, Fibrous Compact Black Moist		5	SS	105/15											
106.3			6	SS	95											
3.1	Organic content of sample 4 = 4.5%															
105.5	Silty Sand, trace gravel and clay Very dense Grey Moist (Glacial Till)		7	SS	55/08											
3.8			8	SS	50/08											
103.2			9	SS	100/13											2 9 80 9
6.1	Silty Sand to Silt and Sand, trace to some gravel, trace clay Very dense Grey Wet to dry below 9.2m depth (Glacial Till)		10	SS	100/08											
102.2	Non-plastic atterberg limits test result for sample 9.		11	SS	100/13											6 46 44 4
101.2			12	SS	100/08											
97.1																
12.2	END OF BOREHOLE															

Notes:
 1. Open borehole dry upon completion of drilling.
 2. Piezometer blocked at 1.5m depth (Elev. 107.8m) on Dec.27/00.
 3. Water level in piezometer frozen at ground surface on Feb.9/01.
 4. Water level measured in piezometer at 4.7m depth (Elev. 104.6m) on May.4/01.

ON MOT 001-8019.GPJ ON MOT.GDT 14/5/01

+³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT 001-8019F **RECORD OF BOREHOLE No 00-11** **1 OF 1** **METRIC**

W.P. 124-99-00 **LOCATION** N 4857031.3; E 343448.7 **ORIGINATED BY** PKS

DIST 6 **HWY** 401 **BOREHOLE TYPE** 114mm Solid Stem Augers **COMPILED BY** DKB

DATUM Geodetic **DATE** April 18/01 **CHECKED BY** ASP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100	20	40	60			
103.3	GROUND SURFACE															
0.0	Topsail		1	SS	8											
102.7																
0.6	Silty Clay to Clayey Silt, trace to some sand and gravel Very stiff Brown Moist (Fill)		2	SS	17						o					
101.8																
1.5	Silty Clay to Clayey Silt, trace to some sand and gravel, occ. cobbles Hard Brown becoming grey below 3.8m depth Moist (Glacial Till)		3	SS	122											
			4	SS	138						o					
			5	SS	100/1											
			6	SS	100/15						+				5 12 71 12	
			7	SS	100/15											
			8	SS	100/15						o					
96.1																
7.2	Silty Sand to Sandy Silt, trace clay and gravel, occ. cobbles Very dense Grey Moist to wet below 9.1m depth (Glacial Till)		9	SS	100/15											
			10	SS	100/15						o				1 17 79 3	
92.6																
10.7	END OF BOREHOLE		11	SS	100/00											
	Note Water level measured in open borehole at 6.1m depth (El.97.2m) upon completion of drilling.															

ON MOT 001-8019.GPJ ON MOT.GDT 14/5/01

PROJECT 001-8019F **RECORD OF BOREHOLE No 00-12** **1 OF 1** **METRIC**

W.P. 124-99-00 **LOCATION** N 7/89943.6; E 343247.9 **ORIGINATED BY** PKS

DIST 6 **HWY** 401 **BOREHOLE TYPE** 108mm Solid Stem Augers **COMPILED BY** DKB

DATUM Geodetic **DATE** Nov.2/00 **CHECKED BY** ASP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20
107.2	GROUND SURFACE																	
0.0	Topsoil																	
0.1	Sandy Silt to Silt and Sand, trace gravel and clay, occasional cobbles Very dense Brown to grey below 3.8m depth Moist (Glacial Till)		1	SS	61													
			2	SS	98													
			3	SS	60/15													
			4	SS	50/08													
			5	SS	100/00													
			6	SS	100/00													
			7	SS	75/00													
			8	SS	100/00													
			9	SS	100/00													
99.5	Clayey Silt to Silty Clay with sand partings, trace gravel Hard Grey Moist (Glacial Till)		10	SS	100/00													
7.6			11	SS	100/00													
			12	SS	100/00													
94.9	END OF BOREHOLE																	
12.2	Note: 1. Water level measured in piezometer at 3.6m depth (Elev. 103.6m) on Dec.27/00. 2. Water level measured in piezometer at 3.0m depth (Elev. 104.2m) on Feb.9/01. 3. Water level measured in piezometer at 2.6m depth (Elev. 104.6m) on May.4/01.																	

