

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 476-89-02

DIST 2

HWY 401

STR SITE 19-367

Dingman Creek Culvert

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FOUNDATION INVESTIGATION REPORT

For

Dingman Creek Culvert

W.P. 476-89-02, Site 19-367

Highway 401, District 2, London

INTRODUCTION

This report contains the results of a foundation investigation carried out at the above mentioned site. The field work was carried out on 1993 02 10 and 11, and comprised of two sampled boreholes and Dynamic Cone Penetration Test adjacent to these holes. However, the boring for the existing culvert was advanced on 1955 06 22.

Boreholes were advanced to a maximum depth of 14.2 m (El. 241.3) below the existing ground level using 82 mm I.D. continuous flight hollow stem auger.

SITE DESCRIPTION

The site under investigation is located about 1.5 km west of Highway 401 and Wellington Road in the City of London, County of Middlesex.

The topography of the surrounding area, with the exception of the existing crossing of Hwy. 401 & Dingman Drive (fill) is generally flat to gently undulating. The creek was diverted to the present location as well as the site was modified to the present condition by the construction of the existing culvert. Physiographically, the area is located in the region known as the "Mount Elgin Ridges".

SUBSURFACE CONDITIONS

The underlying subsoil at this site consists of very stiff to stiff clayey silt to the full extent of the depth probed. Sandy fill was encountered near the

existing wing wall. For classification purposes, the soils encountered at this site can be divided into two different zones.

- a) Silty Sand, Some Gravel (fill)
- b) Clayey Silt

The soils encountered during the course of the investigation, together with the field and laboratory test results are shown on the Record of Borehole Sheets contained in the Appendix of this report. A stratigraphical section is shown on Drawing No. 4768902-A. This drawing also shows the locations and elevations of the borings. Description of the strata encountered are given below.

The Record of Borehole Sheet as well as the information obtained from the site investigation carried out for the existing culvert is included in the Appendix of this report.

Silty Sand, Some Gravel (Fill)

This silty sand fill was encountered only in one borehole located near the wing wall on upstream side. The thickness of the fill is about 1.8 m and extends to elevation 253.7. The Standard Penetration Test results indicate that this fill is in loose state of denseness (N-value 4 blows/0.3m).

Clayey Silt

The clayey silt which was encountered immediately below ground level extends to the depth probed (ie. El. 241.3). The full extent of this deposit was not proven. The results of the Atterberg Limit Tests carried out on representative soil samples are shown on Figure 1. The natural moisture content of this deposit varies from 15.3% to 28.5% with an average value of 19.4%. The in-situ Vane Shear Test carried out at various depths indicated shear strength in excess of 90 kPa indicating very stiff to stiff consistency. However, the Standard Penetration Test Values were observed to vary from 7 blows/0.3 m to 22 blows/0.3 m.

Groundwater Conditions

The groundwater level measurements were taken in open boreholes during investigation and was observed only in borehole #2 at or near the creek level (EL. 254.7). Seasonal fluctuation of the groundwater level may be expected. The groundwater level at each borehole location is as follows.

<u>Borehole No:</u>	<u>Elevation</u>	<u>Remarks</u>
1		not observed
2	254.7	
101		not observed

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to widen the existing culvert at the crossing of Highway 401 and Dingman Creek to accommodate the widening of Highway 401 to six lanes.

The existing structure is a box type culvert consisting of three 6.0 X 4.7 m cells. The profile grade of the road is set at elevation 258.5. The wing walls as well as the vertical walls of the culvert appear in very good condition. However, about 3 to 4 mm wide crack running to the full width of the culvert roof slab have been noticed.

It appears from the structural drawing of the existing culvert that it is placed at about elevation 253.1 and the wing walls are supported on spread footing.

Structure Foundation

Considering the subsoil conditions at the site, it is recommended that the culvert and associated wing walls for the widening be supported on spread footings placed at about El. 253.1 to match the elevation of the existing footings.

For the purpose of the O.H.B.D.C., the following bearing capacity values are recommended.

Factored Bearing Capacity at U.L.S. =	300 kPa
Bearing Capacity at S.L.S. Type II =	200 kPa

Earth pressure should be computed as per Section 6.6.1.2.2 of the O.H.B.D.C. and "at rest" condition may be assumed for the calculation of earth pressure on

culvert. The Granular "A" or "B" backfill should be in accordance with the Special Provision No. 109F03. The following parameters are recommended for the granular backfill.

