



**PRELIMINARY FOUNDATION INVESTIGATION REPORT
for
HICKORY DRIVE EBL AND WBL OVERPASSES
HIGHWAY 402
MTO WEST REGION 59 STRUCTURE REHABILITATIONS
SITES 19-523-1 & 19-523-2, CONTRACT 3
GWP 3075-11-00
TOWNSHIP OF STRATHROY-CARADOC
MIDDLESEX COUNTY, ONTARIO**

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PRELIMINARY FOUNDATION INVESTIGATION REPORT

for
Hickory Drive EBL and WBL Overpasses
Highway 402
MTO West Region 59 Structure Rehabilitations
Sites 19-523-1 & 19-523-2, Contract 3
GWP 3075-11-00
Township of Strathroy-Caradoc
Middlesex County, Ontario

1. INTRODUCTION

This report summarizes the results of the foundation investigation carried out for the proposed rehabilitation of the Hickory Drive EBL and WBL Overpasses on Highway 402 in the Township of Strathroy-Caradoc, Middlesex County, Ontario. The proposed rehabilitation is a part of the assignment for the rehabilitation of 59 structures in MTO West Region along Highways 4, 6, 401, 402 and 403. The study was carried out by Peto MacCallum Ltd. (PML) for MMM Group Limited (MMM) on behalf of the Ministry of Transportation of Ontario (MTO).

A Technical Memorandum, dated January 21, 2015, was also prepared as a part of this assignment and is presented in Appendix 1. The purpose of the Technical Memorandum was to summarize the subsurface and groundwater conditions based on available Geocres reports for the design project terms of reference and to update the foundation design recommendations provided in the available reports to the Limit State design terminology in conformance with the requirements of the Canadian Highway Bridge Design Code (CHBDC).

The purpose of this report was to summarize the subsurface stratigraphy encountered at the proposed structure site during the present preliminary investigation to supplement geotechnical data for the design of temporary roadway protection.

For subsurface conditions from previous foundation investigations reference should be made to the Technical Memorandum. The present Foundation Investigation and Design Report should be read in conjunction with the Technical Memorandum.

The elevations in this report are expressed in meters.



2. SITE BACKGROUND AND GEOLOGY

The Hickory Drive EBL and WBL Overpasses on Highway 402 are located in Middlesex County, Ontario. Strathroy lies 4.9 km southwest of the overpass location.

The area of the site is relatively flat and gently sloping toward the southeast. Physiographically, the site is situated in the region known as the Caradoc Sand Plains. Sand and other light textured water laid deposits are characteristic of this region. The limestone, dolostone or shale bedrock in the area belongs to Hamilton Group of Middle Devonian period.

In the previous investigation report (GEOCRES No. 40I13-46, dated April 6, 1976), the subsurface conditions encountered generally included firm to very stiff silty clay deposit underlain by loose to very dense sandy silt to silty sand soils, which in turn overlain stiff to hard clayey silt layer.

3. FIELD INVESTIGATION

A total of two boreholes, HD-1 and HD-2, were drilled on July 9, 2014 at the site location. The boreholes were selected by PML and the survey of the boreholes was conducted by MMM. The boreholes locations are shown in Drawing HD-1.

The two boreholes were drilled through the soil cover to 12.8 m. The boreholes were advanced using continuous flight solid augers powered by a track mounted CME 55 drill rig, supplied and operated by a specialist drilling contractor. The drilling crew worked under the full-time supervision of a member of our engineering staff.

Representative samples of the soils encountered in the boreholes were recovered at frequent depth intervals. In the boreholes advanced with conventional drill rigs, soil samples were obtained using a split spoon sampler in conjunction with standard penetration tests. Where standard penetration tests were not carried out the consistency/compactness of the encountered soils was estimated from manual examination or the rate (ease) of advance of the augers.



The boreholes were backfilled in accordance with the MTO guidelines and MOE regulation 903 for borehole abandonment procedures using a bentonite/cement mixture grout and asphalt patch.

The groundwater conditions at the borehole locations were assessed during drilling by visual examination of the soil, the sampler and drill rods as the samples were retrieved and, when appropriate, by measurement of the water level in the open boreholes.

Soils were identified in the field in accordance with the MTO Soil Classification procedures. Recovered soil samples were returned to our laboratory for detailed visual examination and soil classification. The laboratory test program for the current subsurface investigation comprised the following tests:

- Natural moisture content determinations (19)
- Grain size analyses (6)
- Atterberg limits (2)

The results of the laboratory natural moisture content determinations and grain size analyses are shown on the Record of Borehole sheets HD-1 and HD-2. The grain size distribution charts are presented on Figures HD-GS-1 to HD-GS-4 and the plasticity charts are presented in Figures HD-PC-1 and HD-PC-2.

4. SUBSURFACE CONDITIONS

Reference is made to the appended Record of Boreholes HD-1 and HD-2 sheets for details of the subsurface conditions including soil classifications, inferred stratigraphy, standard penetration test N values, grain size distribution and groundwater observations. The boundaries between soil strata have been established at the borehole locations only. Between and beyond the boreholes, the boundaries are assumed and may vary.

In summary, the subsurface encountered in the two boreholes included 0.9 and 2.5 m fill overlying stiff to very stiff 3.6 m thick clayey silt layer (borehole HD-2) and compact to very dense sand and silt/silt and sand, and sand deposits. Bedrock was not encountered in the two boreholes. The two boreholes were terminated at 12.8 m.



4.1 Fill

Surficial fill was encountered in the two boreholes and extended to 0.9 and 2.5 m, elevation 238.2 and 236.2. The fill included sandy silt, clayey silt and silty clay with organic and rootlets inclusions. N values recorded in the fill units ranged between 3 and 23.

Grain size distribution chart of a silty clay fill sample is presented in Figure HD-GS-1 and the corresponding plasticity chart is presented in Figure HD-PC-1. The liquid and plastic limits determined were 42 and 21. The plasticity index value was 21. Moisture content determinations of the fill samples ranged between 19 and 21%.

4.2 Clayey Silt

A stiff to very stiff clayey silt layer was encountered below the fill layer in borehole HD-2 at 0.9 m, elevation 238.2 and extended to 4.5 m, elevation 234.6. N values recorded were between 11 and 24.

A grain size distribution chart of a selected clayey silt sample is presented in Figure HD-GS-2 and the corresponding plasticity chart is presented in Figure HD-PC-2. The liquid and plastic limits obtained were 35 and 17. The plasticity index value was 18. Moisture content determinations of the clayey silt samples were between 21 and 22%.

4.3 Silt and Sand / Sand and Silt

A silt and sand / sand and silt deposit of varying compactness (compact to very dense) was encountered below the fill layer in borehole HD-1 at 2.5 m, elevation 236.2 and below the clayey silt layer in borehole HD-2 at 4.5 m, elevation 234.6. The silt and sand layer in borehole HD-1 extended to 7.5 m, elevation 231.2 and in borehole HD-2, the sand and silt layer extended to the borehole termination depth of 12.8 m, elevation 226.3. N values recorded ranged from 12 to 64.



Grain size distribution results of selected samples are presented in Figure HD-GS-3. Moisture content determinations ranged between 6 and 20%.

4.4 Sand

A compact to very dense sand deposit was encountered below the silt and sand layer in borehole HD-1 at 7.5 m, elevation 231.2. The borehole was terminated in the sand deposit at 12.8 m, elevation 225.9. N values ranged between 23 blows for 305 mm penetration and 72 blows for 250 mm penetration.

A grain size distribution result of a selected sand sample is presented in Figure HD-GS-4. Moisture content determinations ranged from 5 to 20%.

4.5 Groundwater

Groundwater was encountered in borehole HD-1 at 9.1 m, elevation 229.6 and in borehole HD-2 at 9.2 m, elevation 229.9, during augering. Upon completion of augering, groundwater was encountered in borehole HD-1 at 8.2 m, elevation 230.5 and in borehole HD-2 at 10.0 m, 229.1.

It should be noted that the groundwater level is subjected to fluctuations due to seasonal and rainfall patterns.

5. MISCELLANEOUS

Mr. S. Aziz carried out the field investigation for this study under the supervision of Mr. N. Rahman, P.Eng. Fisher Environmental Ltd. supplied the drilling equipment for the subsurface exploration. The laboratory testing of the selected samples was carried out in the PML laboratory in Toronto.



6. CLOSURE

This preliminary report was prepared by Mr. N. Rahman, P.Eng and was reviewed by Mr. R. Ng, PhD, P.Eng., Senior Project Engineer. Mr. B. R. Gray, MEng, P.Eng., MTO Designated Principal Contact conducted an independent review of the report.

Yours very truly,

Peto MacCallum Ltd.



Nazibur Rahman, P.Eng.
Project Engineer, Geotechnical Services



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Senior Project Engineer



Brian R. Gray, M.Eng, P.Eng.
MTO Designated Principal Contact

NR/RN/BRG.nr-mi-jk

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.

COMPOSITION: SECONDARY SOIL COMPONENTS ARE DESCRIBED ON THE BASIS OF PERCENTAGE BY MASS OF THE WHOLE SAMPLE AS FOLLOWS:

PERCENT BY MASS	0 - 10	10 - 20	20 - 30	30 - 40	> 40
	TRACE	SOME	WITH	ADJECTIVE (SILTY)	AND (AND SILT)

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:

R Q D (%)	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
F V FIELD VANE	

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
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'_{v0}	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_i	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

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

RECORD OF BOREHOLE No. HD-1

1 of 1

METRIC

G.W.P. 3075-11-00 **LOCATION** Co-ordinates 4 761 088.5 N; 379 775.9 E **ORIGINATED BY** S.A.
DIST London **HWY** 402 **BOREHOLE TYPE** Continuous Flight Solid Stem Augers **COMPILED BY** N.R.
DATUM Geodetic **DATE** July 09, 2014 **CHECKED BY** B.R.G.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100					
238.7	Ground Surface															
0.0	Sandy silt, with gravel rootlets and organic inclusions		1	SS	6											
238.1																
0.6	Loose Dark brown/ Moist clayey silt, rootlets organic inclusions		2	SS	23											
237.2																
1.5	Silty clay trace sand, trace gravel		3	SS	23											
	Very stiff Brown Moist to firm (FILL)															
236.2																
2.5	Silt and sand, trace clay wet seams		4	SS	6											
	Compact Brown Moist															
			5	SS	16											
	Brown/ grey		6	SS	21											
	Compact Grey to dense		7	SS	26											
231.2																
7.5	Sand trace to with silt trace clay		8	SS	55											
	Dense to Grey to Moist very dense brown/ to wet grey															
			9	SS	67											
	Compact to very dense		10	SS	23											
			11	SS	72/25cm											
225.9																
12.8	End of borehole															
* 2014 07 09 ▽ Water level observed during drilling ▼ Water level measured after drilling NOTE: Upon completion of augering, borehole caved in at 11.3m depth																

RECORD OF BOREHOLE No. HD-2

1 of 1

METRIC

G.W.P. 3075-11-00 **LOCATION** Co-ordinates 4 761 131.8 N; 379 732.1 E **ORIGINATED BY** S.A.
DIST London **HWY** 402 **BOREHOLE TYPE** Continuous Flight Solid Stem Augers **COMPILED BY** N.R.
DATUM Geodetic **DATE** July 09, 2014 **CHECKED BY** B.R.G.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa										WATER CONTENT (%)		
							20 40 60 80 100										20 40 60		
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
239.1	Ground Surface					239													
0.0	Sandy silt, some gravel rootlets and organic inclusions		1	SS	3														
238.2	Very loose Dark Moist brown/brown (FILL)		2	SS	11	238													
0.9	Clayey silt, trace sand																		
	Stiff to Brown Moist very stiff		3	SS	19	237													
			4	SS	24														
	oxidized partings		5	SS	22	236													
						235													
234.6	Sand and silt, trace clay		6	SS	27	234													
4.5	Compact Brown Moist to dense																		
			7	SS	40	233													
						232													
	Very dense Grey/ Moist to compact brown to wet to grey		8	SS	64	231													
						230													
			9	SS	26	229													
						228													
	Compact Brown Wet to dense		10	SS	12														
						227													
			11	SS	33														
226.3	End of borehole																		
12.8																			
	<div>* 2014 07 09</div> <div>▽ Water level observed during drilling</div> <div>▼ Water level measured after drilling</div> <div>NOTE: Upon completion of augering, borehole caved in at 11.3m depth</div>																		

* 2014 07 09
 ▽ Water level observed during drilling
 ▼ Water level measured after drilling
 NOTE: Upon completion of augering, borehole caved in at 11.3m depth

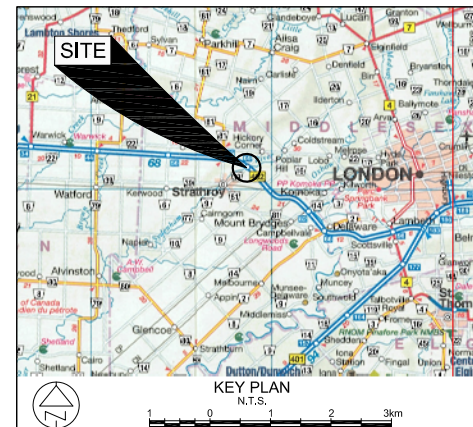
CONT No
GWP No 3075-11-00
WP No 3081-08-01

HICKORY DRIVE OVERPASSES
HIGHWAY 402
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET

PML Peto MacCallum Ltd.
CONSULTING ENGINEERS



LEGEND

- Borehole
- Borehole and cone
- Cone penetration test
- 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 July 2014
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER

BH No	ELEVATION	COORDINATES	
		NORTHINGS	EASTINGS
HD-1	238.7	4 761 088.5	379 775.9
HD-2	239.1	4 761 131.8	379 732.1

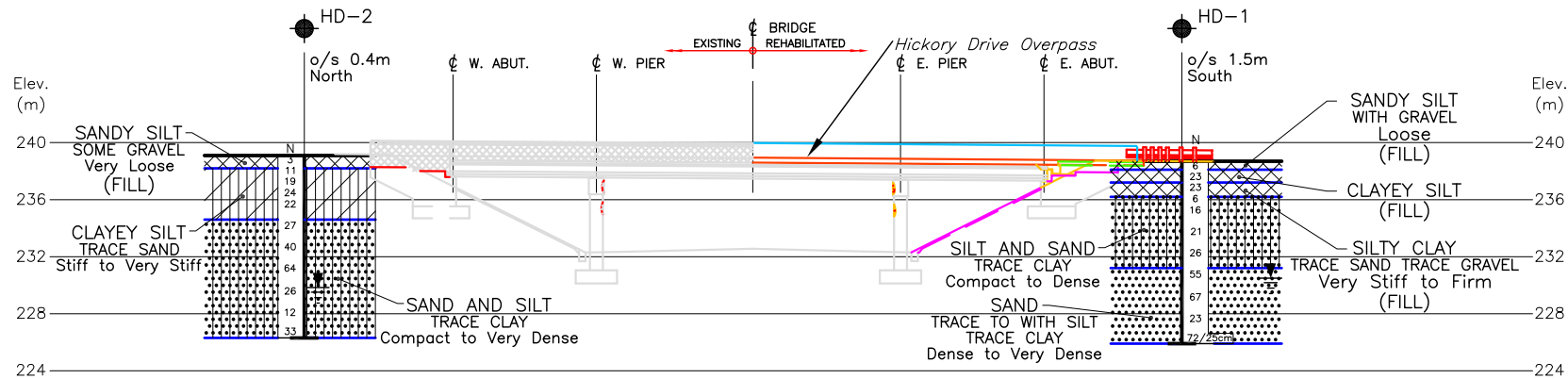
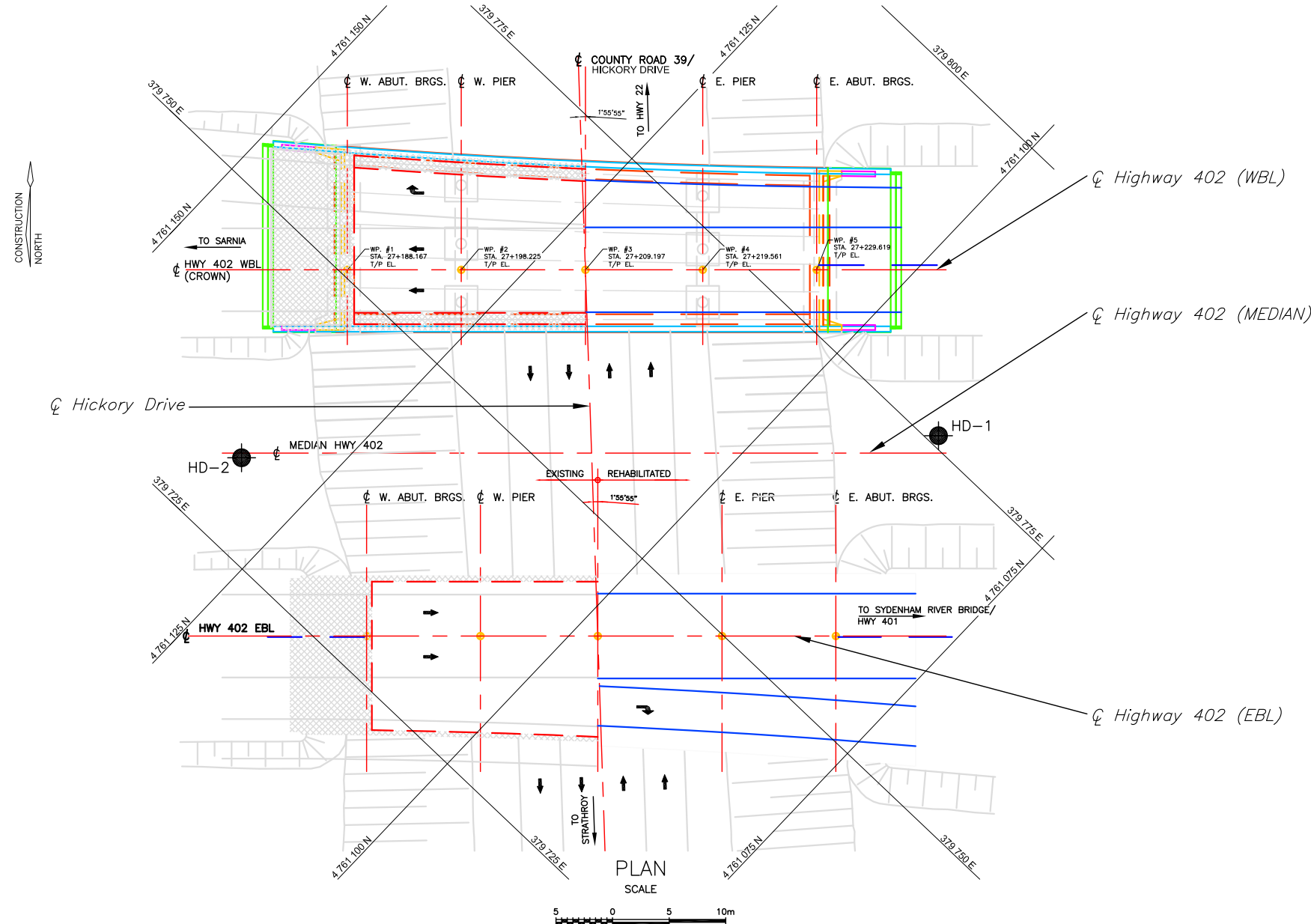
NOTE

The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

Geocres No. 40113-58

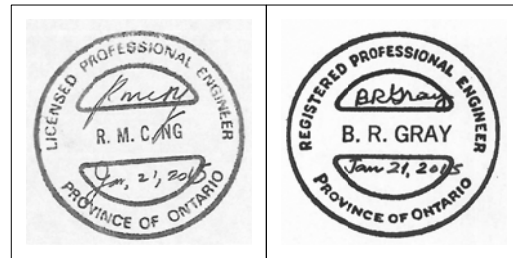
HWY No	402	CHECKED	NR	DATE	JAN. 21, 2015	DIST	LONDON
SUBMD	NA	CHECKED	NR	DATE	JAN. 21, 2015	SITE	19-523 / 1 & 2
DRAWN	NA	CHECKED	NR	APPROVED	BRG	DWG	HD-1



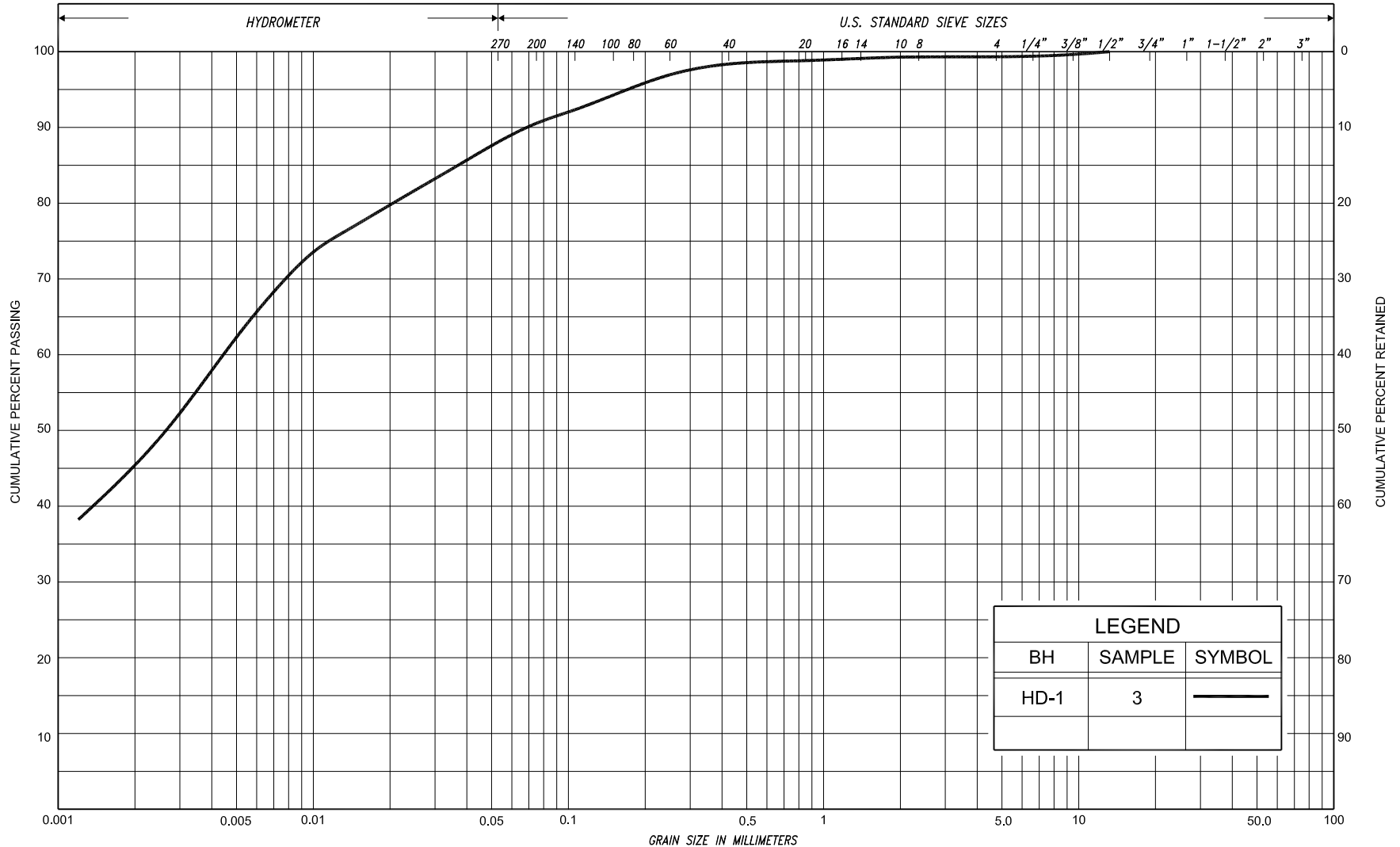
PROFILE ALONG MEDIAN HIGHWAY 402
SCALE

NOTES:

- THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH RECORD OF BOREHOLES AND REPORT
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
- DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.



Reference Composite of MMM Drawings:
S381 3001-312-001.GA.dwg; and S381 3001-313-001GA.dwg
dated August 2014

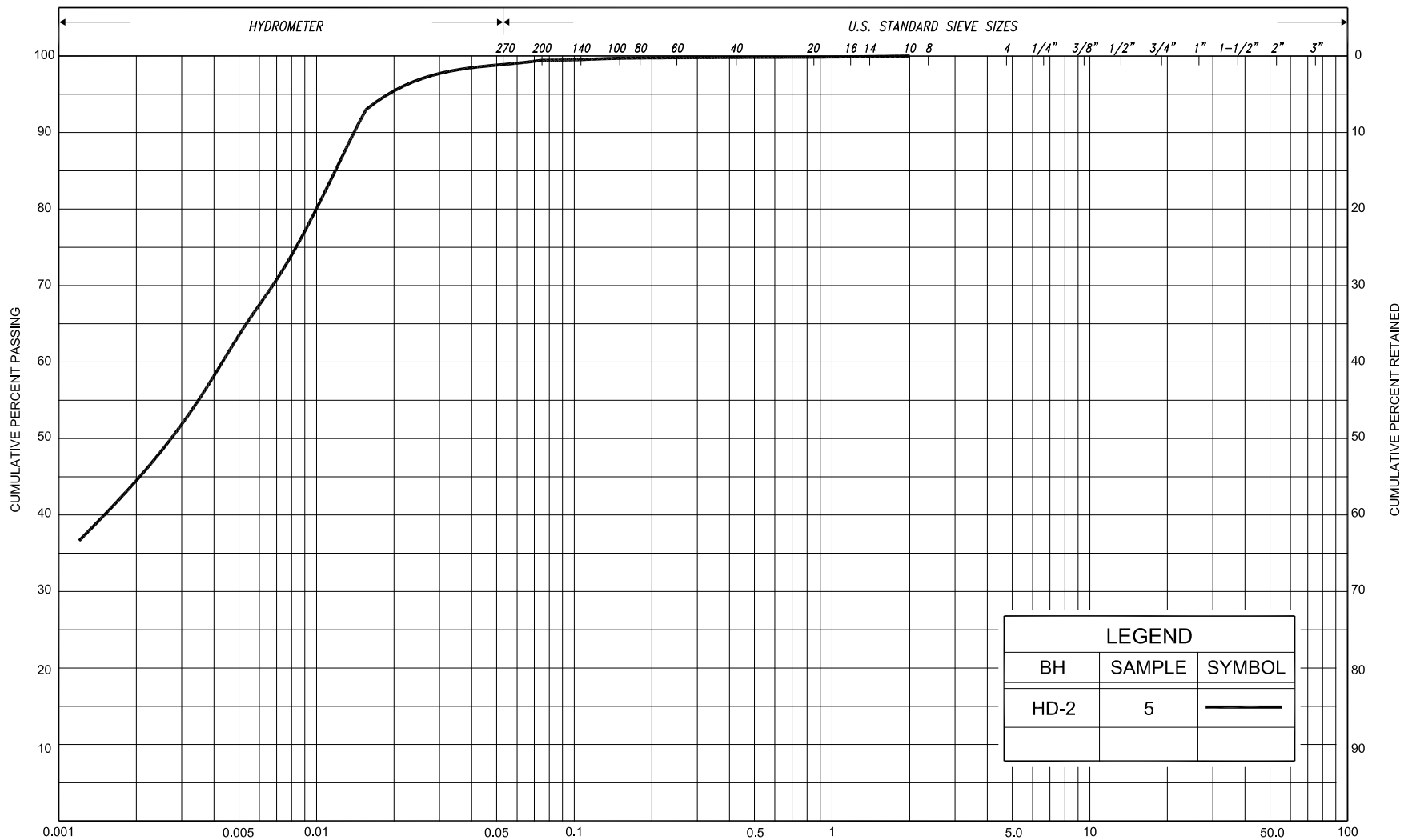


SILT & CLAY				FINE		MEDIUM		COARSE	GRAVEL		COBBLES	UNIFIED
				SAND								
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	GRAVEL				COBBLES	M.I.T.
	SILT			SAND								
CLAY		SILT		V. FINE	FINE	MED.	COARSE	GRAVEL				U.S. BUREAU
				SAND								



GRAIN SIZE DISTRIBUTION **SILTY CLAY, trace sand, trace gravel (CI)** **(FILL)**

FIG No. HD-GS-1
 HWY: 402
 G.W.P. No. 3075-11-00



LEGEND		
BH	SAMPLE	SYMBOL
HD-2	5	—

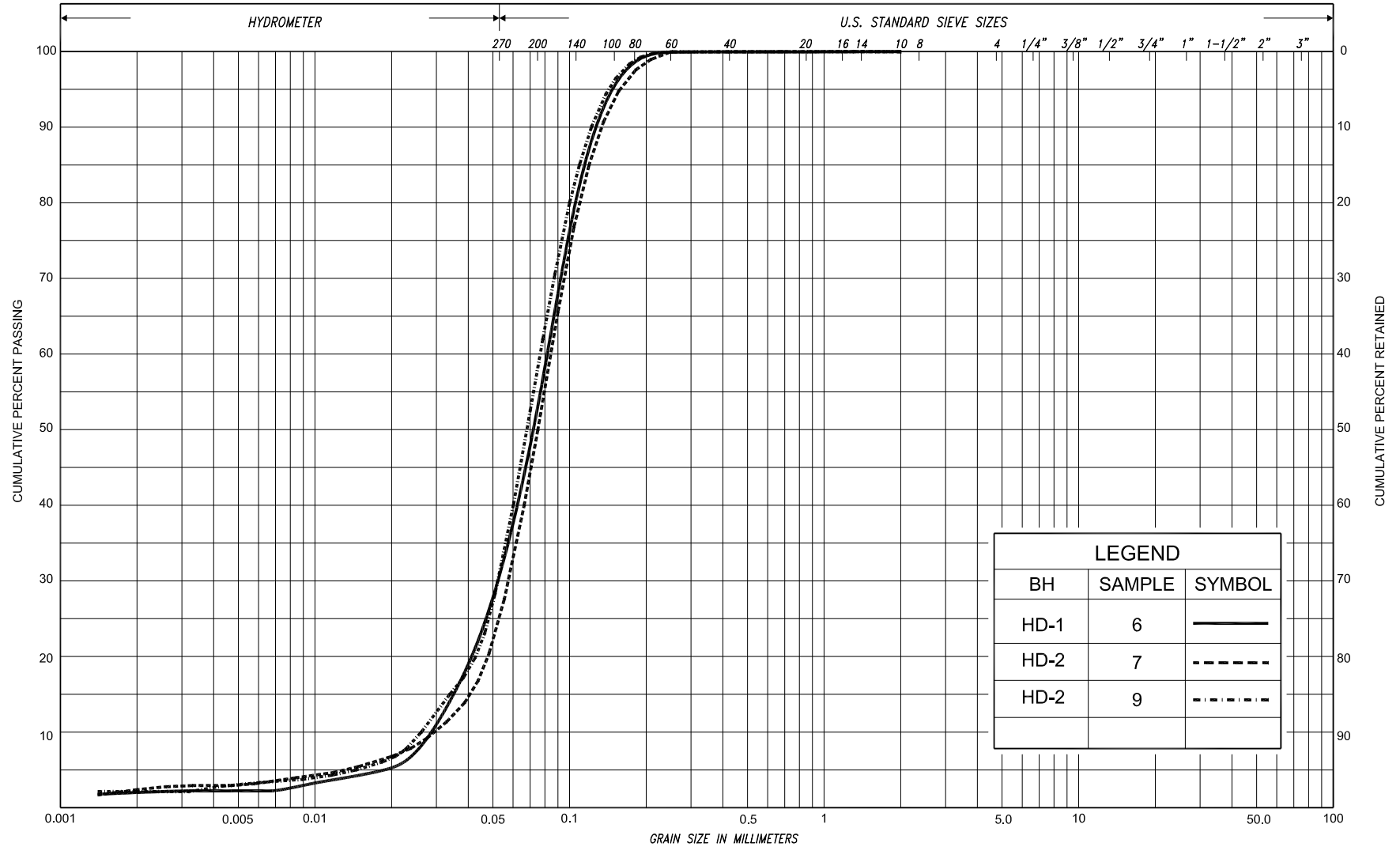
SILT & CLAY				FINE SAND			COARSE SAND	GRAVEL	COBBLES	UNIFIED
CLAY	FINE SILT	MEDIUM SILT	COARSE SILT	FINE SAND	MEDIUM SAND	COARSE SAND	GRAVEL	COBBLES		M.I.T.
CLAY	SILT			V. FINE SAND	FINE SAND	MED. SAND	COARSE SAND	GRAVEL		U.S. BUREAU