ON MOT 001-8019.GPJ ON MOT.GDT 14/5/01

+³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT 001-8019G **RECORD OF BOREHOLE No 00-20** **1 OF 1** **METRIC**

W.P. 124-99-00 LOCATION N 4856988.0; E 343367.0 ORIGINATED BY PKS

DIST 6 HWY 401 BOREHOLE TYPE 114mm Solid Stem Augers COMPILED BY DKB

DATUM Geodetic DATE April 18/01 CHECKED BY ASP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
106.1	GROUND SURFACE															
0.0	Sand and Gravel, trace silt Brown Moist (Fill)															
105.3																
0.8	Silty Sand, trace to some gravel, trace clay, occ. cobbles Dense to very dense Brown Moist (Glacial Till)		1	SS	30											
			2	SS	84											
			3	SS	105/15										21	49 27 3
			4	SS	100/15											
			5	SS	128/15											
			6	SS	113/15											
99.8																
6.3	END OF BOREHOLE															
	Note: 1. Water level measured in open borehole at 6.2m depth (El.99.9m) upon completion of drilling.															

ON_MOT_0018019G.GPJ ON MOT.GDT 14/5/01

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

PROJECT 001-8019F **RECORD OF BOREHOLE No 00-23** 1 OF 1 **METRIC**
W.P. 124-99-00 **LOCATION** N 4856890.0; E 343080.0 **ORIGINATED BY** PKS
DIST 6 **HWY** 401 **BOREHOLE TYPE** 114mm Solid Stem Augers **COMPILED BY** DKB
DATUM Geodetic **DATE** April 17/01 **CHECKED BY** ASP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20
104.2	GROUND SURFACE																	
0.0	Sand and Gravel, trace silt Brown Moist (Fill)																	
103.4																		
0.8	Clayey Silt to Silty Clay, some to with sand, trace to some gravel, occ. cobbles Very stiff to hard Brown becoming grey below 3m depth Moist (Glacial Till) Note: silty clay of intermediate plasticity encountered between 2.2m and 3m depth		1	SS	19													
			2	SS	50													
			3	SS	36													4 13 41 42
			4	SS	60													
			5	SS	126													
			6	SS	54													
			7	SS	26													2 36 26 10
			8	SS	45													
96.0	END OF BOREHOLE																	
8.2	Note: 1. Open borehole dry upon completion of drilling.																	

ON_MOT_001-8019.GPJ ON_MOT.GDT 14/5/01

PROJECT 001-8019F **RECORD OF BOREHOLE No 00-24** 1 OF 1 **METRIC**

W.P. 124-99-00 LOCATION N 4856877.0; E 343046.0 ORIGINATED BY PKS

DIST 6 HWY 401 BOREHOLE TYPE 114mm Solid Stem Augers COMPILED BY DKB

DATUM Geodetic DATE April 17/01 CHECKED BY ASP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
103.0	GROUND SURFACE															
0.0	Sand and Gravel, trace silt Brown Moist (Fill)															
102.2																
0.8	Clayey Silt, some sand, trace to some gravel, occ. cobbles Hard Brown becoming grey below 3.8m depth Moist (Glacial Till)		1	SS	35											
			2	SS	53											
			3	SS	66											
			4	SS	115											
			5	SS	54											
			6	SS	43											
			7	SS	38											
			8	SS	19											
94.8	END OF BOREHOLE															
8.2	Note: 1. Open borehole dry upon completion of drilling.															

