



**PRELIMINARY FOUNDATION INVESTIGATION AND DESIGN REPORT
for**

**BEAVER CREEK STRUCTURES
HIGHWAY 404 HOV LANE EXPANSION
FROM HIGHWAY 407 TO GREEN LANE
SITES 37-277-1 & 37-277-2, WO 03-20024
REGIONAL MUNICIPALITY OF YORK, ONTARIO**

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PML Ref.: 14TF003A-BC
Index No.: 048FIDR
Geocres No.: 30M14-420
June 8, 2015



PRELIMINARY FOUNDATION INVESTIGATION REPORT

for

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PART A
PRELIMINARY FOUNDATION INVESTIGATION REPORT

for
Beaver Creek Structures
Highway 404 HOV Lane Expansion
From Highway 407 to Green Lane
WO 03-20024, Sites 37-277-1 & 37-277-2
Regional Municipality of York, Ontario

1. INTRODUCTION

The Foundation Engineering Services required for this project include preparation of a preliminary design level Foundation Investigation and Design Report for the proposed Highway 404 High Occupancy Vehicle (HOV) lanes expansion from Highway 407 to Green Lane, 26 km, in the Regional Municipality of York.

This report addresses the proposed widening into the median of both the existing Highway 404 NBL and SBL bridge structures over Beaver Creek. The report was prepared for the MMM Group Limited on behalf of the Ontario Ministry of Transportation.

This Preliminary Foundation Investigation Report summarizes the subsurface conditions based on information from available relevant reports and PML's recent field investigation at this site. The related Preliminary Foundation Design Report provides preliminary design level recommendations. The report is intended for preliminary design and planning purposes. Detail design level foundation engineering services will be required for the detail design phase of the project.

The elevations in this report are expressed in metres, unless otherwise noted.

2. SOURCES OF INFORMATION

The following reports, including drawings, were available for the Beaver Creek Bridge Structures. The boreholes from the Foundation Investigation Report in Reference 2 are included in Appendix A of this report. The Borehole Locations and Soil Strata Drawing from the Foundation Investigation Report in Reference 2 are included in Appendix B of this report.



REFERENCE 1:

- Foundation Investigation Report for Proposed Crossing at the New Highway #404 (Line 'A') and Beaver Creek Diversion, Township of Markham, County of York, District No. 6 (Toronto), W.O. 70-11102, W.P. 290-61, Department of Highways Ontario - Foundation Section, dated February 9, 1971, GEOCRE 30M14-53.

REFERENCE 2:

- Foundation Investigation Report for Beaver Creek Bridge, 0.5 Miles North of Highway 7, Highway 404, District 6, Toronto, W.P. 160-74-24, Site 37-277 by Soil Mechanics Section – Ministry of Transportation and Communications - Ontario, dated April 20, 1977, GEOCRE 30M14-53.
- General Layout Drawing, HWY 404 Crossing at Beaver Creek, Site 37-277, Drawing 1, W.P. No. 160-74-24, CONT NO. 78-45 by McCormick, Rankin & Associates Limited, dated June 1977.

In addition to the above GEOCRE reports, the following documents were also reviewed:

- Ministry of Northern Development and Mines. 1991. Bedrock Geology of Ontario – Southern Sheet, Map 2544, Scale 1:1,000,000.
- Chapman and Putnam. 1984. The Physiography of Southern Ontario, 3rd Edition.
- Ontario Geological Survey. 1984. Physiography of Southern Ontario, Map 2715, Scale 1:600,000.

3. SITE DESCRIPTION AND GEOLOGY

The site is located approximately 800 m north of Highway 7 and Highway 404 interchange junction in the Regional Municipality of York.

Each of the Highway 404 overpass structures carries four lanes of traffic over Beaver Creek. The topography of the site area is generally flat to gently undulating with industrial lands in the immediate vicinity of the site location. The Toronto Buttonville Municipal Airport is located approximately 450 m north-east of the site.

Physiographically, the site is located in a region known as the Peel Plain. The subsoil in the area is characterized by moraine till layers and silty sand deposits. Coarse grained granular deposits of variable thickness are interbedded in the till at random locations. Upper Ordovician shale bedrock of Georgian Bay Formation underlies the overburden in the area.



4. INVESTIGATION PROCEDURES

The subsurface conditions presented in this report were determined through review of the past Foundation Investigation and Design Reports identified in Section 2 under References and supplemented with 4 new boreholes.

The recent field work was carried out during the period September 14 to 26, 2014. Four sampled boreholes were investigation at the locations shown on Drawing BCR-1. The boreholes were drilled to depths of 15.4 to 17.0 m.

Approximate borehole locations (previous and recent) are shown in Map-1.

The boreholes were staked out by PML and the ground surface elevations at the boreholes were provided by MMM. Approximate borehole locations (previous and recent) are shown on Map-1, which shows a regional perspective to illustrate all borehole locations referred to. Boreholes relevant to the current site are illustrated on Borehole Locations and Soil Strata Drawing BCR-1.

The boreholes were advanced using continuous flight solid stem augers and mud rotary, powered by a truck-mounted CME-75 drill rig, supplied and operated by a specialist drilling contractor, working under the full-time supervision of a member of our engineering staff. The water for the mud rotary drilling operations was brought to the site in a water truck and a sediment tank was used to capture and recirculate the water. No water from the drilling operation was introduced in the creek. Boreholes were abandoned in compliance with MOE Regulation 903.

Representative samples of the soils were recovered in the boreholes at depth intervals of 0.75 and 1.5 m. The soil samples were obtained using a split spoon sampler in conjunction with standard penetration tests. Pocket penetrometer testing was performed to obtain shear strengths on selected recovered cohesive soils. It is noted that the results of penetrometer tests may be lower than the actual values due to sample disturbance.



The groundwater conditions at the borehole locations were assessed during drilling by visual examination of soil, the sampler and drill rods as the samples were retrieved and, when appropriate, by measurement of the water level in the open boreholes. The water level observations are noted on the attached Record of Borehole Sheets. Piezometers were installed in the boreholes for subsequent groundwater measurements.

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, soil classification and laboratory testing. The laboratory testing program comprised the following tests:

- Natural moisture content determinations (52)
- Grain Size analyses (16)
- Atterberg Limits (11)

5. SUBSURFACE CONDITIONS

According to the previous report (boreholes and relevant figures attached in Appendices A and B), on the east side of Beaver Creek, the subsoil consisted of a 7.3 m thick compact silty sand to silt deposit underlain by very stiff to hard cohesive glacial till. On the west side of the Beaver Creek the overburden consisted of 1.2 to 1.8 m of silty sand with some clay and organic inclusions followed by 0.6 to 2.1 m of loose to compact silt with trace of sand and gravel. This granular stratum is underlain by a very stiff to hard cohesive glacial till. The water levels measured in the open boreholes was found to be at depths between 0.9 to 3.0 m (elevation 184.8 to 185.6). The water level in Beaver Creek was at elevation 184.7 at the time of the field investigation (February 1977).

The borehole locations at the site are presented on the attached Drawing BCR-1. Boreholes BC-1 and BC-2 were advanced at the south abutments. Boreholes BC-3 and BC-4 were advanced at the north abutments.

Reference is made to the appended Log of Borehole sheets for details of the subsurface conditions, including soil classifications, inferred stratigraphy and boundary elevations, standard penetration test data, groundwater observations as well as the results of laboratory grain size distribution analysis, Atterberg limits and moisture content determinations. The results of the



laboratory natural moisture content determinations, grain size analyses and Atterberg limits are shown on the Record of Borehole sheets. Grain size distributions and Atterberg limits are presented in Figures identified for specific soil layers.

The stratigraphy at the north and south abutments locations essentially consists of approximately 6.2 to 7.2 m thick noncohesive and cohesive fills overlying an approximately 4.6 to 6.7 m thick layer of clayey silt till, which is underlain by a deposit of sandy silt till at least 5 m deep in which boreholes were terminated.

Descriptions of the soil strata and groundwater conditions encountered are provided below:

5.1 Fill

The soil strata encountered at ground surface at the borehole locations consisted of 6.2 to 7.2 m thick fills consisting of alternating layers of silty sand and clayey silt materials. The fill was penetrated at elevation 183.0 to 183.8. The denseness of the silty sand fill ranged from very loose to compact but was generally compact. The consistency of the clayey silt fill ranged from firm to very stiff. Occasional boulders and debris were encountered within the fill. Refer to the borehole logs for illustrations of the sequence of and thicknesses of fill layers.

Refer to Figures BC-GS-1A and BC-GS-1B for grain size distributions of the silty sand fill and clayey silt fill respectively.

The Atterberg limits of the clayey silt fill are shown on the Plasticity Chart Figure BC-PC-1. The liquid limits of two typical samples of the clayey silt fill are 28 and 25 and the corresponding plastic limits are 15 and 14, resulting in plastic index values of 13 and 11. The moisture content of the fill samples ranged between 4 and 25%.



5.2 Clayey Silt Till

Beneath the fill, a 4.6 to 6.7 m thick layer of cohesive clayey silt till deposit with sand was encountered at depths of 6.2 to 7.2 m (elevation 183.0 to 183.8) and penetrated at 10.8 to 13.4 m (elevation 176.6 to 179.2). A 1.5 m thick deposit of sandy silt was encountered at a depth of 10.1 m (elevation 179.9) within this deposit at boreholes BC-3 and BC-4 at the north abutment location.

The clayey silt till deposit was stiff to hard with N values ranged from 9 to over 100. Pocket penetrometers tests on selected samples were 50 to 125 kPa.

A grain size envelope of selected samples of the clayey silt till is shown on Figure BC-GS-2.

Atterberg limits from representative samples are shown on Figure BC-PC-2. The liquid limits of the clayey silt till unit are 15, 15 and 16 and the corresponding plastic limits are 10, 11 and 11, resulting plasticity index values of 5, 4 and 5. The moisture contents of the clayey silt varied from 11 to 62%.

5.3 Sandy Silt Till

A deposit of sandy silt till containing occasional cobbles and boulders was encountered in all boreholes below the clayey silt till at depths of 10.8 to 13.4 m (elevation 176.6 to 179.2). The deposit was not fully penetrated by the boreholes but is at least 5 m thick. The denseness of the deposit is very dense with N values in excess of 100.

The grain size distribution of a similar deposit within the overlying Clayey Silt Till layer is shown on Figure BC-GS-3.



5.4 Groundwater

Water level observed during drilling was at 5.2 m, between elevations 184.8 and 185.1. Upon completion of drilling groundwater could not be established due to mud drilling method. The following table summarizes the subsequent groundwater level measurements in the piezometers installed in the four boreholes.

BOREHOLE NO.	GROUND SURFACE ELEVATION (M)	WATER LEVEL MEASURED DURING DRILLING		PIEZOMETER WATER LEVEL MEASURED DATE SEPTEMBER 17, 2014		PIEZOMETER WATER LEVEL MEASURED DATE DECEMBER 18, 2014	
		Depth (m)	Elevation	Depth (m)	Elevation	Depth (m)	Elevation
BC-1	190.0	5.2	184.8	2.0	188	0.7	189.3
BC-2	190.3	5.2	185.1	-	-	5.2	185.1
BC-3	190.0	5.2	184.8	-	-	0.7	189.3
BC-4	190.0	5.2	184.8	-	-	Not ¹ Measured	-

Note 1: The flush mount was covered with ice and snow on December 18, 2014.

At the time of the investigation, the creek water level was measured at about elevation 185.3 on September 14, 2014. The groundwater levels are subjected to fluctuations due to seasonal and rainfall patterns.



6. MISCELLANEOUS

The Preliminary Foundation Investigation portion of this report was prepared by Mr. N. Rahman, P.Eng., and reviewed by Mr. D. Dundas, P.Eng. The report was independently reviewed by Mr. B. R. Gray, MEng, P.Eng., MTO Designated Principal Contact.

Yours very truly,

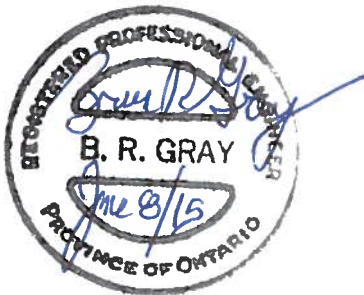
Peto MacCallum Ltd.