GRAIN SIZE DISTRIBUTION

CLAYEY SILT, trace sand (CL)

FIG No.	HD-GS-2
HWY:	402
G.W.P. No.	3075-11-00



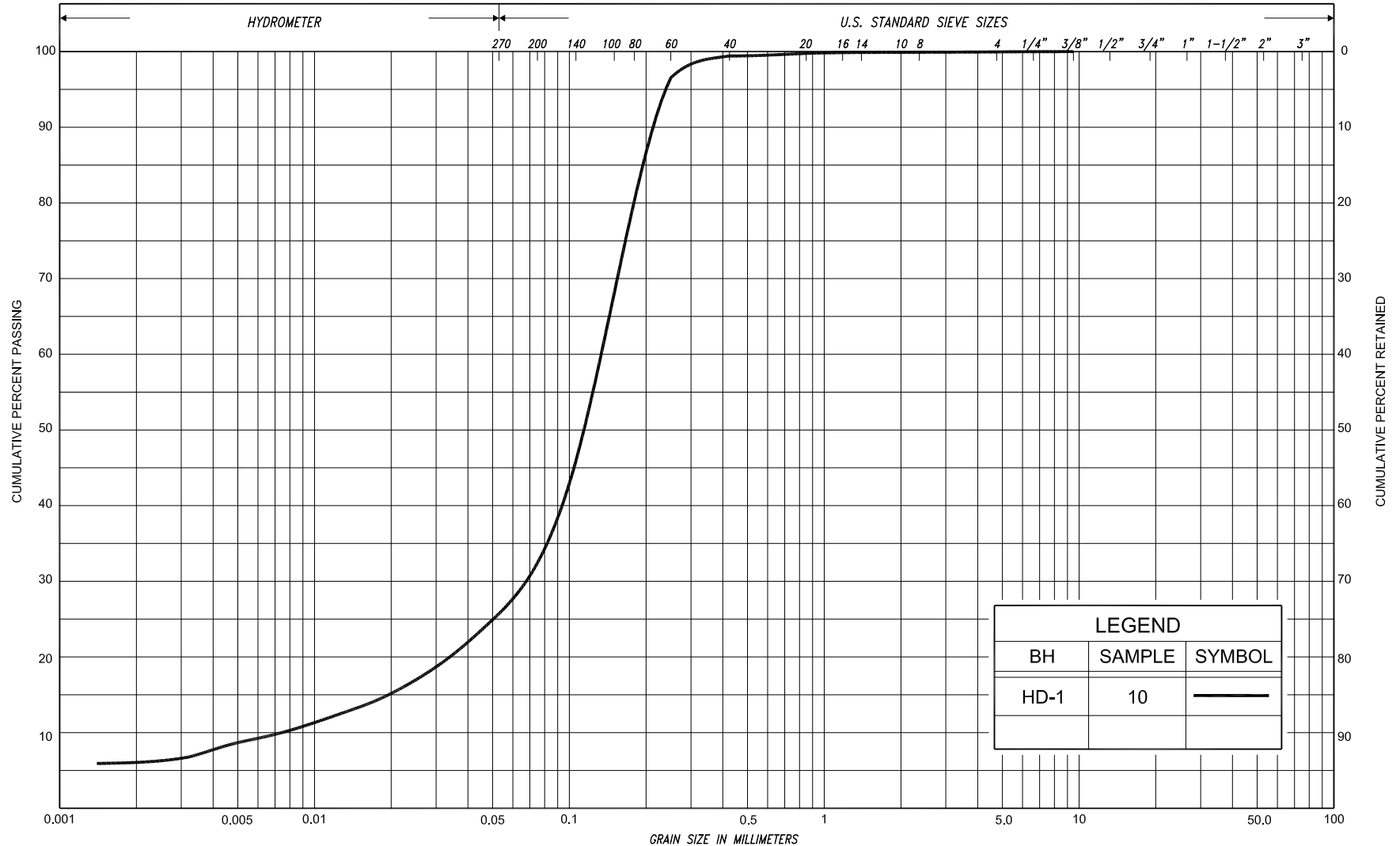
SILT & CLAY				FINE		MEDIUM		COARSE	GRAVEL			COBBLES	UNIFIED
				SAND									
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	GRAVEL			COBBLES	M.I.T.		
	SILT			SAND									
CLAY		SILT		V. FINE	FINE	MED.	COARSE	GRAVEL			U.S. BUREAU		
				SAND									



GRAIN SIZE DISTRIBUTION

SILT AND SAND, trace clay

FIG No.	HD-GS-3
HWY:	402
G.W.P. No.	3075-11-00



SILT & CLAY					FINE		MEDIUM		COARSE	GRAVEL			COB BLES	UNIFIED		
					SAND											
CLAY	FINE		MEDIUM		COARSE		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	M.I.T.
	SILT															
CLAY		SILT			V. FINE	FINE	MED.	COARSE		GRAVEL					U.S. BUREAU	
					SAND											

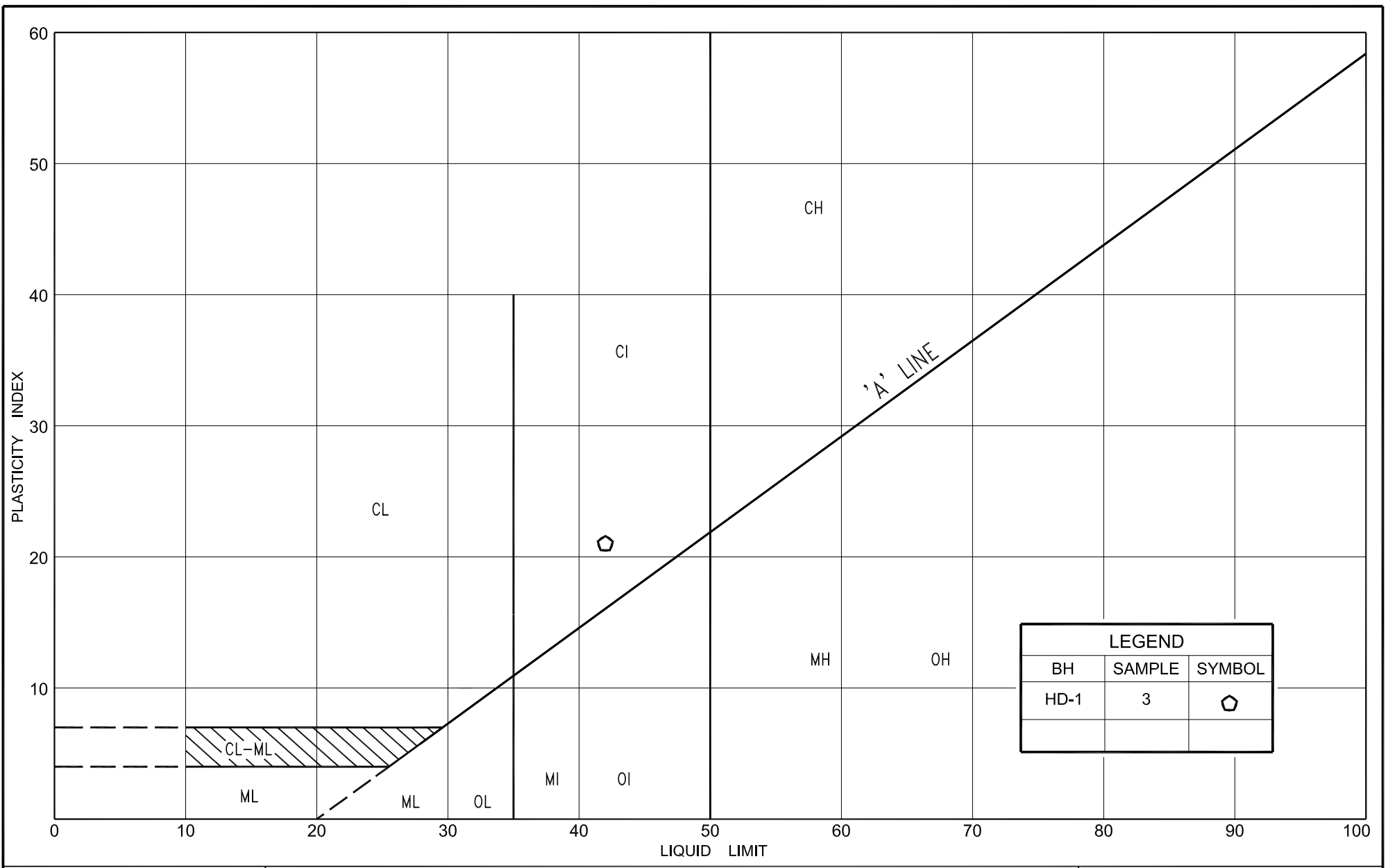


GRAIN SIZE DISTRIBUTION SAND, with silt, trace clay

FIG No. HD-GS-4

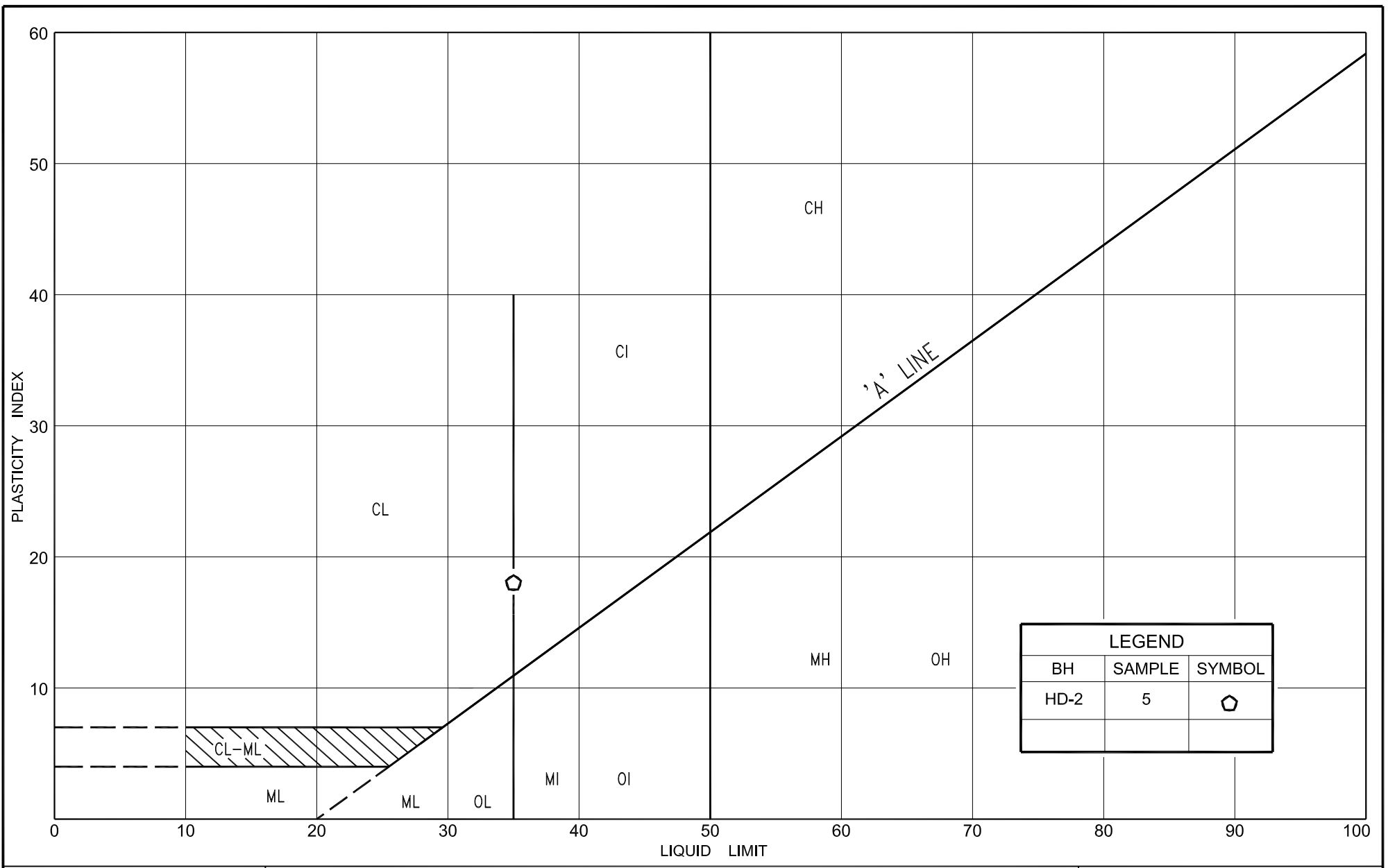
HWY: 402

G.W.P. No. 3075-11-00



PLASTICITY CHART
 SILTY CLAY, trace sand (CI)
 (FILL)

FIG No.	HD-PC-1
HWY:	402
G.W.P. No.	3075-11-00



PLASTICITY CHART

CLAYEY SILT, trace sand (CL)

FIG No.	HD-PC-2
HWY:	402
G.W.P. No.	3075-11-00



APPENDIX 1

TECHNICAL MEMORANDUM



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Figure 1 – Key Plan

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– General Plan, County Road 39 Interchange Overpass

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FOUNDATION TECHNICAL MEMORANDUM

For

Hickory Drive EBL and WBL Overpasses
Highway 402
MTO West Region 59 Structure Rehabilitations
Sites 19-523-1 & 19-523-2, Contract 3
GWP 3075-11-00
Township of Strathroy-Caradoc
Middlesex County, Ontario

1. INTRODUCTION

The Foundation Engineering Services for the present project involve the detail foundation investigation and design for the rehabilitation of 59 structures in MTO West Region along Highways 4, 6, 401, 402 and 403. Ten (10) Group Work Projects (GWPs) are contemplated to be completed between 2014 and 2020.

This technical memorandum summarizes the factual results of geotechnical data based on review and compilation of existing subsurface information from relevant reports in MTO GEOCRES Library for the Highway 402 Hickory Drive Eastbound Lanes (EBL) and Westbound Lanes (WBL) Overpasses in the Township of Strathroy-Caradoc, Middlesex County, Ontario. The Foundation Engineering recommendations from the original bridge foundation reports are summarized with reference to the "Canadian Highway Bridge Design Code" (CHBDC) and follow in general the "Guidelines for Professional Engineers providing Geotechnical Engineering Services".

From the Minutes of Meeting Report, dated May 5, 2014, it is understood that the rehabilitation of the underpass structure will include replacement of the existing concrete barrier walls and conversion to semi-integral abutments. In addition, traffic staging will be required during the rehabilitation work of the Hickory Drive EBL and WBL Overpass structures and will be coordinated with the traffic staging of the Sydenham River EBL and WBL bridges rehabilitation work.

The purpose of this technical memorandum is to summarize the subsurface and groundwater conditions and foundation recommendations based on available reports for the design project team's reference. The elevations in this report are expressed in meters, unless otherwise noted.



2. PROJECT SITE BACKGROUND AND GEOLOGY

The Hickory Drive EBL and WBL Overpasses on Highway 402 are located in the Township of Strathroy-Caradoc, Middlesex County, Ontario. Strathroy lies 4.9 km southwest of the EBL and WBL overpass locations. A key plan is shown in Figure 1.

The area of the site is relatively flat and gently sloping toward the southeast. Physiographically, the site is situated in the region known as the Caradoc Sand Plains. Sand and other light textured water laid deposits are characteristic of this region. The limestone, dolostone or shale bedrock in the area belongs to Hamilton Group of Middle Devonian period.

3. SOURCE OF INFORMATION

The following report and drawing were available for review and information for the Hickory Drive EBL and WBL Overpass structures which is appended in Appendix A. Reference 1 below represents the foundation investigation report for the final bridge alignment.