ON_MOT_001-8019.GPJ ON_MOT.GDT 14/5/01

+³.X³: Numbers refer to Sensitivity ○³% STRAIN AT FAILURE

PROJECT <u>001-8019G</u>	RECORD OF BOREHOLE No 00-26	1 OF 1	METRIC
W.P. <u>124-99-00</u>	LOCATION <u>N 4856849.8; E 342950.2</u>	ORIGINATED BY <u>PKS</u>	
DIST <u>6</u> HWY <u>401</u>	BOREHOLE TYPE <u>114mm Solid Stem Augers</u>	COMPILED BY <u>DKB</u>	
DATUM <u>Geodetic</u>	DATE <u>April 20/01</u>	CHECKED BY <u>ASP</u>	

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
			NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
								20	40	60	80	100						
100.6	GROUND SURFACE																	
0.0	Silty Sand and Gravel, trace clay Loose	[Strat Plot Hatched Box]	1	SS	10													
100.0	Brown Moist (Fill)		2	SS	16													
0.6	Clayey Silt to Silty Clay, some sand, trace to some gravel, occ. cobbles Very stiff to hard Brown becoming grey below 3m depth Moist becoming wet below 3.8m depth (Glacial Till)		3	SS	48													
			4	SS	58													
			5	SS	30													
			6	SS	44													
			7	SS	31													
			8	SS	15													
93.9	END OF BOREHOLE																	
6.7	Note: 1. Water level measured in open borehole at 6.1m depth (El. 94.5m) upon completion of drilling.																	

ON MOT 0018019G.GPJ ON MOT.GDT 14/5/01

+³.X³: Numbers refer to Sensitivity ○³% STRAIN AT FAILURE

PROJECT 001-8019G **RECORD OF BOREHOLE No 00-29** 1 OF 1 **METRIC**

W.P. 124-99-00 LOCATION N 4856803.6; E 342807.0 ORIGINATED BY PKS

DIST 6 HWY 401 BOREHOLE TYPE 114mm Solid Stem Augers COMPILED BY DKB

DATUM Geodetic DATE April 20/01 CHECKED BY ASP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					w _p	w		
						20	40	60	80	100						
100.6	GROUND SURFACE															
0.0	Topsoil															
100.0	Clayey Silt to Silty Clay, some sand and gravel Firm Brown Moist (Fill) Clayey Silt to Silty Clay, some sand, trace to some gravel, occ. cobbles Very stiff to hard Brown becoming grey below 3m depth Moist becoming wet below 3.8m depth (Glacial Till)		1	SS	7											
0.6			2	SS	21											
				3	SS	30										
				4	SS	25										
				5	SS	35										
				6	SS	24										
				7	SS	34										
				8	SS	31										
93.9	END OF BOREHOLE															
6.7	Note: 1. Water level measured in open borehole at 6.6m depth (El.94.0m) upon completion of drilling. 2. Water level measured in piezometer at 1.1m depth (El.99.5m) on May 4,2001.															

ON MOT. 0018019G.GPJ ON MOT.GDT 14/5/01

PROJECT <u>001-8019G</u>	RECORD OF BOREHOLE No 00-30	1 OF 1	METRIC
W.P. <u>124-99-00</u>	LOCATION <u>N 4856788.8; E 342759.7</u>	ORIGINATED BY <u>PKS</u>	
DIST <u>6</u> HWY <u>401</u>	BOREHOLE TYPE <u>114mm Solid Stem Augers</u>	COMPILED BY <u>DKB</u>	
DATUM <u>Geodetic</u>	DATE <u>April 20/01</u>	CHECKED BY <u>ASP</u>	

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)
							20	40	60	80	100						
100.0	GROUND SURFACE																
0.0	Topsoil																
0.2	Clayey Silt to Silty Clay, some sand, trace to some gravel, occ. cobbles Very stiff to hard Brown becoming grey below 2.3m depth Moist becoming wet below 4.6m depth (Glacial Till)		1	SS	23												
			2	SS	54	99							○				
			3	SS	61	98											
			4	SS	38	97							○				
			5	SS	21	96											
			6	SS	20	95											
			7	SS	17	94											
93.3		END OF BOREHOLE		8	SS	20								○			
6.7	Note: 1. Open borehole dry upon completion of drilling.																

