

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 73-83-01

DIST 6

HWY 9

STR SITE

Proposed Widening
Highway 9, West of Highway 50

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FOUNDATION INVESTIGATION REPORT

For

Proposed Widening

Highway 9, West of Highway 50

W.P. 73-83-01, Central Region

District 6, Toronto

INTRODUCTION

A foundation investigation, was carried out at the above-captioned site, for proposed embankments to be constructed for the widening of Highway 9, within Caledon and Albion Townships, Ontario.

The field work, for the above-captioned project, was carried out by this office between June 17 and 28, 1991. A total of eighteen (18) boreholes were advanced to depths ranging from 8.2 m to 24.6 m by means of continuous flight hollow stem augers driven by two truck-mounted drilling rigs equipped with standard soil sampling equipment.

This report contains the factual information for the proposed embankment structures at the borehole locations shown on Drawing No.'s 738301-A to 738301-C.

SITE DESCRIPTION

The site consists of selected locations along Highway 9, between approximately 80 m west of 7th Line Road East within Caledon Township to approximately 830 m east of Township Line Road, within Albion Township, Ontario

The site is located at the fringes of the physiographic region known as the Oak Ridges Moraine. Much of the Oak Ridges Moraine is known to be covered by till. However, the crest of the moraine is extensively covered with sand and gravel. Beds of stratified fine sand, silt and clay are also common indicating that parts of the moraine were submerged during the latter stages of deposition.

The topography at the site, and in the surrounding area, is hilly with the hills being covered by grassed and wooded areas.

PROCEDURES

As noted above, a total of eighteen boreholes were drilled at the above-captioned site using standard soil sampling techniques.

Groundwater levels were measured in several of the open boreholes immediately upon completion of sampling. Piezometers were then installed in four of them in order to measure the long term groundwater conditions. The water levels in the piezometers were measured immediately prior to leaving the site.

The boreholes were staked out in the field and their elevations determined by the Central Region Surveys and Plans Office. However, due to difficulties in gaining access to most of these locations, all of the boreholes were drilled on the north and south shoulders of the existing highway. For those boreholes which were slightly moved, small changes in their locations and elevations were determined by our field representatives. The locations and elevations of four of the boreholes, which were significantly moved, were resurveyed by representatives of the Central Region Surveys and Plans Office.

The soil samples, obtained in the field, were examined in the laboratory by visual and tactile methods. Moisture content, Atterberg Limits and Grain Size Distribution Tests were conducted on some selected samples.

SUBSURFACE CONDITIONS

The subsoils encountered at the boreholes generally consist of sandy silt to silty sand fill, from 0.7 m to 12 m thick, which is, in turn, underlain by a major deposit of generally cohesionless, compact to very dense sandy silt to fine sand containing occasional zones or layers of clayey silt or sand and gravel. Deposits of heterogeneous mixtures of clayey silt with some sand to sandy silt with a trace of clay were encountered in BH's 2, 4, 10, 13 and 14. These are likely to have a glacial origin and may be considered to be glacial tills.

What appeared to be either reddish brown weathered shale bedrock or slabs of the underlying bedrock were encountered at the three boreholes drilled from the

lowest elevation and furthest to the east (ie. BH's 16 to 18). This very hard layer was found to be at depths of 8.2 m to 10.2 m at these boreholes and generally sloped down towards the east.

Although the depth to the groundwater table varied significantly between boreholes (between 2.1 m and 11.6 m), generally, it was found to slope down towards the east. It should be noted that the groundwater table is always subject to seasonal fluctuations and is expected to rise during the spring freshet and during and immediately following any periods of prolonged heavy rainfall.

Detailed descriptions of both the soil and groundwater conditions encountered at the boreholes are shown on Table 1 - Borehole Logs given at the back of this report.

DISCUSSION AND RECOMMENDATIONS

General

The existing Highway 9, which extends through the area of investigation, consists of a relatively narrow road running east/west with a single lane going in each direction. The highway is constructed of a series of embankments and cuts, with a general decrease in elevation from west to east.

It appears from the boreholes drilled during this investigation, that, except for traces or occasional topsoil enclosures, in most areas, the existing embankment is constructed of fairly clean fill. However, it appears that, in several areas investigated, the fill has been placed prior to the complete removal of the underlying topsoil layer. Such conditions were noted at BH's 2, 3, 6, 8, 10 and 11 and are likely to occur in other areas as well. It should also be noted that, although generally, the compaction of the fill was also quite good, the fill placed at or near the bottom of the embankments at BH's 3 and 6 and particularly BH's 10, 12 and 16 through 18 appeared to be relatively loose.

It is proposed to widen the existing highway to two lanes running in each direction throughout the area investigated. This will, therefore, involve the lateral extension of the existing embankments where the roadway is adjacent to a valley and additional cutting where the roadway is adjacent to a hill. This investigation includes the proposed embankments from Stations 18+850 to 18+975, Stations 10+500 to 11+100 and Stations 12+200 to 12+600 (approximately). Although most of the embankments will be less than 8 m in height, they are expected to reach a maximum height of up to 17 m (adjacent to BH 4).

Design Considerations

The embankment slopes should be constructed to no steeper than 2H:1V. In addition, where the fill is greater than 8 m in height, a 2 m wide berm should be provided for internal stability. Drainage and erosion protection of the slope should be carried out according to OPSS Standards.

It is proposed to construct retaining structures consisting of gabion walls at several locations. These structures should be designed to resist the lateral earth pressures given by the following equation:

$$PH = K_a (\gamma H + q)$$

where: PH = lateral earth pressure at depth H.

K_a = coefficient of active earth pressure (assume 0.3 for granular fill and for the native silty fine sand)

γ = unit weight of the retained soil (assume 21 kN/m³)

q = surcharge loading

The gabion walls must be taken below all organic, loose, disturbed or otherwise unsuitable soil and founded on the undisturbed native silt to silty fine sand. Gabion walls placed on undisturbed native silt to silty fine sand may be designed to impose a maximum toe pressure of 100 kPa. It should be noted, however, that this only applies to the walls constructed within the areas investigated (ie. between Stations 10+775 and 11+060 and approximately Stations 12+250 to 12+500).

Construction Considerations

Where the new embankments are to be constructed, it is recommended that all of the existing topsoil, organic or other unsuitable soils at founding level be removed throughout the full width of the proposed embankment.

The selection of the fill material and its placement and compaction must be carried out according to OPSS Standards and MTO practice.

The field investigation was conducted by J. Blair, Project Foundation Engineer, and P. Thase using equipment owned and operated by Master Soil Investigation Limited and Archer Drilling Limited.

The report was written by J. Blair, reviewed by B. Iyer, Senior Foundation Engineer and approved by M. Devata, Chief Foundation Engineer.



John A. Blair

J. Blair, P.Eng.
Project Foundation Engineer

M. Devata
M. Devata, P.Eng.
Chief Foundation Engineer

APPENDIX

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

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

Table I
Borehole Logs

Borehole No.	Depth		Elevation		Soil Description	Approximate Groundwater Table (m)
	From	To	From	To		
1	0	6.9	424.0	417.1	Fill - Silty Fine Sand, occasional Clayey Silt, occasional traces of Topsoil, Reddish Brown Compact (n=10-20 blows/0.3 m)	416.0
	6.9	9.5	417.1	414.5	Sandy Silt - Brown Compact (n=16-27 blows/0.3 m)	
	9.5	13.2	414.5	410.8	Clayey Silt - Brown to Reddish Brown, occasional Silty Clay layers, Very Stiff to Hard (n=17-43 blows/0.3 m)	
	13.2	14.3	410.8	409.7	Silty Sand - some Gravel, Reddish Brown, Very Dense (n=87 blows/0.3 m)	
2	0	10.3	423.9	413.6	Fill - Silty Clay to Sandy Silt, occasionally traces of Root Fibres, Topsoil enclosures, Topsoil layer at 10 m, Brown to Reddish Brown, Stiff to Very Stiff (n=11-51 blows/0.3 m)	414.0
	10.3	15.3	413.6	408.6	Heterogeneous Mixture of Sandy Silt, some Gravel, trace of Clay (Glacial Till) - occasionally Clayey, occasional Sand or Gravel layers, Reddish Brown to Grey, Dense to Very Dense (n=28-57 blows/0.2 m)	
3	0	8.2	422.8	414.6	Fill - Sandy Silt to Silty Sand, occasional Clayey Silt pockets, Topsoil enclosures, Topsoil enclosures at 8.0 m, Brown to Reddish or Greyish Brown, Loose to Compact (n=7-33 blows/0.3 m)	411.0
	8.2	12.7	414.6	410.1	Silty Fine Sand - Brown to Greyish Brown, Dense to Very Dense (n=35-50 blows/0.5 m)	