	<u>Granular "A"</u>	<u>Granular "B"</u>
Angle of Internal Friction	$\phi = 35^\circ$	$\phi = 30^\circ$
Unit Weight (kN/m^3)	$\gamma = 22.8$	$\gamma = 21.2$

The footings should have a minimum of 1.2 m earth cover to protect against the frost penetration.

Other Considerations

The backfill operations should be carried out simultaneously on both sides of the culvert. Compaction of the backfill should adhere to the Ministry Directive B-131.

In view of the impervious nature of the subsurface at the founding level, no major dewatering problems are anticipated during construction. Any minor seepage or surface run-off into the excavation may be readily handled by pumping from the sump. Care shall be exercised during construction to prevent any flow of water from the creek into the excavation. The base of the excavation at the founding level should be covered with a 150 mm thick lean concrete pad within 8 hours of exposure.

Considering the height of fill (0.7 m) above the culvert, no major settlement problems are anticipated. However, it will be advisable to provide an "Isolation" or "Separation" joint between the new and the old structure to accommodate any differential movement.

MISCELLANEOUS

The field work for this investigation was carried out under the supervision of M. Vasavithasan. The equipment used was owned and operated by London Soil Test. This report was prepared by M. Vasavithasan, reviewed by Mr. P. Payer, Senior Foundation Engineer and approved by Mr. M. Devata, Chief Foundation Engineer.