ON_MOT_0018019G.GPJ ON_MOT.GDT 14/5/01

TABLE A-1

**RECORD OF BOREHOLES 33+080, 34+000 AND 34+080
GOLDER ASSOCIATES LTD. REPORT NO. 971-8036, DATED FEBRUARY 1998**

Borehole Station Offset (m)	Ground Surface Elevation (m)	Borehole Depth (m)	Stratigraphy	Sample Number	Sample Depth 'N' Value (blow / 0.3 m)	Water Level (m)
33+800 3.0 m N	100.17	6.6	Topsoil		0 mm to 200 mm	
			Stiff, brown silty clay, trace gravel (FILL)	1	0.76 m to 1.2 m	13
			Very stiff, grey silty clay, trace gravel and sand (Till)	2	1.5 m to 2.1 m	22
			Dense, brown Silty Sand, some gravel, trace clay (Till)	3	2.3 m to 2.7 m	48
			Compact, grey Sandy Silt, some gravel, trace clay (Till)	4	3.1 m to 3.5 m	26
				5	4.6 m to 5.0 m	22
	6	6.1 m to 6.6 m	19			
34+000 4.0 m N	101.0	6.6	Topsoil		0 mm to 200 mm	
			Very loose to compact, brown sandy silt to silty sand, trace clay, trace gravel, trace organics (FILL)	1	0.76 m to 1.2 m	12
				2	1.5 m to 2.0 m	7
				3	2.3 m to 2.7 m	5
				4	3.1 m to 3.5 m	2
				5	3.8 m to 4.3 m	8
				6	4.6 m to 5.0 m	12
34+080 4.5 m N	101.8	6.6	Compact, grey Sandy Silt, some gravel, trace clay (Till)	7	6.1 m to 6.6 m	52
			Topsoil		0 mm to 200 mm	
			Compact, brown silty sand, trace clay, trace gravel, trace organics (FILL)	1	0.76 m to 1.2 m	22
			Stiff, brown silty clay, some sand and gravel (FILL)	2	1.5 m to 2.0 m	12
			Compact to very dense, grey Sandy Silt to Silty Sand, some gravel, trace clay (Till)	3	2.3 m to 2.7 m	27
				4	3.1 m to 3.5 m	26
				5	4.6 m to 5.0 m	61
	6	6.1 m to 6.6 m	31			