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



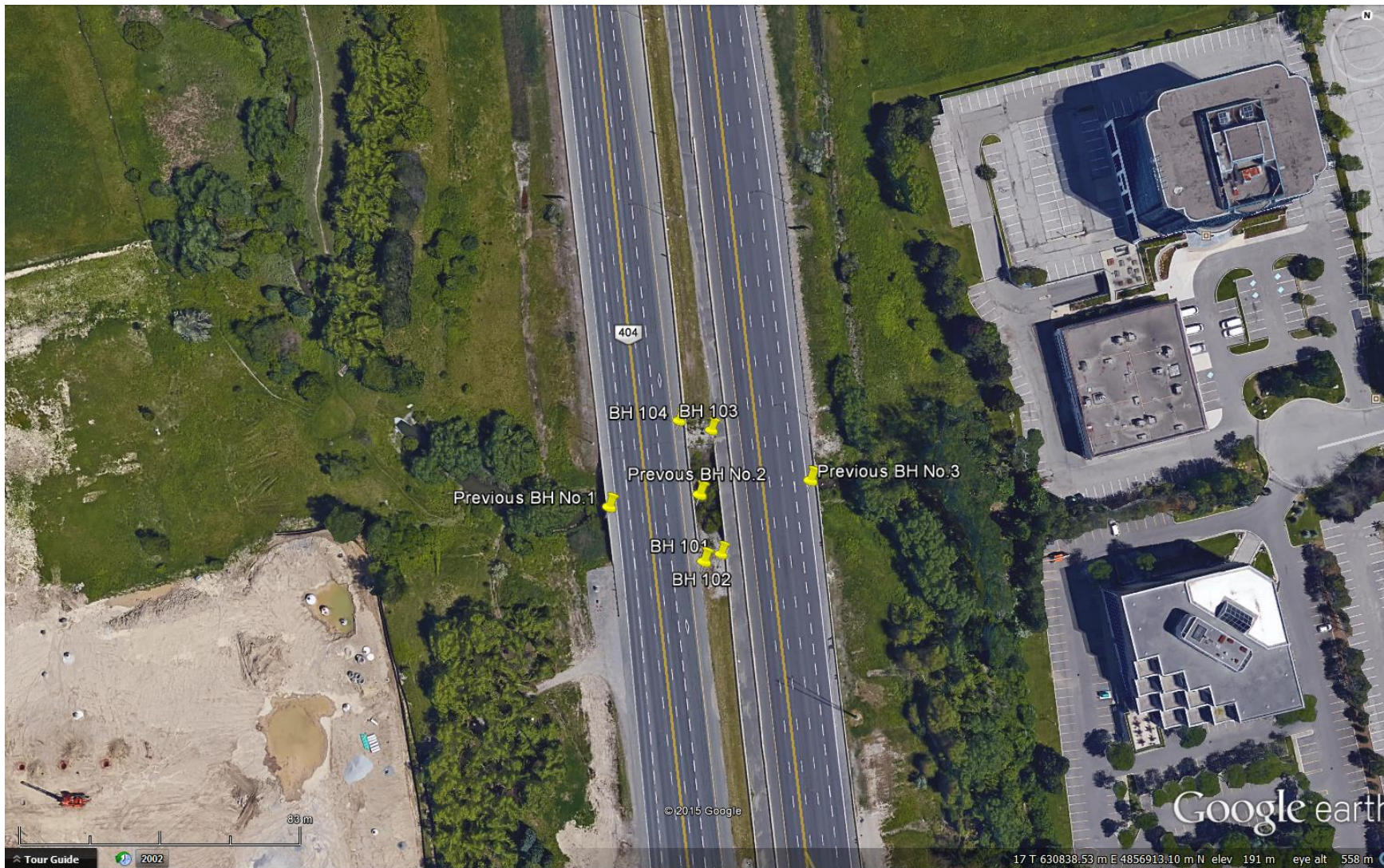
David Dundas, P.Eng.
Senior Engineer, Geotechnical Services



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

NR/DD/BRG:nr-mi-jk-nk

MAP 1: PREVIOUS AND RECENT BOREHOLE LOCATIONS (APPROXIMATE)



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'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_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 BC-1

1 of 2

METRIC

G.W.P. 03-20024 LOCATION Coords: 4 857 129.6 N; 315 038.3 E ORIGINATED BY F.P.
 DIST Central HWY 404 BOREHOLE TYPE C.F.S.S.A. and Mud Rotary COMPILED BY N.R.
 DATUM Geodetic DATE September 14-17, 2014 CHECKED BY D.D.

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			SHEAR STRENGTH kPa									WATER CONTENT (%)	
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE							
190.0	Ground Surface						20	40	60	80	100		20	40	60			
0.0	Silty sand occasional gravelly zones Compact		1	SS	23								○					
			2	SS	13								○					
	Clayey silt, with sand Very stiff Moist		3	SS	16								○					
	(FILL)		4	SS	17								○			7 35 35 23		
			5	SS	33								○					
	Silty sand Compact		6	SS	23								○					
	Clayey silt Firm to stiff		7	SS	5								○					
	Silty sand occasional silt zones Loose		8	SS	4								○					
183.8																		
6.2	Clayey silt with sand, trace garvel Stiff to very stiff		9	SS	13								○					
	(TILL)																	
			10	SS	9								■			3 38 40 19		
			11	SS	16										○			
179.2																		
10.8	Sandy silt trace clay, trace gravel occasional cobbles Dense to very dense		12	SS	40								■			1 19 68 12		
	(TILL)																	
			13	SS	50/5cm													
			14	SS	100/10cm								○			9 41 42 8		




Cont'd

RECORD OF BOREHOLE No BC-1

2 of 2

METRIC

G.W.P. 03-20024 **LOCATION** Coords: 4 857 129.6 N; 315 038.3 E **ORIGINATED BY** F.P.
DIST Central **HWY** 404 **BOREHOLE TYPE** C.F.S.S.A. and Mud Rotary **COMPILED BY** N.R.
DATUM Geodetic **DATE** September 14-17, 2014 **CHECKED BY** D.D.

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE											
						20 40 60 80 100											
175.0																	
174.4	Sandy silt trace clay, trace gravel occasional cobbles		15	SS	117/23cm												
15.6	Dense to very dense (TILL) (Cont'd.)																
	End of borehole																
	* 2014 09 14 to 17																
	▽ Water level observed during drilling																
	■ Penetrometer																
	<u>Water Level Readings:</u>																
	Date Depth (m) Elev.																
	Sept.17/2014 2.0 188.0																
	Dec.18/2014 0.7 189.3																
	<u>Piezometer Legend:</u>																
	 Bentonite																
	 Filter sand																
	 Screen																

RECORD OF BOREHOLE No BC-2

1 of 2

METRIC

G.W.P. 03-20024 LOCATION Coords: 4 857 127.1 N; 315 033.3 E ORIGINATED BY F.P.
DIST Central HWY 404 BOREHOLE TYPE C.F.S.S.A. and Mud Rotary COMPILED BY N.R.
DATUM Geodetic DATE September 17-19, 2014 CHECKED BY D.D.

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE							
190.3 0.0	Ground Surface						20 40 60 80 100		20 40 60							
Silty sand occasional gravelly zones Compact Clayey silt, with sand Firm to very stiff			1	SS	13											
			2	SS	25											
			3	SS	19											
			4	SS	15											
			5	SS	35											
			6	SS	31											
			7	SS	6											
			8	SS	3											
			9	SS	22											
183.1 7.2	Clayey silt with sand, trace gravel Stiff to hard		10	SS	14											
(TILL)			11	SS	27											
			12	SS	50/8cm											
			13	SS	81											
176.9 13.4	Sandy silt trace clay, trace gravel occasional cobbles Very dense		14	SS	50/8cm											
(TILL)																

Cont'd






Cont'd

RECORD OF BOREHOLE No BC-2

2 of 2

METRIC

G.W.P. 03-20024 **LOCATION** Coords: 4 857 127.1 N; 315 033.3 E **ORIGINATED BY** F.P.
DIST Central **HWY** 404 **BOREHOLE TYPE** C.F.S.S.A. and Mud Rotary **COMPILED BY** N.R.
DATUM Geodetic **DATE** September 17-19, 2014 **CHECKED BY** D.D.

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE											
						20 40 60 80 100											
175.3	Sandy silt trace clay, trace gravel occasional cobbles Very dense (Cont'd.) (TILL)		15	SS	74/8cm		175										
							174										
173.3 17.0	End of borehole		16	SS	65/8cm												
* 2014 09 17 to 19  Water level observed during drilling <u>Water Level Readings:</u> Date Depth Elev. (m) Dec.18/2014 5.2 185.9 <u>Piezometer Legend:</u>  Bentonite  Filter sand  Screen																	

RECORD OF BOREHOLE No BC-3

1 of 2

METRIC

G.W.P. 03-20024 LOCATION Coords: 4 857 167.0 N; 315 033.6 E ORIGINATED BY F.P.
 DIST Central HWY 404 BOREHOLE TYPE C.F.S.S.A. and Mud Rotary COMPILED BY N.R.
 DATUM Geodetic DATE September 22 & 23, 2014 CHECKED BY D.D.




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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE					
190.0	Ground Surface						20	40	60	80	100					
0.0	Silty sand occasional gravelly zones Compact		1	SS	13											
			2	SS	9											
	Clayey silt, with sand		3	SS	12											
	Stiff to very stiff		4	SS	12											2 48 32 18
			5	SS	17											
			6	SS	18											
	Silty sand occasional silt zones		7	SS	5											
	Very loose to loose		8	SS	7											
	(FILL)		9	SS	3											
183.3	Clayey silt with sand, trace gravel															
6.7	Very stiff to hard		10	SS	21											
	(TILL)															
			11	SS	38											1 30 37 32
	Sandy silt trace clay, trace gravel		12	SS	59											2 48 42 8
	Very dense															
			13	SS	105											9 31 34 26
176.6	Sandy silt trace clay, trace gravel															
13.4	Very dense		14	SS	100/13cm											
	(TILL)															
	Cont'd															

RECORD OF BOREHOLE No BC-3

2 of 2

METRIC

G.W.P. 03-20024 **LOCATION** Coords: 4 857 167.0 N; 315 033.6 E **ORIGINATED BY** F.P.
DIST Central **HWY** 404 **BOREHOLE TYPE** C.F.S.S.A. and Mud Rotary **COMPILED BY** N.R.
DATUM Geodetic **DATE** September 22 & 23, 2014 **CHECKED BY** D.D.

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
175.0																
174.5	Sandy silt trace clay, trace gravel		15	SS	100/15cm											
15.5	Very dense (TILL) (Cont'd.)															
	End of borehole															
	* 2014 09 23															
	∇ Water level observed during drilling															
	<u>Water Level Readings:</u>															
	Date Depth Elev. (m)															
	Dec.18/2014 0.7 189.3															
	<u>Piezometer Legend:</u>															
	 Bentonite															
	 Filter sand															
	 Screen															

RECORD OF BOREHOLE No BC-4

1 of 2

METRIC

G.W.P. 03-20024 LOCATION Coords: 4 857 168.5 N; 315 023.5 E ORIGINATED BY F.P.
 DIST Central HWY 404 BOREHOLE TYPE C.F.S.S.A. and Mud Rotary COMPILED BY N.R.
 DATUM Geodetic DATE September 23-26, 2014 CHECKED BY D.D.

