DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 30M13-120

DIST. 6 REGION

W.P. No. 137-79-01

CONT. No. 93-56

W. O. No.

STR. SITE No.

HWY. No. 10

LOCATION FROM REG. ROAD 9, NORTHERLY TO 5.1KM, SOUTH OF HWY 24

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

Ministry of Transportation

Ontario

FILE No. _____ **DATE** _____

REMARKS

AJAY SHAKYAVER ---- 235-5533
(PLANNING & DESIGN) - ELEVATIONS

FILE COPY

Ministry
of
Transportation
Ontario

FOUNDATION DESIGN SECTION

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 137-79-01 DIST 6

HWY 10 STR SITE

Proposed Road Widening for Highway 10

DISTRIBUTION

V.F. Boehnke (3)
G. Cautillo
J. Cullen
A. Wittenberg
K.G. Bassi
S.J. Dunham
E.A. Joseph
I. Harrod (Cover Only)
F. Bacchus (Cover Only)
File Copy

GEOCRES 30M13-120 DATE AUG 23 1991

FOUNDATION INVESTIGATION REPORT

For

Proposed Road Widening for Highway 10

From Reg Road 9, Northerly to 5.1 km South of Highway 24

W.P. 137-79-01

District 6, Toronto

INTRODUCTION

Subsequent to requests submitted by the Central Region Geotechnical Section, an investigation was carried out by this office to determine foundation conditions at two locations for a widening of Highway 10 from 2 lanes to 4 lanes. The project would require 8-4 m high fills placed along side existing advanced structures. The proposed widening profile grades vary greatly in elevation from 281 m to 274 m at one site sloping down towards the north with decreasing fill heights and from 287.5 m to 288.5 m sloping up towards the north at the second site. In both locations varying amounts of fill will be necessary to attain design profile grades. The natural ground surface at the two sites varied from 275 m to 272 m and approximately at an elevation of 284 m respectively.

The investigation procedures, including the fieldwork, a detailed summary of the subsurface conditions and the requested design recommendations are included in this report.

SITE DESCRIPTION AND GEOLOGY

The above project consists of two locations between Sta. 11+200 to 11+375 and 13+700 to 13+800 located 1.2 km and and 3.75 km respectively north of Peel Road along Highway 10. The area is surrounded by farms and randomly placed private homes and consists of rolling grass lands with groups of trees. The boreholes at the first site (Sta. 11+200 to 11+375) were placed immediately east of the north bound lane along the shoulder to the right of the car protection barriers. These holes were located down a sloping portion of the Highway with existing 8 to 4 m high side embankments on either side down to the natural ground surface. Just north of the site a creek crosses Highway 10 through a culvert. At the second site (Sta. 13+700 to 13+800) the boreholes were placed on the east shoulder of Highway 10 just north and south of an existing culvert.

Physiographically, the sites are located at the fringes of the physiographic regions known as the Oak Ridges Moraine and the the Hillsburgh Sandhills. Much of the Oak Ridges Moraine for the most part are hills composed of sandy or gravelly materials, this is not always the case with some of the highest ridges formed of till which protudes above the sands. The rough topography, sandy materials, and flatbottomed swampy valley running through the moraine are the outstanding characteristics. Further west the sand gradually gives way to a till.

Investigation Procedures

Soil data were obtained by in situ testing and examined in the laboratory. The fieldwork for the investigation was carried out between 91 05 27 to 91 05 30 and consisted of three boreholes at the first site (Sta. 11+200 to 11+375) and two boreholes at the second site (Sta. 13+700 to 13+800) located on the east shoulder of Highay 10.

All boreholes were advanced 15.7 m to 12.7 m below the existing ground surface.

Vanes were taken when plastic cohesive material was encountered. Cone Penetration Tests at the bottom of each borehole and one surface cone at each site were performed. The foundation investigation, specifically the location of the boreholes were based on the ETR sheets marked by the Geotechnical Section where the cross sections for cut/fills are in excess of 4 m for which foundation investigations are required.