May 2001

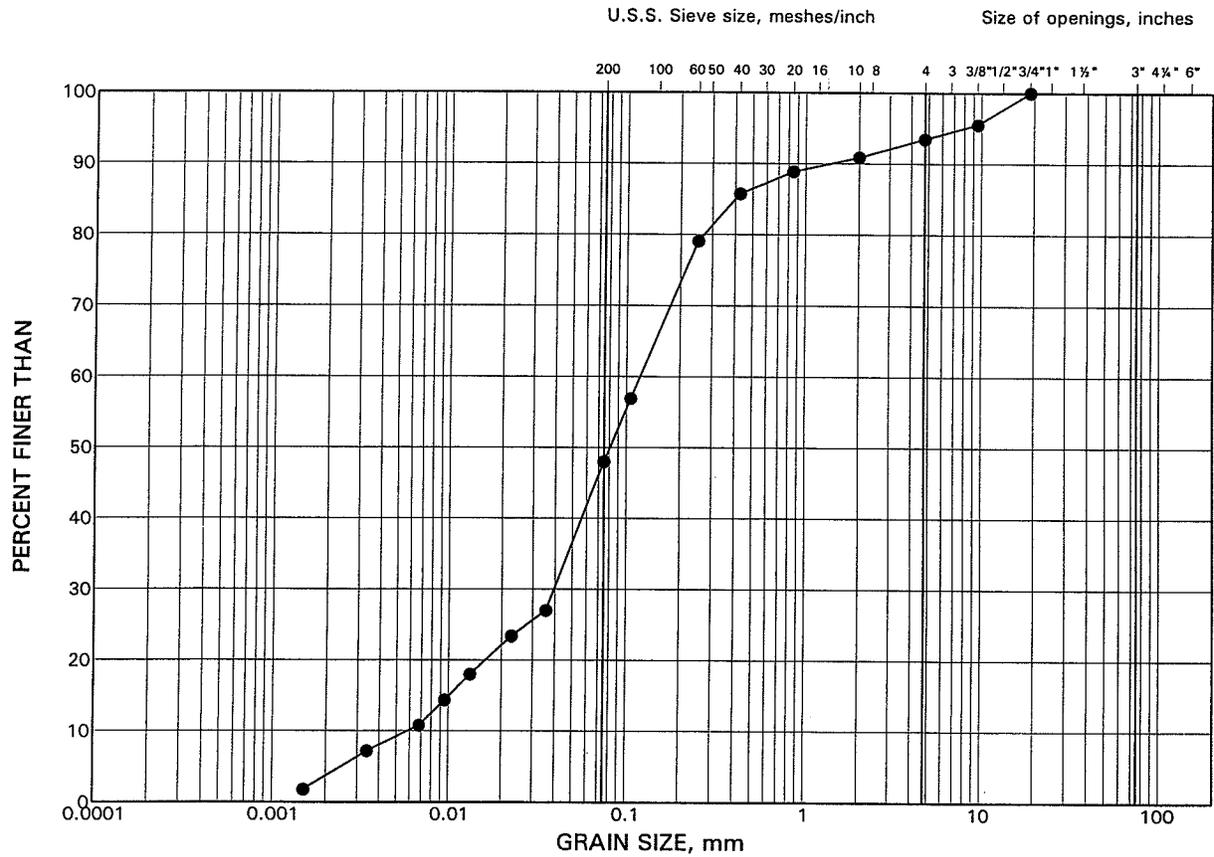
001-8019G-6

APPENDIX B
LABORATORY TEST RESULTS

GRAIN SIZE DISTRIBUTION

Silt and Sand (Glacial Till)

FIGURE B-1



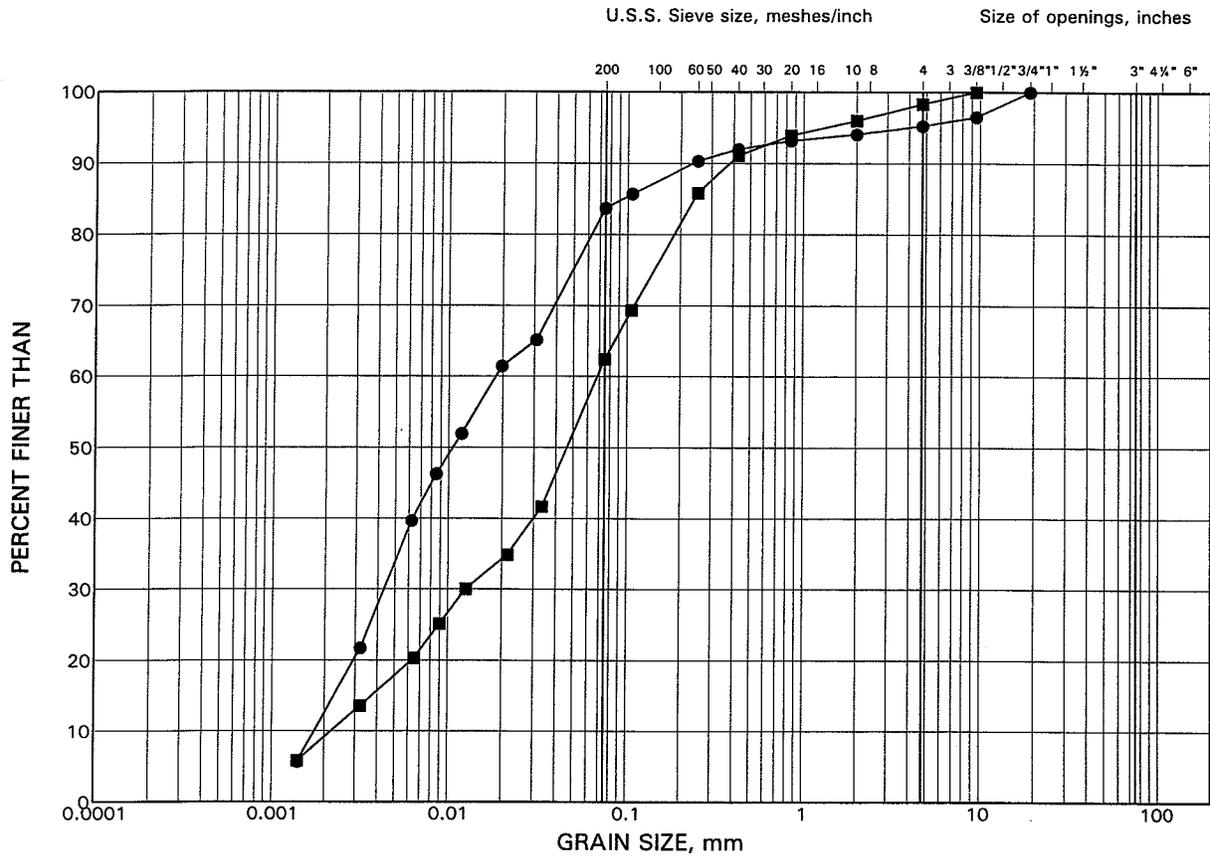
LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
•	2	9	101.7