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE									
190.0	Ground Surface							20	40	60	80	100		20	40	60	GR SA SI CL			
0.0	PAVEMENT STRUCTURE																			
189.7	Silty sand		1	SS	37								○							
0.3	occasional gravelly zones		2	SS	29								○							
	Compact																			
	Clayey silt, with sand		3	SS	18								○							
	occ. cobbles and boulders																			
	Stiff to		4	SS	19								○							
	very stiff																			
	(FILL)		5	SS	19								○				3 34 39 24			
			6	SS	13									○						
	Silty sand		7	SS	6										○					
	occasional silt zones		8	SS	6								○							
	Loose		9	SS	5								○				1 80 17 2			
183.0	Clayey silt																			
7.0	with sand, trace gravel		10	SS	10				■				○							
	Stiff to																			
	hard																			
	(TILL)																			
			11	SS	36								○							
	Silty sand																			
	trace clay, trace gravel																			
	Very dense		12	SS	65								○				5 62 30 3			
			13	SS	103								○				4 34 44 18			
176.6	Sandy silt																			
13.4	trace clay, trace gravel		14	SS	50/8cm								○							
	Very dense																			
	(TILL)																			
	Cont'd																			

Cont'd

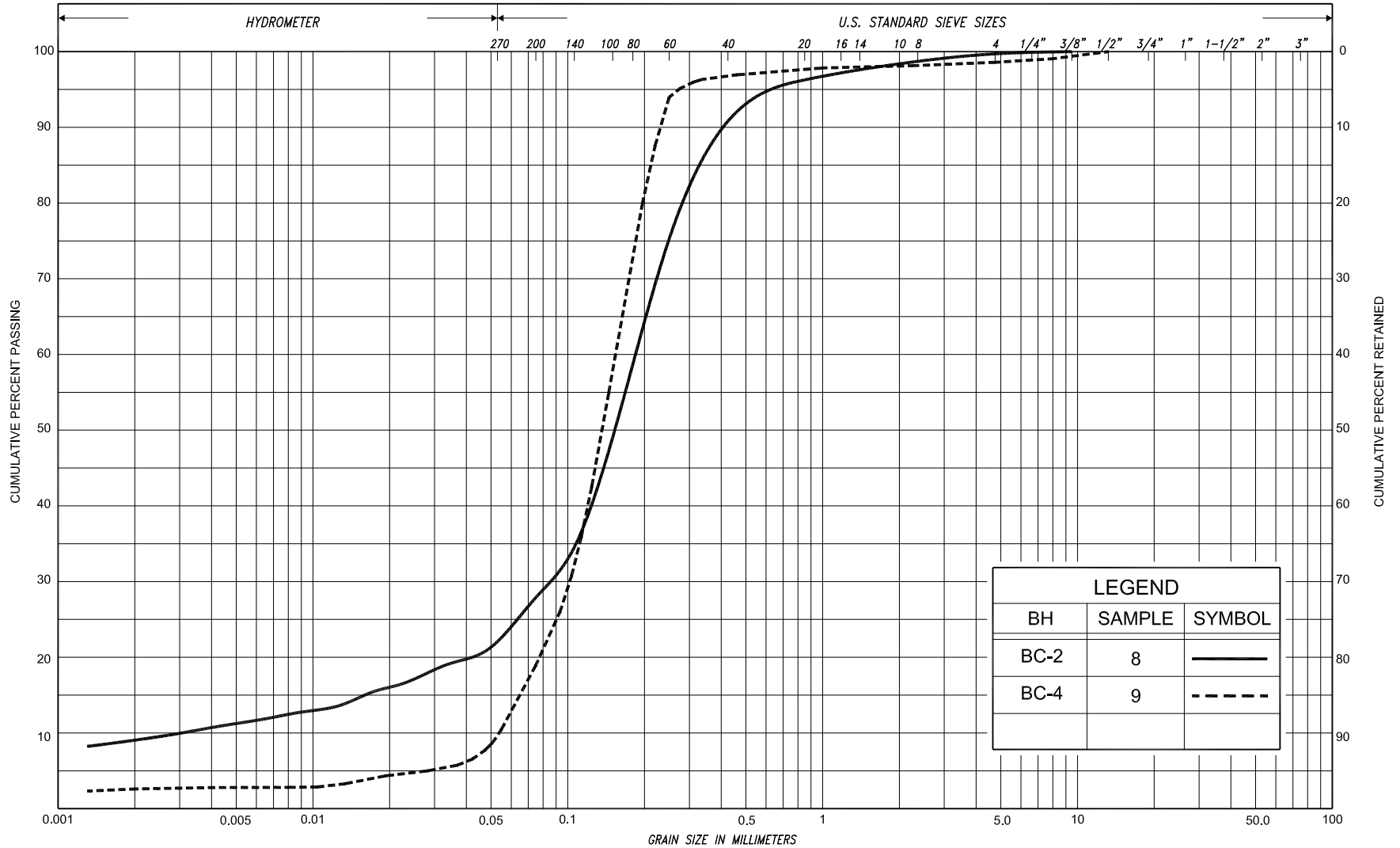
RECORD OF BOREHOLE No BC-4

2 of 2

METRIC

G.W.P.	03-20024	LOCATION	Coords: 4 857 168.5 N; 315 023.5 E	ORIGINATED BY	F.P.
DIST	Central	HWY	404	BOREHOLE TYPE	C.F.S.S.A. and Mud Rotary
				COMPILED BY	N.R.
DATUM	Geodetic	DATE	September 23-26, 2014	CHECKED BY	D.D.

[illegible]



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

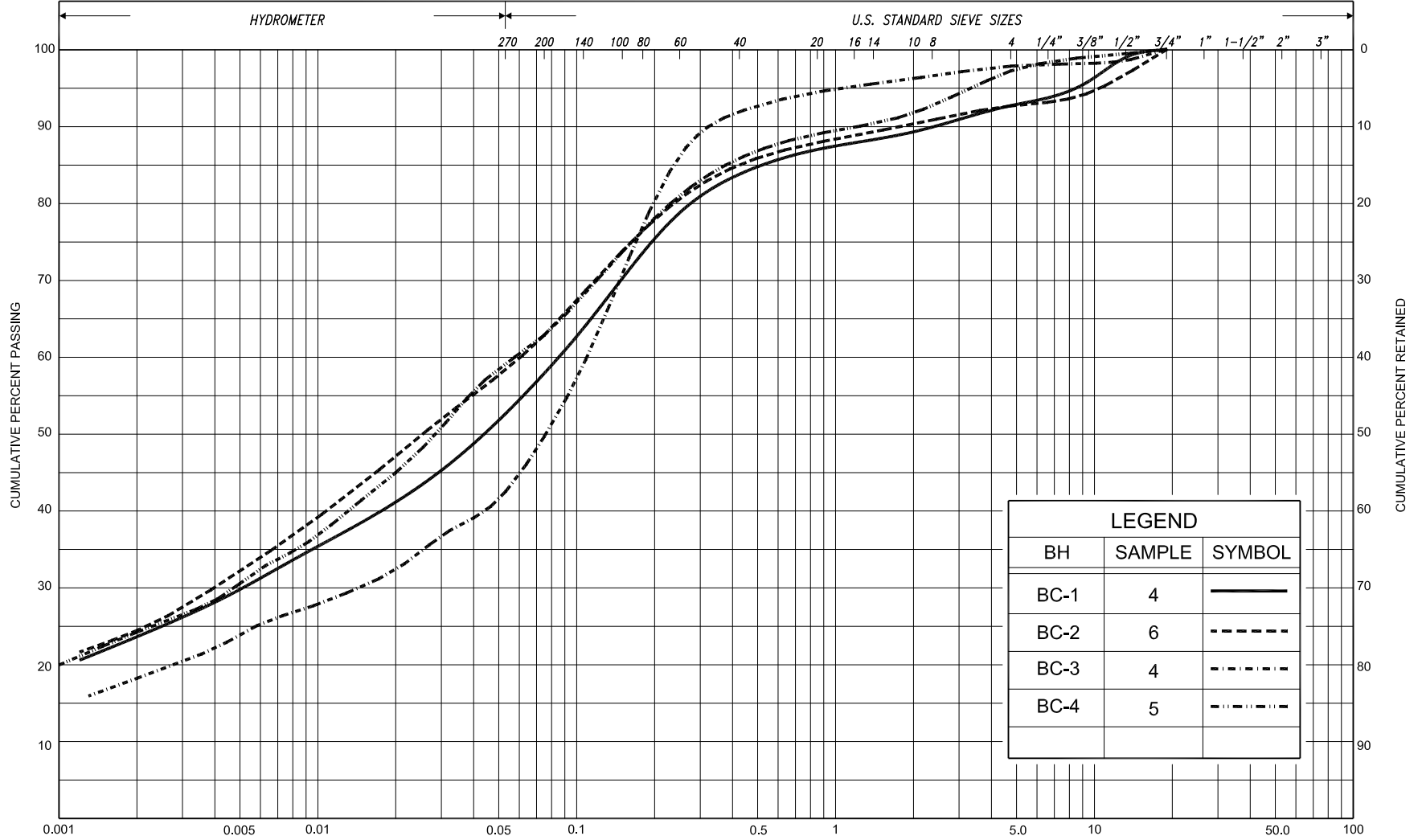


GRAIN SIZE DISTRIBUTION SILTY SAND (FILL)

FIG No. BC-GS-1A

HWY: 404

G.W.P. No. 03-20024

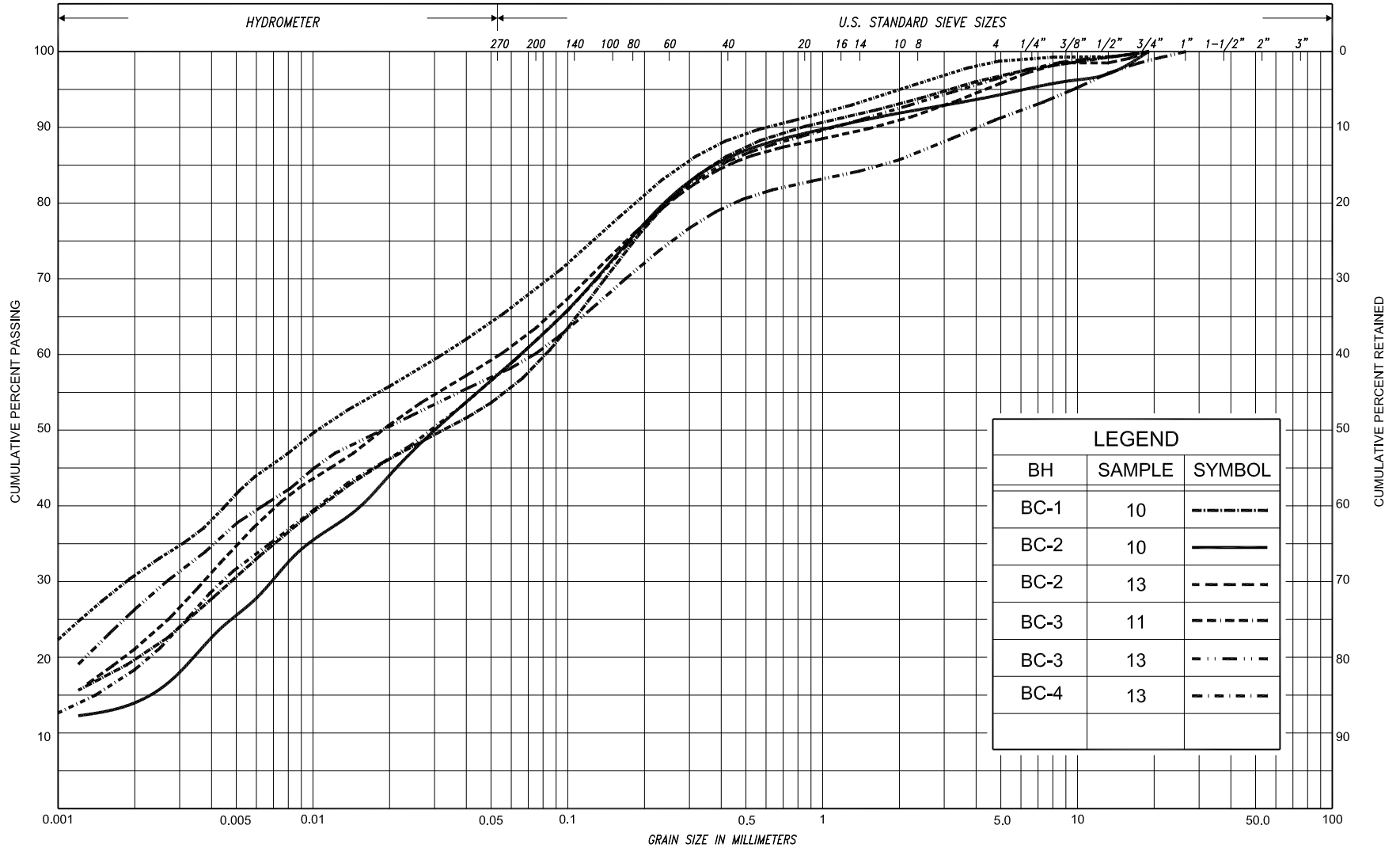


SILT & CLAY				FINE		MEDIUM		COARSE	GRAVEL		COBBLES	UNIFIED
				SAND								
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	GRAVEL				COBBLES	M.I.T.
	SILT											
CLAY		SILT		V. FINE	FINE	MED.	COARSE	GRAVEL				U.S. BUREAU
				SAND								



GRAIN SIZE DISTRIBUTION CLAYEY SILT, with sand (FILL)