Track-mounted CME55 equipment employing hollow stem and solid stem augering techniques was used to advance all boreholes in the overburden. In general, disturbed subsoil samples were retrieved at 0.75 m intervals for the surficial 4.5 m and near the profile grade surface of the proposed widening, 1.5 m intervals thereafter. All samples were identified in the field and returned to the laboratory for review.

Groundwater levels were obtained by monitoring the levels in two piezometers installed and in open boreholes throughout the duration of the field

investigation. All boreholes were backfilled at the completion of the fieldwork.

Survey information related to the location and elevation of boreholes was provided by the Central Region Surveys and Plans Office.

SUBSURFACE CONDITIONS

The stratigraphy encountered at the first site (Sta. 11+200 to 11+375) consisted of a clayey silt, trace gravel fill which varied in thickness as Highway 10 sloped down towards the north (BH 1 - 6.86 m, BH 2 - 4.19 m and BH 3 - 2.67 m). Underlying this fill was the native clayey silt, trace gravel, trace sand, till which contained random organics and particles of wood. This layer extended down to 13.0 m in the most southern borehole (BH 1) tapered off and was not found in the most northern borehole (BH 3) organics were found at depths of 7 m (BH 1) and 8.4 m (BH 2). Underlying the above material was a non-cohesive heterogeneous mixture of silt, sand and gravel with interbedded layers of gravel encountered at greater depths. This deposit was found at depths ranging from 2.6 m to 13 m and extended down to the terminated length of the borehole.

The stratigraphy encountered at the second site (Sta. 13+700 to 13+800) consisted of 5.3 m to 1.90 m depth of the clayey silt (till), trace gravel, trace sand underlain by a non-cohesive heterogeneous mixture of silt, sand and gravel interbedded particularly to the south by sandy silt, trace clay layers. Organics were encountered at 2.5 m to 5.3 m. Near the terminated depths of the southern borehole (BH 4) and at depths of 8.4 m for the northern borehole (BH 6) a clayey silt till, trace sand, trace gravel was encountered down to the terminated depth of the investigation at this site.

Although the depth to the groundwater table varied significantly between boreholes, in general, it was found for the first site (Sta. 11+200 to 11+375) to slope down towards the north to an elevation approximately of the existing culvert north of the site. (from 11.7 m to 2 m) for the second site the water table height again was down to approximately the elevation of the existing culvert (8 m). It should be noted that the groundwater table is always subject

to seasonal fluctuations and is expected to rise during the spring 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 Log sheets given at the back of this report. Borehole locations shown on sketch, Drawing No. 1377901-A.

DISCUSSION AND RECOMMENDATIONS

The existing Highway 10 running north/south consists of 2 lane to 4 lane segments and is constructed with a series of fills and cuts. It is proposed to widen the existing Highway from 2 lanes to 4 lanes which will involve the lateral extension of the existing embankments where the road is adjacent to a valley. This investigation includes the proposed embankments between Sta. 11+200 to 11+375 and 13+700 to 13+800. Embankment fills are expected to be from 4 m to an approximate maximum height of up to 12 m. Fill heights will vary greatly due to the sloping nature of the sites.

It appears from the boreholes drilled during this investigation that except for traces of topsoil enclosures the existing embankment is constructed of fairly clean fill.

Design Considerations

For a foundation stability viewpoint, fills up to 8 m in height shall be constructed using a 2 H:1V slope or flatter, provided any surficial organic matter encountered within the base limits of the fill is excavated and replaced by suitable embankment fill material.

Fills of 8 m to 12 m in height shall be constructed using a 2H:1V slope, together with a 2 m wide mid-height berm. The design of embankments as discussed above would have an adequate factor of safety from internal stability considerations.

The fill material should consist of well compacted acceptable material. Drainage and erosion protection of the slope should be carried out according to OPSS Standards.

It is anticipated that approximately 40 mm to 120 mm of the total settlement can be realized as a result of elastic settlements induced within the fill itself and the elastic recompression of the native subsoil. It is expected that the majority of these settlements will be realized during or immediately following construction.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of M. Michalek and J. Blair, Project Foundation Engineers and P. Thase, Studend Engineer utilizing equipment owned and operated by Malones Soil Samples.