1. Foundation Investigation Report, for W.P. 40-66-19/20 Highway. 402, District 2, London County Road # 39 Interchange Overpass EBL/WBL 9.8 Miles West of Highway 2. Soil Mechanics Section Geotechnical office, Ministry of Transportation and Communications Ontario, dated April 6, 1976 GEOCREs No. 40I13-46. (Reference 1)
2. General Plan, County Road 39 Interchange Overpass, 9.8 Miles West of Highway 2, Drawing No. 1, Site 18-523A, WP No. 40-66-19, Cont No. 79-51, dated August, 1977. (Reference 2)

4. SITE RECONNAISSANCE

As part of the current foundation engineering assessment study, a site reconnaissance of the Highway 402 Hickory Drive EBL and WBL Overpass structures was carried out on February 19, 2014. A photographic record of the site visit is attached in Appendix B.



4.1 West Abutments and Piers of the WBL and EBL Overpasses

The site photographs present current visual conditions of the west abutments and piers of the WBL and EBL structures including appearance of the structures, visual slope stability and soil erosion.

The adjacent slopes of the abutments were covered with snow and some withered grass. There was no major observable erosion on the slopes and the edges of the abutment structures (Photographs 2, 5, 6 and 8). The slopes were in a visibly surficial stable condition during the time of reconnaissance. The front slopes of the abutments were covered with concrete, approximately at 2H: 1V slope. No obvious major cracks were observed on the abutment walls (Photographs 3, 4 and 7). Concrete cracks, spalling and deterioration were observed on the columns of the west pier (Photograph 13). On some piers, the deterioration exposed the reinforcement in the piers (Photograph 14). It was observed that some surface rehabilitation of the piers has been performed.

Based on the General Layout (Reference 2) a 150 mm diameter perforated CSP was to be placed behind the west abutment walls of the EBL and WBL structures; however, the CSPs were not visible during the site reconnaissance. Weep drains or outlet holes were not observed in the abutment walls or wingwalls; however, no water ponding was observed in front of or adjacent to the abutments and wingwalls of the EBL and WBL structures. It is inferred that the drainage system is performing satisfactorily.

4.2 East Abutments and Piers of the WBL and EBL Overpasses

The site photographs present current conditions of the east abutments and piers of the WBL and EBL structures including appearance of the structures, visual slope stability and soil erosion.

The adjacent slopes of the abutments were covered with snow and some withered grass. There was no major observable erosion on the slopes and the edges of the abutment structures (Photographs 9 to 12). The slopes were in a visibly surficial stable condition during the time of reconnaissance. The front slopes of the abutments were covered with concrete, approximately at 2H: 1V slope. No obvious major cracks were found on the abutment walls (Photograph 4). A local area of concrete damage at the corner of the south wingwall of the east abutment of the EBL structure was observed



(Photograph 12). Concrete cracks, spalling and deterioration were observed on the columns of the west pier. On some piers, the deterioration exposed the reinforcement in the piers. It was observed that some surface rehabilitation of the piers has been performed; however, on some piers the rehabilitated areas were deteriorating (Photographs 15 and 16).

Based on the General Layout (Reference 2) a 150 mm diameter perforated CSP was to be placed behind the east abutment walls of the EBL and WBL structures; however, they were not visible during the site reconnaissance. Weep drains or outlet holes were not observed in the abutment walls or wingwalls; however, no water ponding was observed in front of or adjacent to the abutments and wingwalls of the EBL and WBL structures. It is inferred that the drainage system is performing satisfactorily.

5. PREVIOUS FIELD INVESTIGATION AND SUMMARIZED SUBSURFACE CONDITIONS

The site is located on Hwy 402 about 4.8 northeast of Strathroy in Middlesex County, Ontario. The general subsurface conditions presented in this section are based on the Foundation Report, GEOCREC 40I13-46 dated April 6, 1976.

5.1 Field Investigation

The field work on this site included six boreholes (1 to 6) with accompanied five dynamic cone penetration tests (DCPTs) that were carried out in the period of November 5 to 18, 1975. The boreholes were drilled to the depth of 15.7 to 37.0 m (elevation 200.0 to 221.3). All boreholes accompanied DCPT except for borehole 5. The boreholes were drilled using continuous flight hollow or solid stem augers above groundwater and by wash boring method below that groundwater depth.

5.2 West Abutments of WBL and EBL Overpasses

Boreholes 1 and 2 were investigated under the west abutments of the WBL and EBL structures, respectively.



5.2.1 Silty Clay

A 2.6 m thick surficial very stiff silty clay layer was encountered in boreholes 1 and 2 and extended to elevation 235.6 and 235.4, respectively. N values of 21 to 25 were recorded.

A grain size distribution result of a selected silty clay sample obtained 50% clay, 49% silt and 1% sand sized particles. The Atterberg liquid limits of two silty clay samples were 43 and 44 and a plastic limit was 20. Plasticity index values of 23 and 24 were obtained. Moisture content determinations for silty clay ranged from 18 to 23%.

5.2.2 Sandy Silt to Silty Sand

A deposit of loose to very dense sandy silt to silty sand was encountered below the silty clay layer at 2.6 m, elevation 235.6 and 235.4 and extended to 17.2 to 30.9, elevation 221.0 to 207.1 in boreholes 1 and 2, respectively. Borehole 1 was terminated in sandy silt layer at depth of 17.2 m, elevation 221.0. N values recorded between 9 and 100.

Grain size distribution results of sandy silt to silty sand samples obtained 11 to 90% clay and silt and 10 to 89% sand sized particles. Moisture content determinations were between 5 and 22%.

5.2.3 Clayey Silt

The sandy silt to silty sand deposit was underlain by stiff to hard clayey silt stratum, which was encountered in borehole 2 at 30.9 m, elevation 207.1. The clayey silt layer extended to the borehole termination depth 37.0 m, elevation 201.0. N values of 24 and 41 were recorded.

The Atterberg limit test for a clayey silt sample in borehole 2 was 27 and the corresponding plastic limit was 16. The plasticity index was 11. A moisture content determination of about 23% was obtained.



5.3 East Abutments of WBL and EBL Overpasses

Boreholes 5 and 6 were investigated under the east abutments of the WBL and EBL structures, respectively.

5.3.1 Silty Clay

A 1.2 and 1.1 m thick surficial firm to very stiff silty clay layer was encountered and extended to elevation 235.9 in boreholes 5 and 6, respectively. N values of 8 and 18 were recorded.

An Atterberg liquid limit of 43 and a plastic limit of 20 for a silty clay sample were obtained, with a plasticity index of 23. A single moisture content determination of 26% was obtained.

5.3.2 Sandy Silt to Silty Sand

A deposit of loose to very dense sandy silt to silty sand was contacted below the silty clay layer in boreholes 5 and 6 at 1.2 and 1.1 m, respectively, elevation 235.9, which extended to 25.9 and 15.7 m, elevation 211.2 and 221.3. Borehole 6 was terminated in the silty sand to sandy silt layer at 15.7 m, elevation 221.3. N values recorded were between 5 and 202 blows for 250 mm penetration.

Grain size distribution results of silty sand to sandy silt samples obtained 8 to 49% clay and silt and 51 to 92% sand sized particles. Moisture content determinations ranged between 7 and 27%.

5.3.3 Clayey Silt

Below sandy silt to silty sand a 5.3 m thick hard clayey silt layer was encountered at 25.9 m, elevation 211.2, in borehole 5 and extended to borehole termination depth 37.0 m, elevation 200.0. N values of 34 to 95 were recorded.

A grain size distribution result of a clayey silt sample obtained 31% clay and 69% silt sized particles. Atterberg liquid limits obtained for two clayey silt samples was 23 and plastic limits for both samples were 13. A plasticity index of 10 was obtained. Two moisture content determinations of about 19% were obtained.



5.4 East and West Piers of EBL and WBL Overpasses

Boreholes 3 and 4 were investigated in vicinity of the west and east piers of the WBL and EBL structures.

5.4.1 Fill

A 1.1 and 0.8 m very loose surficial fill unit, which included sand, clayey silt and organic matter, was contacted in boreholes 3 and 4. The fill unit extended to elevation 235.7 and 235.5, respectively, in boreholes 3 and 4. One N value of 3 was recorded in this layer.

5.4.2 Sandy Silt to Silty Sand

A very loose to very dense sandy silt to silty sand layer was contacted below the surficial fill at 1.1 and 0.8 m, elevation 235.7 and 235.5 in boreholes 3 and 4 and extended to the termination depths of 16.5 and 15.7 m, elevation 220.3 and 220.5, respectively. N values of 10 to 167 were recorded.

Grain size distribution results obtained 13 to 85% clay and silt and 15 to 87% sand sized particles. Moisture content determinations ranged from 13 to 21%.

5.5 Groundwater

Groundwater was observed during the field investigation at depths of 5.3 to 8.3 m, elevation 229.5 to 231.0. It was pointed out that the water level observation was carried out during a relatively dry period and that higher levels would probably prevail in the spring period.

6. FOUNDATION

6.1 Previous Foundation Discussions and Recommendations

The foundation report recommended three spans, 10.7-22.3-10.7 m (35-73-35 ft), and twin (EBL/WBL) overpass structures at the proposed site. The original grade of County Road # 39 was at



elevation of 237.1 (778 \pm ft) and the profile grade of the proposed Highway 402 was at elevation 239.0 (784 \pm ft). Thus, the grade of the County Road No. 39 was envisioned to be at a lower new elevation 232.5 (763 \pm ft). For the proposed profile of Highway 402, up to 1.8 m of fill and about 4.6 m (16 ft) cut was envisioned at the site location.

The report proposed that the abutments and piers for the EBL and WBL structures could be founded on spread footings on competent underlying soils (sandy silt to silty sand layer).

The report recommended that the encountered subsoil at the EBL and WBL abutment locations for both structures was competent to support an allowable bearing pressure of 3 tsf (280 kPa) at or below the elevation 235.3 (772 ft.) for the west abutments and at or below elevation 234.1 to 234.7 (770 to 768 ft) for the east abutments of the EBL and WBL structures. It was recommended to assume a friction coefficient of 0.4 to calculate the sliding resistance between the bases of footings and the underlying soil at the foundation level. The report recommended that the front face of the abutment footing should not be placed closer than 3.0 m (10 ft) from the forward slope surface. Based on the General Plan (Reference 2), the top of the footing for the east and west abutments of EBL and WBL structures was to be at elevation 235.2 (771.75 ft) and 235.5 (772.75 ft), respectively.

The report recommended for the piers of both EBL and WBL structures to be founded on spread footings placed within the sandy silt to silty sand deposit. An allowable bearing pressure of 4.0 tsf (380 kPa) was recommended for design of footing at or below elevation 231.9 (761 ft). Based on the general layout drawing the top of the footings for both structures was to be placed at approximate elevation 231.0 (758.0 ft) for the piers.

A frost protection of minimum 1.2 m of earth cover was recommended at the footings of abutments and piers.

The groundwater level was observed at elevation 230.9 at the time of the investigation adjacent to the east piers of both EBL and WBL structures, but this elevation may be higher during the wet season. It was recommended that a dewatering scheme may be required for excavations below groundwater since the encountered sandy silt to silty sand subsoil was considered to be highly susceptible to conditions of unbalanced hydrostatic head.



The settlement under the footing was considered not to be greater than 25 mm and would occur immediately after the load is applied. The differential settlement between the abutments and piers was considered to be no more than 25 mm.

At the approaches, no stability problems were anticipated for the proposed fills and cuts, constructed to 2H:1V slope, for the proposed profile grade of Highway 402. It was recommended to provide erosion protection for the slopes according to MTC practices. Further, the settlement at the approaches was considered to be negligible due to the anticipated load of the fill.

Based on the General Plan, the spread footings were to be founded at the following elevations for the abutments and piers:

FOUNDATION	FOUNDATION TYPE	TOP ELEVATION		THICKNESSES
Abutments	Spread footing	EBL 235.2 (771.75 ft)	WBL 235.5 (772.75 ft)	840 mm
Piers		231.0 (758.0 ft)	231.0 (758.0 ft)	910 mm

Based on the General Plan (Reference 2), the proposed EBL and WBL structures were to be constructed with three spans of 10.1-21.3-10.1 m (33-70-33 ft). The County Road # 39 grade elevation cut to approximately 232.1 (761.5 ft) and Highway 402 grade elevation raised up to approximately 238.8 (783.5 ft) were anticipated.

6.2 Assessment of Foundation Parameters

Based on the previous investigation and subsurface conditions encountered, the following table summarizes the foundation design parameters that were recommended in the previous report and the updated geotechnical reaction at SLS and factored geotechnical resistance at ULS are provided.



FOUNDATION DESIGN PARAMETERS

Foundation	Founding Elevation		Previous Working Stress Values ¹	Previous Equivalent Limit State Design Values		Limit State Design Values Updated to Current Industry Practice ²	
	(ft)	(m)	Safe Bearing Resistance (tsf)	SLS Bearing Reaction (kPa)	ULS Factored Geotechnical Resistance (kPa)	SLS Bearing Reaction (kPa)	ULS Factored Geotechnical Resistance (kPa)
Piers of EBL and WBL Structures on Spread footing	761.0	231.9	4.0	380	570	415	625
East Abutment of WBL Structure on Spread footing	770.0	234.7	3.0	280	420	350	500
East Abutment of EBL Structure on Spread footing	768.0	234.1	3.0	280	420	350	500
West Abutments of EBL and WBL Structures on Spread footings	772.0	235.3	3.0	280	420	350	500

Notes: 1. Working stress design values. The Ultimate Limit State design values are based on the working stress. No field verifications were made.
2. Resistance Factor = 0.5 for shallow foundation (CFEM 4th edition)
Assumed Factor of Safety is 3 (CFEM 4th edition)

The seismic site coefficient for the conditions at this site is 1.0 (soil profile Type 1, Canadian Highway Bridge Design Code (CHBDC) 2006 Edition, clause 4.4.6).

The bearing resistance for inclined loads should be reduced in accordance with the requirements of clause 6.7.4 of the CHBDC.

The foundation frost penetration depth at the site is 1.2 m according to OPSD 3090.101.



7. DISCUSSION

It is understood that the Hickory Drive EBL and WBL Overpasses rehabilitation project includes modification of the bridge abutments to semi-integral abutments and to replace existing concrete barrier walls. Traffic staging will be required during the rehabilitation work in two stages. In the first stage, traffic will be shifted to the outside lanes and all ramps will remain open. In the second stage, traffic will be shifted to the inside lane and all the ramps will be closed. The staging will be coordinated with the Sydenham River EBL and WBL bridges rehabilitation work.

It is understood that temporary support systems will be implemented to provide roadway protection and to permit excavation and backfilling of trenches or excavations for the conversion to semi-integral deck ends. The construction for temporary support system should conform to OPSS 404 and 539. A performance level of 2 for the protection system, according to OPSS 539, should be adopted to prevent excessive lateral and/or vertical movement of the existing embankment during construction. The contractor is responsible for the selection, detailed design and performance of the roadway protection scheme. The contractor should monitor the movement of the roadway protection system.

The groundwater level was observed at elevation 230.9 in the previous investigation adjacent to the east piers of both EBL and WBL structure. It is anticipated that for the rehabilitation work of the Hickory Drive EBL and WBL overpasses, conventional filtered sump pumping techniques will be sufficient to control seepage of water into the excavation. Groundwater control of excavations is the Contractor's responsibility. It should be noted that the groundwater levels are subject to seasonal fluctuations and precipitation patterns.

Further, based on the site reconnaissance, it is recommended that the pier and abutment surfaces should be rehabilitated to prevent further concrete degradation and corrosion.



8. CLOSURE

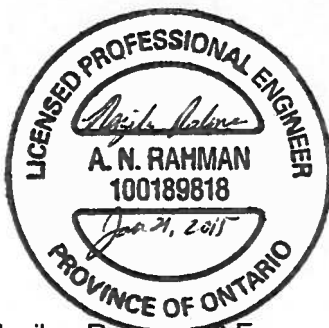
PML has carried out a foundation investigation at the Highway 402 Hickory Drive Overpass EBL/WBL structures to determine the existing subsoil and groundwater conditions prior to the commencement of the rehabilitation work. The preliminary foundation investigation and design report is presented under a separate cover.

This technical memorandum was prepared by Mr. N. Rahman, P.Eng with the assistance of Mr. M. Khorsand, EIT and was reviewed by Mr. R. Ng, PhD, P.Eng. Mr. B. R. Gray, MEng, P.Eng., MTO Designated Principal Contact conducted an independent review of the report.

We trust this memo is sufficient for your immediate needs. Please, do not hesitate to contact us if you have any inquiries and/or comments.