FIG No. BC-GS-1B
HWY: 404
G.W.P. No. 03-20024



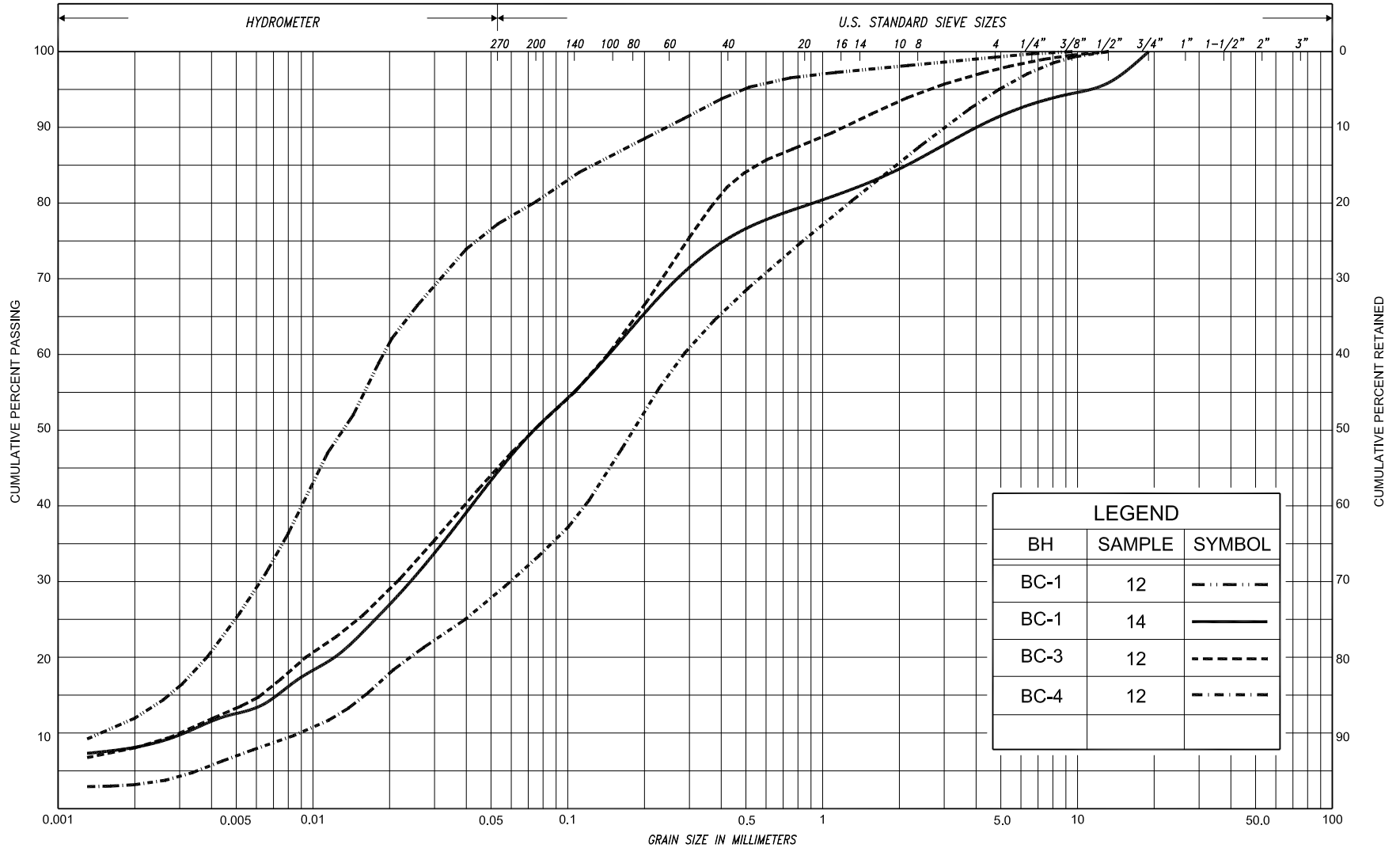
SILT & CLAY				FINE		MEDIUM		COARSE	GRAVEL		COBBLES	UNIFIED			
				SAND											
CLAY	FINE		MEDIUM		COARSE		FINE		MEDIUM		COARSE	GRAVEL	COBBLES	M.I.T.	
	SILT						SAND								
CLAY			SILT			V. FINE		FINE		MED.		COARSE		GRAVEL	U.S. BUREAU
						SAND									



GRAIN SIZE DISTRIBUTION

CLAYEY SILT, with sand, trace gravel
(TILL)

FIG No. BC-GS-2
HWY: 404
G.W.P. No. 03-20024

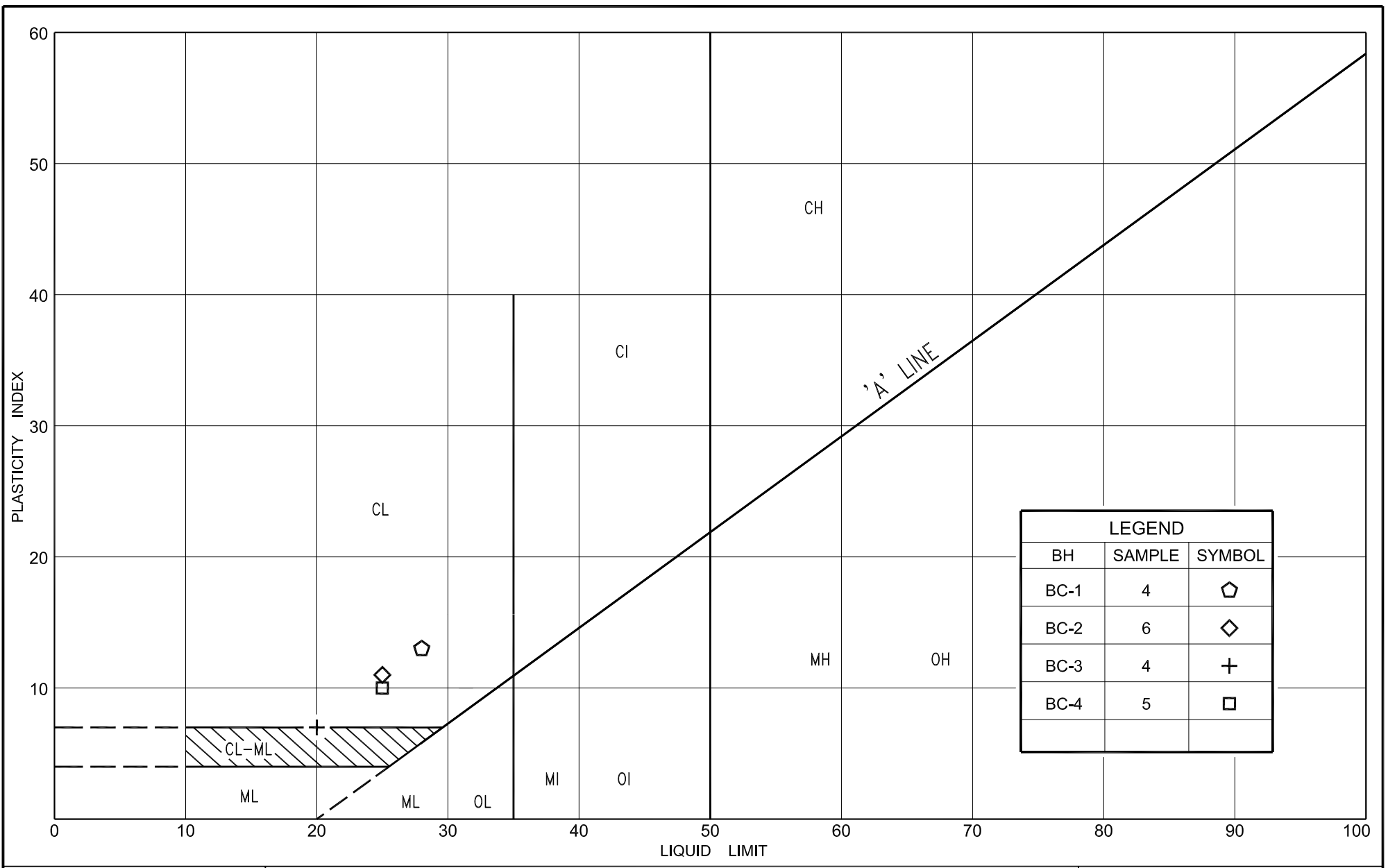


SILT & CLAY				FINE		MEDIUM		COARSE	GRAVEL			COBBLES	UNIFIED	
				SAND										
CLAY	FINE		MEDIUM	COARSE	FINE		MEDIUM		COARSE		GRAVEL		COBBLES	M.I.T.
SILT				SAND						GRAVEL			COBBLES	U.S. BUREAU
CLAY		SILT			V. FINE	FINE	MED.	COARSE	GRAVEL					
				SAND										



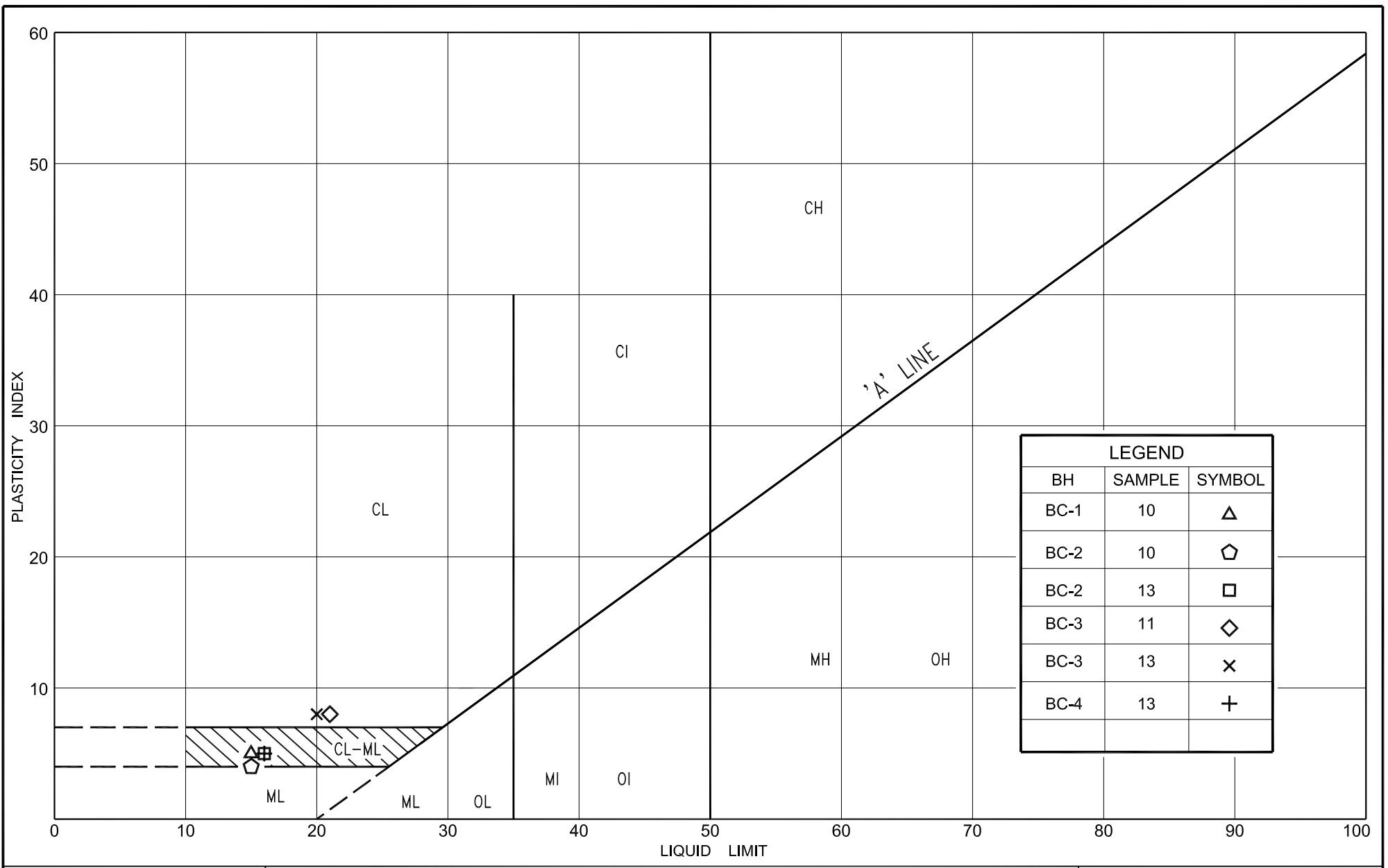
GRAIN SIZE DISTRIBUTION SANDY SILT, trace clay, trace gravel (TILL)