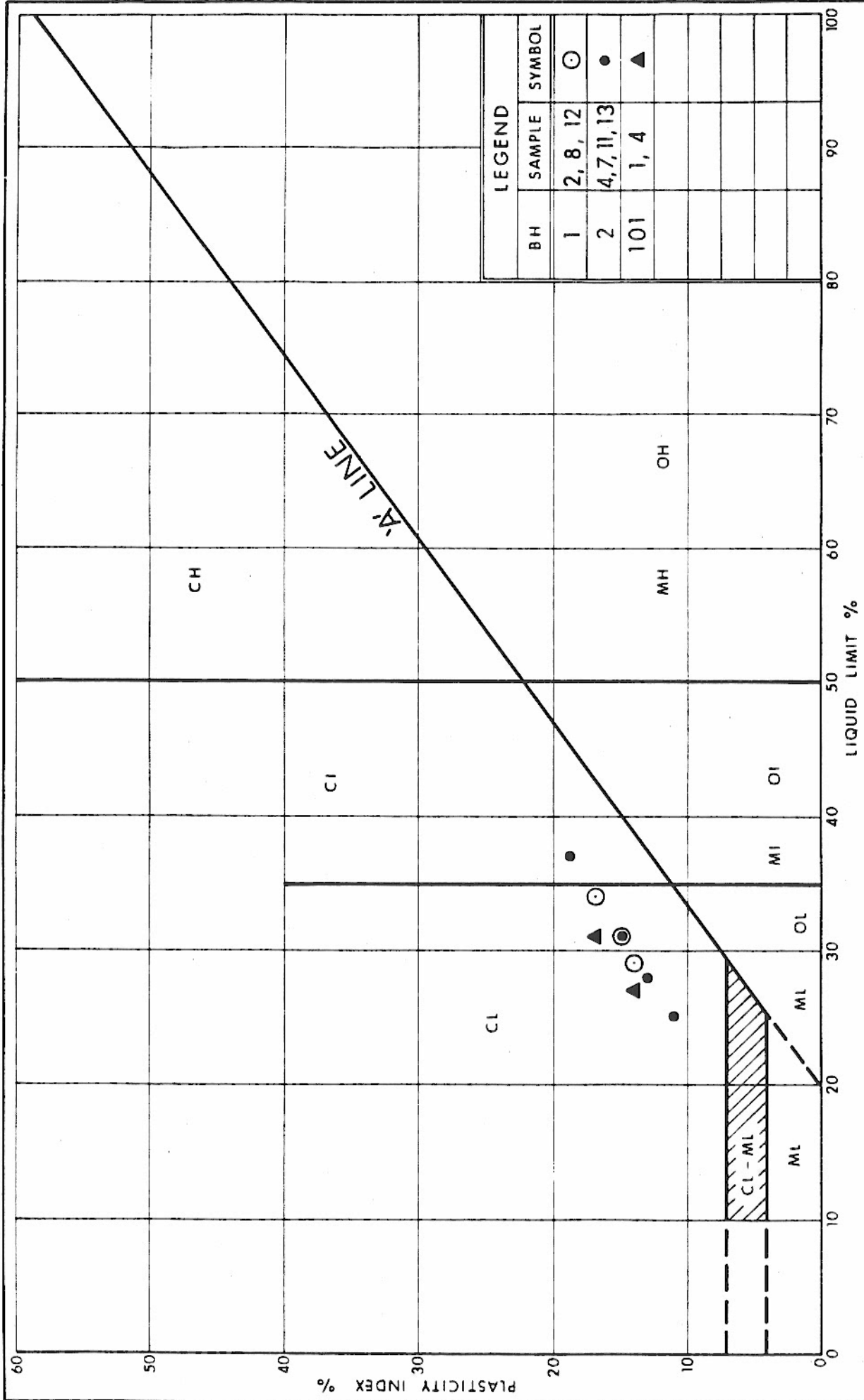
M. Vasavithasan

M. Vasavithasan, P. Eng.
Foundation Engineer

M. Devata

M. Devata, P. Eng.
Chief Foundation Engineer

APPENDIX



PLASTICITY CHART
CLAYEY SILT

FIG No 1

W P 476 -89 -02

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 (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	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_f	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_f}$

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						

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 476 - 89 - 02

LOCATION

Co-ords: N 4 753 056.0; E 408 888.6

ORIGINATED BY M V

DIST 2 HWY 401

BOREHOLE TYPE

CONTINUOUS FLIGHT HOLLOW STEM AUGER & CONE TEST

COMPILED BY M V

DATUM GEODETIC

DATE

93 02 10

CHECKED BY P P

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 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
255.8	Ground Surface													
0.0														
	Trace of Sand		1	SS	7									
			2	SS	22									
			3	SS	19									
			4	SS	15									
			5	SS	16									
			6	SS	14									
			7	SS	15									
	CLAYEY SILT, Very Stiff to Stiff		8	SS	11									
			9	SS	11									
			10	SS	13									
			11	SS	13									
			12	SS	20									
241.6	End of Borehole													
14.2	Note: Water Level Not Observed													

RECORD OF BOREHOLE No 2

1 OF 1 METRIC

W.P. 476 - 89 - 02 LOCATION Co-ords: N 4 753 062.0; E 408 960.0 ORIGINATED BY M V
 DIST 2 HWY 401 BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGER & CONE TEST COMPILED BY M V
 DATUM GEODETIC DATE 93 02 11 CHECKED BY P P

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 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
255.5	Ground Surface													
0.0	Trace of Organics													
	SILTY SAND, Some Gravel, Loose, (Fill)		1	SS	4		255							
253.7			2	SS	4		254							
1.8	Trace of Organics		3	SS	15		253							
			4	SS	17		252							
			5	SS	11		251							
			6	SS	15		250							
			7	SS	12		249							
			8	SS	14		248							
	CLAYEY SILT, Very Stiff to Stiff		9	SS	14		247							
			10	SS	14		246							
			11	SS	12		245							
			12	SS	17		244							
			13	SS	14		243							
			14	SS	20		242							
241.3														
14.2	End of Borehole													