Yours very truly,

Peto MacCallum Ltd.



Nazibur Rahman, P.Eng.
Project Engineer, Geotechnical Services



Robert Ng, MBA, PhD, P.Eng.
Senior Project Engineer



Brian R. Gray, MEng, P.Eng.
MTO Designated Principal Contact

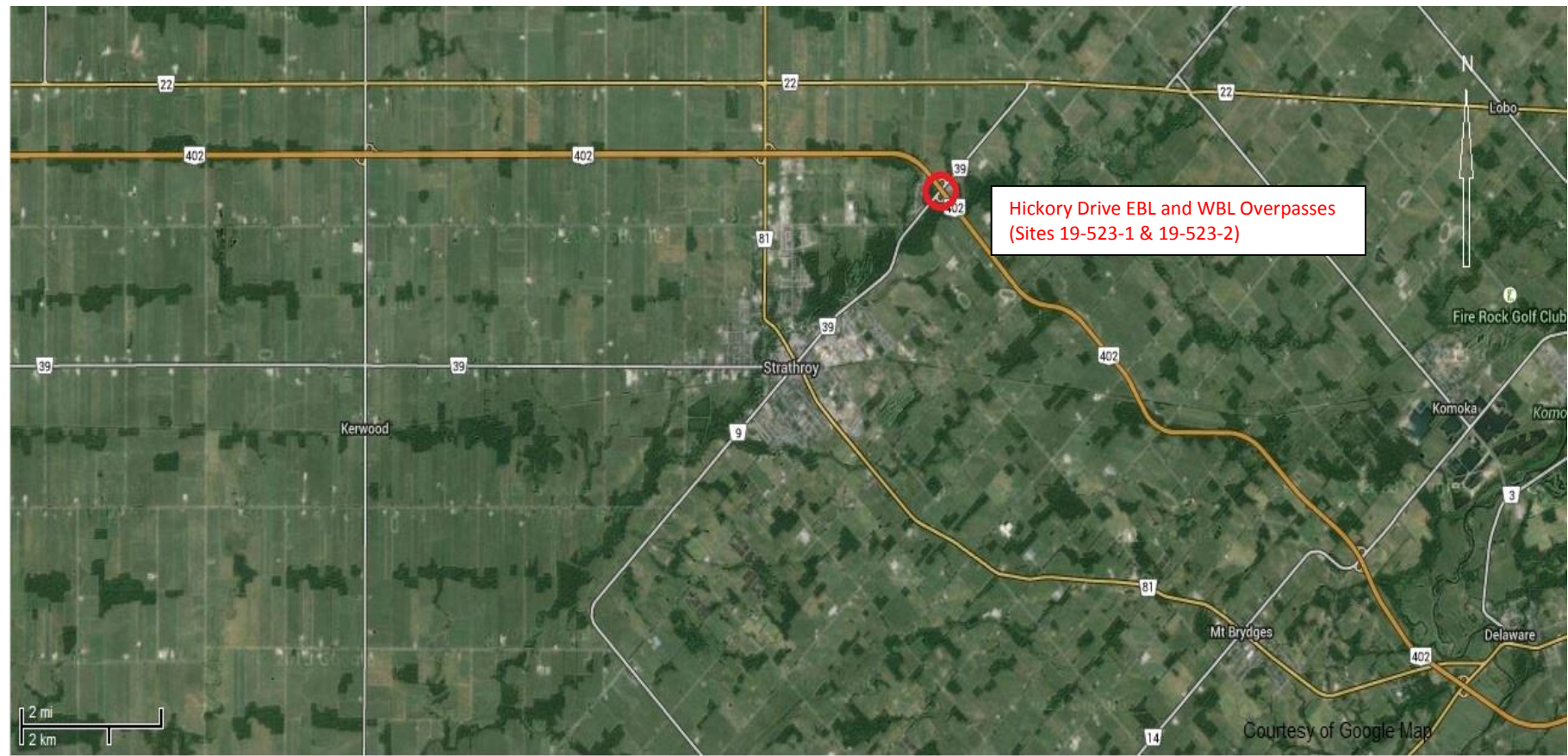


TABLE 1

LIST OF STANDARD SPECIFICATIONS REFERENCED IN REPORT

DOCUMENT	TITLE
OPSS 404	Construction Specification for Support Systems
OPSS 539	Construction Specification for Temporary Protection Systems
OPSD 3090.101	Foundation Frost Depth for Southern Ontario

Figure 1 – Key Plan





APPENDIX A

Previous Foundation Investigation Report (GEOCRES 40I13-46)
General Plan, County Road 39 Interchange Overpass

DOCUMENT MICROFILMING IDENTIFICATION

CONTRACT 3

HICKORY DRIVE OVERPASS

GEOCRES No. 40I13-46

DIST. 2 REGION

W.P. No. 40-66-19/20

CONT. No. 79-51

W. O. No.

STR. SITE No. 19-523

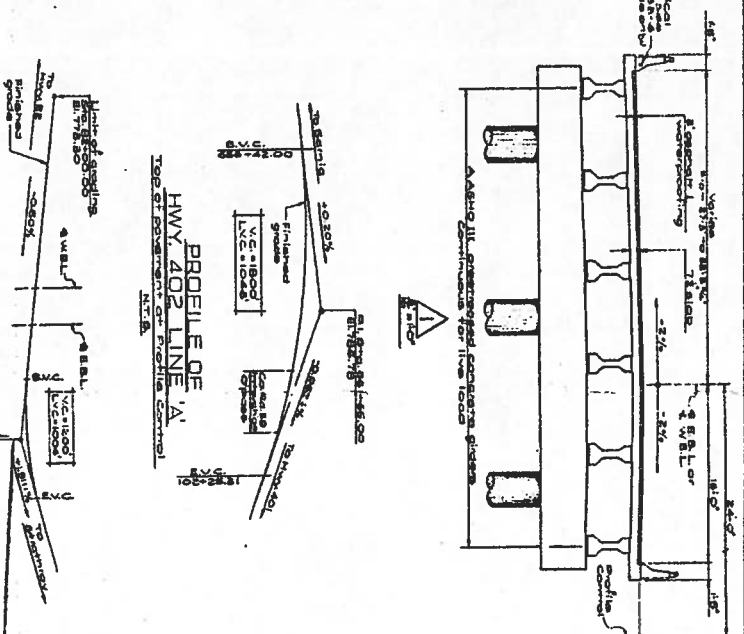
HWY. No. 402

LOCATION County Rd. 39 Interchange
Overpass (EBL & WBL)

No. of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

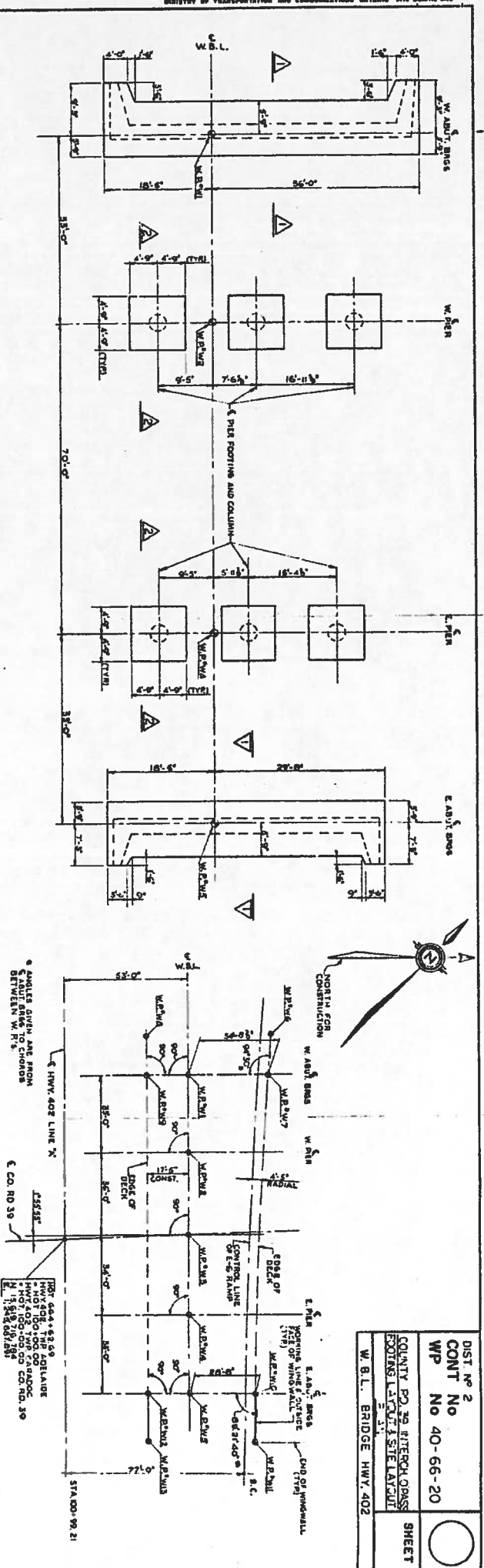
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LIST OF DRAWINGS

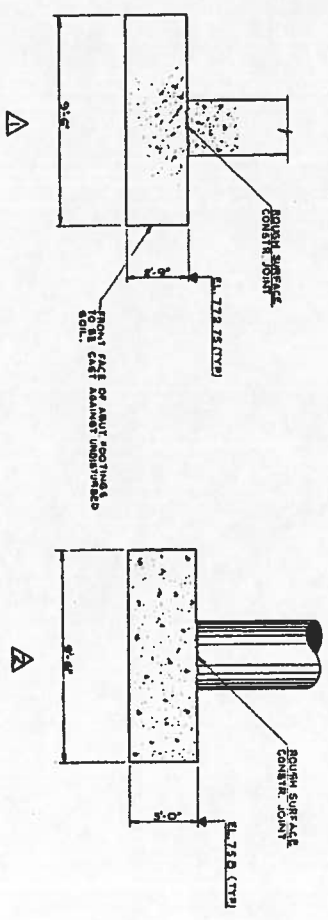
" 16-5228-1	General Plan
" " "	2 Bone Hole Locations
" " "	3 Footing Layout & Shear Layout Plan
" " "	4 Wall Abutment
" " "	5 East Abutment
" " "	6 Piers
" " "	7 Bearing Layout & Details
" " "	8 Prestressed Girders
" " "	9 Tack Details
" " "	10 Barrier Walls
" " "	11 Spread Railings
" " "	12 20 Ft. Approach Slopes
" " "	13 Details of Concrete Slab Sailing
" " "	14 Standard Details I
" " "	15 Standard Details II
" " "	16 Bridge Electrical Plans - Type
" " "	17 General Notes

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 1/42535295865117307932921825928971026432 INCHES PER FOOT
 1/85070591730234615865843651857942052864 INCHES PER FOOT

DIST. NO. 2	
WP	NO. 40-66-20
COUNTY ROAD DISTRICT	
FOOTING LAYOUT & SITE LAYOUT	
SHEET	
W. B. L. BRIDGE HWY. 402	



PLAN S-1-0'



W.P.	STATION	CO. - COORDINATES	STATION	CO. - COORDINATES
W.P.1	653.91.00	154.9504.51	W.P.2	653.91.00
W.P.2	654.24.00	154.9504.51	W.P.3	654.24.00
W.P.3	654.63.00	154.9504.51	W.P.4	654.63.00
W.P.4	655.02.00	154.9504.51	W.P.5	655.02.00
W.P.5	655.41.00	154.9504.51	W.P.6	655.41.00
W.P.6	655.80.00	154.9504.51	W.P.7	655.80.00
W.P.7	656.19.00	154.9504.51	W.P.8	656.19.00
W.P.8	656.58.00	154.9504.51	W.P.9	656.58.00
W.P.9	656.97.00	154.9504.51	W.P.10	656.97.00
W.P.10	657.36.00	154.9504.51	W.P.11	657.36.00
W.P.11	657.75.00	154.9504.51	W.P.12	657.75.00
W.P.12	658.14.00	154.9504.51	W.P.13	658.14.00
W.P.13	658.53.00	154.9504.51	W.P.14	658.53.00
W.P.14	658.92.00	154.9504.51	W.P.15	658.92.00
W.P.15	659.31.00	154.9504.51	W.P.16	659.31.00
W.P.16	659.70.00	154.9504.51	W.P.17	659.70.00
W.P.17	660.09.00	154.9504.51	W.P.18	660.09.00
W.P.18	660.48.00	154.9504.51	W.P.19	660.48.00
W.P.19	660.87.00	154.9504.51	W.P.20	660.87.00
W.P.20	661.26.00	154.9504.51	W.P.21	661.26.00
W.P.21	661.65.00	154.9504.51	W.P.22	661.65.00
W.P.22	662.04.00	154.9504.51	W.P.23	662.04.00
W.P.23	662.43.00	154.9504.51	W.P.24	662.43.00
W.P.24	662.82.00	154.9504.51	W.P.25	662.82.00
W.P.25	663.21.00	154.9504.51	W.P.26	663.21.00
W.P.26	663.60.00	154.9504.51	W.P.27	663.60.00
W.P.27	663.99.00	154.9504.51	W.P.28	663.99.00
W.P.28	664.38.00	154.9504.51	W.P.29	664.38.00
W.P.29	664.77.00	154.9504.51	W.P.30	664.77.00
W.P.30	665.16.00	154.9504.51	W.P.31	665.16.00
W.P.31	665.55.00	154.9504.51	W.P.32	665.55.00
W.P.32	665.94.00	154.9504.51	W.P.33	665.94.00
W.P.33	666.33.00	154.9504.51	W.P.34	666.33.00
W.P.34	666.72.00	154.9504.51	W.P.35	666.72.00
W.P.35	667.11.00	154.9504.51	W.P.36	667.11.00
W.P.36	667.50.00	154.9504.51	W.P.37	667.50.00
W.P.37	667.89.00	154.9504.51	W.P.38	667.89.00
W.P.38	668.28.00	154.9504.51	W.P.39	668.28.00
W.P.39	668.67.00	154.9504.51	W.P.40	668.67.00
W.P.40	669.06.00	154.9504.51	W.P.41	669.06.00
W.P.41	669.45.00	154.9504.51	W.P.42	669.45.00
W.P.42	669.84.00	154.9504.51	W.P.43	669.84.00
W.P.43	670.23.00	154.9504.51	W.P.44	670.23.00
W.P.44	670.62.00	154.9504.51	W.P.45	670.62.00
W.P.45	671.01.00	154.9504.51	W.P.46	671.01.00
W.P.46	671.40.00	154.9504.51	W.P.47	671.40.00
W.P.47	671.79.00	154.9504.51	W.P.48	671.79.00
W.P.48	672.18.00	154.9504.51	W.P.49	672.18.00
W.P.49	672.57.00	154.9504.51	W.P.50	672.57.00
W.P.50	672.96.00	154.9504.51	W.P.51	672.96.00
W.P.51	673.35.00	154.9504.51	W.P.52	673.35.00
W.P.52	673.74.00	154.9504.51	W.P.53	673.74.00
W.P.53	674.13.00	154.9504.51	W.P.54	674.13.00
W.P.54	674.52.00	154.9504.51	W.P.55	674.52.00
W.P.55	674.91.00	154.9504.51	W.P.56	674.91.00
W.P.56	675.30.00	154.9504.51	W.P.57	675.30.00
W.P.57	675.69.00	154.9504.51	W.P.58	675.69.00
W.P.58	676.08.00	154.9504.51	W.P.59	676.08.00
W.P.59	676.47.00	154.9504.51	W.P.60	676.47.00
W.P.60	676.86.00	154.9504.51	W.P.61	676.86.00
W.P.61	677.25.00	154.9504.51	W.P.62	677.25.00
W.P.62	677.64.00	154.9504.51	W.P.63	677.64.00
W.P.63	678.03.00	154.9504.51	W.P.64	678.03.00
W.P.64	678.42.00	154.9504.51	W.P.65	678.42.00
W.P.65	678.81.00	154.9504.51	W.P.66	678.81.00
W.P.66	679.20.00	154.9504.51	W.P.67	679.20.00
W.P.67	679.59.00	154.9504.51	W.P.68	679.59.00
W.P.68	680.00.00	154.9504.51	W.P.69	680.00.00
W.P.69	680.40.00	154.9504.51	W.P.70	680.40.00
W.P.70	680.80.00	154.9504.51	W.P.71	680.80.00
W.P.71	681.20.00	154.9504.51	W.P.72	681.20.00
W.P.72	681.60.00	154.9504.51	W.P.73	681.60.00
W.P.73	682.00.00	154.9504.51	W.P.74	682.00.00
W.P.74	682.40.00	154.9504.51	W.P.75	682.40.00
W.P.75	682.80.00	154.9504.51	W.P.76	682.80.00
W.P.76	683.20.00	154.9504.51	W.P.77	683.20.00
W.P.77	683.60.00	154.9504.51	W.P.78	683.60.00
W.P.78	684.00.00	154.9504.51	W.P.79	684.00.00
W.P.79	684.40.00	154.9504.51	W.P.80	684.40.00
W.P.80	684.80.00	154.9504.51	W.P.81	684.80.00
W.P.81	685.20.00	154.9504.51	W.P.82	685.20.00
W.P.82	685.60.00	154.9504.51	W.P.83	685.60.00
W.P.83	686.00.00	154.9504.51	W.P.84	686.00.00
W.P.84	686.40.00	154.9504.51	W.P.85	686.40.00
W.P.85	686.80.00	154.9504.51	W.P.86	686.80.00
W.P.86	687.20.00	154.9504.51	W.P.87	687.20.00
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W.P.88	688.00.00	154.9504.51	W.P.89	688.00.00
W.P.89	688.40.00	154.9504.51	W.P.90	688.40.00
W.P.90	688.80.00	154.9504.51	W.P.91	688.80.00
W.P.91	689.20.00	154.9504.51	W.P.92	689.20.00
W.P.92	689.60.00	154.9504.51	W.P.93	689.60.00
W.P.93	690.00.00	154.9504.51	W.P.94	690.00.00
W.P.94	690.40.00	154.9504.51	W.P.95	690.40.00
W.P.95	690.80.00	154.9504.51	W.P.96	690.80.00
W.P.96	691.20.00	154.9504.51	W.P.97	691.20.00
W.P.97	691.60.00	154.9504.51	W.P.98	691.60.00
W.P.98	692.00.00	154.9504.51	W.P.99	692.00.00
W.P.99	692.40.00	154.9504.51	W.P.100	692.40.00