FIG No. BC-GS-3
HWY: 404
G.W.P. No. 03-20024



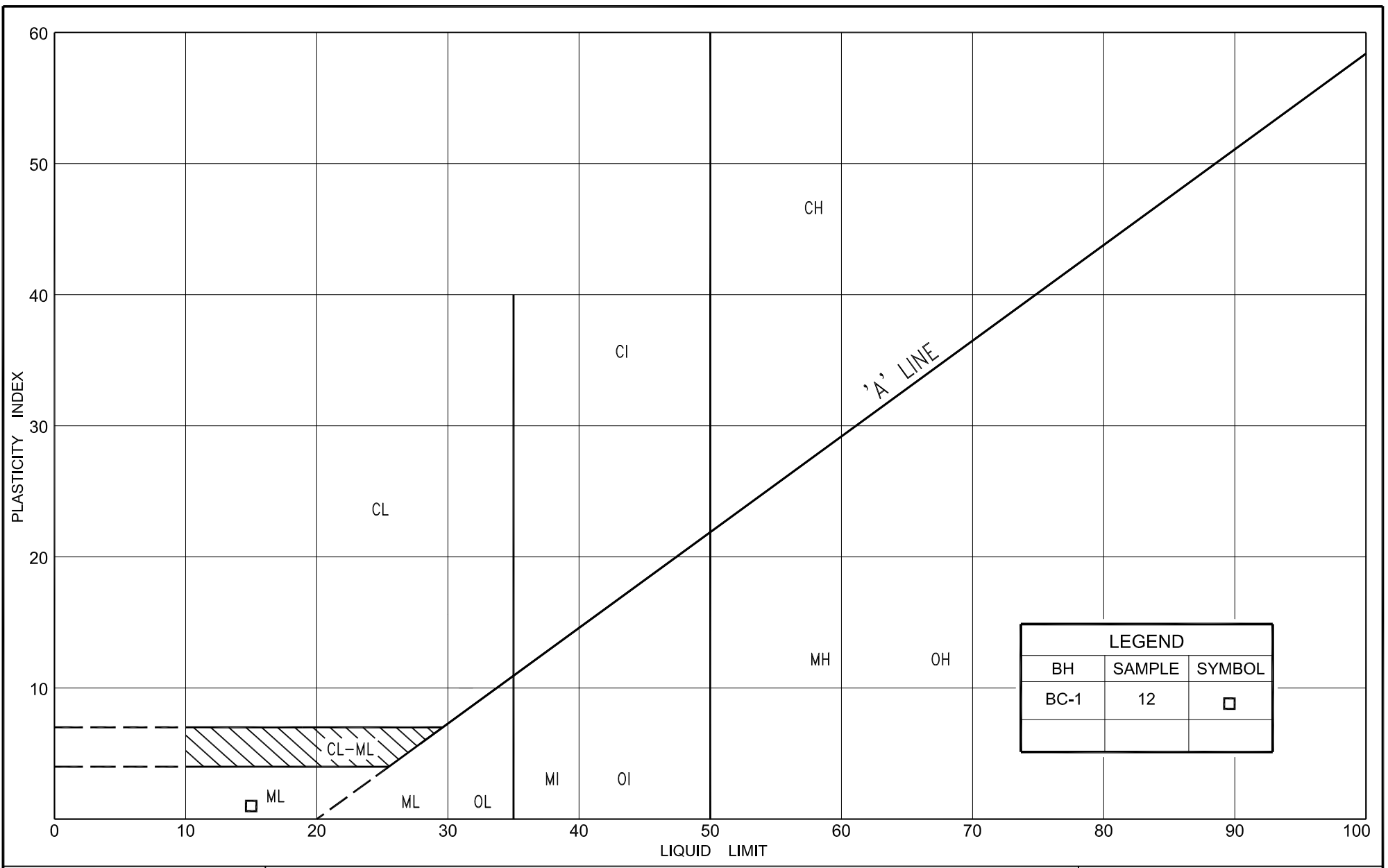
PLASTICITY CHART
CLAYEY SILT, with sand
(FILL)

FIG No.	BC-PC-1
HWY:	404
G.W.P. No.	03-20024



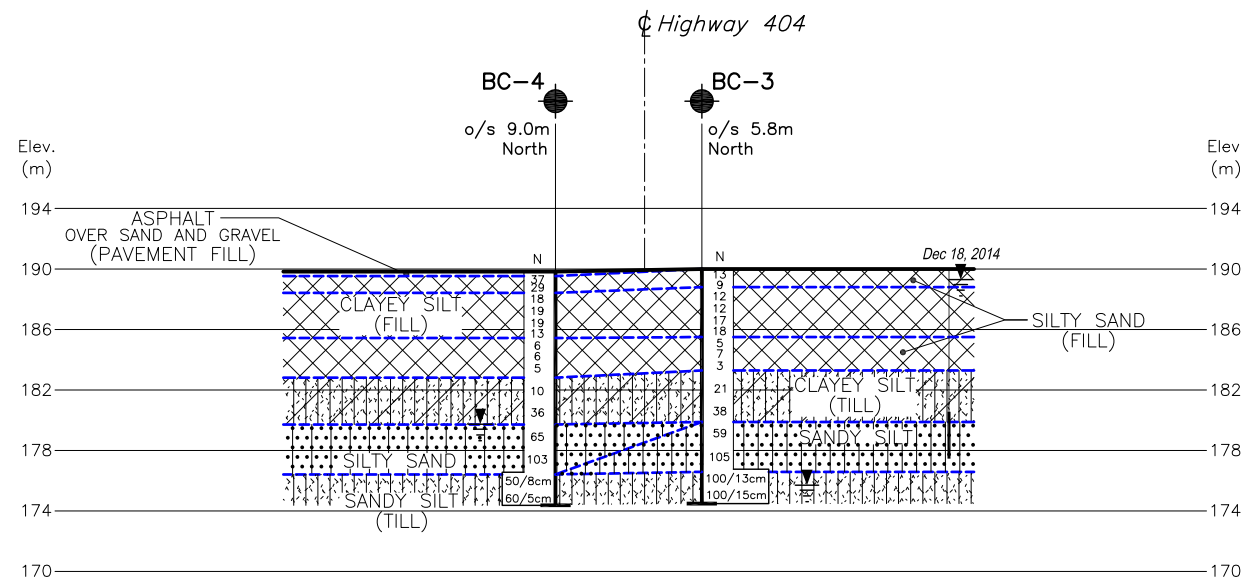
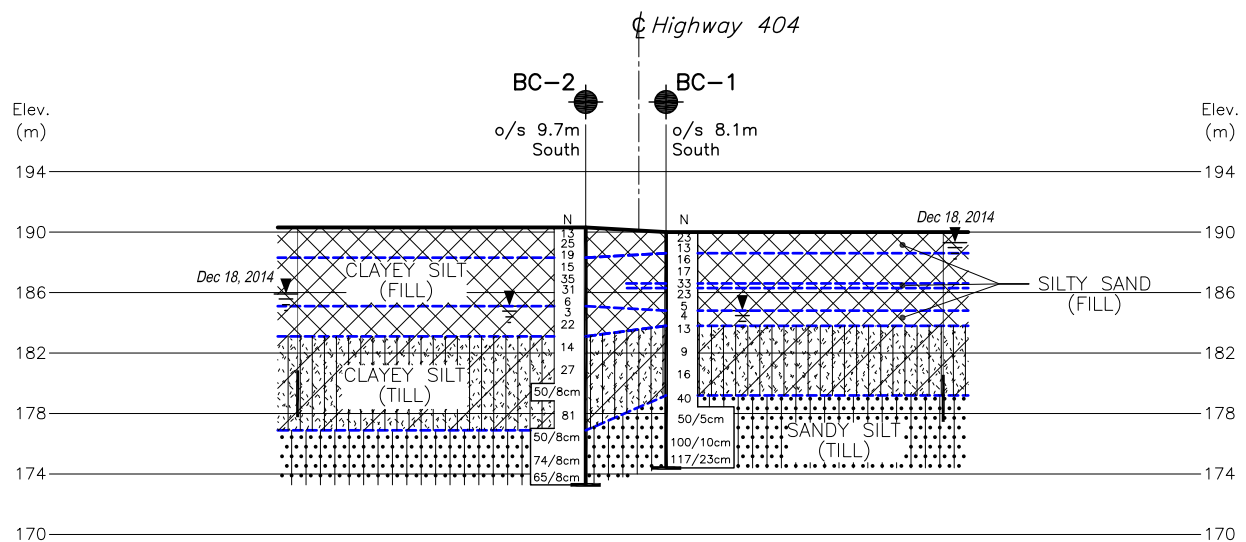
PLASTICITY CHART
CLAYEY SILT, with sand, trace gravel
(TILL)

FIG No.	BC-PC-2
HWY:	404
G.W.P. No.	03-20024



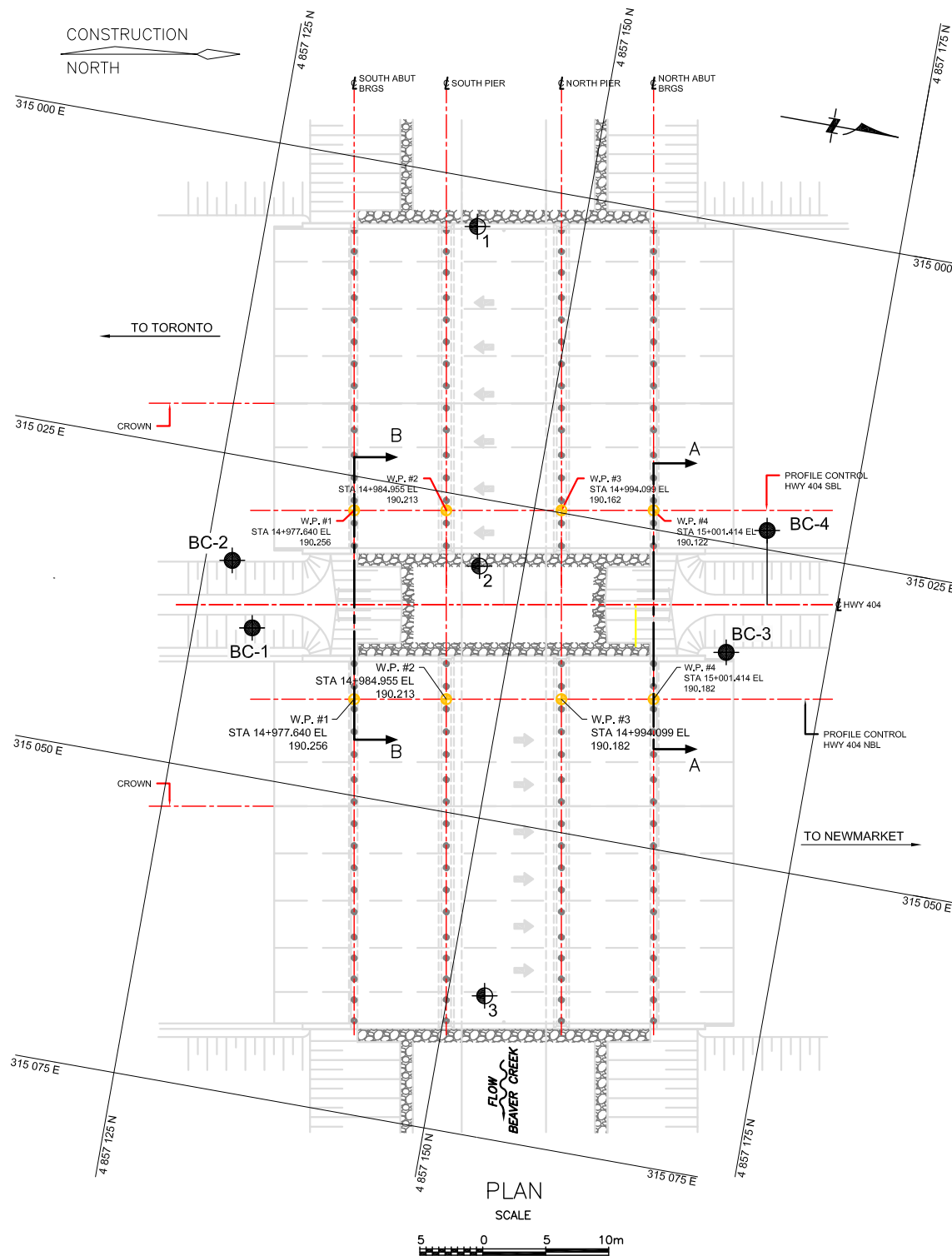
PLASTICITY CHART SANDY SILT, trace clay, trace gravel (TILL)

FIG No.	BC-PC-3
HWY:	404
G.W.P. No.	03-20024

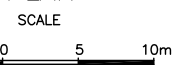
PROFILE A-A ALONG \varnothing HIGHWAY 404 NORTH ABUTMENTPROFILE B-B ALONG \varnothing HIGHWAY 404 SOUTH ABUTMENT

NOTES:

- THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT AND RECORD OF BOREHOLE LOGS.
- 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.