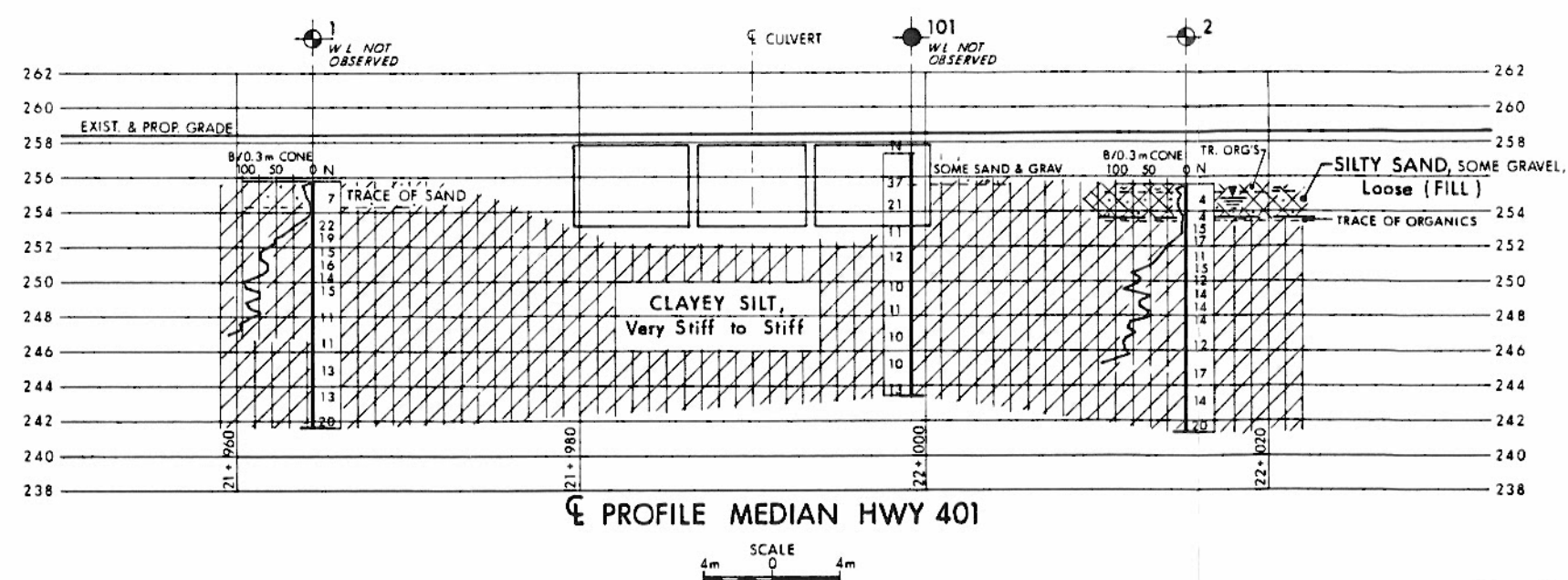
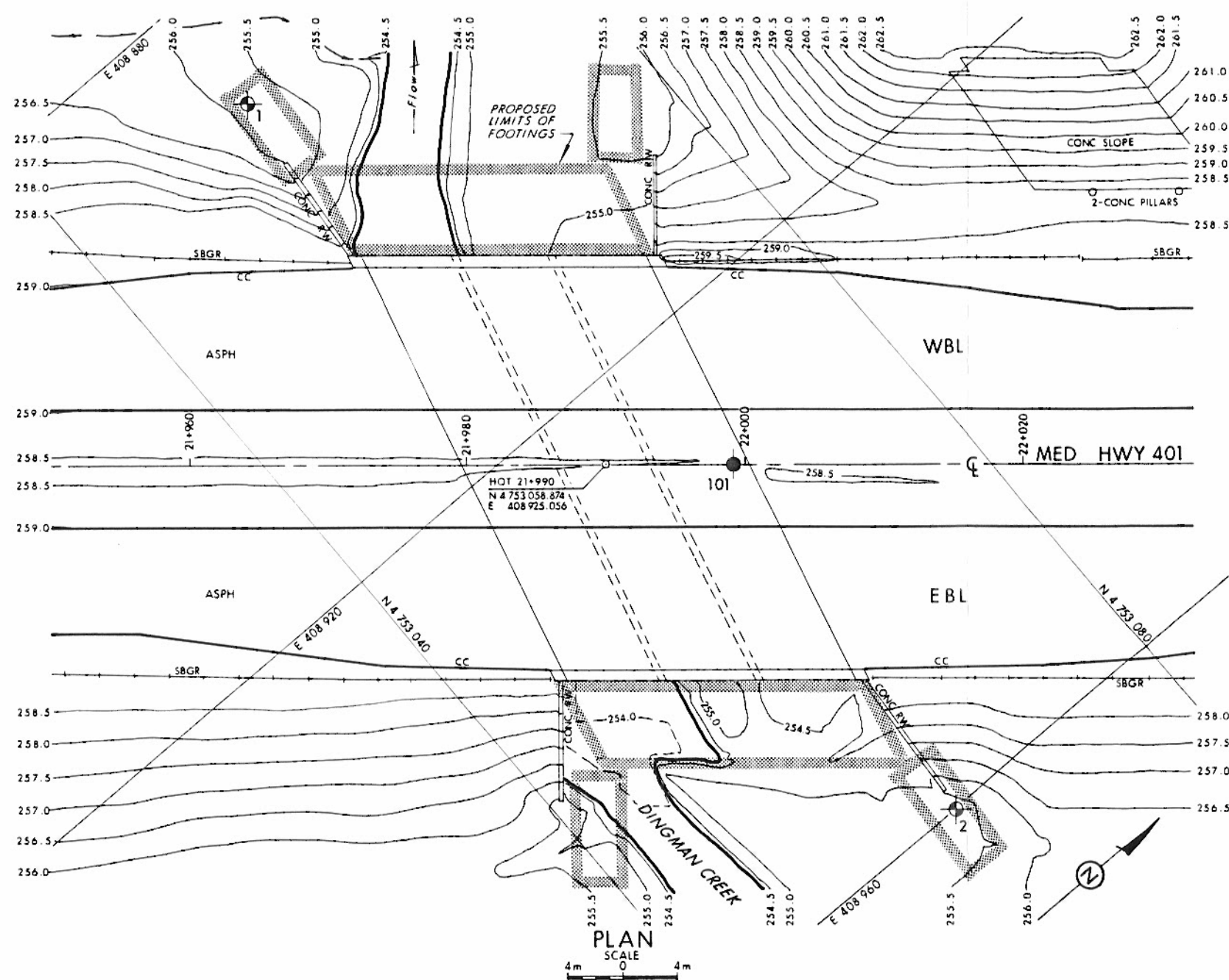
RECORD OF BOREHOLE No 101

