

G.I.-30 SEPT. 1976

GEOCRES No. 30M15-45DIST. 7 REGION W.P. No. 59-75-04CONT. No. 80-55W. O. No. STR. SITE No. 21-158HWY. No. 401LOCATION Courtice Rd.No. of PAGES -OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.REMARKS:

site 38

ENGINEERING MATERIALS OFFICE  
SOIL MECHANICS SECTION

WP 59-75-01

DIST 7

HWY 401

STR SITE 21-158

CONT 80-55

Courtice Road Overpass

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# FOUNDATION INVESTIGATION REPORT

For

Courtice Road Overpass

W.P. 59-75-01, Site 21-158

Hwy. 401, District 7, Port Hope

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## INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above mentioned project during the period of February 17, 1978. The fieldwork consisted of two sampled boreholes advanced by means of a continuous flight auger machine equipped with solid and hollow stem augers. The boreholes ranged in depth from 20.5 to 26.0 feet below the ground surface.

## SITE DESCRIPTION AND GEOLOGY

The site is located approximately 5 miles east of Oshawa City on Hwy. 401 in the Regional Municipality of Durham. The area is located in the physiographical region known as Iroquois Plain. In this area the subsoil is a mosaic of till plains, drumlins and areas of silty lacustrine deposits.

The existing bridge which was designed in 1959 and constructed in 1961 under Contract 61-24, is a 127 foot wide 30'3" single span rigid frame structure. According to available information (D 4307-1, 2 & 3; W.P. 117-58) this overpass structure is supported on spread footings founded at elevation 301.5. The four corners of the structure are extended by about 30 feet long and 10 feet high curved retaining walls to retain the approach fills. The retaining walls are also founded on spread footings at elevation 301.5.

## SUBSURFACE CONDITIONS

Subsurface conditions at the site were found to be generally uniform. The original ground under about 18 inches of existing pavement is a glacial till composed of a heterogeneous mixture of silt and sand with some clay and gravel, generally slightly cohesive in character. The results of grain size distribution testing performed on representative samples from the overall glacial till deposit are shown in an envelope form on Figure 1 of the Appendix.

The physical properties of the glacial till as determined from laboratory testing are summarized as follows:

		<u>Range</u>
Liquid Limit	( $W_L$ ) %	13-14
Plastic Limit	( $W_p$ ) %	11-11.5
Moisture Content	( $W$ ) %	3.5-8
Plasticity Index	( $I_p$ ) %	1.5-2.5

The Standard Penetration Tests gave 'N' values in the range of 13 to over 100 blows per foot, generally increasing with depth. Based on these 'N' values the relative consistency of this deposit is stiff to hard, generally in the hard range. The lower boundary of the glacial till deposit was not established but was proven to a maximum thickness of 24.5 feet.

The boundaries between the various soil types are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, along with an estimated stratigraphical profile based on borehole data, is shown on Drawing 597501-A.

### Groundwater

The groundwater level conditions were observed by measuring in the open boreholes during and after the completion of the foundation investigation. The groundwater level was found to vary between elevation 305.0 to 303.5 which corresponds to 3 to 4.5 feet below the existing ground surface. The groundwater levels are shown on the Record of Borehole Sheets, as well as on Drawing No. 597501-A.

## DISCUSSION AND RECOMMENDATIONS

It is proposed to widen the existing single span overpass structure at the crossing of Hwy. 401 and Courtice Road, east of Oshawa, in order to accommodate a new eastbound ramp to Hwy. 401. This construction will require that the existing overpass structure be extended on the south side by about 9 feet at the southwest corner and about 5.5 feet at the southeast corner. The widening will be located in the area of the existing curved wingwalls which are supported on 8 foot wide spread footings at elevation 301.5. The subsoil at the site consists of compact to very dense glacial till deposit. In view of this we recommend that the existing 8 foot wide footings of the wingwalls should be utilized to accommodate the required widening of the two abutments at the south side. This means that no new construction will be required for the abutment footings. However, the redesigned wingwalls, if necessary, may have to be founded on spread footings within the parent glacial till stratum at or below elevation 301.5. Any reworked material or backfill material in the new wingwall footing base area should be subexcavated to the full depth and replaced with mass concrete. It is recommended that a construction joint should be provided between the new footing and the existing footing in order to articulate any possible differential movements. The new footings for the wingwalls may be designed using an allowable load of up to 3.0 t.s.f. During construction care should be exercised at all times to prevent any loss of ground beneath the existing footings. The footing pressure on the widened abutments should not exceed 3.0 t.s.f.