The project was carried out by M. Michalek under the general supervision of B. Iyer, Senior Foundation Engineer. The report was written by M. Michalek reviewed and approved by B. Iyer.

M. Michalek, P.Eng.
Junior Foundation Engineer

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 $\tilde{N}$.

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_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_p	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_p	%	PLASTICITY INDEX = $w_L - w_p$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE
e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

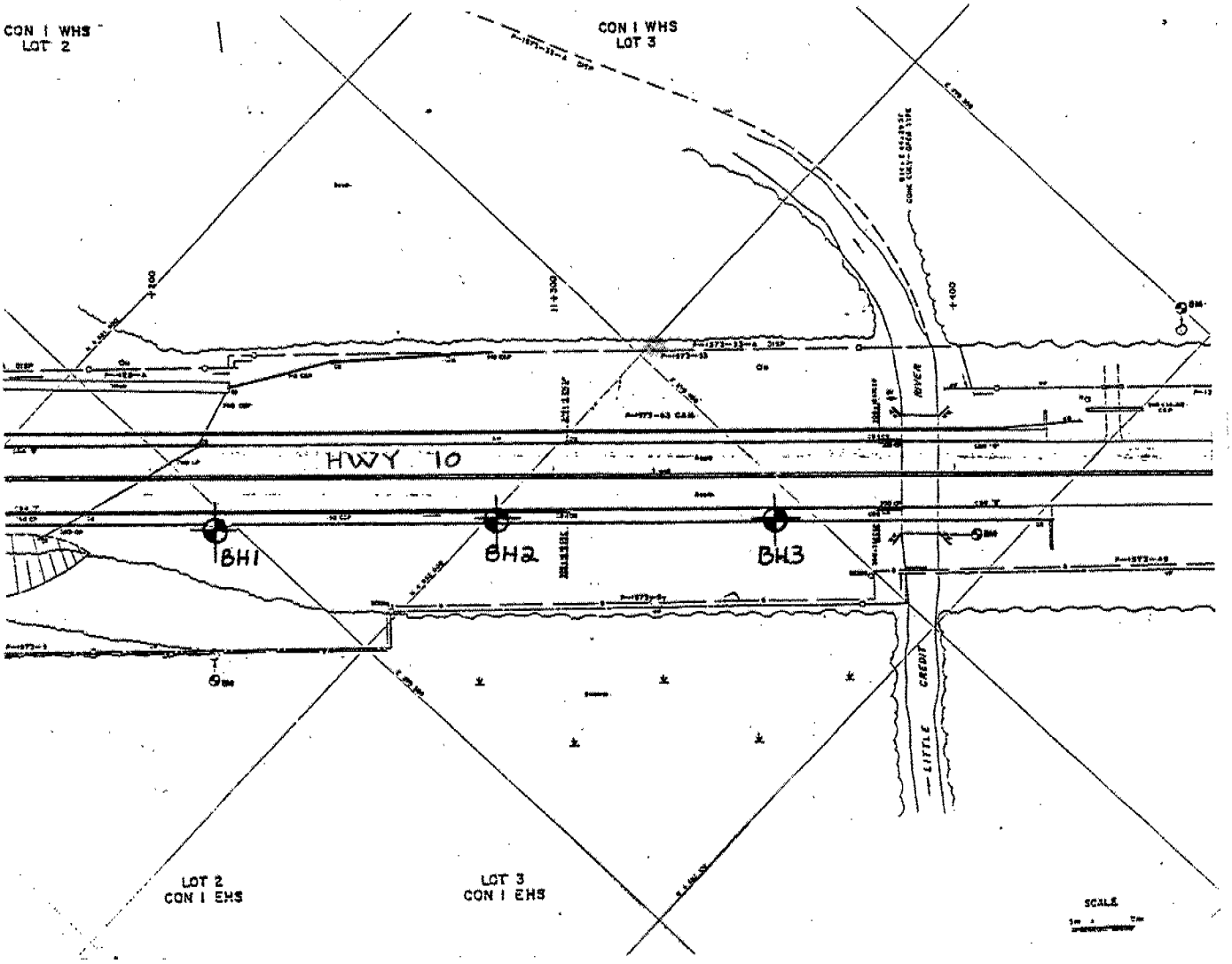
Table I
Borehole Logs

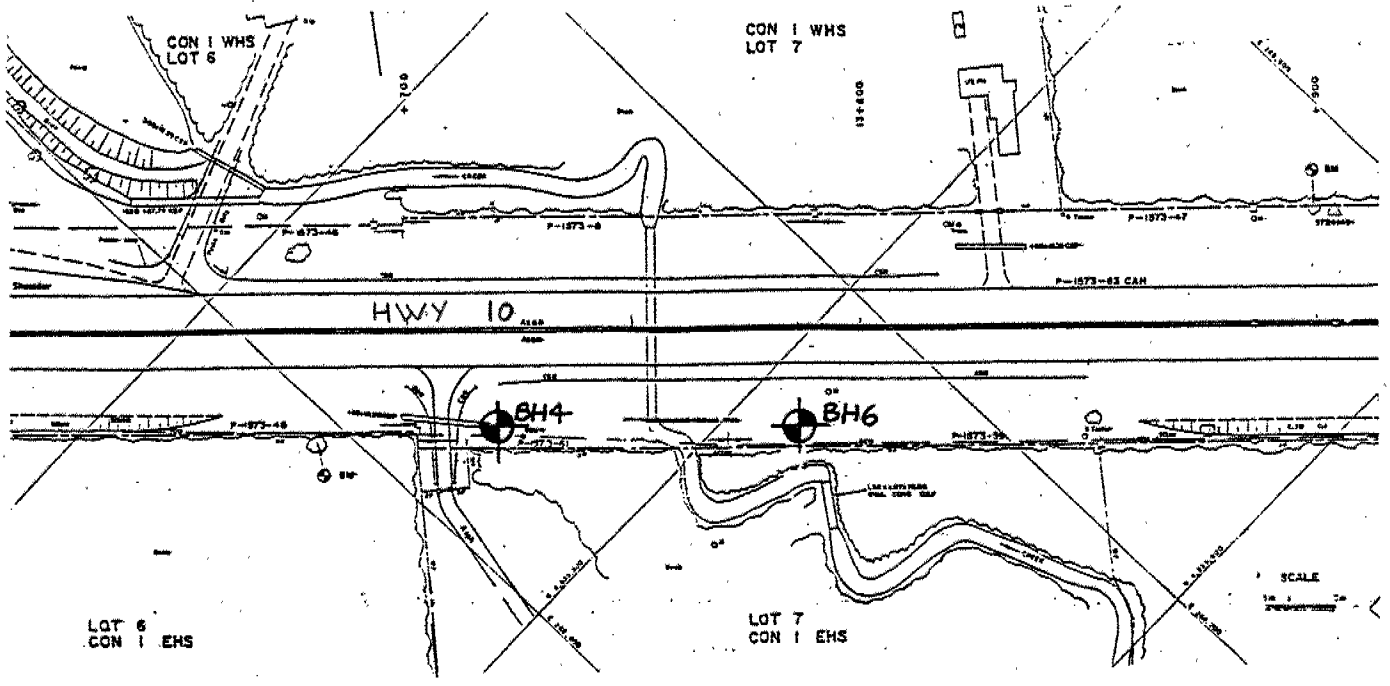
Borehole No.	Depth From	Depth To	Elevation From	Elevation To	Soil Description	Blows 'N'	Groundwater Table (m)
1	0	6.86	279.91	273.05	Clayey Silt (Fill) Trace Gravel, Stiff Brown	12,13,21, 8,18,14,10	11.7
Sta. 11+216 O/S 13.0 RT Coor: N 4,851,952 E 270,505	6.86	10.29	273.05	269.62	Clayey Silt, trace Gravel, trace Sand, Stiff (Till) trace Organics, pieces of wood	15,8,13	
	10.29	13.0	269.62	266.91	Clayey Silt (Till) trace Gravel, trace Sand, Grey - Firm	9,7	