1 OF 1

METRIC

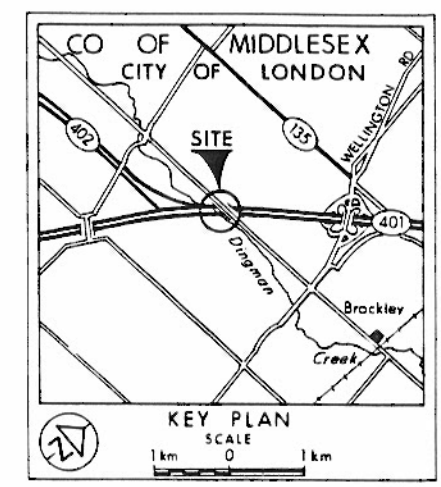
W.P. 475 - 89 - 02 LOCATION Co-ords: N 4 753 065.9; E 408 930.9 ORIGINATED BY R McCA
DIST 2 HWY 401 BOREHOLE TYPE WASHBORING COMPILED BY M V
DATUM GEODETIC DATE 55 06 22 CHECKED BY P P

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
257.3	Ground Surface													
0.0														
	Some Sand and Gravel		1	SS	37		256							
			2	SS	21		255							
			3	SS	11		254							
			4	SS	12		253							
	CLAYEY SILT, Very Stiff to Stiff		5	SS	10		252							
			6	SS	11		251							
			7	SS	10		250							
			8	SS	10		249							
			9	SS	13		248							
243.4							247							
13.9	End of Borehole						246							
	Note: Water Level Not Observed Formerly BH# 1 of 55 - F - 209C						245							
	R McCA: Racy MacCallum & Associates						244							



METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 476-89-02
DINGMAN CREEK CULVERT
(1.5 km West of Wellington Rd.)
BORE HOLE LOCATIONS & SOIL STRATA



LEGEND			
	Bore Hole		
	Dynamic Cone Penetration Test (Cone)		
	Bore Hole & Cone		
N	Blows/0.3m (Std Pen Test, 475 J/blow)		
CONE	Blows/0.3m (60° Cone, 475 J/blow)		
	W.L. at time of investigation		
	1955 06 and 1993 02		
No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	255.8	4 753 056.0	408 888.6
2	255.5	4 753 062.0	408 960.0
101	257.3	4 753 065.9	408 930.9

Formerly BH #1
55-F-209 C

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

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

REV	DATE	BY	DESCRIPTION
1			
Geocres No 40114-121			
HWY No 401			
SUBM'D MV	CHECKED	DATE 1993 03 29	SITE 19-367
DRAWN RS	CHECKED	DATE	DWG 4768902-A