The rigid walls of the extended portion of the abutments should be designed using a coefficient of earth pressure at rest ( $K_0$ ) of 0.5 for the granular fill material placed behind the walls. In computing the lateral resistance of the footings an adhesion value of 2000 p.s.f. may be used between the rough concrete and undisturbed glacial till. In view of the nature of the subsoil no major dewatering problems are anticipated. Any minor surface runoff or groundwater seepage into the excavations could be handled by pumping from sumps. In order to relieve the buildup of excess hydrostatic pressure behind the abutment extensions suitable drainage measures should be provided. Backfill behind the wall should be carried out in accordance with current M.T.C. practices.

### Approach Embankments

The existing approach embankments are to be widened in a southerly direction about 5.5 feet at the southeast side and about 9.0 feet at the southwest side. No stability problems are anticipated provided:


1. Standard 2:1 side slopes are employed
2. The topsoil or any soft organic material along the existing banks be stripped and the new fill "keyed" into the existing slope in accordance with current M.T.C. practices.

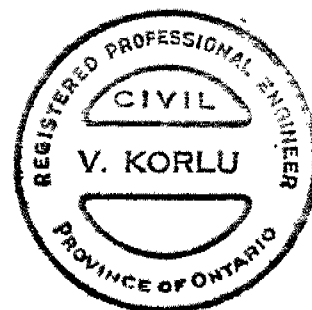
### MISCELLANEOUS

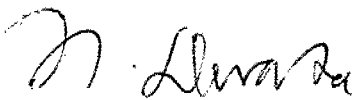
The fieldwork was carried out during February 17, 1978 under the supervision of Mr. V. Korlu, Project Engineer, who also prepared this report.

The drilling equipment was owned and operated by Master Soil Investigation Limited of Toronto.

This report was reviewed by Mr. M. Devata, Supervising Engineer.