Table I .../cont'd
Borehole Logs

Borehole No.	Depth		Elevation		Soil Description	Approximate Groundwater Table
	From	To	From	To		(m)
4	0	10.1	420.6	410.5	Fill - Sandy Silt to Silty Sand, occasional Clayey Silt pockets, occasional traces of Topsoil, Brown to Dark Brown, Compact to Dense (n=19-84 blows/0.3 m)	408.9
	10.1	14.7	410.5	405.9	Silty Fine Sand - trace of Gravel, Brown to Reddish Brown or Brownish Grey, Dense to Very Dense (43->72 blows/0.3 m)	
	14.7	20.6	405.9	400.0	Heterogeneous Mixture of Silty Sand, some Gravel, Trace of Clay (Glacial Till) - Brown or Reddish Brown to Greyish Brown, Compact to Very Dense (26->50 blows/0.3 m)	
	20.6	24.6	400.0	396.0	Silty Sand to Sandy Silt - Brown to Grey, Very Dense (>50 blows/0.3 m)	
5	0	9.8	418.6	408.8	Fill - Sandy Silt to Sand and Gravel, occasional Clayey Silt enclosures, Very Gravelly, traces of Topsoil, Brown, Compact to Dense (30->50 blows/0.3 m)	411.5
	9.8	14.2	408.8	404.4	Sandy Silt to Silty Fine Sand, Brown, Compact to Very Dense (30->50 blows/0.3 m)	
6	0	4.4	416.5	412.1	Fill - Clayey Silt to Sand, traces of Gravel and Topsoil enclosures, Topsoil layer at a depth of 4 m, occasional Boulders, Brown to Mottled Brown and Dark Brown, Compact to Dense (or Firm to Hard) (n=10 to 44 blows/0.3 m)	412.7
	4.4	8.3	412.1	408.2	Silty Fine Sand, trace of Gravel, Brown, Compact (n=11-36 blows/0.3 m)	
	8.3	9.0	408.2	407.5	Coarse Sand and Gravel, Brown, Dense (40 blows/0.3 m)	

Table I .../cont'd
Borehole Logs

Borehole No.	Depth		Elevation		Soil Description	Approximate Groundwater Table
	From	To	From	To		(m)
7	0	9.8	415.2	405.4	Fill - Clayey Silt to Sand and Gravel, occasional Root Fibres, Topsoil enclosures and Cobbles, Mottled Light to Dark Brown or Reddish Brown, Compact to Very Dense (n=16-120 blows/0.3 m)	408.9
	9.8	12.7	405.4	402.5	Sand, some Silt, trace of Gravel, Brown, Very Dense (n=60-126 blows/0.3 m)	
8	0	12.0	413.6	401.6	Fill - Sandy Silt to Silty Fine Sand, occasional traces of Topsoil, Topsoil layer at depth of 11.9 m, Brown, Compact to Dense (n=17-35 blows/0.3 m)	401.6
	12.0	13.6	401.6	400.0	Sand and Gravel, Brown, Dense to Very Dense (n=35-54 blows/0.3 m)	
	13.6	17.2	400.0	396.4	Sandy Silt to Sand, Greyish or Reddish Brown to Brown, Compact (n=26-35 blows/0.3 m)	
9	0	2.1	410.5	408.4	Fill - Sand, trace to some Gravel, Brown, Compact (n=27 blows/0.3 m)	
	2.1	6.6	408.4	403.9	Sand with some Gravel (Possible Fill) Brown Compact to Very Dense (n=35-65 blows/0.3 m)	
10	0	12.6	412.2	400.0	Fill - Silty Sand, contains traces of Root Fibres. Topsoil encountered at 11.6 m, Brown to Mottled Brown and Dark Brown, Loose to Dense (3-32 blows/0.3 m)	399.7
	12.0	17.8	400.0	394.4	Sandy Silt to Sand, occasional Pockets and Layers of Coarse Sand and Silty Clay, Brown to Greyish or Reddish Brown, Loose to Dense (7-41 blows/0.3 m)	
	17.8	22.1	394.4	390.1	Heterogeneous Mixture of Silty Clay, some Sand, trace of Gravel (Glacial Till), Reddish Brown, Hard	

Table I .../cont'd
Borehole Logs

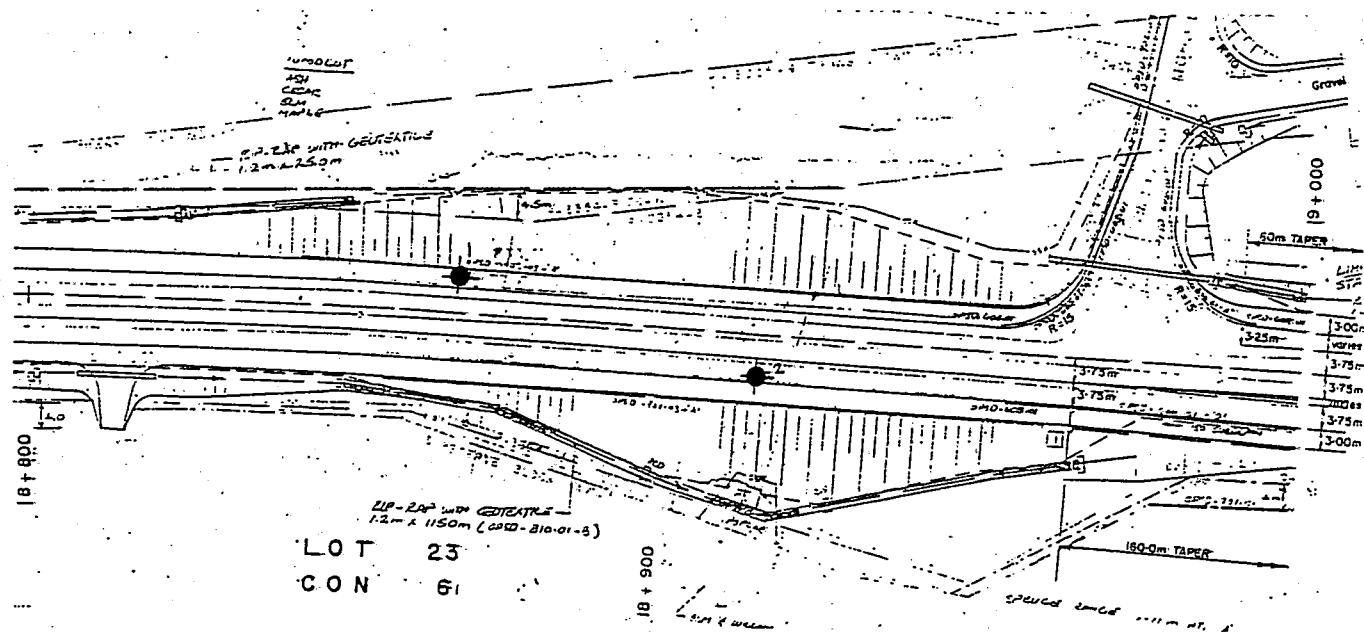
Borehole No.	Depth		Elevation		Soil Description	Approximate Groundwater Table
	From	To	From	To		(m)
11	0	0.7	406.8	406.1	Fill - Gravelly Sand underlain by thin Topsoil layer	404.7
	0.7	9.6	406.1	397.2	Silt to Silty Fine Sand - occasional Layers and pockets of Coarse Sand and Clayey Silt and Sand, Brown to Greyish or Reddish Brown, Compact to Dense (n=20-50 blows/0.3 m)	
12	0	7.5	403.3	395.8	Fill - Silty Sand changing to Clayey Silt, Brown to Mottled Brown and Reddish Brown or Black, Loose to Compact (n=6-30 blows/0.3 m) becoming Hard (n=50-58 blows/0.5) below 7.2 m	393.5
	7.5	13.2	395.8	390.1	Silt to Sandy Silt - occasional Clayey Silt and Silty Sand layers, Brown to Brownish Grey, Dense (n=38-45 blows/0.3 m)	
	13.2	15.7	390.1	387.6	Heterogeneous Mixture of Sandy Silt, some Gravel, trace of Clay (Glacial Till) Reddish Brown, Very Dense (50->50 blows/0.3 m)	
13	0	2.5	400.2	397.7	Fill - Gravelly Sand to Sand, Brown, Compact (n=16 blows/0.3 m)	<394.3
	2.5	4.0	397.7	396.2	Sandy Silt to Fine Sand, Light Brown to Brown, Compact (n=13-16 blows/0.3 m)	
	4.0	5.9	396.2	394.3	Heterogeneous Mixture of Clayey Silt, some Sand, trace of Gravel (Glacial Till) - Brown to Greyish Brown, Hard (n=35-38 blows/0.3 m)	
	5.9	8.8	394.3	391.4	Clayey Silt to Silt (Occasionally Till-Like), Greyish Brown, Dense to Very Dense/Hard (n=45-59 blows/0.3 m)	
14	0	0.76	400.0	399.2	Fill - Gravelly Sand to Clayey Silt, contains Topsoil enclosures, Dark Brown with Black Mottling	<393.4
	0.76	4.1	399.2	395.9	Silty Fine Sand to Sand, Light Brown to Brown, occasionally Reddish Brown, Compact (n=22-27 blows/0.3 m)	