	13.0	15.7	266.91	264.21	Silty Sand, interbedded Gravel - Compact trace Organics	22,63	
2	0	4.19	276.67	272.48	Clayey silt (Fill) trace Sand, trace Gravel, Brown - Stiff interbedded Sands and Silts	9,3,8,10,8	3.71
Sta. 11+286 11.0 RT O/S Coor: N 4,852,003 E 270,455	4.19	8.38	272.48	268.29	Clayey Silt (Till) trace Gravel, trace Sand, Organics interbedded Sands and Silts	14,21,5	
	8.38	15.7	268.29	260.97	Heterogeneous mixture of Silt, Sand and Gravel - Very Dense - Dense	20,22,40, 50,40	
3	0	2.67	273.5	270.83	Clayey silt, Brown, trace Gravel - Stiff (Fill)	8,19,13	2
Sta. 11+355 12.0 RT O/S Coor: N 4,852,764 E 270,407	2.67	12.65	270.83	260.85	Heterogeneous mixture of Silt, Sand and Gravel trace Clay interbedded Gravel Loose to Dense	47,8,21,11 8,28,40,25	
4	0	1.90	283.25	281.35	Clayey Silt, (Fill) trace Gravel, trace Sand, Stiff, Brown	14,18	8
Sta. 13+720 22 RT O/S Coor: N 4,853,764 E 268,776	1.90	2.44	281.35	280.81	Sandy Silt, trace Clay, Brown (Fill)	19,7	
	2.44	6.89	280.81	276.36	Heterogeneous mixture of Silt, Sand and Gravel, trace/some Organics, Wood Chips - Very Loose		
	6.89	12.65	276.36	270.6	Sandy Silt, some Gravel, small pockets of Clayey Silt, Brown - Stiff to Very Dense	13,25,23, 14	