  
V. Korlu, P. Eng.  
Project Engineer

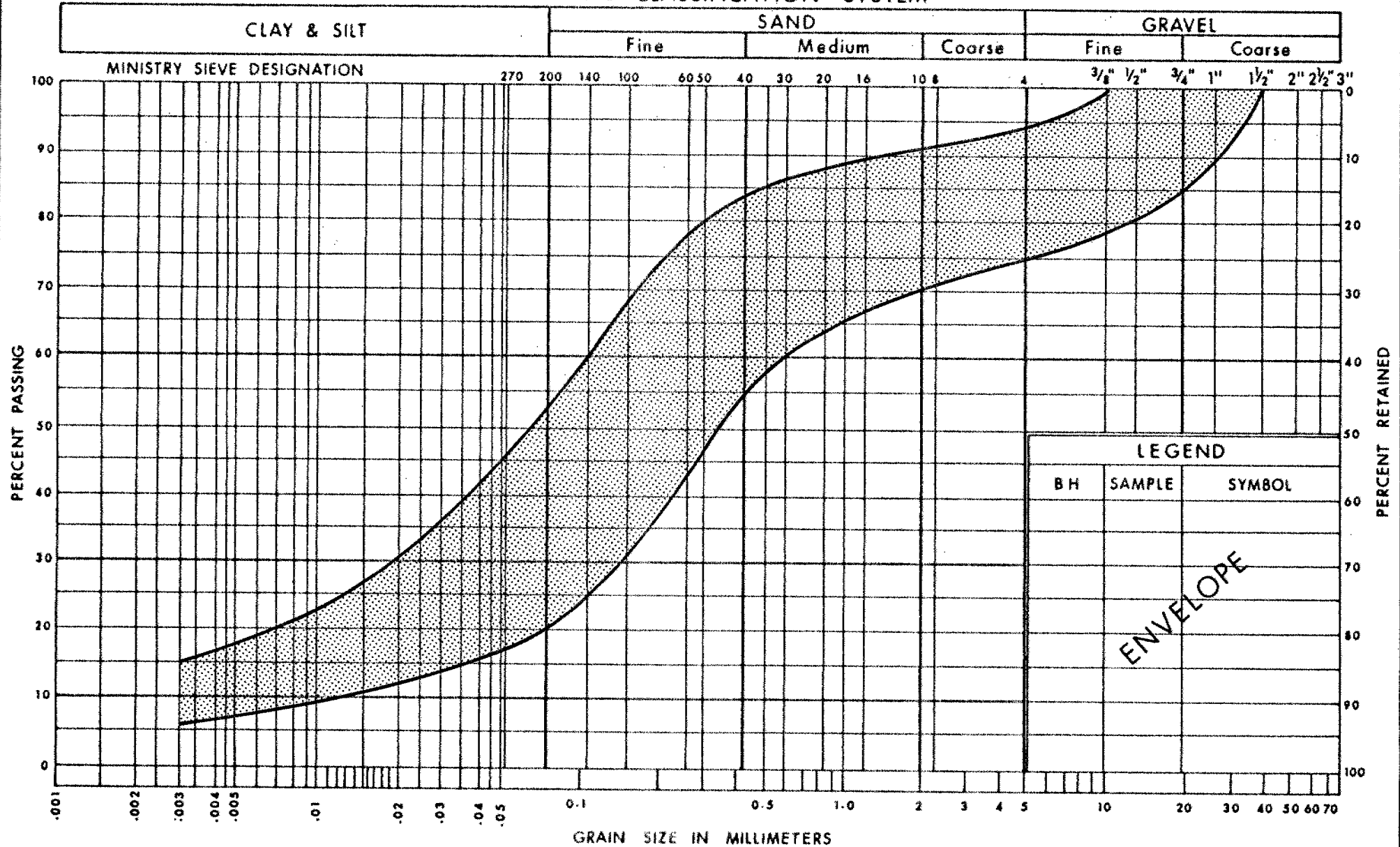


  
M. Devata, P. Eng.  
Supervising Engineer

May, 1978

## APPENDIX

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

 Ministry of  
Transportation and  
Communications

 GRAIN SIZE DISTRIBUTION  
GLACIAL TILL

HET MIXTURE OF SILT, SAND WITH SOME GRAVEL &amp; CLAY

FIG No 1

WP 59-75-01



## RECORD OF BOREHOLE No 1

W P 59-75-01 LOCATION Coords. N 15,944,512; E 1,194,158 ORIGINATED BY V.K.  
DIST 7 HWY 401 BOREHOLE TYPE 3 1/2 H.S. Auger COMPILED BY V.K.  
DATUM Geodetic DATE February 17, 1978 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH										WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	10						20	30	
308.0	Ground Level																			
0.0	(Fill)																			
1.5	Glacial Till Heterogeneous Mixture of Silt, Sand With Some Gravel and Clay		1	SS	39		W.L.	300						○			23 57 15 5			
			2	SS	25								○	I			26 33 32 9			
			3	SS	36															
			4	SS	18								○	I			43 28 20 9			
			5	SS	28															
			6	SS	52								○	I			12 20 52 16			
282.0			7	SS	135/11"															
26.0	End of Borehole																			