Table I .../cont'd
Borehole Logs

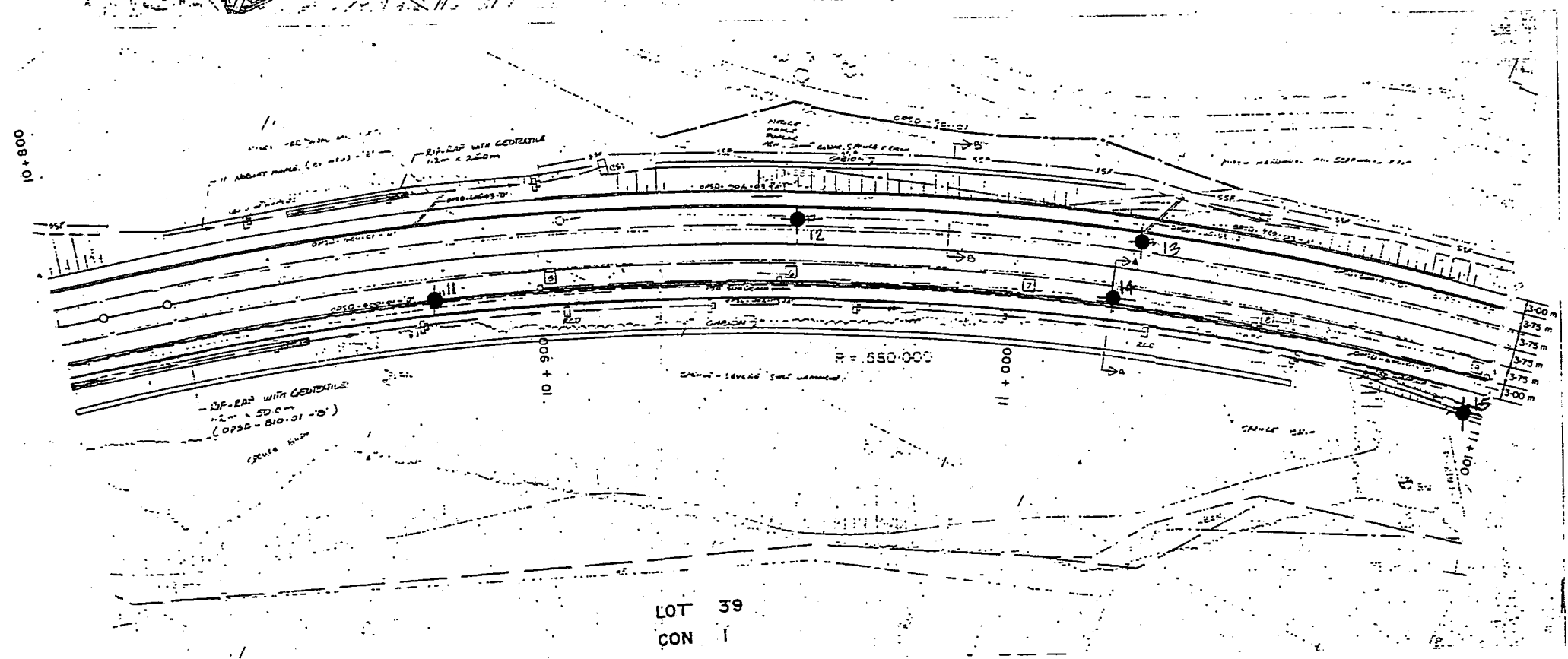
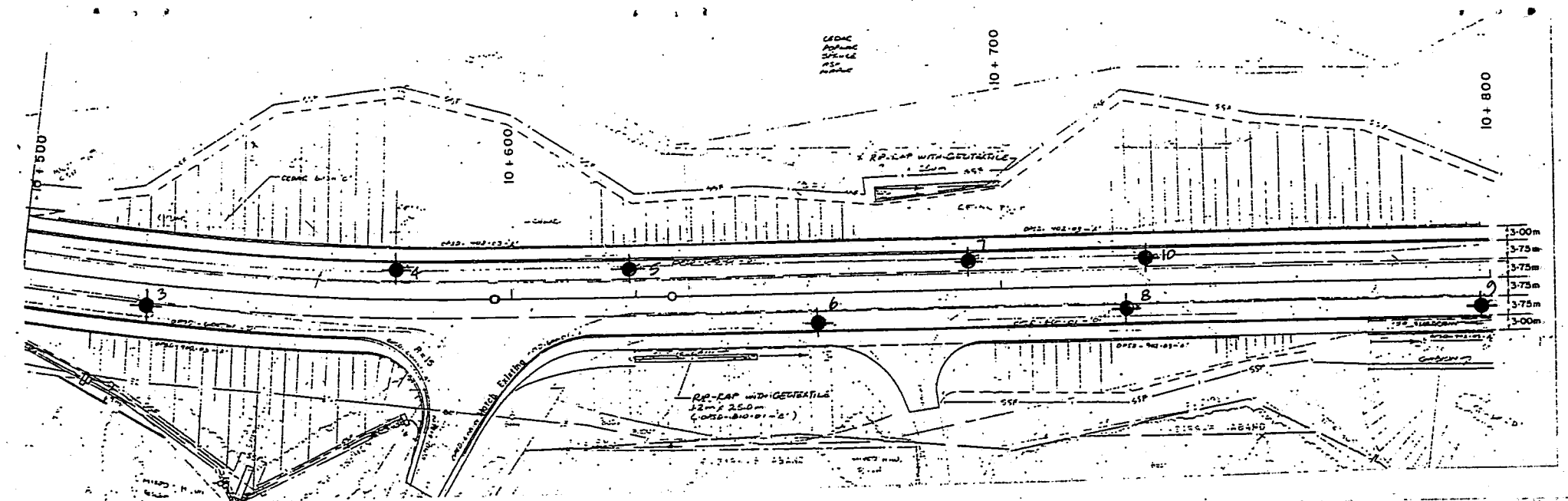
Borehole No.	Depth		Elevation		Soil Description	Approximate Groundwater Table (m)
	From	To	From	To		
	4.1	5.2	395.9	394.8	Heterogeneous Mixture of Clayey Silt, some Sand, trace of Gravel (Glacial Till) - Brown to Greyish Brown, Very Stiff to Hard (n=25-34 blows/0.3 m)	
	5.2	6.6	394.8	393.4	Clayey Silt, some Sand (Till-Like), Greyish Brown, Hard (n=48-63 blows/0.3 m)	
15	0	3.7	396.9	393.2	Fill - Gravelly Sand to Sandy Silt, occasionally Clayey, occasional traces of Topsoil enclosures, Brown to Dark Brown with Black mottling, Compact to Dense (n=11-41 blows/0.3 m)	389.8
	3.7	9.6	393.2	387.3	Sandy Silt to Fine Sand, occasionally Coarser, Light Brown to Brown, Compact to Dense (n=14-21 blows/0.3 m)	
16	0	5.2	350.2	345.0	Fill - Fine Sand, some Silt to Sandy Silt, occasional Clayey, contains traces of Topsoil and Root Fibres, Mottled Brown and Dark Brown or Reddish Brown, Loose to Dense (n=2-42 blows/0.3 m)	345.0
	5.2	9.6	345.0	340.6	Silty Fine Sand, occasional Clayey Silt and Sand pockets, Brown, Loose to Compact (n=4-34 blows/0.3 m)	
	9.6		340.6	<340.6	Weathered Shale Bedrock or Possible Slabs of Rafted Rock, Reddish Brown, Hard (n=85 blows/0.3 m)	
17	0	1.8	345.4	343.6	Fill - Sandy Silt to Silty Sand, Brown to Mottled Brown and Dark Brown, Loose (n=8 blows/0.3 m)	340.2
	1.8	8.3	343.6	337.1	Sandy Silt to Silty Fine Sand, Light Brown, Compact to Dense (n=14-41 blows/0.3 m)	
	8.2		337.1	<337.1	Bedrock or Possible Slabs of Rafted Rock	