PLAN

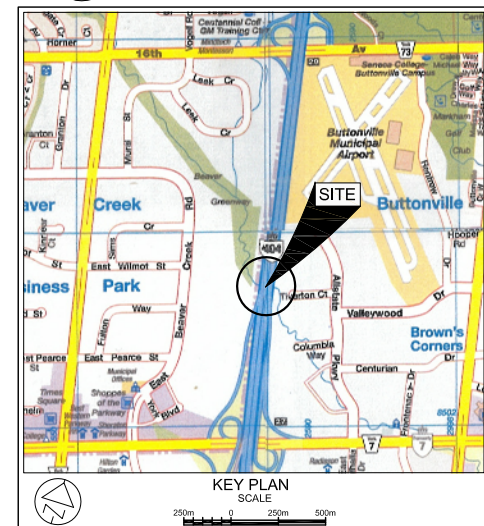


CONT No
WO No 03-20024
BEAVER CREEK BRIDGES
HIGHWAY 404 HOV LANES
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET

PML Peto MacCallum Ltd.
CONSULTING ENGINEERS



LEGEND

- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- Geocres Report Boreholes (30M14-53)
- N Blows/0.3m (Std. Pen Test, 475 J/blow)
- CONE Blows/0.3m (60°Cone, 475 J/blow)
- WL at time of investigation Sept. 2014
- Head
- ARTESIAN WATER
- Encountered
- PIEZOMETER

BH No	ELEVATION	COORDINATES	
		NORTHINGS	EASTINGS
BC-1	190.0	4 857 129.6	315 038.3
BC-2	190.3	4 857 127.1	315 033.3
BC-3	190.0	4 857 167.0	315 033.6
BC-4	190.0	4 857 168.5	315 023.5

GEOCRES REPORT BOREHOLES

BH No	ELEVATION	COORDINATES	
		NORTHINGS	EASTINGS
1	186.4	4 857 141.6	315 003.8
2	186.2	4 857 146.5	315 030.3
3	188.7	4 857 152.9	315 063.8

- 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. 30M14-420

HWY No	404	DIST	54
SUBM'D	NA	CHECKED	MM
DRAWN	NA	CHECKED	DD
APPROVED	BRG	DWG	BCR-1



Reference MMM Drawing:
S37-277-001GA_Combined-Global Coords.dwg dated April 2015



APPENDIX A

Record of Previous Borehole Sheets (Borehole No. 1 to 3)

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 1

WP 160-74-24 LOCATION Co-ords. N 15 934 778; E 1 033 423 ORIGINATED BY C.T.J.
 DIST 6 HWY 404 BORING DATE February 7 & 8, 1977 COMPILED BY C.T.J.
 DATUM Geodetic BOREHOLE TYPE 3 1/2" H.S.A. and Wash Boring with Penetration Test CHECKED BY

SOIL PROFILE			SAMPLES		GROUND WATER	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ P.C.F	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		20	40	60	80	100	w_p	w	w_L		
611.4	Ground Level				ELEV										
0.0	Topsoil				610										
2.0	Silty Sand some clay and organic inclusions		1	SS	3										Organic
603.5	Gravel		2	SS	2/15"										6.1%
7.9	Silt traces of sand and gravel loose		3	SS	13										0 52 38 10
601.4	Glacial Till		4	SS	9										3 10 77 10
10.0	Heterogeneous Mixture of Clayey Silt and Sand, traces of Gravel		5	SS	15										6 35 46 13
	Stiff to Hard		6	SS	36										
	Silt trace of sand		7	SS	28										
	Grey		8	SS	21										4 34 36 26
			9	SS	46										
586.2			10	SS	76										
25.2	End of Borehole		11	SS	100 8 1/4"										

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 2

W.P. 160-74-24 LOCATION Co-ords N 15 934 794; E 1 033 510 ORIGINATED BY C.T.J.
 DIST 6 HWY 404 BORING DATE February 8 and 9, 1977 COMPILED BY C.T.J.
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger & Boring with Penetration TEST CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w w_p — w — w_L WATER CONTENT % 10 20 30	UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N ^o VALUES		20	40	60	80	100			
611.0	Ground Level					ELEV								
0.0	Topsoil					610								
2.0	Silty sand some Clay & organic inclusions.		1	SS	2									
605.1	Gravel		2	SS	10									
5.9	Silt trace of sand and gravel Loose		3	SS	4									
598.5	Grey		4	SS	10	600								1 0 94 5
12.5	Glacial Till		5	SS	28									
	Heterogenous Mixture of Clayey Silt and sand. Traces of Gravel Very stiff to hard		6	SS	32									3 37 31 29
	Silt, trace of Sand		7	SS	59	590								1 8 81 10
585.4	Grey		8	SS	150	1 1/4"								
25.6	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 3

WP 160-74-24 LOCATION Co-ords N 15 934 815; E 1 033 620 ORIGINATED BY C.T.J.
 DIST 6 HWY 404 BORING DATE February 9 & 10, 1977 COMPILED BY C.T.J.
 DATUM Geodetic BOREHOLE TYPE 3 1/2" Hollow Stem Auger with Dynamic Penetration CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					Test			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	LIQUID LIMIT w_L	PLASTIC LIMIT w_p	WATER CONTENT w		
619.2	Ground Level															
0.0	Topsoil															GR SA SI CL
1.0	Traces of Clay		1	SS	10											
			2	SS	18											
			3	SS	24											
			4	SS	24											
	Brown		5	SS	21											
	Grey		6	SS	10											
	Silty fine Sand to Silt Compact		7	SS	13											0 68 (32)
			8	SS	11											0 6 89 5
594.7			9	SS	61/8"											3 32 40 25
24.5			10	SS	24											
	Glacial Clayey Silt Till very stiff		11	SS	115											4 33 42 21
	Heterogeneous Mix. of Clayey Silt and Sand, traces of Gravel															
577.9	Gray		12	SS	142/9"											
41.3	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION



APPENDIX B

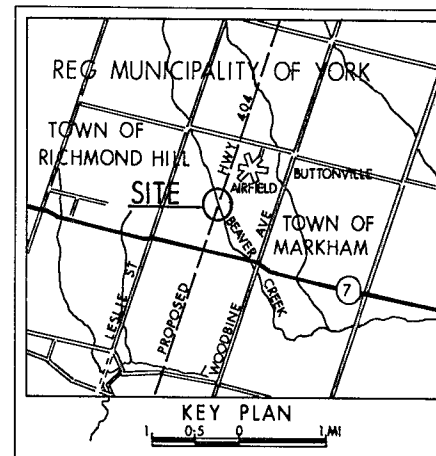
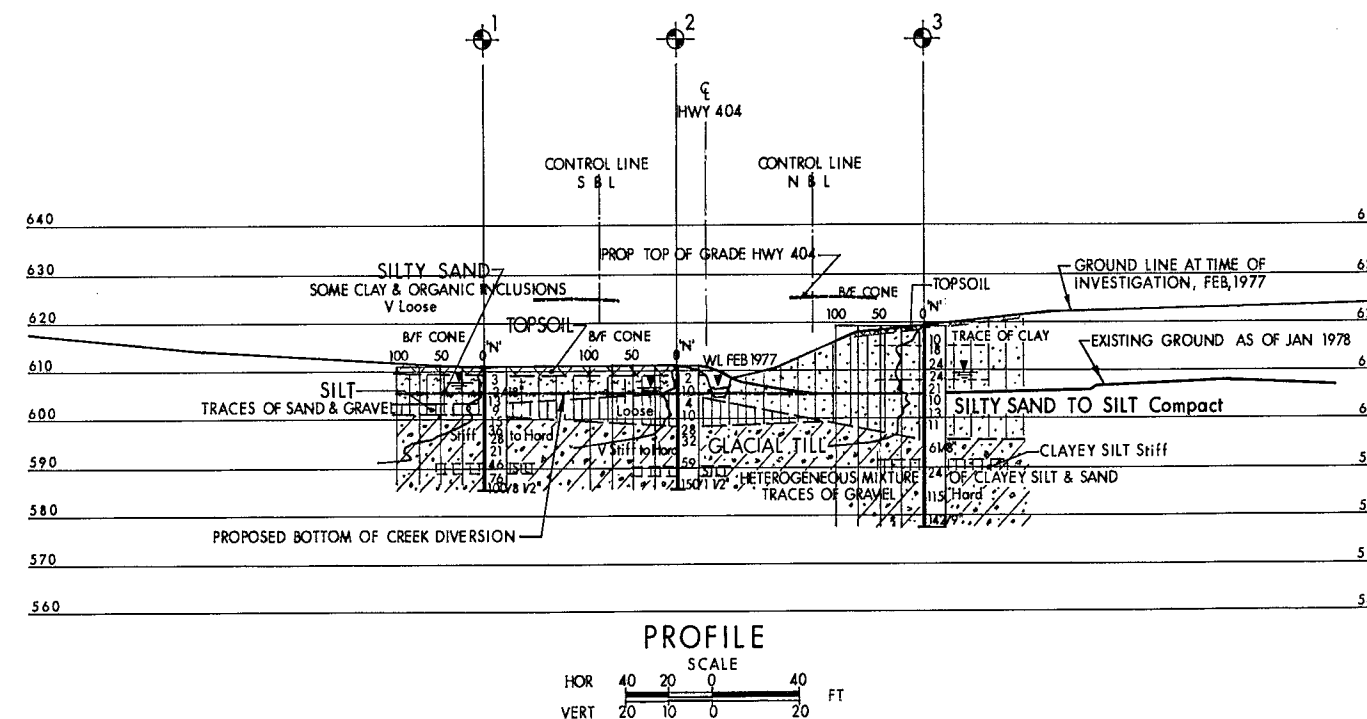
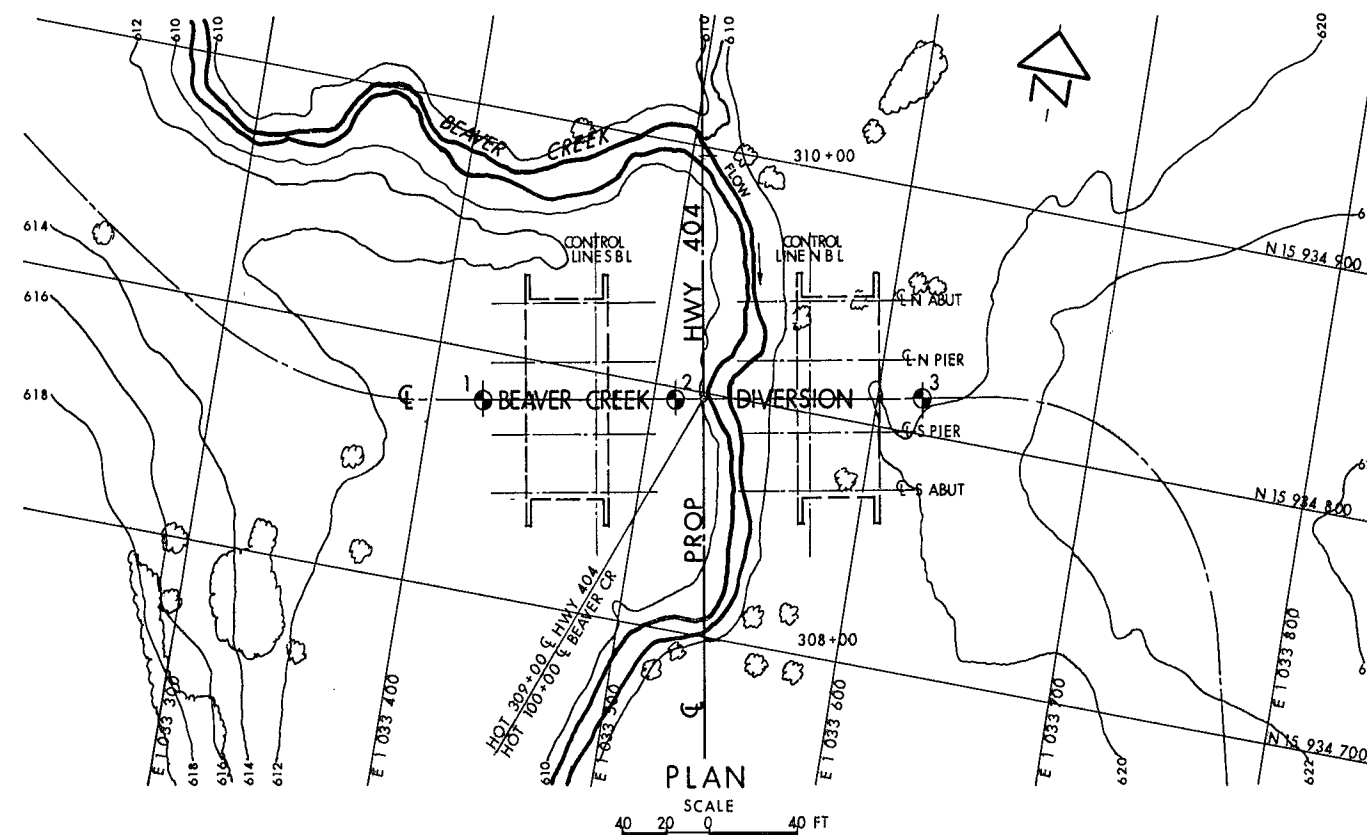
Previous Borehole Locations and Soil Strata