## RECORD OF BOREHOLE No 2

W P 59-75-01 LOCATION Coords. N 15,944,503; E 1,194,124 ORIGINATED BY V.K.  
DIST 7 HWY 401 BOREHOLE TYPE 3 1/2 H.S. Auger COMPILED BY V.K.  
DATUM Geodetic DATE February 17, 1978 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT Wp	NATURAL MOISTURE CONTENT W	LIQUID LIMIT Wl	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH					WATER CONTENT (%)					
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	x LAB VANE	10	20	30				
308.0	Ground Level																	
0.0	(Fill)																	
1.5	Glacial Till Heterogeneous Mixture of Silt, Sand With Some Gravel and Clay		1	SS	41	 W.L.  300  290							○	H			11 39 38 12	
			2	SS	108													6 42 40 12
			3	SS	13									○				
	Stiff to Hard		4	SS	40													
			5	SS	161									○				17 37 37 9
			6	SS	125/11"													
287.5																		
20.5	End of Borehole																	

# EXPLANATION OF TERMS USED IN REPORT

**'N' VALUE:** AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS  $N_c$ .

**DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3):** CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON "A" SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

**SOIL QUALITY:** SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

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

$S_u$ (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

**DENSENESS:** COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF SPT 'N' VALUES AS FOLLOWS:

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

**ROCK QUALITY:** 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 DRILLED IN THAT CORING RUN.

**MODIFIED RECOVERY:** SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), 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	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MED. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

## ABBREVIATIONS & SYMBOLS

### LABORATORY TESTING

TRIAXIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG.  $CUU$  = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

### FIELD SAMPLING

SS SPLIT SPOON  
WS WASH SAMPLE  
ST SLOTTED TUBE SAMPLE  
BS BLOCK SAMPLE  
CS CHUNK SAMPLE  
TW THINWALL OPEN  
TP THINWALL PISTON  
OS OSTERBERG SAMPLE  
FS FOIL SAMPLE  
RC ROCK CORE  
PH T.W. ADVANCED HYDRAULICALLY  
PM T.W. ADVANCED MANUALLY

### EARTH PRESSURE TERMS

$\mu$  COEFFICIENT OF FRICTION  
 $\delta$  ANGLE OF WALL FRICTION  
 $k_o$  COEFFICIENT OF EARTH PRESSURE AT REST  
 $k_a$  COEFFICIENT OF ACTIVE EARTH PRESSURE  
 $k_p$  COEFFICIENT OF PASSIVE EARTH PRESSURE  
 $i$  ANGLE OF INCLINATION OF SURCHARGE  
 $w$  SLOPE ANGLE-BACKFACE OF WALL  
 $\beta$  ANGLE OF SLOPE  
 $N_q, N_c$  BEARING CAPACITY FACTORS  
 $D_f$  DEPTH OF FOOTING  
 $B, L$  FOOTING DIMENSIONS

### INDEX PROPERTIES

$\gamma$  UNIT WEIGHT OF SOIL (BULK DENSITY)  
 $\gamma_w$  UNIT WEIGHT OF WATER  
 $\gamma_d$  UNIT DRY WEIGHT OF SOIL (DRY DENSITY)  
 $\gamma'$  UNIT WEIGHT OF SUBMERGED SOIL  
 $G_s$  SPECIFIC GRAVITY OF SOLIDS  
 $e$  VOIDS RATIO  
 $e_o$  INITIAL VOIDS RATIO  
 $e_{max}$   $e$  IN LOOSEST STATE  
 $e_{min}$   $e$  IN DENSEST STATE  
 $D_r$  RELATIVE DENSITY =  $\frac{e_{max} - e}{e_{max} - e_{min}}$   
 $n$  POROSITY  
 $w$  WATER CONTENT  
 $w_L$  LIQUID LIMIT  
 $w_p$  PLASTIC LIMIT  
 $w_s$  SHRINKAGE LIMIT  
 $I_p$  PLASTICITY INDEX =  $w_L - w_p$   
 $L_L$  LIQUIDITY INDEX =  $\frac{w - w_p}{I_p}$   
 $I_c$  CONSISTENCY INDEX =  $\frac{w_L - w}{I_p}$   
 $A_c$  ACTIVITY =  $\frac{I_p \text{ of soil}}{I_p \text{ of } 2\mu m \text{ Soil Fraction}}$   
 $Om$  ORGANIC MATTER CONTENT  
 $S_r$  DEGREE OF SATURATION  
 $S$  SENSITIVITY =  $\frac{S_o \text{ (undisturbed)}}{S_o \text{ (remoulded)}}$