Table I .../cont'd
Borehole Logs

Borehole No.	Depth		Elevation		Soil Description	Approximate Groundwater Table
	From	To	From	To		(m)
18	0	5.7	341.8	335.2	Fill - Sandy Silt to Silty Fine Sand, occasional Medium Sand Layers, occasional Root Fibres and Topsoil enclosures, Brown or Mottled Brown to Reddish or Greyish Brown, Loose to Compact (2-30 blows/0.3 m)	334.5
	5.7	10.2	335.2	331.6	Silty Fine Sand to Sandy Silt, contains layers of Clayey Silt or Medium Sand to Sand and Gravel, Brown to Grey, Compact (n=11-23 blows/0.3 m)	
	10.2	13.5	331.6	328.3	Weathered Shale Bedrock or Possible Slabs of Rafted Rock, Reddish Brown, Hard (n>>50 blows/0.3 m)	



DWG 738301-A

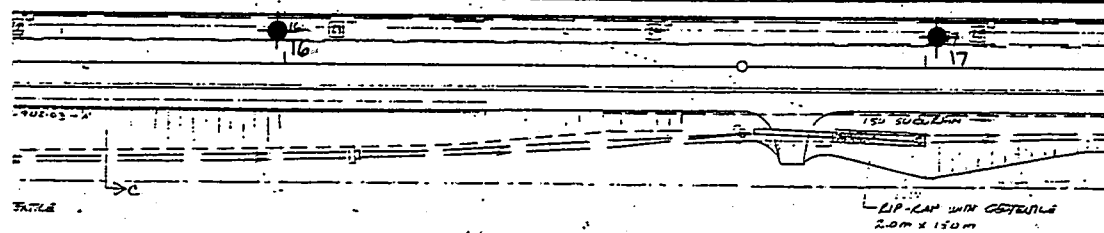


LOT 39
CON 1

DWG 738301-B

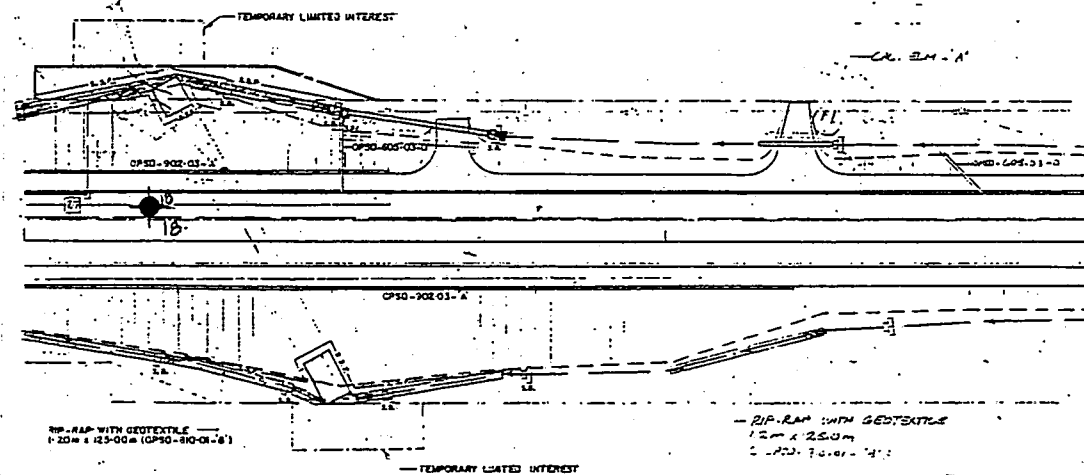
$\cdot 12 + 400$

12 + 300



12 + 500

12 + 600



CON 2.

DWG 738301-C

NATIONAL SHORING LIMITED

Suite #206, 90 Burnhamthorpe Road West
Mississauga, Ontario, L5B 3C3

FACSIMILE TRANSMISSION

FILE # _____
DATE: 24 February 1992
FROM: **PHILIP DUCHEN**
Tel. No. (416) 896-9760
Fax No. (416) 272-4851

89013

TO: ERIC CHENG
COMPANY: WILLIAM L SEARS & ASSOC
FAX: (416) 664-3159

PLEASE FIND 3 PAGES (INCL COVER SHEET) CONFIRMATION BY MAIL YES NO

PROJECT: MINISTRY OF TRANSPORTATION HIGHWAY 9

PROJECT NO:

COMMENTS / INSTRUCTIONS:

Herewith our draft letter for the above project in order to assist you with your report preparation.

Photographs will only be available from the slides tomorrow afternoon so I will courier through final report as soon as they become available.

Please let me know if there is anything else required for the letter.

Regards

SIGNATURE: _____ NAME (PRINT): PHILIP DUCHEN



24 February 1992

William L. Sears and Associates Ltd.
455 Seaman Street
Stoney Creek
Ontario
L8E 2R2

Attention Mr Eric T. W. Cheng M.BA., P.Eng.

RE: MINISTRY OF TRANSPORTATION PROJECT
HIGHWAY 9
PROPOSAL FOR SHORING AND FINISHING OF CUT

Dear Sir:

Thank you for the opportunity to present our system of shoring to yourself and Mr. Joseph Y. K. Lai P.Eng. of the Ministry of Transportation on February 20, 1992 in your offices.

We understand that you require a proposal for the shoring and finishing of the Highway 9 cut. The cut will be in natural material and there are a variety of engineering solutions available. You requested that we consider a typical 5m high shored face in the cut for approximately 300m in length. The final location and size of the shored face would be determined during a more detailed design. Aesthetics are considered a key element of the process.

We propose that in principle we use our Ground Control Method of Shoring to provide permanent support to the face of the cut and use one of a variety of ways to finish the surface to achieve aesthetic acceptability.

The Ground Control Method of shoring is a tie-back system of shoring using shotcrete as lagging and soil anchors for tie-backs. It is commonly used in temporary shoring of excavations and would be upgraded for the "permanent" nature of this project e.g. using corrosion protection techniques etc. The system of shoring has been used in the U.S.A. for a highway cut known as the Cumberland Gap?????.

The aesthetic finish could be achieved with one of the following techniques:

1. Provide a smooth surface to the shotcrete by wood floating the surface;
2. Provide "architectural" imprint features in the shotcrete similar to imprints made in cast-in-place concrete;
3. Provide "ground cover" to the shotcrete using creepers such as an ivy;
4. Provide a system of pre-cast panels over the shotcrete;
5. Provide stone facing to the shotcrete (see attached photos)

DRAFT

The cost of providing the basic shoring including design fees would be approximately \$200/m2 (\$18.50/sf) to which the cost of excavation and the alternative finishes should be added.

As the excavated material would probably be used in a cut to fill operation we have not include for the cost of the excavation here. The key to minimising the cost of the combined excavation and shoring process would be in the co-ordination of the two activities as they would run concurrently.

The estimated additional cost to achieve the chosen aesthetic finish would be:

1. Smooth finish to shotcrete: \$20.00/m2;
2. Architectural imprints: \$40.00/m2 to \$70.00/m2 depending on the detail;
3. Ground cover: Landscape contractors should be approached for this cost;
4. Precast panel facade: \$100.00/m2 to \$150.00/m2;
5. Stone facing: \$60.00/m2 to \$120.00/m2.

The above approach would not require excavation and backfilling behind the shored face as would be the case for a cast-in-place retaining wall, reinforced earth or the gabion wall alternative.

Enclosed are photographs of some temporary shoring projects which demonstrate the capacity of the system of shoring. In addition the photograph of the stone faced wall shows what can be done to achieve aesthetic qualities. We also enclose a schematic of the basic shoring we would propose. We are unable to provide schematics of the various finished alternatives in the time available but should you wish to pursue those options further we would be happy to work with you in this regard.