CONT No 78-45
WP No 160-74-24



BEAVER CREEK BRIDGE
(0.5 Mi North of Hwy 7)
BORE HOLE LOCATIONS & SOIL STRATA

SHEET
240



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N' Blows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- W L at time of investigation FEB 1977

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	611.4	15 934 778	1033 423
2	611.0	15 934 794	1033 510
3	619.2	15 934 815	1033 620

NOTE:
The complete foundation investigation file for this project may be examined at the Engineering Materials Office, Downsview. Information contained in this file and any supplementary files is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

-NOTE-

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

REVISIONS	DATE	BY	DESCRIPTION

REF McCORMICK RANKIN & ASSOC M-404-BC

HWY No 404	DIST 6
SUBMIT C J	CHECKED BY DATE APR 7 1977
DRAWN BY J	CHECKED BY SITE 37-277
	APPROVED DWG 37-277-2



APPENDIX C

Previous General Layout Drawing

MARKHAM TWP B.M. M-50.
ELEV 644.751

TWO STOREY WHITE BRICK BUILDING (MARKHAM TOWNSHIP)
OFFICE) ON EAST SIDE OF DON MILLS RD. TABLE IS SET
HORIZONTALLY (BY MARKHAM TWP) IN WEST FACE OF
CONCRETE PILLAR AT SOUTH-WEST CORNER OF BUILDING,
BEING 0.8 FEET NORTH OF SOUTH-WEST CORNER OF
PILLAR AND 2.7 FEET ABOVE PAVEMENT.

NOTE:
APPROACH SLABS, WATERPROOFING AND
ASPHALT WEARING SURFACE NOT PART
OF THIS CONTRACT.
N.I.C. DENOTES 'NOT IN CONTRACT'

CONCRETE QUANTITIES

(FOR LUMP SUM CONCRETE TENDER ITEMS)

	N.B. STRUCT	S.B. STRUCT
1. CONCRETE IN ABUTMENTS & WINGWALLS	60 CU.YD.	60 CU.YD.
2. CONCRETE IN DECK	162 CU.YD.	162 CU.YD.
3. CONCRETE IN BARRIER WALLS	16 CU.YD.	16 CU.YD.
4. CONCRETE IN APPROACH SLABS	46 CU.YD.	46 CU.YD.

GENERAL NOTES

CLASS OF CONCRETE	
DECK AND BARRIER WALLS	4,000 P.S.I.
REMAINDER	3,000 P.S.I.

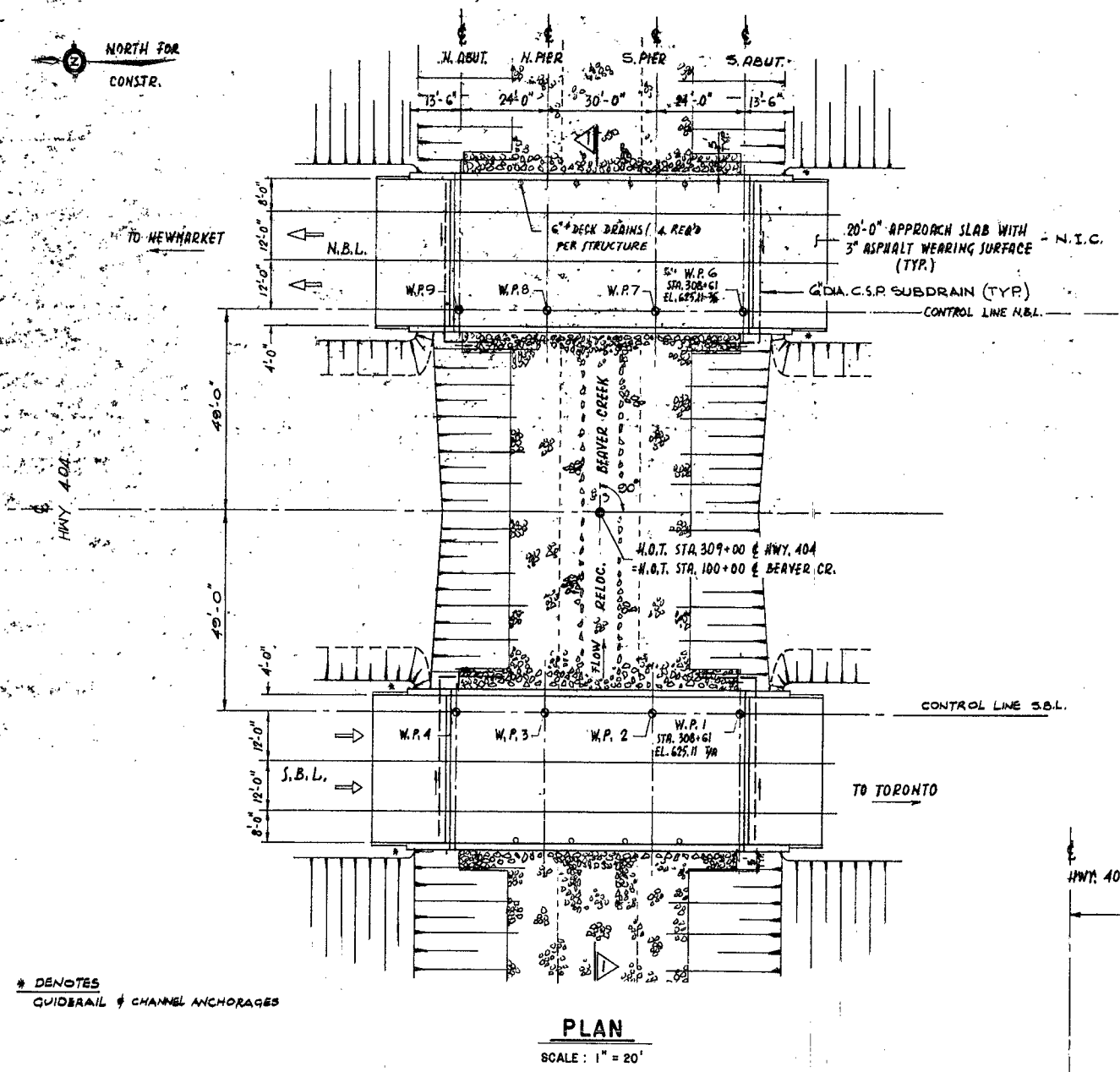
CLEAR COVER ON REINFORCING STEEL

DECK	(TOP) 2"
	BOTTOM 1 1/2"
BARRIER WALLS	AS NOTED
APPROACH SLABS	2"
REMAINDER	3"

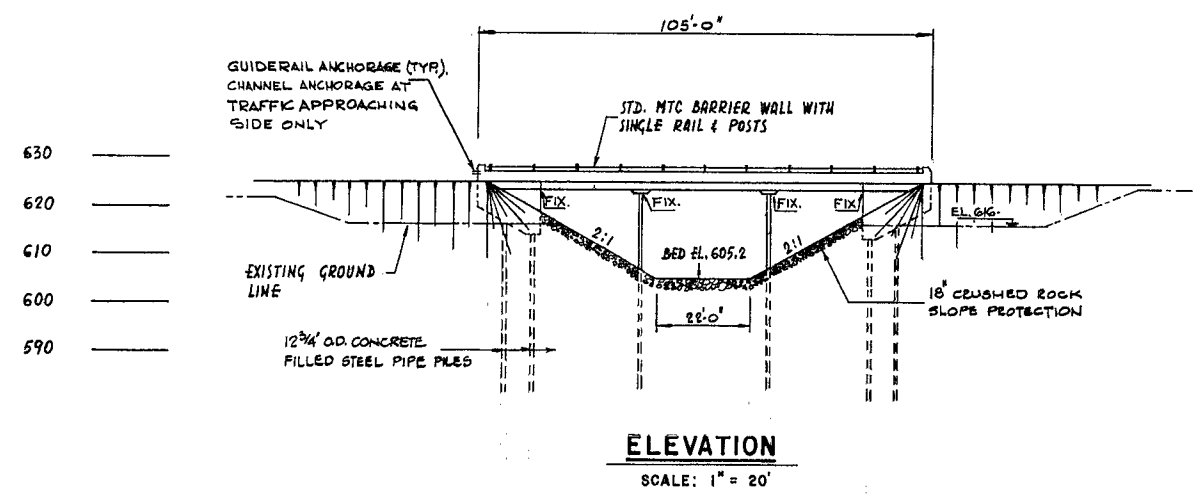
REINFORCING STEEL SHALL BE CS A.G.30 SERIES
GRADE 60

NOTE: TO ACHIEVE THE MIN. CLEAR COVER OF 2" SPECIFIED
THE TOP LAYER OF DECK, RE-BARS SHALL BE PLACED
PRIOR TO CONCRETING, WITH A CLEAR COVER OF
2 1/2" ± 1/2" TOLERANCE.

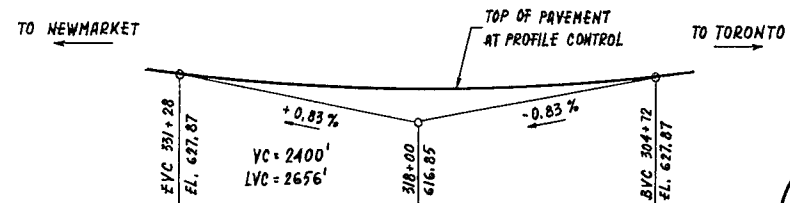
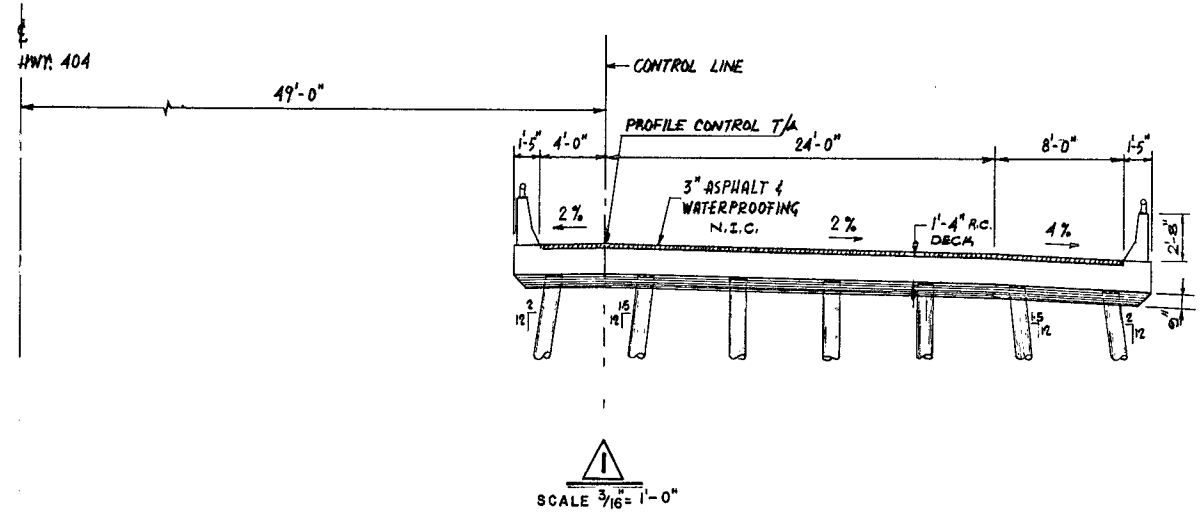
- LIST OF DRAWINGS
1. GENERAL LAYOUT.
 2. BOREHOLE LOCATIONS & SOIL STRATA.
 3. FOUNDATION LAYOUT.
 4. ABUTMENTS
 5. DECK.
 6. APPROACH SLABS.
 7. CONCRETE BARRIER WALLS.
 8. STEEL RAILING.
 9. AS CONSTRUCTED ELEV' & DIMENSIONS
 10. STANDARDS.
 11. STANDARDS.