GRAIN SIZE DISTRIBUTION

Silty Clay to Clayey Silt (Glacial Till)

FIGURE B-2



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

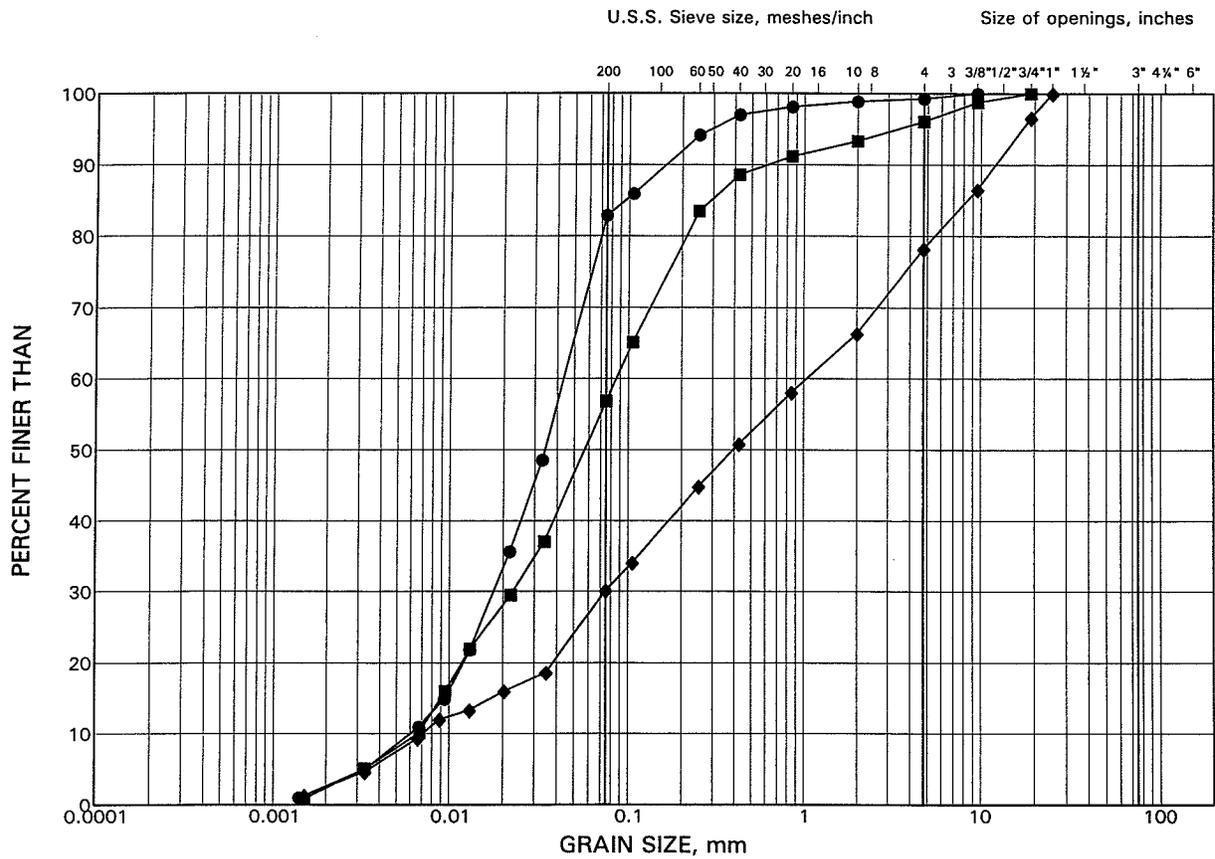
LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
●	00-11	6	99.2
■	00-23	7	97.5