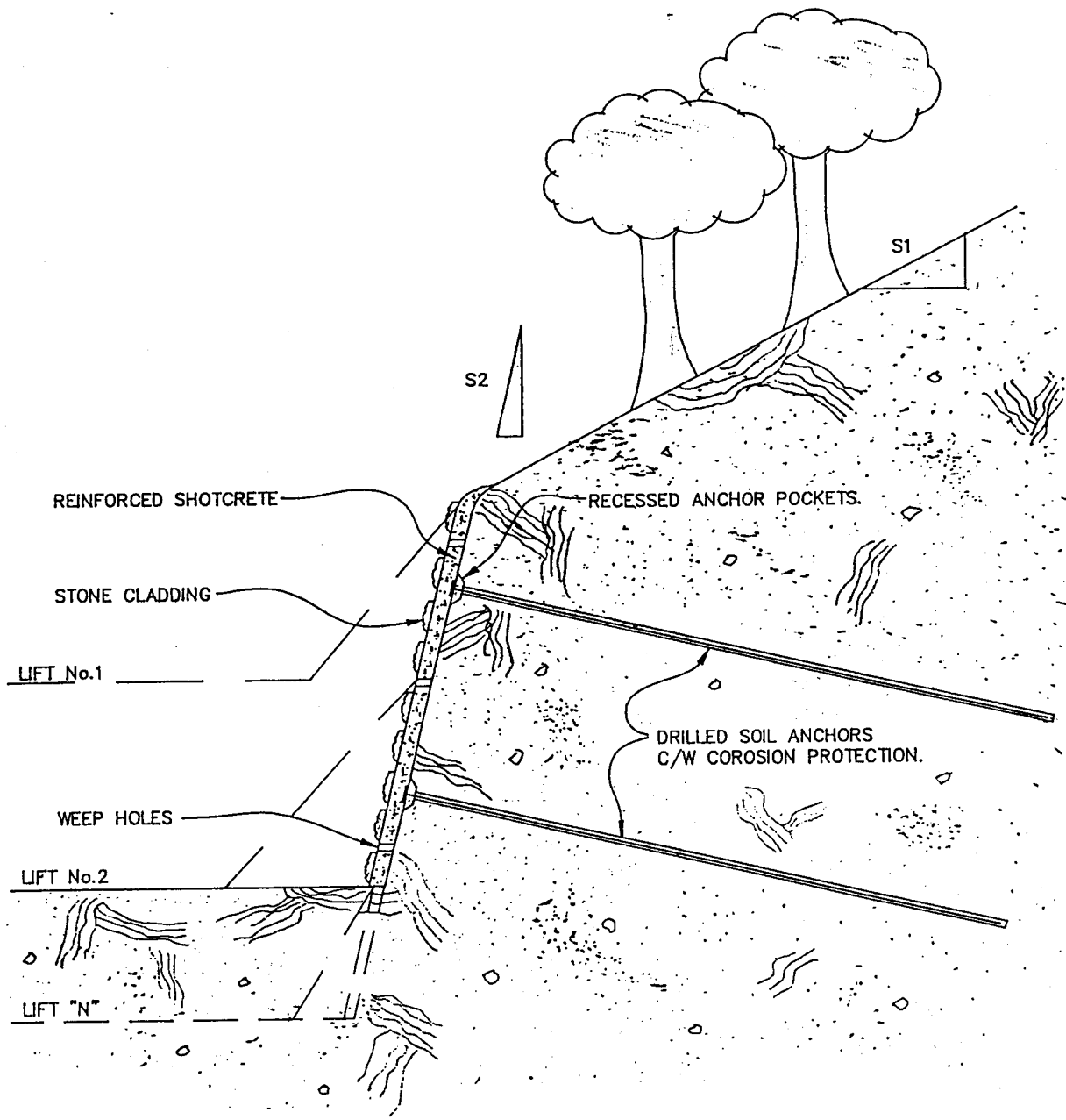
We trust this information is of use to yourselves. Should you require more information please contact the writer.

Yours truly
NATIONAL SHORING LTD

Philip Duchon

file: i:\philip\MTOHWY9

THE SYSTEM



TYPICAL SECTION

"SHOT-STONE" RETAINING WALLS

DATE: FEB 5, 92	DRAWN BY: M.Z.	DWG NO.
SCALE: N.T.S.	CHECKED BY: K.D.	ST-1
		R-0

NATIONAL SHORING LTD.

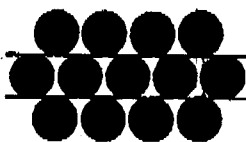
~ A JOINT VENTURE ~

WESTERN CANADA

SUITE 106-26 LORNE ST. NEW WESTMINSTER, B.C. V3M 3L7
TEL: 604/521-6678 FAX: 604/521-3905

EASTERN CANADA

SUITE 906, 50 BURNHAMTHORPE RD. W. MISS. ONT. L5B 3C2
TEL: 416/896-9760 FAX: 416/896-1821



reinforced earth®

Toronto Office
February 25, 1992

By Fax (6 Pages Total)

William Sears and Associates Ltd.,
455 Seaman Street,
Stoney Creek, Ontario
L8E 2R2

Attention: Mr. Eric Cheng, P.Eng.,
Associate

Dear Sir:

Re: Preliminary Estimate
Highway 9
Greenwall and Matrex
Slope Steepening Options
Near Mono Mills, Ontario
RECO No. T921174

Pursuant to your request, we include herein our preliminary cost estimate for your consideration. Please find enclosed two section drawings of the Greenwall and Matrex options. Based on our preliminary take-offs, the upper wall would be approximately 1140 m² and the lower wall would be approximately 330 m² for a total of 1470 m² in the vertical projection of the inclined surfaces.

Price

Based on 1992 dollars, our approximate supply prices would be in the order of \$170.00/m² for the Greenwall option and \$70.00/m² for the Matrex slope steepening option.

Budget Estimate

In order to assist you in making a global estimate of this project, we have summarized below, the supply and erection cost for these two options:

A) Greenwall Option

1) Site Preparation, Mobilization & Excavation	Estimate by others
2) Cast-in-place Levelling Pad	
Upper 100 m @ ± \$20.00 m	\$ 2,000.00
Lower 34 m @ ± \$20.00 m	\$ 680.00

...2/



Mr. Eric Cheng, P.Eng.,
T921174 Preliminary Estimate continued ...
February 25, 1992

Page ... 2

Price cont'd.

3) Supply Greenwall Components
(including strips)

Upper 1140 m ² @ \$170.00/m ²	\$ 193,800.00
Lower 330 m ² @ \$170.00/m ²	\$ 56,100.00

4) P.S.T. on Greenwall Components

Upper 193,800 @ 8%	\$ 15,504.00
Lower 56,100 @ 8%	\$ 4,488.00

5) Wall Erection

Upper 1140 m ² @ \$40.00/m ²	\$ 45,600.00
Lower 330 m ² @ \$40.00/m ²	\$ 13,200.00

6) Backfill Supply, Placement &
Compaction (Neat R/E Volume only)
(not including topsoil fill at
front face)

Upper 3420 m ³ @ \$20.00/m ³	\$ 68,400.00
Lower 990 m ³ @ \$20.00/m ³	\$ 19,800.00

7) Contractor's mark up on Components
Say 10%

Upper	\$ 19,380.00
Lower	\$ 5,610.00

Sub subtotal	Upper	\$ 344,684.00
	Lower	99,878.00

Subtotal	\$ 444,562.00
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Mr. Eric Cheng, P.Eng.,
T921174 Preliminary Estimate continued ...
February 25, 1992

Page ... 3

B) Matrex Option

1) Site Preparation, Mobilization & Excavation	Estimate by others
2) Supply Matrex Primary Reinforcement and Soil Retention Fabric (Erosion Control Mat, North American Green or Similar, not included)	
Upper 1140 m ² @ \$70.00/m ²	\$ 79,800.00
Lower 330 m ² @ \$70.00/m ²	\$ 23,100.00
3) PST on RECO, Matrex Materials	
Upper 79,800 @ 8%	\$ 6,384.00
Lower 23,100 @ 8%	\$ 1,848.00
4) Slope Steepening Construction	
Upper 1140 m ² @ \$30.00/m ²	\$ 34,200.00
Lower 330 m ² @ \$30.00/m ²	\$ 9,900.00
5) Backfill Supply, Placement & Compaction (Neat R/E Volume only) (not including topsoil fill at front face)	
Upper 3420 m ³ @ \$20.00/m ³	\$ 68,400.00
Lower 990 m ³ @ \$20.00/m ³	\$ 19,800.00
6) Contractor's mark up on Components Say 10%	
Upper	\$ 7,980.00
Lower	\$ 2,310.00
Sub subtotal Upper	\$ 196,764.00
Lower	\$ 56,958.00
Subtotal	\$ 253,722.00



Mr. Eric Cheng, P.Eng.,
T921174 Preliminary Estimate continued ...
February 25, 1992

Page ... 4

We trust that the above information is sufficiently detailed to allow cost comparisons. We look forward to working with you and await your further instructions.