Table I .../cont'd
Borehole Logs

Borehole No.	Depth From	Depth To	Elevation From	Elevation To	Soil Description	Blows 'N'	Groundwater Table (m)
6 Sta. 13+786 O/S 22 RT Coor: N 4,853,814 E 268,736	0	5.33	283.38	278.05	Clayey Silt (Fill) Trace Gravel, trace Sand, Brown - Stiff to Very Stiff pockets of Sandy silt	18,13,11, 63,13,13	11.7
	5.33	8.38	278.05	275	Heterogeneous mixture of Silt, Sand and Gravel, trace Organics, trace Clay - Compact	15,19	
	8.38	15.7	275	267.68	Clayey Silt (Till), trace Gravel, trace Sand - Stiff to Very Stiff, Grey	16,23,25	

W.P. 137-79-01A


CON I WHS
LOT 2
CON I WHS
LOT 3
HWY 10
BH1
BH2
BH3
LITTLE CREDIT RIVER
LOT 2
CON I EHS
LOT 3
CON I EHS
SCALE


CON I WHS
LOT 6
CON I WHS
LOT 7
HWY 10
BH4
BH6
LOT 6
CON I EHS
LOT 7
CON I EHS
SCALE

memorandum

Ontario

To: G. Cautillo
Head, Geotechnical SECTION
2nd Floor, Atrium Tower

Date: 91/06/28

Att: K. Hadipour

Frm: Foundation Design Section
RM 315, Central Building

Re: Hwy 10, From Regional Road 9, Northerly to 5.1 km south of Hwy 24
WP 137-79-01
District 6, Toronto

A foundation investigation was carried out at the above site, between Stations 11+200 to 11+375 and 13+700 to 13+800. Based on an evaluation of the results of this investigation the following recommendations are provided for the road widening.

From a foundation stability viewpoint, fills up to 8m in height shall be constructed using a 2H to 1V slope or flatter, provided any surficial organic matter encountered within the base limits of the fill is excavated and replaced by suitable embankment fill material.

Fills of 8m to 12 m in height shall be constructed using a 2H to 1V slope, together with a 4 m wide mid-height berm.

The design of embankments as discussed above would have an adequate factor of safety from internal stability considerations.

We hope that the comments given in this memo are sufficient for your design needs. Please call us if you need further input from us on this project.

FOR:

Dr. B. Iyer, P. Eng.
Sr. Foundation Engineer

cc A. Shakyaver (Planning and Design Section)