CURVE DATA OF S-E RAMP			
Δ	8°23'00"	R	2201.43
D	2°20'00"	T	161.13
L	325.67		

FOR REDUCED PLAN

DESIGNED BY: [Signature]

CHECKED BY: [Signature]

DATE: 10/17/2017

PROJECT: [Project Name]

SHEET: [Sheet Number]



Memorandum

40I13-46
GEOCRES No.

To: Mr. A.P. Watt (2)
Regional Structural Planning Engineer
Southwestern Region, London

From: Soil Mechanics Section
Geotechnical Office
West Building, Downsview

Attention:

Date: March 30, 1976

Our File Ref. W.P. 40-66-19/20

In Reply to

APR 06 1976

Subject:

GEOCRES No. 40I13-46
FOUNDATION INVESTIGATION REPORT
for

W.P. 40-66-19/20
Hwy. 402, District 2, London
County Road 39 Interchange Overpass
EBL/WBL 9.8 Miles West of Hwy. 2

CONT. No 79-51

Attached we are forwarding to you our detailed Foundation Investigation Report on the subsoil conditions existing at the above mentioned site.

We believe that the factual data and recommendations contained therein will prove adequate for your requirements. Should additional information be required, please do not hesitate to contact our Office.

K.G. SELBY
Supervising Engineer

cc: R.S. Pillar
C.S. Grebski
B.J. Giroux
G.A. Wrong
A. Wittenberg
J.R. Roy
D.P. Collins
R. Hore
J. Anderson)
A. Crowley } memo only
G. Sloan)
Files

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5. DISCUSSION AND RECOMMENDATIONS
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FOUNDATION INVESTIGATION REPORT

for

W.P. 40-66-19/20
Hwy. 402, District 2, London
County Road 39 Interchange Overpass
EBL/WBL 9.8 Miles West of Hwy. 2

1. INTRODUCTION

This report contains the results of a Foundation Investigation carried out at the following site:

County Road #39 Overpass
W.P. 40-66-19 & 20
1.8 Miles SW of Hickory Corner (Hwy. #22)
Hwy. 402, Line 'A'
District 2, London

The Report contains factual and interpreted soil data and recommendations pertaining to the design and construction of the proposed twin structures and approaches.

2. SITE DESCRIPTION

The proposed overpass structures will be located at the crossing of the existing Middlesex County Rd. #39 and future Hwy. #402, approximately 1.8 miles southwest of Hickory Corner which is situated at the junction of Co. Rd. #39 and Hwy. #22.

County Road #39 is the boundary line between Townships of Adelaide and Caradoc. The road is located in a shallow cut (approx. 6' deep), the top of pavement at centreline being at elev. 778 \pm . The depth of drainage ditches which are located on both sides of the roadway is about 3.5 feet.

In terms of topography, the immediate area of the site is relatively flat and gently sloping toward the southeast. The land is used for agricultural purposes and was plowed at the time of the field investigation.

Physiographically, the site is situated in the region referred to as the Caradoc Sand Plains. Sand and other light textured waterlaid deposits are characteristic of this region.

3. FIELD AND LABORATORY INVESTIGATION

A total of six boreholes, five accompanied by dynamic cone penetration tests, were carried out during the course of the field investigation (Nov. 5-18, 1975).

The borings were advanced by means of continuous flight augers (hollow stem or solid) above the groundwater and by washboring methods below that depth.

Samples were obtained in 2" O.D. split-spoon samplers, which were hammered into the soil in accordance with the specifications for the Standard Penetration Test. The same energy was used to carry out the dynamic cone penetration tests.

The groundwater conditions across the site were determined by recording the water level in the open holes during the course of the field investigation.

The locations and elevations of all borings were surveyed by personnel from the Southwestern Region Engineering Surveys and are shown on Drawing 406619 & 20-A.

The samples were subjected to visual examination in the field and subsequently in the laboratory.

Laboratory tests were performed on selected samples to determine the physical properties of the various soil types, namely:

Natural Moisture Content

Grain-size Distributions

Atterberg Limits (cohesive soils only)

The results of the field and laboratory testing are plotted on the Record of Borehole Sheets.

4. SUBSURFACE CONDITIONS

(4.1) Soil Conditions

The soil conditions at the site in general, were found to be uniform over the area investigated.

The surficial deposit (below original ground level) across the site is composed of a 3.5' to 8.5' thick, very stiff silty clay with traces of sand, followed by an extensive loose to very dense

cohesionless deposit of sands and silts with traces of clay to a minimum depth of 93 ft. Beneath this cohesionless deposit, a stratum of very stiff to hard clayey silt was penetrated up to 37 ft. The sandy silt to silty sand deposit was fully penetrated in boreholes No. 2 & 5 and the borings were terminated in the clayey silt layer.

Roadway fill material (up to 3.5') consisting of mixtures or layers of sand, silt, clay and organics, was encountered in boreholes No. 3 & 4 which were put down adjacent to the existing Co. Rd. #39.

The boundaries of the various deposits are shown on the accompanying Record of Borehole Sheets. The stratigraphical sections plotted on drawing No. 406619 & 20-A are inferred from this data. A description of the soil types encountered in the boreholes follows:

(4.1.1) Silty Clay With Traces of Sand

This deposit occurs from the original (natural) ground surface to a maximum depth of 8.5' (B.H.'s #1, 2, 5 & 6). The material in the stratum consists of silty clay with traces of sand. Atterberg Limit Tests indicate that the compressibility or plasticity of this inorganic stratum is in the medium range.

Standard Penetration Tests were carried out within this deposit. The obtained 'N' values varied between 8 and 25 blows per foot from which it is estimated that the consistency ranges from firm to very stiff.

(4.1.2) Fill Material

This material was observed in B.H.'s No. 3 and 4 which were drilled through the existing road shoulders. The soil consists of mixtures or layers of sand, silt, clay and organics. The thickness at the borehole locations ranges from 2.5 to 3.5 ft.

(4.1.3) Sandy Silt to Silty Sand, Traces of Clay

This deposit was intersected at every boring location immediately beneath the silty clay or the fill material but was not penetrated to its full extent in every borehole. The thickness was found to range from 81 to 93 ft. in borehole No. 5 and 2 respectively.

The material in the stratum consists of silts and sand in varying proportions. The chief constituent is silt in the upper half of the deposit, while the lower half consists mostly of sand. Traces of clay were also found throughout the stratum. Grain-size distribution tests were carried out on selected samples. The results are plotted in envelope form on Fig. 1 of the Appendix.

Standard Penetration Tests were carried out within this cohesionless (granular) deposit and the results are plotted on the Record of Borehole Sheets. The obtained 'N' values varied from 5 blows/ft. to 100 blows for 5 inches. Based on these results, it is estimated that the relative density of this deposit is generally loose in the upper 5 feet and ranges somewhat randomly from compact to very dense in the remainder of the deposit.

The natural moisture content varies between 5% and 21%, however, the bulk of the deposit has a moisture content close to 20%.

(4.1.4) Clayey Silt

Boreholes No. 2 & 5 which were drilled beyond the lower boundary of the sandy silt to silty sand deposit encountered a stratum of clayey silt at elev. 679+ and elev. 693+ respectively. The stratum was penetrated up to 37 feet.

A limited number of laboratory tests indicated that the deposit is inorganic and has a low plasticity.

The natural moisture content ranges from 20 to 23%.

Based on Standard Penetration Test 'N' values, the consistency is estimated to range from very stiff to hard.

(4.2) Groundwater Conditions

At the time of the field investigation, Nov. 5-18, 1975, the following groundwater levels were recorded:

B.H. #1	Elev. 754.2
2	754.2
3	753.0
4	757.5
5	756.3
6	758.0

The average natural ground surface is at elev. 780 \pm in the vicinity of the site.

It is pointed out that the water level observations were carried out during a relatively dry period and that higher levels will probably prevail in the spring period.

5. DISCUSSION AND RECOMMENDATIONS

(5.1) General

It is proposed to build three span (35'-73'-35') twin over-pass structures at the crossing of County Road #39 and future EB lanes and WB lanes (ref. dwg. 406619 & 20-A) of Hwy. #402.

The profile grade of Hwy. #402 will be at elev. 784 \pm which is about 3 to 6 ft. above the original ground. County Road #39 will be lowered from the existing grade (elev. 778 \pm) to elev. 763.

(5.2) Foundations

(5.2.1) Piers

The proposed piers for both structures may be founded on spread footings placed within the sandy silt to silty sand deposit. An allowable bearing pressure of 4.0 tsf may be used for design purposes at or below elev. 761. In the vicinity of the east piers for both EBL and WBL structures the groundwater level was observed to be at elev. 757.5. This level may be higher during the wet season and it may be necessary to employ a dewatering scheme to prevent boiling of the footing bases, depending on the prevailing groundwater level at the time of construction.

(5.2.2) Abutments

The subsoil at the abutment locations consists of approximately 3 to 8.5 ft. of silty clay with traces of sand, followed by an extensive deposit of mainly compact to very dense sand and silt.

The sand and silt material is competent to support an allowable bearing pressure of 3.0 tsf at or below the following elevations:

West Abutments: WBL Structure: Elev. 772+
EBL Structure: Elev. 772+

East Abutments: WBL Structure: Elev. 770+
EBL Structure: Elev. 768+

For computation of sliding resistance a friction coefficient of 0.40 may be assumed to apply between bases of footings and the underlying soil at the foundation level.

The front face of the abutment footing (measured in the plane of the underside of footing) should not be placed closer than 10 ft. from the forward slope surface.

(5.2.3) Settlement

Total settlements under the footings should not be more than 1 inch and should occur immediately the load is applied. Differential settlements between piers and abutments should be less than 1 inch.

(5.2.4) Frost Protection

Bases of spread footings should be protected against frost action with a minimum of 4 ft. of earth cover.

(5.2.5) Dewatering

The sandy silt to silty sand subsoil encountered at this site is highly susceptible to conditions of unbalanced hydrostatic head and it is likely to 'boil' when exposed to such conditions.

In view of this, a dewatering scheme may be necessary if excavations are carried below the groundwater level.

(5.3) Approaches

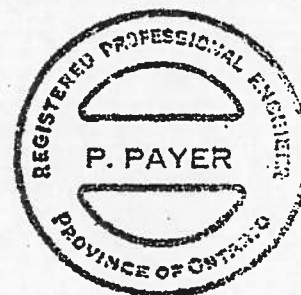
To realize the proposed profile grade (elev. 784+) of highway #402 up to 6 ft. high fills and about 16 ft. deep cuts will be required at this location.

No stability problems are anticipated for the proposed fills and cuts, constructed with 2 horizontal to 1 vertical slopes.

The slopes should be protected against erosion according to current MTC practices.

Settlement of the subsoil due to the load imposed by the
fills will be negligible.

P. Payer
P. Payer
Senior Engineer



K.G. Selby
K.G. Selby, P. Eng.
Supervising Engineer

March, 1976

APPENDIX

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 1

WP 40-66-19/20 LOCATION Co-ords. 15,619,814 N; 1,245,881 E. ORIGINATED BY MK
DIST 2 HWY 402 BORING DATE November 5-7, 1975 COMPILED BY OJ
DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger & Cone Test CHECKED BY *ep.*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		25	50	75	100	125	w_p	w	w_L		
781.5	Ground Level															
0.0	Silty clay, traces of sand. Very Stiff		1	SS	23	780										0 1 49 50
773.0			2	SS	25											0 10 74 16
8.5			3	SS	9											
	Sandy silt to silty		4	SS	21	770										
			5	SS	35											
			6	SS	39											
			7	SS	34											
			8	SS	95	760										
	sand, traces of clay		9	SS	67											0 89 (11)
			10	SS	41											
			11	SS	31											
			12	SS	95/6"	750										
			13	SS	52											
	Loose to Very Dense		14	SS	24											
			15	SS	9	740										0 75 (25)
			16	SS	31											
			17	SS	83	730										
			18	SS	100/5"											
725.0			19	SS	76											
56.5	End of Borehole															

20
15 ϕ 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 2

WP 40-66-19/20

LOCATION Co-ords. 15,619,730 N; 1,245,793 E.

ORIGINATED BY MK

DIST 2 HWY 402

BORING DATE November 7-11, 1975

COMPILED BY GP

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger & Bi-Cone & Cone Test

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		25	50	75	100	125	w_p	w	w_L		
780.8	Ground Level															
0.0	Silty clay traces of sand Very Stiff		1	SS	21	780										
			1A	TW	PH											
772.3			1B	TW	PH											
8.5			2	SS	17	770										0 27 (73)
			3	SS	32											
			4	SS	31											
			5	SS	43											
	Sandy Silt		6	SS	107	760										
			7	SS	127											
	to		8	SS	60											
			9	SS	39											
	Silty Sand		10	SS	100	750										0 83 (17)
			11	SS	15											
	Trace of Clay		12	SS	154	740										
			13	SS	90											
			14	SS	100	730										
	Compact to Very		15	SS	80	720										
	Dense		16	SS	117											0 89 (11)
			17	SS	153	710										
			18	SS	130	700										0 54 42 4
			19	SS	58	690										
679.4			20	SS	86	680										
101.4	Clayey silt, very															
676.8	Stiff to Hard															
104.0																

20
15 5 % STRAIN AT FAILURE
10

Continued

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 2 Continued

WP 40-66-19/20 LOCATION Co-ords. 15,619,730 N; 1,245,793 E. ORIGINATED BY mk
 DIST 2 HWY 402 BORING DATE November 7-11, 1975 COMPILED BY GP
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger & Bi-Cone CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		25	50	75	100	125	W_P	W	W_L		
676.8	continued															
104.0	Clayey Silt Very Stiff to Hard		21	SS	41	670										
659.3			22	SS	24	660										
121.5	End of Borehole															

20
15 ϕ 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 3

WP 40-66-19/20

LOCATION Co-ords. 15,619,737 N; 1,245,869 E.