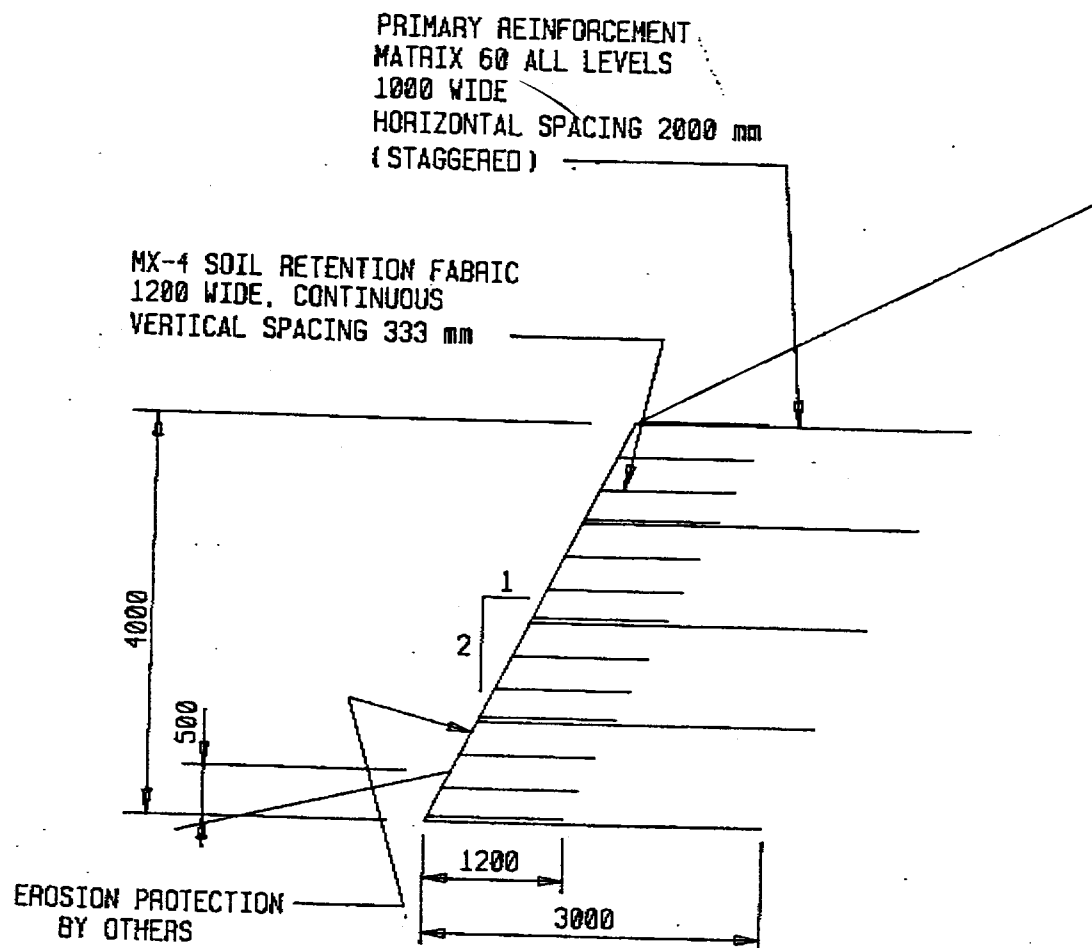
Yours very truly,

REINFORCED EARTH COMPANY LTD.

A handwritten signature in cursive script, appearing to read "Richard Burgess".

Richard Burgess, P. Eng.,
Project Manager.

RB/kp



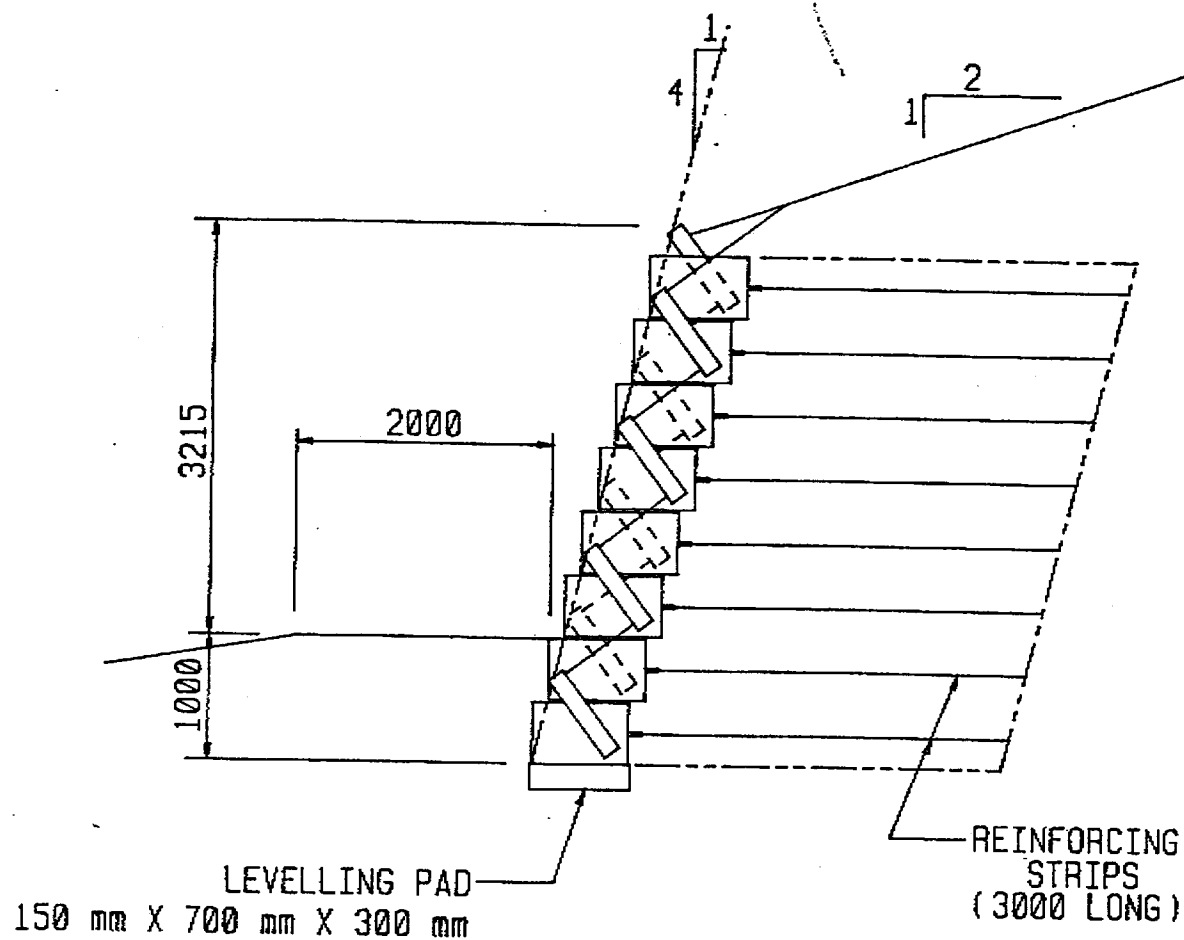
NOTE: FINAL DESIGN PENDING EXTERNAL SOIL CONDITIONS.

TYPICAL SECTION

STA. 10+925 TO STA. 11+020 (LT)

RECO NO. 921174

24 FEB. 92



NOTE: FINAL DESIGN PENDING EXTERNAL SOIL CONDITIONS

TYPICAL SECTION

STA. 10+775 TO STA. 11+060 (RT)

RECO NO. 921147

24 FEB 92

TYPE	ADVANTAGES	DISADVANTAGES	COST (APPROX.)			
			STRUCTURE	FINISH	PLANTING	TOTAL
1. Shoring using Shotcrete	<ul style="list-style-type: none"> -less disturbance of the existing slope -allow for mural design -provide ground cover using creepers such as ivy. 	<ul style="list-style-type: none"> -require concrete finish for decoration -maximum visual impact -project is new to M.T.O. -more effective in cut area 	350,000.	103,000. (architecture) imprints	-	453,000.
				220,500. (pre-cast)	-	570,500.
				176,000. (stone facing)	-	526,000.
2. Greenwall	<ul style="list-style-type: none"> -planting for decoration 	<ul style="list-style-type: none"> -disturb more slope due to the ships -Greenwall has not been used in Ontario -more maintenance requirements 	500,000.	-	20,000.	520,000.
3. Matrex Wall	<ul style="list-style-type: none"> -least expensive 	<ul style="list-style-type: none"> -needs decorating -planting needs a fairly long time to develop 	293,000.	-	20,000.	313,000.
4. Gabion Wall	<ul style="list-style-type: none"> -commonly used product 	<ul style="list-style-type: none"> -requires more maintenance -more disturbance 	511,500.	-		511,500.

memorandum



To: Joseph Lai
Project Manager
P & D Section, Central Region

Date: 1993 03 05

From: Foundation Design Section
Room 315, Central Building

Subject: Geotechnical Considerations
Hwy 9 - West of Hwy 50
W.P. 73-83-01
District 6, Toronto

This memo is to record certain geotechnical items discussed at the time of our meeting of 1993 03 04 regarding the above project.