### STRENGTH PARAMETERS

$\phi$  ANGLE OF SHEARING RESISTANCE  
 $\tau_f$  PEAK SHEAR STRENGTH  
 $\tau_R$  RESIDUAL SHEAR STRENGTH  
 $c$  COHESION INTERCEPT  
 $\sigma_1, \sigma_2, \sigma_3$  NORMAL PRINCIPAL STRESSES  
 $u$  PORE WATER PRESSURE  
 $u_e$  EXCESS  $u$   
 $r_u$  PORE PRESSURE RATIO  
 $q_u$  UNCONFINED COMPRESSIVE STRENGTH  
 $s_u$  UNDRAINED SHEAR STRENGTH  
 $\epsilon$  LINEAR STRAIN  
 $\gamma$  SHEAR STRAIN  
 $\nu$  POISSON'S RATIO  
 $E$  MODULUS OF ELASTICITY  
 $G$  MODULUS OF SHEAR DEFORMATION  
 $k_s$  MODULUS OF SUBGRADE REACTION  
 $m, n$  STABILITY COEFFICIENTS  
 $A, B$  PORE PRESSURE COEFFICIENTS

### HYDRAULIC TERMS

$h$  HYDRAULIC HEAD OR POTENTIAL  
 $q$  RATE OF DISCHARGE  
 $v$  VELOCITY OF FLOW  
 $i$  HYDRAULIC GRADIENT  
 $j$  SEEPAGE FORCE PER UNIT VOLUME  
 $\eta$  COEFFICIENT OF VISCOSITY  
 $k$  COEFFICIENT OF HYDRAULIC CONDUCTIVITY  
 $k_h$   $k$  IN HORIZONTAL DIRECTION  
 $k_v$   $k$  IN VERTICAL DIRECTION  
 $m_v$  COEFFICIENT OF VOLUME CHANGE  
 $c_v$  COEFFICIENT OF CONSOLIDATION  
 $C_c$  COMPRESSION INDEX  
 $C_r$  RECOMPRESSION INDEX  
 $d$  DRAINAGE PATH DISTANCE  
 $T_v$  TIME FACTOR  
 $U$  DEGREE OF CONSOLIDATION  
 $O_c$  OVERCONSOLIDATION RATIO (OCR)

**NOTE:** EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:  
 $\phi'$  = EFFECTIVE ANGLE OF SHEARING RESISTANCE;  
 $\sigma'$  = EFFECTIVE NORMAL STRESS

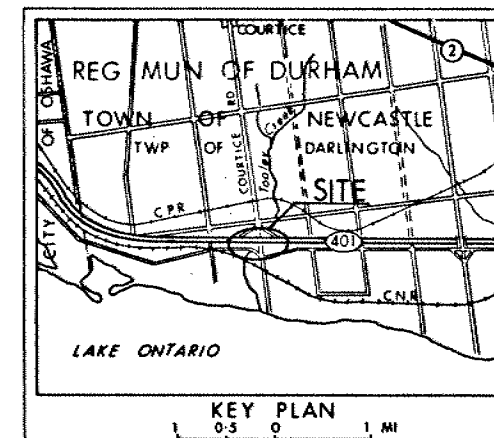
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COURTICE ROAD OVERPASS

BORE HOLE LOCATIONS & SOIL STRATA



SHEET



# LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊙ Bore Hole & Cone
- 'N' Blows/ft (Std Pen Test 350ft lbs energy)
- CONE Blows/ft (60° Cone, 350ft lbs energy)
- ↓ W.L. at time of investigation FEB 1978