ORIGINATED BY MK

DIST 2 HWY 402

BORING DATE November 12, 1975

COMPILED BY GP

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger & Tri-Cone & Cone Test

CHECKED BY *GP*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		25	50	75	100	125	w_p	w	w_L		
776.7	Ground Level															
0.0	Fill Material-layers of sand, clayey silt & organics.															
773.2			1	SS	3											0 15 75 10
3.5			2	SS	10											
	Sandy Silt		3	SS	33	770										
	to		4	SS	35											
	Silty Sand		5	SS	31											0 60 (40)
	traces of clay		6	SS	63	760										
			7	SS	73											
			8	SS	49											
			9	SS	167	750										
	Loose to Very Dense		10	SS	85											
			11	SS	160	740										0 87 (13)
			12	SS	127											
			13	SS	54	730										
			14	SS	62											
722.7			15	SS	42											
54.0	End of Borehole															

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 4

WP 40-66-19/20 LOCATION Co-ords. 15,619,694 N; 1,245,914 E. ORIGINATED BY PP
 DIST 2 HWY 402 BORING DATE November 20-24, 1975 COMPILED BY GP
 DATUM Geodetic BOREHOLE TYPE Auger BX Casing & B1-Cone & Cone Test CHECKED BY *GP*

SOIL PROFILE		SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS	
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		'N' VALUES	25	50	75	100	125	SHEAR STRENGTH				
												O UNCONFINED + FIELD VANE				
												● QUICK TRIAXIAL x LAB VANE				
						WATER CONTENT %					w_p — w — w_L					
						10 20 30										
775.0	Ground Level															
0.0	Fill mat'l., layers of															
772.5	sand, clayey sil. & org.															
2.5			1	SS	26											
			2	SS	47											
			3	SS	58											
	Sandy silt to silty		4	SS	63											
			5	SS	68											
	sand, traces of clay		6	SS	90											
			7	SS	132											
			8	SS	63											
			9	SS	139											
	Compact to Very Dense		10	SS	87											
			11	SS	33											
			12	SS	34											
			13	SS	123											
			14	SS	113											
			15	SS	63											
723.5			16	SS	68											
51.5	End of Borehole															

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 5

WP 40-66-19/20 LOCATION Co-ords. 15,619,706 N; 1,245,981 E. ORIGINATED BY PP; MK
DIST 2 HWY 402 BORING DATE November 25-27, 1975 COMPILED BY GP
DATUM Geodetic BOREHOLE TYPE Auger & BX Casing CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		25	50	75	100	125	W_P	W	W_L		
777.8	Ground Level															
0.0	Silty clay, traces of sand. Very Stiff		1	SS	18											
773.8			2	SS	5											
4.0			3	SS	18	770										
	Sandy silt to silty		4	SS	21											
			5	SS	48											
	sand, traces of		6	SS	26	760										0 51 (49)
			7	SS	138											
	clay.		8	SS	45											
			9	SS	40											
			10	SS	170	750										
			12	SS	37											0 55 (45)
	Loose to Very Dense		13	SS	66	740										
			14	SS	89											
			15	SS	100	730										
			16	SS	74											
			17	SS	51	720										0 92 (8)
			18	SS	87	710										
			19	SS	100/6"	700										
692.8																
85.0	Clayey Silt		20	SS	54	690										
	Hard															
			21	SS	80	680										0 0 69 31
673.8																
104.0																

20
15 ϕ 5 % STRAIN AT FAILURE

Continued

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 5 Continued

WP 40-66-19/20 LOCATION Co-ords. 15,619,706 N; 1,245,981 E. ORIGINATED BY PP;MK
 DIST 2 HWY 402 BORING DATE November 25-27, 1975 COMPILED BY GP
 DATUM Geodetic BOREHOLE TYPE Auger & BX Casing CHECKED BY GP

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		25	50	75	100	125	w_p	w	w_L		
673.8	continued															
104.0	Clayey silt					670										
	Hard		22	SS	95											
						660										
656.3			23	SS	34											
121.5	End of Borehole															

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

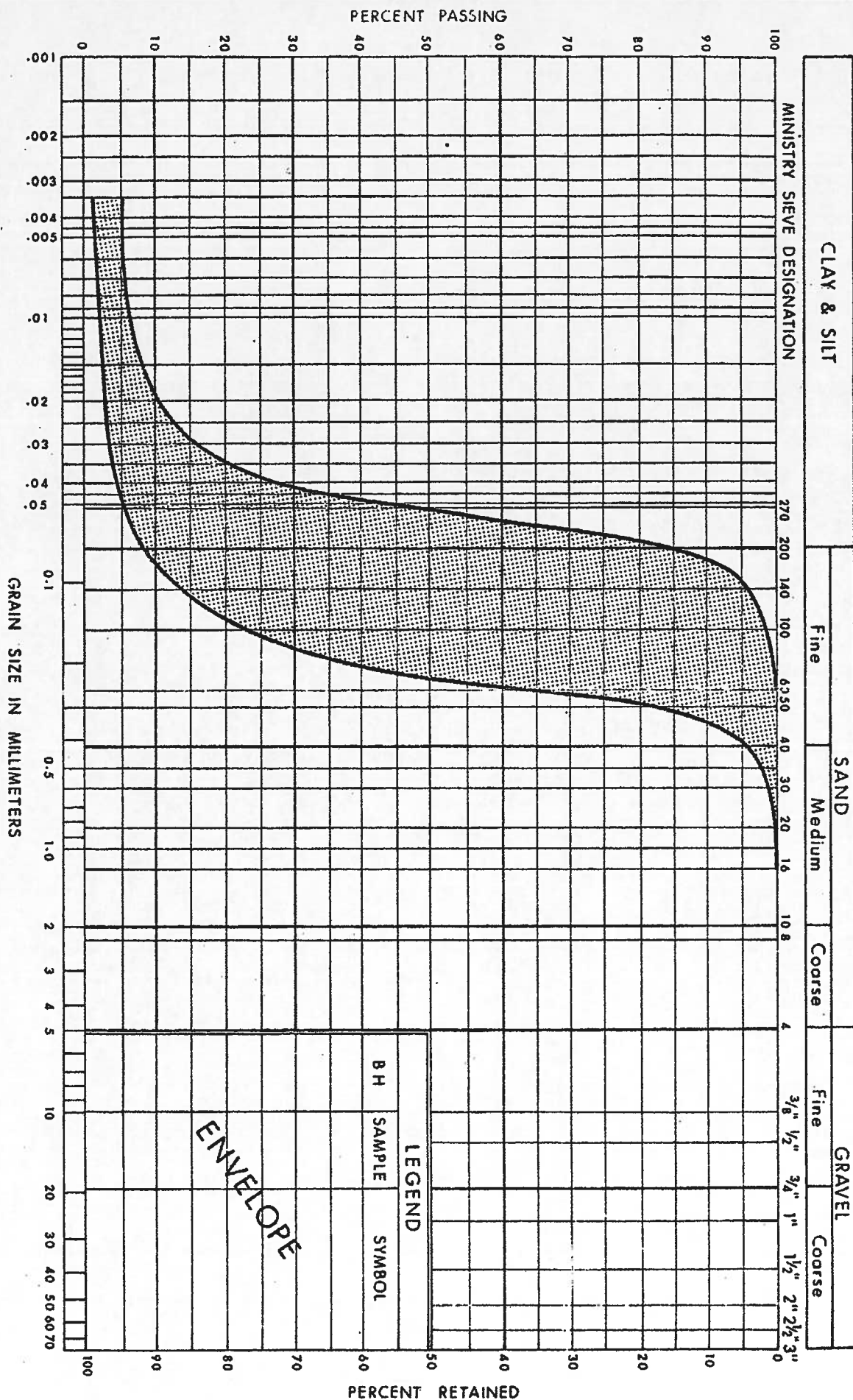
RECORD OF BOREHOLE NO 6

WP 40-66-19/20 LOCATION Co-ords. 15,619,622 N; 1,245,893 E. ORIGINATED BY MR
DIST 2 HWY 402 BORING DATE November 28, 1975 COMPILED BY GP
DATUM Geodetic BOREHOLE TYPE Auger & Cone Test CHECKED BY GP

SOIL PROFILE		STRAT. PLOT	SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT Y	REMARKS
ELEV DEPTH	DESCRIPTION		NUMBER	TYPE	N' VALUES		25	50	75	100	125	w_p	w	w_L		
777.5	Ground Level															
0.0	Silty Clay															
774.0	Firm		1	SS	8											
3.5			2	SS	6											
			3	SS	7	770										
	Sand/silt to silty		4	SS	25											
			5	SS	49											
			6	SS	29											
	sand, traces of		7	SS	104	760										
	clay.		8	SS	52											
			9	SS	41											
			10	SS	137											
	Loose to Very Dense		11	SS	27	750										
			12	SS	50											
			13	SS	70	740										
			14	SS	55											
			15	SS	202	730										
726.0			16	SS	69											
51.5	End of Borehole															

20
15 \diamond 5 % STRAIN AT FAILURE
in

UNIFIED SOIL CLASSIFICATION SYSTEM



PERCENT PASSING

GRAIN SIZE IN MILLIMETERS

PERCENT RETAINED

CLAY & SILT

Fine

SAND

Medium

Coarse

GRAVEL

Fine

Coarse

MINISTRY SIEVE DESIGNATION

270

200

140

100

60

40

30

20

16

10.8

8

4

3/8"

1/2"

3/4"

1"

1 1/2"

2"

2 1/2"

3"

BH

SAMPLE

SYMBOL

LEGEND

ENVELOPE

Ministry of
Transportation and
Communications
Oct 75
ENGINEERING SERVICES BRANCH

GRAIN SIZE DISTRIBUTION
SANDY SILT TO SILTY SAND
TRACES OF CLAY

FIG No 1

W P 40-66-19 & 20

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

PENETRATION RESISTANCE

'N'-STANDARD PENETRATION RESISTANCE : - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE : - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

<u>CONSISTENCY</u>	<u>c LB./SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 250	VERY LOOSE	0 - 4
SOFT	250 - 500	LOOSE	4 - 10
FIRM	500 - 1000	COMPACT	10 - 30
STIFF	1000 - 2000	DENSE	30 - 50
VERY STIFF	2000 - 4000	VERY DENSE	> 50
HARD	> 4000		

TERMS TO BE USED IN DESCRIBING SOILS:-

TRACE < 10% , SOME 10-25% , WITH 25-40% , > 40% SILTY, SANDY, GRAVELLY, CLAYEY ETC.

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.T.	SLOTTED TUBE SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE

P.H. SAMPLE ADVANCED HYDRAULICALLY

P.M. SAMPLE ADVANCED MANUALLY

SOIL TESTS

U	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
UU	UNCONSOLIDATED UNDRAINED TRIAXIAL	F.V.	FIELD VANE
CIU	CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL	C	CONSOLIDATION
CID	" " DRAINED "	S	SENSITIVITY
CAU	" ANISOTROPIC UNDRAINED "		
CAD	" " DRAINED "		

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_p	PLASTIC LIMIT
I_p	PLASTICITY INDEX
w_s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_c	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma}$
C_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR = $\frac{C_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_r	SENSITIVITY

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF σ
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF σ TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

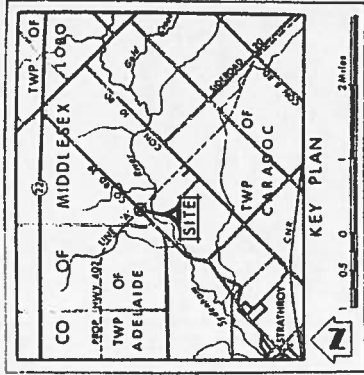
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL



LEGEND

- Bore Hole
- Dynamic Cone Penetration Resistance Test
- SW CDMC (Bore Hole) (See Note 1205N for map)
- Bore Hole & Core Test
- Water Levels established at time of field investigation, Nov 1973

NO	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	781.5	15,619,814	12,458,881
2	780.8	15,619,730	12,457,793
3	776.7	15,619,737	12,453,869
4	775.0	15,619,694	12,455,914
5	777.8	15,619,706	12,455,981
6	777.5	15,619,622	12,455,893

NOTE

The boundaries between soil strata have been established only at the bore hole locations. Between bore holes the boundaries are assumed from geotechnical conditions.

GEORES No 4013-46

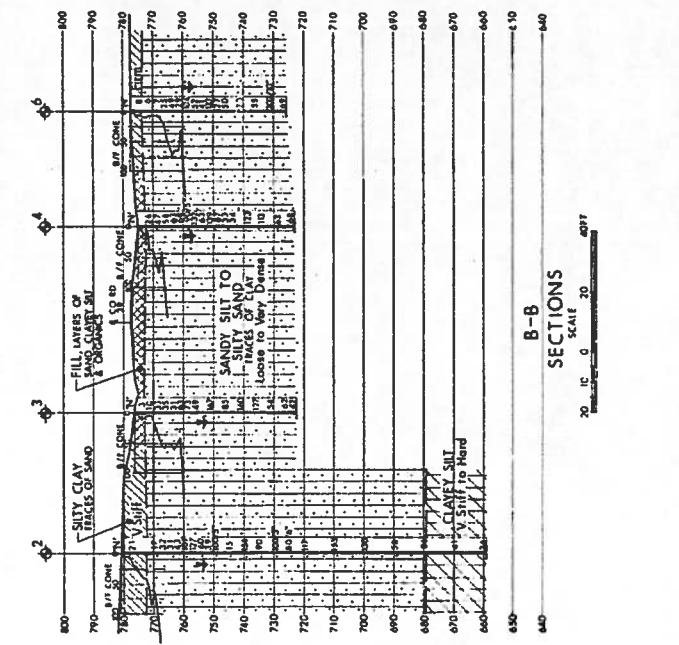
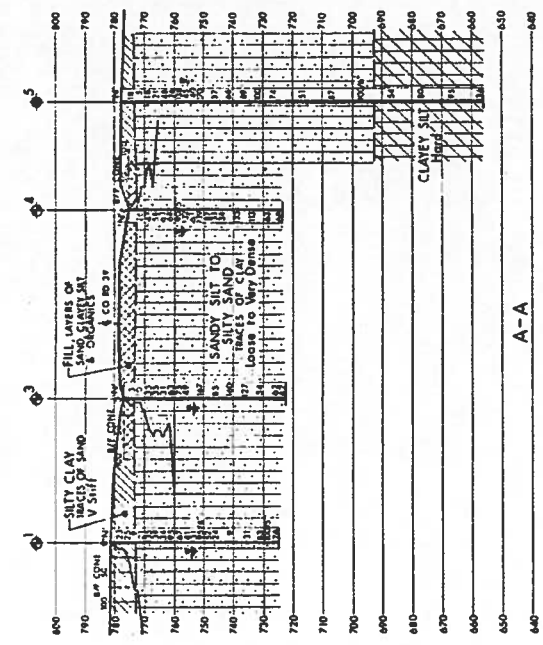
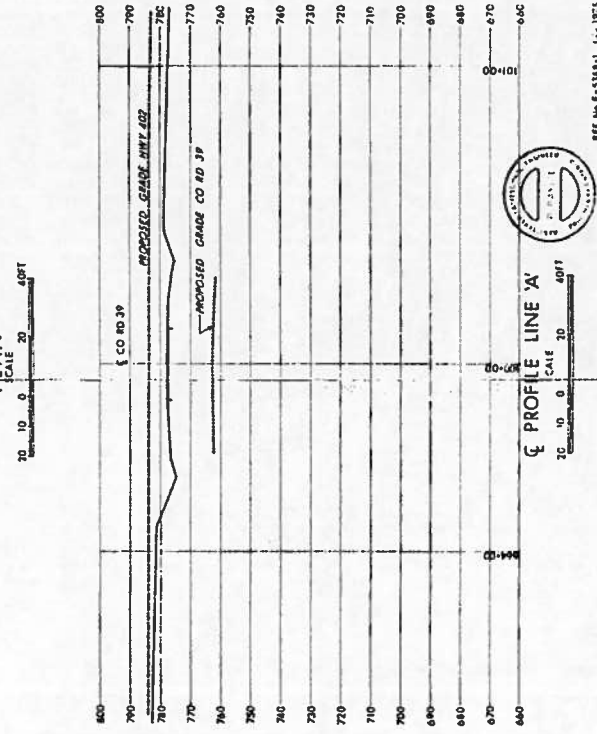
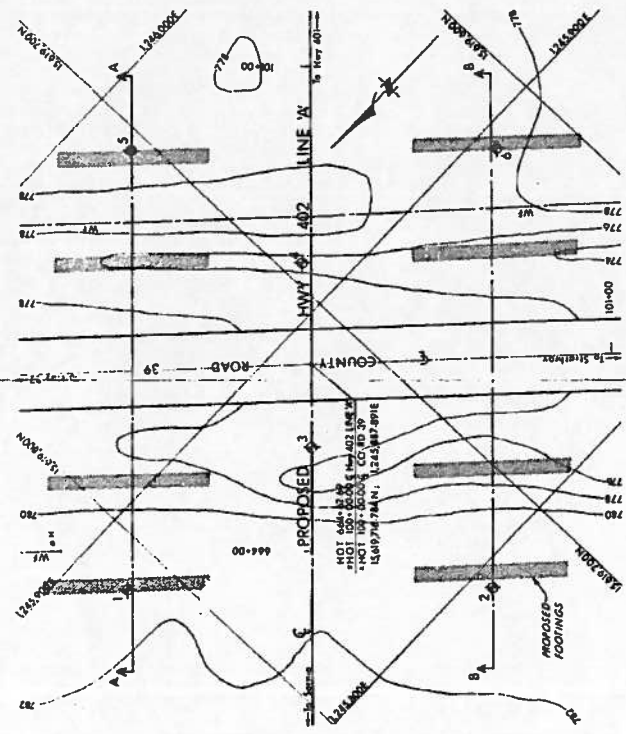
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS - ONTARIO
INSPECTION SERVICES BRANCH, GEOTECHNICAL DIVISION, SOIL MECHANICS SECTION

COUNTY ROAD 39
19.8 Miles West of Hwy 21

CHART NO. 4013-46
TWP. OF MIDDLESEX
TWP. OF ADELAIDE & CARADOC
BORE HOLE LOCATIONS & SOIL STRATA

DATE OF FIELD INVESTIGATION: 1973
DATE OF REPORT: 1973
DRAWN BY: [Name]
CHECKED BY: [Name]

PROJECT NO. 406619 & 20-A
SHEET NO. 18 OF 22



REF No E-338B-1, Jan 1975

DIST. No. 2

CONT No 79-51

WP No 40-66-19

COUNTY RD. 39 INTERCH. O'PASS
9.8 miles west Hwy. 2

GENERAL PLAN

E.B.L. bridge, Hwy. 402

SHEET

120

NOTES

Class of Concrete

Prestressed girders ----- 5000 P.S.I.
Deck, slab, diaphragms, barrier walls, piers ----- 4000 P.S.I.
Remainder ----- 3000 P.S.I.