GRAIN SIZE DISTRIBUTION

Silt / Sand (Glacial Till)

FIGURE B-3



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

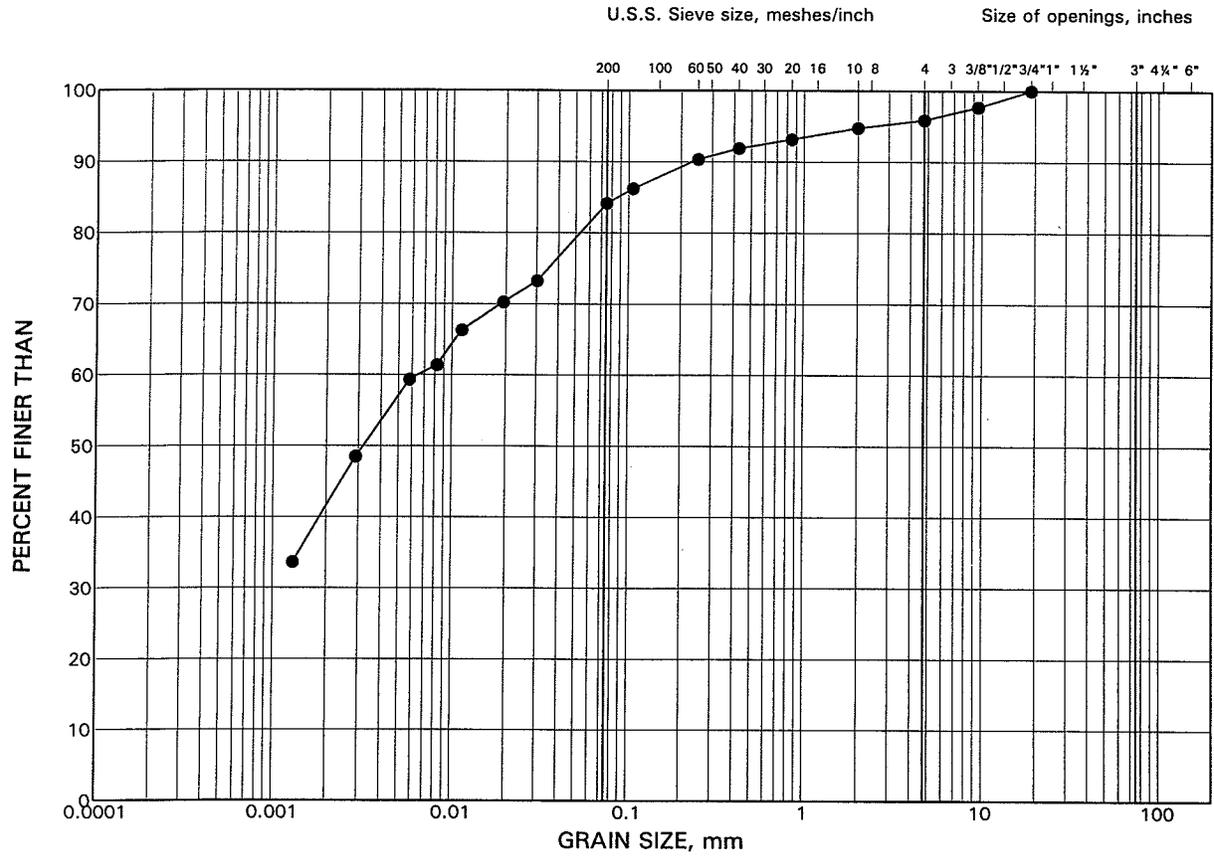
LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
●	00-11	10	94.0
■	00-12	4	104.7
◆	00-20	3	103.3

GRAIN SIZE DISTRIBUTION

Silty Clay (Glacial Till)

FIGURE B-4



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
•	00-23	3	101.3