1. Station 10+550 - South Side

The proposed construction at the above location would involve road widening by about 6 m. The existing ground slopes at about 2H to 1V from the road surface to about 14 m depth. It is understood that the subsurface conditions in this area consist of about 10 m of old fill underlain by natural ground.

It is understood that the following options were considered for the above widening:

- (i) Extending the fill at 2H to 1V slope.
- (ii) Constructing a retaining structure.
- (iii) Constructing a steeper slope at near the top of the existing slope.

From considerations of the existing subsurface conditions, it is considered that option (iii) would not yield adequate factor of safety against deep seated failure and, therefore, should not be pursued.

From considerations of the existing subsurface conditions and the proposed height of the retaining structure, option (ii) would require probably a caisson wall together with an extensive tie back system, making this option very costly.

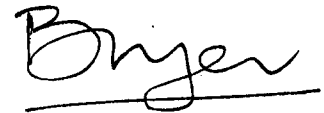
From geotechnical considerations, we conclude that option (i) is the only suitable solution for this area.

2. General Comments for remaining areas

The subsurface conditions, slopes of the existing and proposed grades and heights of the retaining structures vary from location to location. Therefore each structure should be designed taking into consideration all of the above factors.

Since the type of retaining structure at various locations along Hwy 9 may vary from cantilever type soldier pile wall to caisson type structure together with some tie back system to other types of walls such as reinforced earth wall, it is recommended that, until the design of the retaining structures is complete, the generic term "retaining structure" be used on the drawings.

Please call if you want to discuss the contents of this memo.

A handwritten signature in black ink, appearing to read 'B. Iyer', with a horizontal line underneath.

Balu Iyer, P.Eng.
Sr. Foundation Engineer

cc. N. Garland

B:\738301.305

DATE: 93-02-18Ministry
of
Transportation
OntarioCENTRAL REGION
1201 Wilson Avenue
Atrium Tower
Downsview, Ontario
M3M 1J8

FAX # (416) 235-4382

OUT-GOING FAX #: 5240(Please indicate)
LOCAL (9) or LONG DISTANCE (8-1) and AREA CODENUMBER OF PAGES INCLUDING COVERSHEET: 2TO: DR. B. IYER
FOUNDATION SECTION

FROM: (Please indicate name & section)

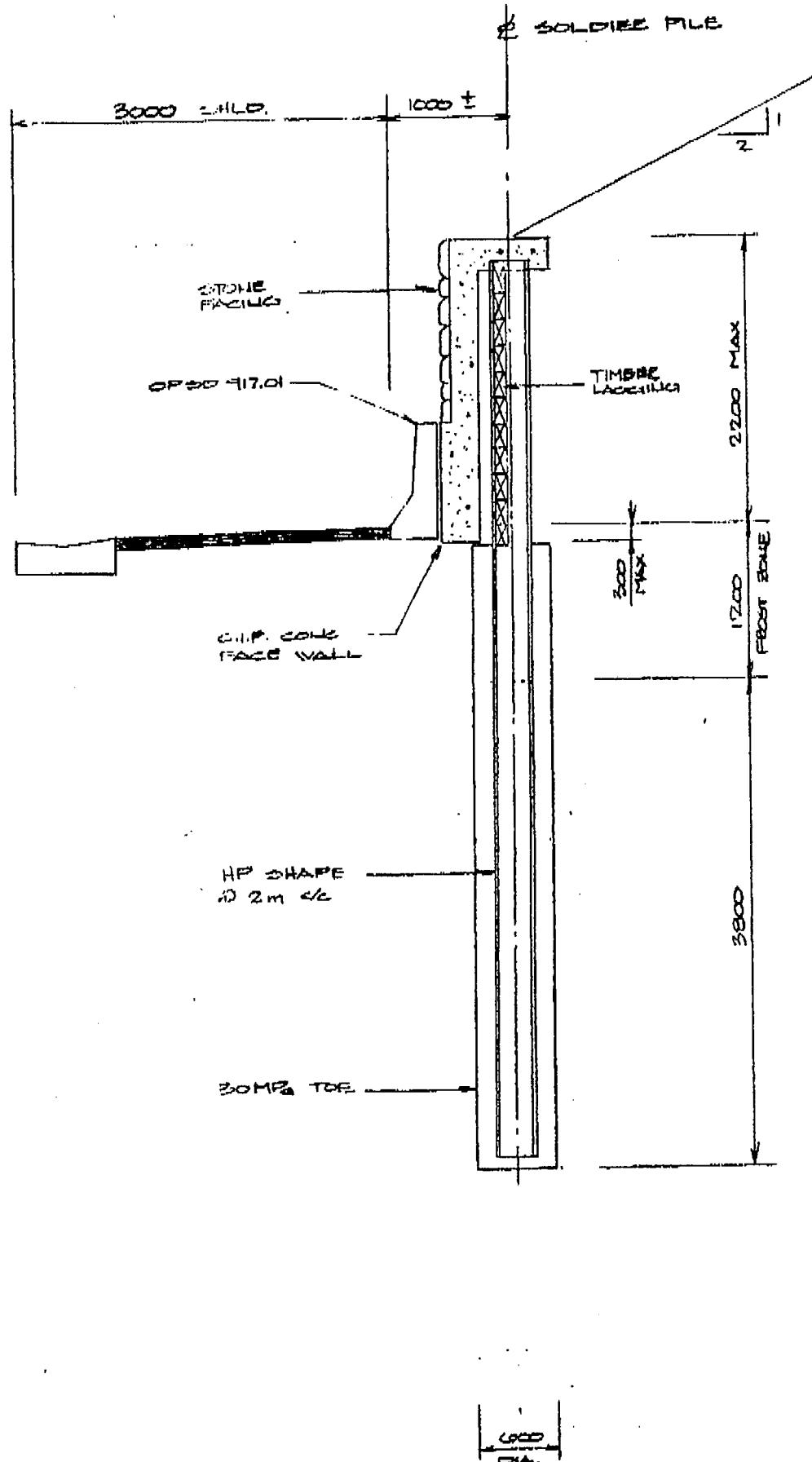
N GARLAND

Structural Section

Atrium Tower, 4th Floor

1201 Wilson Avenue, Downsview, Ontario, M3M 1J8

COMMENTS: W.P. 73-83-01 SOLDIER PILE WALL - TRIAL 2
(NO FROST COVER FOR FACE WALL)IF THIS TRANSMISSION IS RECEIVED INCORRECTLY, PLEASE CALL THIS FAX OPERATOR
IMMEDIATELY AT (416) 235-5423 EXT. # 0139



WP. 73-83-01 HWY 9

TRIAL 2 - NO FROST COVER FOR FACE WALL
(NOM. 300 mm BELOW GRADE)

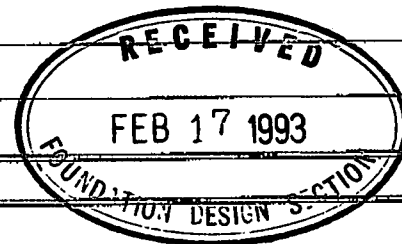
DATE: 93-02-17Ministry
of
Transportation
OntarioCENTRAL REGION
1201 Wilson Avenue
Atrium Tower
Downsview, Ontario
M3M 1J8

FAX # (416) 235-4382

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LOCAL (9) or LONG DISTANCE (8-1) and AREA CODE

NUMBER OF PAGES INCLUDING COVERSHEET: 2TO: DR. B. IYERFOUNDATION SECTION

FROM: (Please indicate name & section)

NICK GARLANDStructural SectionAtrium Tower, 4th Floor1201 Wilson Avenue, Downsview, Ontario, M3M 1J8COMMENTS: PRELIM. SKETCH OF CANTILEVER BOLDER
PILE WALL FOR W.P. 73-85-01 F.Y.I.IF THIS TRANSMISSION IS RECEIVED INCORRECTLY, PLEASE CALL THIS FAX OPERATOR
IMMEDIATELY AT (416) 235-5423 EXT. # 0139



Planning & Design Section
Central Region
Atrium Tower, 4th Floor
1201 Wilson Avenue
Downsview, Ontario M3M 1J8
Telephone (416) 235-5534

March 16, 1993

Mr. Cecil Louls
Assistant Director
Niagara Escarpment Commission
232 Guelph Street
Georgetown, Ontario
L7G 4B1

Attention: Ms. Marion Plaunt

Dear Sir:

**Re: Class Environmental Assessment-Highway 9
Road Improvements from 1.0 km West of Airport
Road to 0.3 km East of Albion 5th Line
W.P. 73-83-01**



In our meeting of February 25, 1993, your letter of February 16, 1993, and its recommendations were discussed in details. Information relating to your concerns and pertinent materials were presented (see enclosed minutes).