Clear Cover to Reinf. Steel

Footings ----- 3"
Abuts. ----- 3"
Deck ----- 2" top, 1" bot
Barrier walls ----- As shown
Approach slabs ----- 2"
Or as noted on the drawings.

Construction Notes

The Contractor is responsible for finishing the bearing seats dead level to the specified elevations with a tolerance of $\pm 1/8"$. No concrete shall be placed above the abutment bearing seats until concrete in the deck has been placed.

Reinforcing Steel Grade ----- 400
Reinf. bars with the designation 'C' at the end of the bar marks shall be coated bars.

Formwork

The formwork between deck & ballast walls, & deck (abut. brg. seats) (E.G. expanded polystyrene) shall be removed by the Contractor.

Concrete Quantities

Concrete quantities are listed below for the appropriate lump sum tender items:

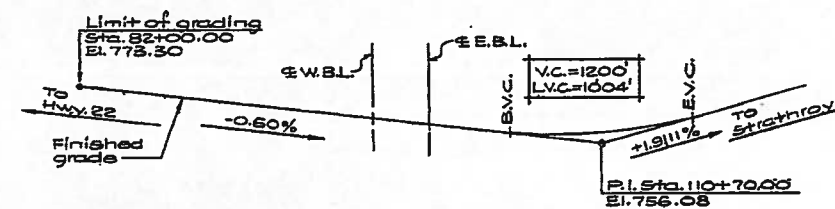
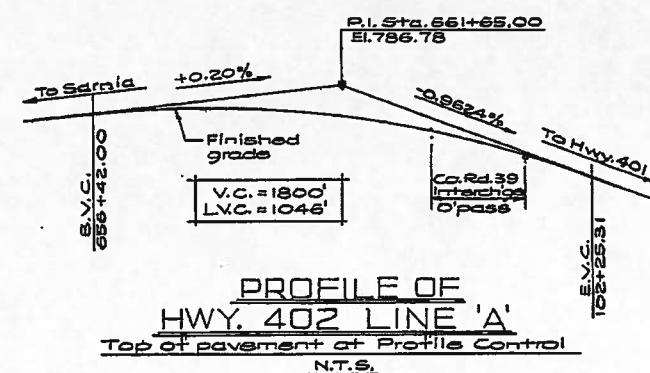
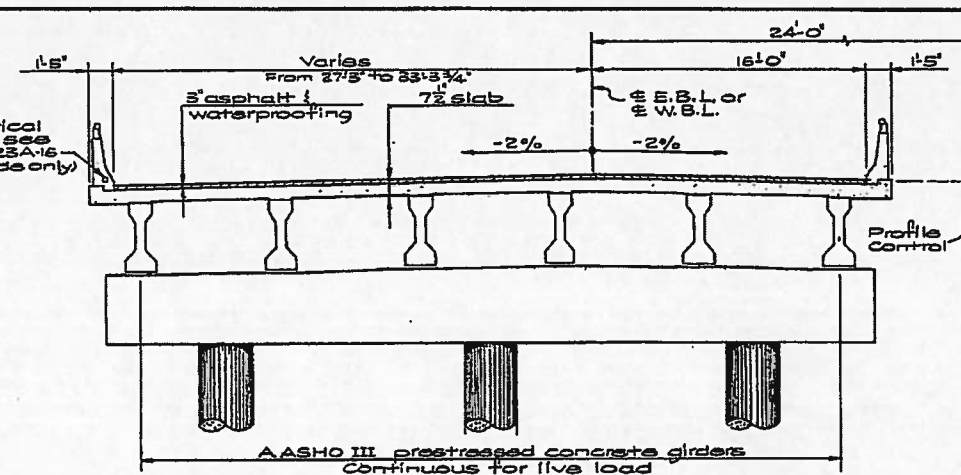
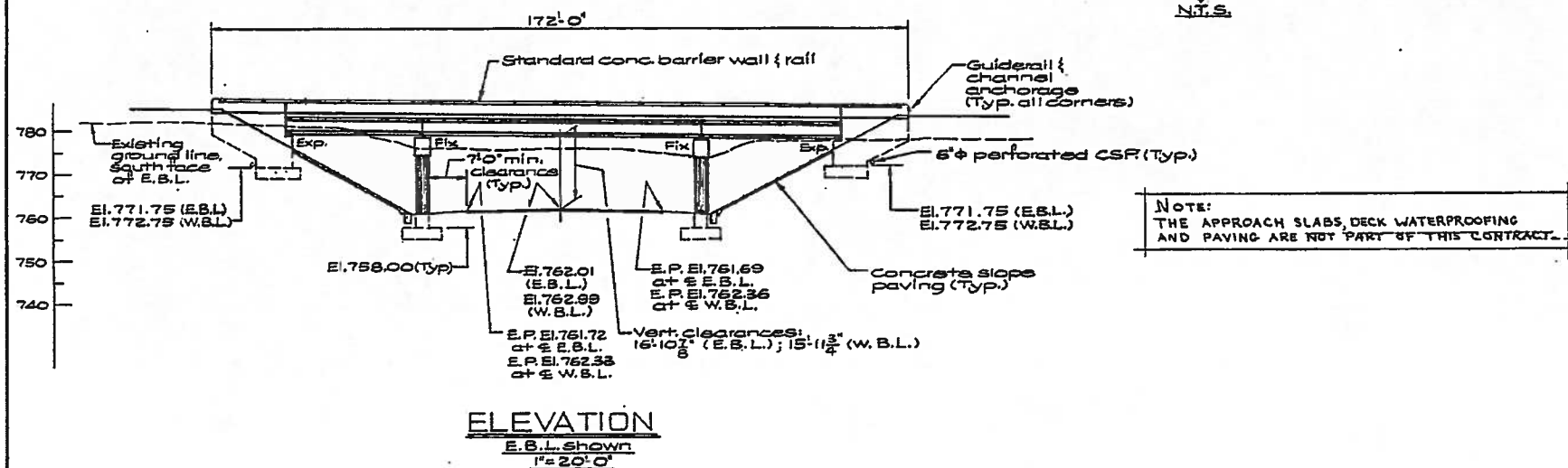
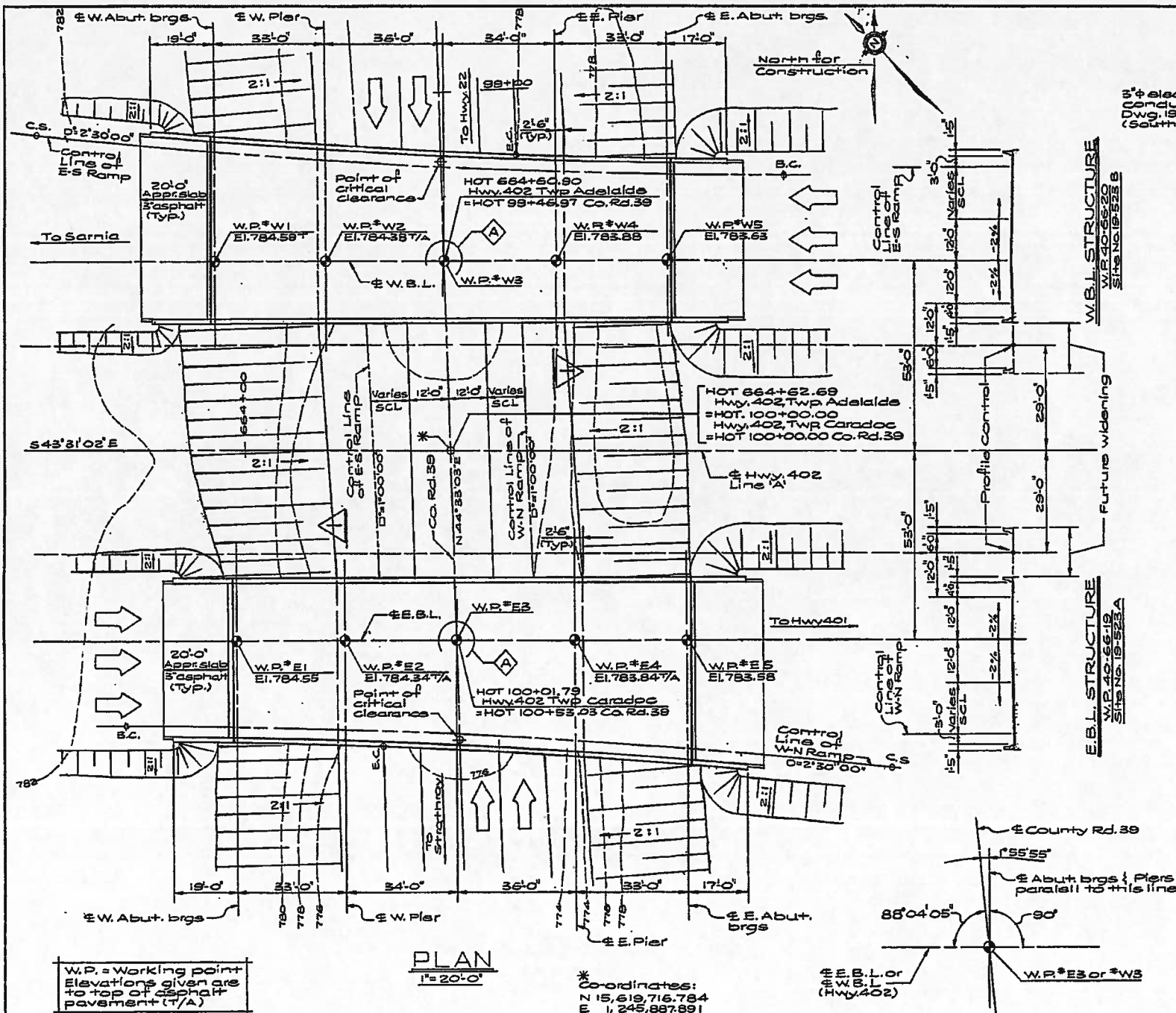
Concrete in piers, abutments & wingwalls ----- 3,000 P.S.I., 129 cu yd.
4,000 P.S.I., 73 cu yd.

Concrete in deck & diaphragms ----- 200 cu yd.

Concrete in barrier walls ----- 26 cu yd.

Concrete in approach slabs ----- 58 cu yd.

Concrete in slope paving ----- 55 cu yd.



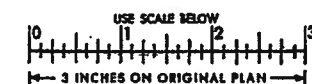
LIST OF DRAWINGS

- 19-523A-1 General Plan
 2 Bore Hole Locations & Soil Strata
 3 Footing Layout & Site Layout Plan
 4 West Abutment
 5 East Abutment
 6 Piers
 7 Bearing Layout & Details
 8 Prestressed Girders
 9 Deck Details
 10 Barrier Walls
 11 Steel Railing
 12 20 Ft. Approach Slabs
 13 Details of Conc. Slope Paving
 14 Standard Details I
 15 Standard Details II
 16 Bridge Electrical Detail-Type IV
 17 As Constructed Elev. & Dim.

BM 783.28

Geodetic Datum
N 1/4 in N.W. Root of 2.0 Maple
363' Ltr. 101+73

FOR REDUCED PLAN



REVISIONS	DATE	BY	DESCRIPTION



APPENDIX B

Site Photographs



Photograph 1: Looking north at Hickory Drive Overpass EBL and WBL structures. Slopes covered with snow and withered grasses. (February 19, 2014)



Photograph 2: Looking at south wingwall of the west abutment of EBL structure. No obvious major cracks observed except for surficial longitudinal cracks. No erosion could be observed on adjacent slope due to snow cover. (February 19, 2014)



Photograph 3: Looking at west abutment of EBL structure. Front slope covered with concrete, no obvious major cracks observed except surficial cracks on the abutment wall. No weeping hole or outlet system observed out of abutment wall. (February 19, 2014)



Photograph 4: Looking at east abutment wall and piers of EBL structure. Front slope covered with concrete; no obvious major cracks observed except for surficial cracks. No weeping hole or outlet system observed on abutment wall. Some surface rehabilitation of the piers was performed. (February 19, 2014)



Photograph 5: Looking at north wingwall of the west abutment of EBL structure, no obvious major cracks observed except for surficial cracks. Adjacent slope covered with snow. (February 19, 2014)



Photograph 6: Looking at south wingwall of the west abutment of WBL structure; no obvious major cracks observed except for surficial cracks. Slight erosion was observed on the exposed slope. (February 19, 2014)



Photograph 7: Looking at west abutment wall of WBL structure. Front slope covered with concrete, no obvious major cracks observed except map cracking. No weeping hole or outlet system observed on abutment. (February 19, 2014)



Photograph 8: Looking at north wingwall of the west abutment of WBL structure; no obvious major cracks observed except for surficial cracks. Slope covered with snow and withered grasses.



Photograph 9: Looking at north wingwall of the east abutment of WBL structures; no obvious major cracks observed except for surficial cracks. Adjacent slope covered with snow and few withered grasses. (February 19, 2014)



Photograph 10: Looking at south wingwall of the east abutment of WBL structure; no obvious major cracks observed except for surficial cracks. Slope covered with snow. (February 19, 2014)



Photograph 11: Looking at north wingwall of the east abutment of EBL structure; no obvious major cracks observed except for surficial cracks. Adjacent slope covered with snow and few withered grasses.



Photograph 12: Looking at south wingwall of the east abutment of EBL structure. Corner concrete damage of the wall was observed. Otherwise no obvious major cracks were observed except for surficial cracks. Adjacent slope covered with snow. (February 19, 2014)



Photograph 13: Looking at the piers of the west abutment of EBL structure. Concrete cracks, spalling and deterioration were observed on the surfaces of the piers. (February 19, 2014)



Photograph 14: Concrete deterioration exposed the reinforcement of piers.



Photograph 15: Looking at a pier of the east abutment of EBL structure. Concrete cracks, spalling and deterioration were observed on the pier surface. Rehabilitation was performed on the pier surface, however, deterioration progressed exposing the rebars. (February 19, 2014)



Photograph 16: Looking at a pier of the east abutment of WBL structure. Surface rehabilitation was performed on the pier surface. (February 19, 2014)