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	308.0	15 944 512	1 194 158
2	308.0	15 944 503	1 194 124

## -NOTE-

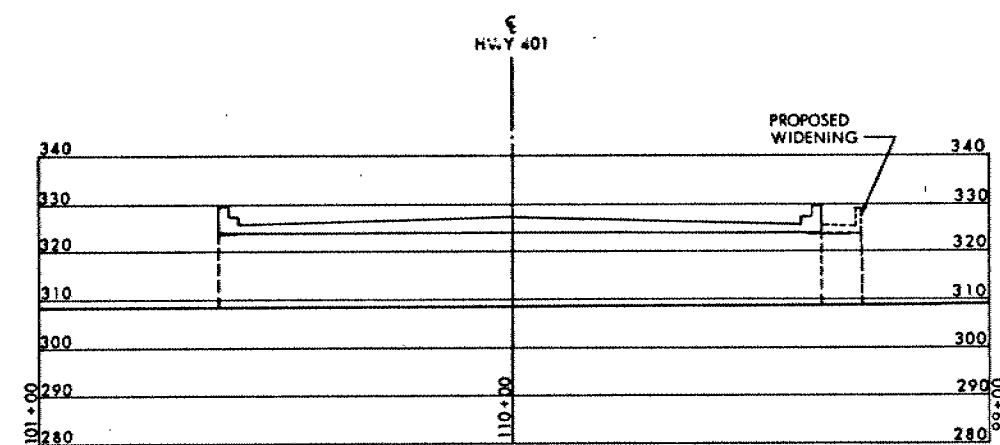
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

Geocres No 30M15-45

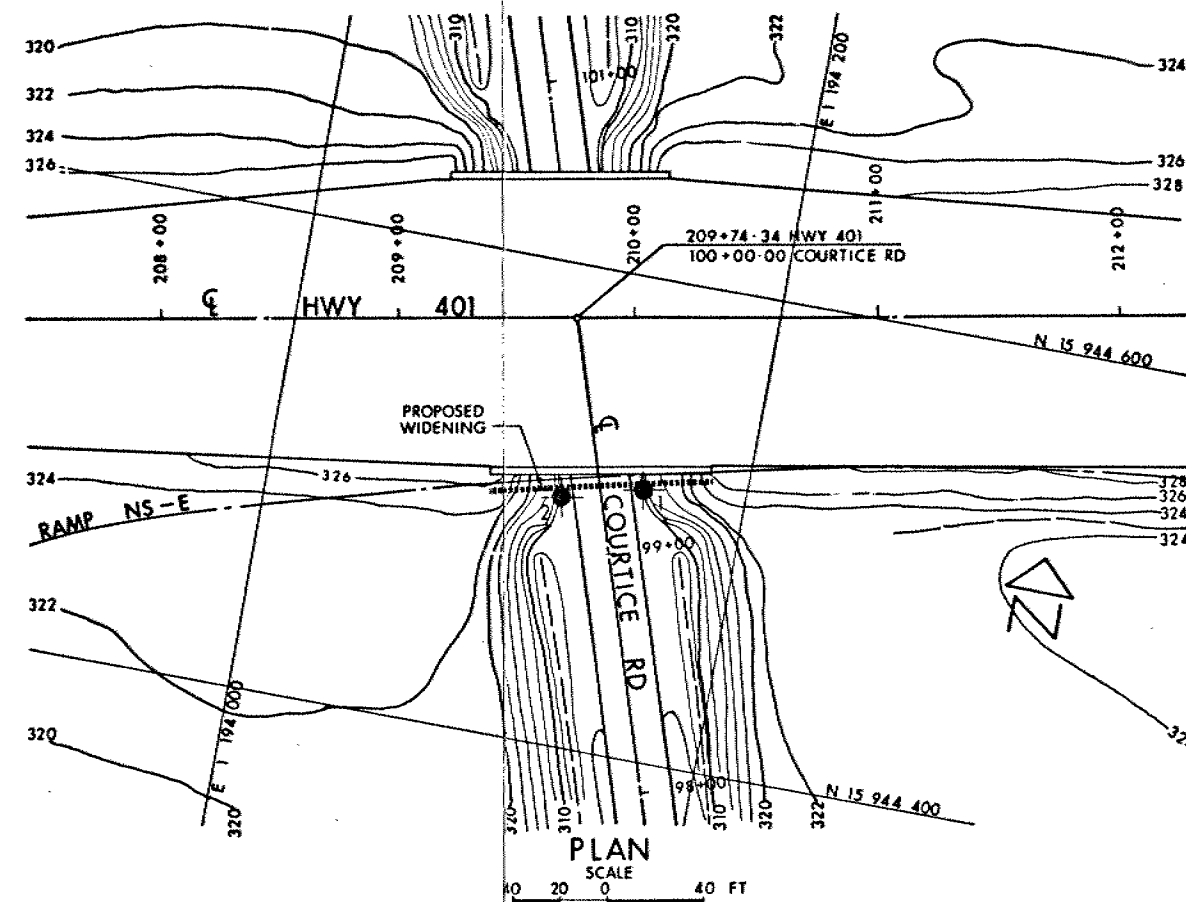
HWY No 401  
SUBMITTAL CHECKED DATE 78 05 31 SITE 21-158  
DRAWN BY J. CHELSEA DATE 78 05 31 DWG 597501-A