As discussed, the ministry's Traffic Section explained that several alternatives were investigated for the eastbound traffic turning left into the Jevicho House. It was shown that from an "operational safety" point of view a left turn lane is warranted in a three lane cross-section. Considering that a slip-around proved to be inadequate, a full left turn lane is needed. A full left turn lane would disturb the south escarpment slope by approximately 80% to 90% of its length. As well, a full left turn lane would geometrically overlap into the lane drop taper from Simcoe Street by 120 m approximately. Taking the above notes into account, the ministry recommends that a 4 lane cross-section be constructed from Simcoe Street to Township Line Road.

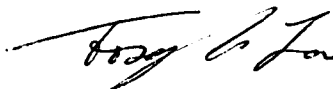
In the area of the south ravine west of the Simcoe Street, the Planning and Design Section in consultation with the Foundation Section investigated the idea of a 1:1 slope with geogrid system. It was found that this option would not yield an adequate factor of safety against deep seated failure and, therefore, this alternative is not a viable option. The ministry is still in the opinion that earthfill at 2:1 slope with extensive landscaping is the only suitable solution for this small isolated ravine.

Structural Section has reviewed the new 3rd edition of the Ontario Highway Bridge Design Code book in regards to the traffic barriers on high structures. The code revealed that for retaining structures on the north side of the Highway 9 with height 5.0 m or less, 15% truck volume, 4% to 5% grade, horizontal curve of 580 m and current traffic volume, a Performance Level 3 barrier is required. In another words, a 1050 mm high concrete barrier is the only approved barrier for placement on top of structures with the above characteristic. It is the ministry's recommendation that 1050 mm concrete barrier be installed on top of retaining structures on the north side of Hwy. 9. This would decrease the disturbance to the fill slope side by 1.5 m. In order to provide a concrete barrier more aesthetically pleasing, the ministry is open for discussion with the NEC and its staff. One idea to consider is to provide an aggregate facing by sand blasting with a single handrail on top of the barrier.

Over the past two and a half years, the ministry has worked with the NEC on this project and numerous discussions and alternative designs has been carried out. This ministry feels that we have derived the best possible solution while still satisfying your aesthetic and environmental requirements and our roadway improvements requirements, which includes safety and cost effective needs. The ministry hopes that a successful resolution will be reached at the next Commission's meeting, allowing this project to complete its detail design by this summer.

I trust the enclosed minutes and the above information will be of assistants in the preparation of your report to the Commission. Should you have any questions, please do not hesitate to contact the undersigned.

Yours truly,



Joseph Lai, P. Eng.
Project Manager

JL:vn

cc: A. Wittenberg
L. Dutchak
T. Steele
P. Howes
N. Garland
B. Iyer
W. Sears - W. Sears & Assoc.

memorandum



To: V.F. Boehnke
Head of Structural Section
Central Region
Attention : Nick Garland

Date: 92 05 28

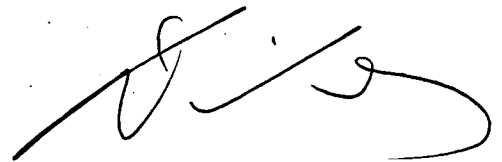
From : Foundation Design Section
Room 315, Central Building

Re : Highway 9, West of Highway 50
W.P.73-83-01
District 6, Toronto

A meeting was held in this office on 92 05 26 to discuss various alternatives of ground support for highway widening at a few concerned locations for the above project, in particular the area around Sta 10+575 where Niagara Escarpment Commission has objections over the presently proposed fill option. The results of our discussions are summarized as follows :

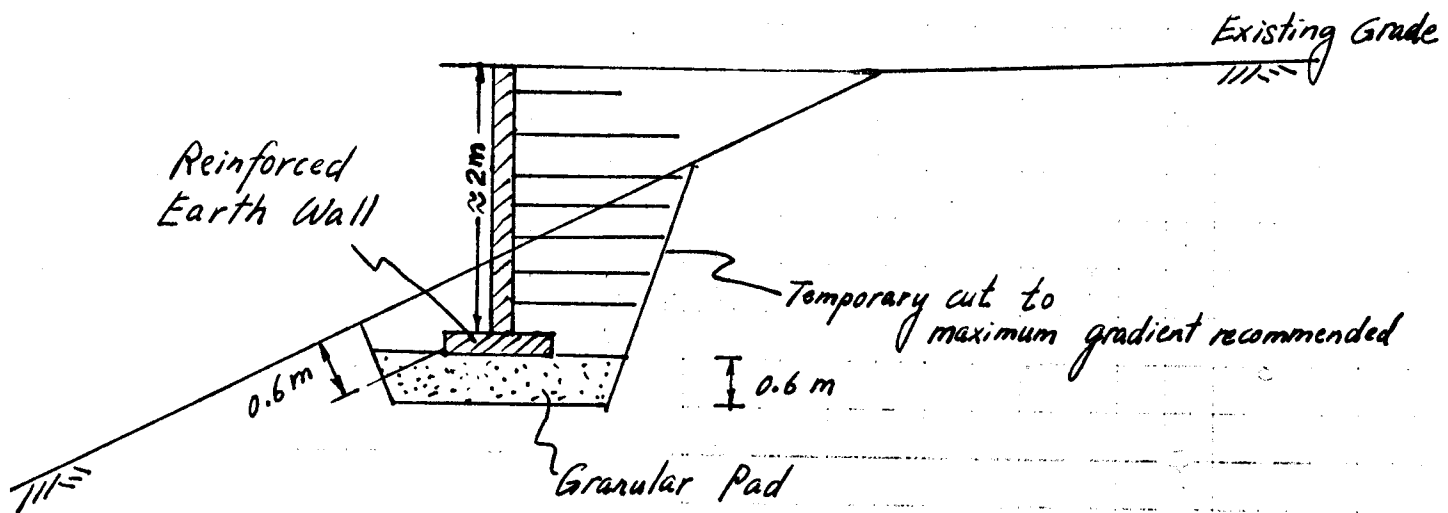
1. The alternative of constructing a reinforced concrete wall at mid height of the slope was discussed and generally considered not cost effective as a major structure on slope is required to support a sloping ground above. There will be construction difficulties as well.
2. It is considered that constructing a flexible retaining wall such as a reinforced earth wall at the top of the slope to support the proposed highway widening is a more feasible solution. Due to the granular nature of the existing fill, it is envisaged the wall can be founded within the fill stratum. The wall base may be subjected to some differential settlements due to the erratic nature of the existing fill. It is believed that the reinforced earth wall may be designed to tolerate the movements.
3. The retained height of the wall is about 2 m. The wall should be founded at least 0.6 m below the surface of the existing slope, on a compacted granular pad of minimum 0.6 m thickness as shown on the attached sketch. The details of the reinforced earth wall should be conservatively designed to minimize movements. No further foundation investigation is necessary if this alternative is adopted.
4. The possibility of changing the highway design from rural standards to urban standards was also put forward to reduce the required width of widening and hence the height of the wall. If this is possible, please notify our office.

5. It was agreed that Structural Section will work together with William L Sears & Associates and come up with a retaining wall design package for all the concerned areas and this office will then provide foundation inputs accordingly.

A handwritten signature in black ink, appearing to be 'David Kwok', written in a cursive style.

David Kwok, P. Eng.
Project Foundation Engineer
for
Balu Iyer, P. Eng.
Senior Foundation Engineer

c.c. Planning & Design Section
(Attention : Joseph Lai)



Schematic Cross-section for Reinforced Earth Wall
(N.T.S.)

		UPPER	SLOPE	992 03 09	ESTIMATED COST
TYPE	ADVANTAGES		DISADVANTAGES		
URBAN	SHOTCRETE	<ul style="list-style-type: none"> - least disturbance of existing slopes - easy construction - allow for mural design - minimum excavation - provide ground cover using creepers 	<ul style="list-style-type: none"> - require concrete finish for decoration - maximum visual impact - more effective in cut area - has not been used for permanent slope by M.T.O. 		\$130,000 (structure) \$25,000 - \$95,000 (surface finish) landscape cover, \$40,000.
	RETAINING WALL (R.C.)	<ul style="list-style-type: none"> - require no surface finish. - effective in both cut and fill area - require minimum maintenance 	<ul style="list-style-type: none"> - require formwork & shuttering - take longer time to construct - moderate disturbance of existing slopes 		\$260,000
	GEOGRID	<ul style="list-style-type: none"> - easy construction - planting for decoration - effective in both cut and fill area 	<ul style="list-style-type: none"> - most disturbance of existing slopes - more maintenance requirements 		\$230,000
RURAL	SHOTCRETE	see above	see above		\$282,000 (structure) \$25,000 - \$190,000 (surface finish)
	GEOGRID	see above	see above		\$460,000