REF No B-5-44; April 1973



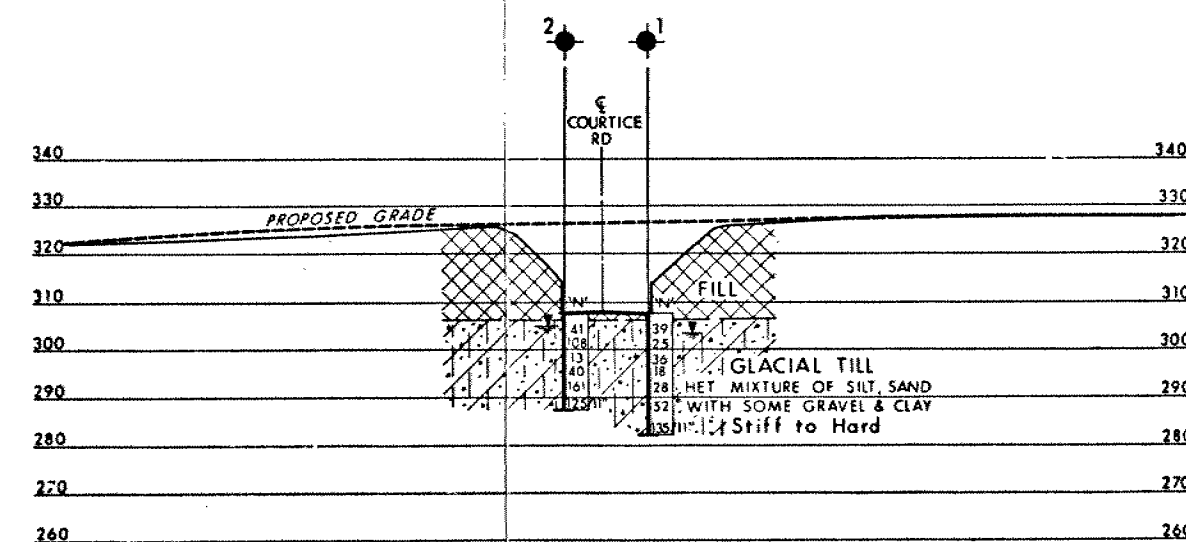
PROFILE COURTICE RD

SCALE  
20 10 0 20 FT



PLAN

SCALE  
0 20 40 FT



PROFILE RAMP NS-E

SCALE  
HOR 20 10 0 20 FT  
VERT 20 10 0 20 FT