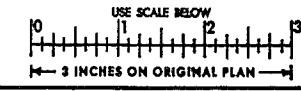
* DENOTES
GUIDERAIL & CHANNEL ANCHORAGES



NOTES:
W.P. DENOTES WORKING POINT.
T/A DENOTES TOP OF ASPHALT
WEARING SURFACE.



FOR REDUCED PLAN



REVISIONS	DATE	BY	DESCRIPTION



PRELIMINARY FOUNDATION DESIGN REPORT

for

**BEAVER CREEK STRUCTURES
HIGHWAY 404 HOV LANE EXPANSION
FROM HIGHWAY 407 TO GREEN LANE
SITES 37-277-1 & 37-277-2, WO 03-20024
REGIONAL MUNICIPALITY OF YORK, ONTARIO**

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PART B
PRELIMINARY FOUNDATION DESIGN REPORT
for
Beaver Creek Structures
Highway 404 HOV Lane Expansion
From Highway 407 to Green Lane
WO 03-20024, Sites 37-277-1 & 37-277-2
Regional Municipality of York, Ontario

7. ENGINEERING RECOMMENDATIONS

7.1 General

This portion of the report provides the preliminary foundation design recommendations for the proposed widening of the existing Beaver Creek Bridge structures associated with the proposed widening of Highway 404 in the Regional Municipality of York. It is understood that the widening of the existing Beaver Creek bridges will be achieved by adding one lane to the inside of the Highway 404 NBL and SBL lanes. However, it is also understood that there is a possibility that the existing Beaver Creek structures may not need widening to accommodate the proposed HOV lanes.

The following preliminary design recommendations assume that widening will be carried out at the Beaver Creek structures. The recommendations are intended for preliminary design and planning purposes only. Further foundation engineering services will be required to provide detail design level recommendations.

Based on the General Arrangement drawing for Contract 78-45, the original bridges consisted of twin 32± m long, 14.6± wide, 3-span bridges with span geometries of approximately 7.3 m, 9.1 m, 7.3 m from south to north. The existing abutments and piers are founded on concrete-filled steel pipe piles with nominal outside diameter of 348.6 mm (12.75 inches). The following table summarizes the number of piles, cut-off elevations for piles, lengths of piles and estimated pile tip elevations at the existing abutments and pier locations.



Table 7.1 Details of Existing Foundations

STRUCTURE	LOCATION	NUMBER OF PILES	CUT-OFF ELEVATION (M)	LENGTH (M)	PILE TIP ELEVATION (M)
North Bound Structure	North Abutment	6	187.0	11.6	175.4
		2	188.3 to 188.2	10.4	177.9 to 177.8
	North Piers	7	189.7 to 189.9	13.1	176.6 to 176.8
	South Piers	7	189.8 to 191.5	13.1	176.7 to 178.4
	South Abutment	6	187.1	11.9	175.2
		2	188.5 to 188.4	10.4	178.1 to 178.0
South Bound Structure	North Abutment	6	187.0	11.6	175.4
		2	188.3 to 188.2	10.4	177.9 to 177.8
	North Piers	7	189.7 to 189.9	13.1	176.6 to 176.8
	South Piers	7	189.8 to 191.5	13.1	176.7 to 178.4
	South Abutment	6	187.1	11.9	175.2
		2	188.5 to 188.4	10.4	178.1 to 178.0

7.2 Foundation Options

The following table (Table 7.2) summarizes the foundation types considered, their advantages and disadvantages as well as relative cost and risks/consequences:

Table 7.2 Evaluation of Foundation Options

FOUNDATION TYPE	ADVANTAGES	DISADVANTAGES	RELATIVE COST	RISKS/CONSEQUENCES
Spread Footings	Ease of installation. No vibration concerns from pile driving.	The required size of the footing may be larger than for a pile cap. Possible differential settlement between the existing and proposed structures. Scour performance concerns at the pier locations.	Low	Differential settlement between widened and existing portions of structure. Loss of support from scour at the pier locations.



FOUNDATION TYPE	ADVANTAGES	DISADVANTAGES	RELATIVE COST	RISKS/CONSEQUENCES
Driven H-Piles	<p>Reliable settlement performance.</p> <p>Reliable scour resistance.</p> <p>Driven H-piles cause small soil displacement and less risk of disturbing existing foundations than driven pipe piles.</p>	<p>Vibration induced during pile driving.</p> <p>Potential interference with existing piles.</p> <p>Driving difficulties due to possible presence of cobbles and boulders in the glacial till soils.</p>	Moderate	<p>Disturbance to existing foundations through physical contact with existing piles during driving of new piles could cause settlement of existing structure.</p> <p>Pile driving induced vibrations could cause disturbance to ground supporting existing piles and subsequent settlement of existing structure.</p>
Driven Steel Tube Piles	<p>Reliable settlement performance.</p> <p>Reliable scour resistance.</p>	<p>Driven pipe piles cause larger soil displacement and more risk of disturbing existing foundations than driven H-piles.</p> <p>A separate construction operation is required for concrete infilling.</p> <p>Less cost efficient load resistance than H-piles due to higher composite pile weight.</p>	Moderate	<p>Disturbance to existing foundations through physical contact with existing piles during driving of new piles could cause settlement of existing structure.</p> <p>Pile driving induced vibrations could cause disturbance to ground supporting existing piles and subsequent settlement of existing structure.</p>
Caissons	<p>Larger bearing capacity than for other options.</p>	<p>Challenging installation due to the presence of noncohesive soil and high groundwater table, which could require liners, mud drilling techniques and tremie concreting methods. Liners could be impractical because of the length of liner required in view of the noncohesive deposits to depth at the site.</p> <p>Construction difficulties due to possible presence of cobbles and boulders in the glacial till soils.</p>	High	<p>Loss of ground during installation that could cause settlement of existing foundations.</p> <p>Flowing soils under along shaft and base could cause necking of concrete in caisson and subsequent reduction in resistance of caisson foundation.</p>



Deep foundations are the preferred foundations for the widened portion of the bridges in order to minimize differential settlements between the existing and widened portions of the bridges and to provide superior scour protection at the pier foundations.

Caissons were given consideration as a deep foundation option, but it was concluded that the non-cohesive deposits at the site present challenging conditions, particularly the high risk for loss of ground during caisson installation. In view of practical difficulties in implementing mitigation techniques, such as installing full depth liners or employing mud drilling in close proximity to existing structures, it is recommended that driven piles are the preferred options for foundations for the proposed widenings.

Steel H-piles driven to refusal are the recommended foundations for the widenings at the piers, abutments and retaining walls in consideration of the importance of avoiding disturbance of the foundations of the existing foundations during pile driving or undermining during caisson installation. Steel H-piles are preferred over pipe piles because they would cause less displacement of the ground and hence less risk of disturbance to the existing foundations.

The locations of retaining walls have not been indicated at this stage. It is presumed that the only locations could be at the inside of widenings at each abutment. Currently, the embankments are about 4.5 m high and sloped at 2H:1V at these locations. Embankment slopes after median widening should maintain geometry of 2H:1V or flatter. However, if 2H:1V slopes cannot be realized, retaining walls will be required. If retaining walls are required, spread footings could be considered for RSS type walls. The retaining walls may be restricted to the median and may be aligned along the Highway 404 lanes or parallel to the abutments.

7.3 Driven Steel H-Piles

The foundations for the widened portions of the bridges may be founded on steel H-piles driven to refusal. Refer to Table 7.1 for details of existing pile tip elevations and equivalent depths. It is anticipated that driven H-piles for the widened portions of the bridges will reach refusal at similar elevations at the respective footings elements as detailed in Table 7.1



Preliminary design level values for factored axial resistance at ultimate limit states (ULS) and factored axial reaction at serviceability limit states (SLS) are provided below:

PILE SECTION	FACTORED AXIAL RESISTANCE AT ULS (kN)	FACTORED AXIAL REACTION AT SLS (kN)
HP 310 x 79	1150	850
HP 310 x 110	1600	1150

The resistance at SLS are related to a target vertical pile displacement of less than 25 mm and probably in the order of 10mm.

The H-piles would have to be equipped with driving shoes and pile installation would be in accordance with OPSS 903. The existing piles would have to be located and avoided during driving of new piles.

It is anticipated that in order to avoid undermining the existing abutment pile caps, excavations for new pile caps below a zone defined by a 1H:1V plane extending from the base of existing pile caps should not be constructed without shoring. The existing piles would have to be located and avoided during driving of new piles. Vibration and settlement monitoring provisions for the existing foundations would have to be developed during the detail design phase of the project.

Any fill placed under the plan limits of proposed pile foundations should comprise granular material such as Granular A or Granular B Type II and should have a maximum nominal size of 75 mm to enable driving of the piles and minimise the potential for damage during pile installation.

As per OPSD 3090.101, a minimum of 1.2 m of soil cover or the equivalent thermal insulation should be provided for frost protection to the pile caps.

Resistance to lateral loads may be provided by the horizontal resistance of vertical piles and the horizontal component of battered piles. Recommendations for the horizontal resistance of piles should be provided in detail design.



7.4 Abutments and Wing Walls

The abutment and wing walls should be designed to resist the unbalanced lateral earth pressure imposed by the backfill adjacent to the wall. Recommendations for earth pressures should be provided in the detail design phase. Conventional or RSS walls may be considered.

7.5 Approach Embankments

The height of new fill required for the widening is expected to be less than 2 m and thus a relatively small portion of the existing embankment load. Hence, it is anticipated that there will be no slope stability issues and that settlements of the approach embankments will be negligible. The amount of downdrag load on foundations resulting from settlements of approach fills should be evaluated during detail design, but is not expected to be significant.

7.6 Construction Considerations

7.6.1 Excavation

All excavations at the structure foundation sites should be carried out in accordance with the Occupational Health and Safety Act (OHSA), local and MTO regulations.

7.6.2 Roadway Protection

Requirements for roadway protection should be determined during detail design. It is anticipated that a minimum performance level of 2, according to OPSS 539 would be required. The Contractor would be responsible for selection, preparation of a detailed design and performance for the roadway protection system.

7.6.3 Groundwater Control

Recommendations for dewatering should be established during detail design. For planning purposes, it is anticipated that the Contractor may be required to lower the groundwater level to at least 0.5 m below the bottom of the excavation depth.



The method for dewatering should remain the responsibility of the Contractor. Dewatering should not be an issue at the abutments. Conventional sump pumping may be adequate at the pier locations, but this would have to be confirmed during detail design. If more positive groundwater control is required at the pier widenings, consideration could be given to using adequate perimeter ditching or cofferdams if necessary.

8. SCOPE OF ADDITIONAL FOUNDATION INVESTIGATION

It is recommended that consideration could be given to the following minimum scope for additional boreholes for the proposed widening:

- 1) The extent of further investigations at this site should be consider 1 borehole in the Highway 404 median at each of the north and south approaches within 20 m of the abutments to determine the extent of compressible material to be removed for the widened highway lanes and at least one additional borehole for the pier widenings at the north pier widening.
- 2) The design recommendations in this report are preliminary. Detailed foundation engineering services will be required during the Detail Design phase of the project.
- 3) Detail design recommendations would be required for all aspects including slope stability, settlement, axial and lateral spread footing or pile resistance, seismic design, temporary roadway protection, dewatering, construction specifications and liaison with the design team.
- 4) The Toronto Buttonville Municipal Airport is located approximately 450 m north-east of the site and may constrain construction activities such as those related to crane heights. This aspect is beyond the scope of Foundations Engineering, but should be considered in the Detail Design phase of the project.



9. CLOSURE

The Preliminary Foundation Design part of this report was prepared by Mr. N. Rahman, P.Eng., and reviewed by Mr. D. Dundas, P.Eng. The report was independently reviewed by Mr. B. R. Gray, MEng, P.Eng., MTO Designated Principal Contact.

Yours very truly,

Peto MacCallum Ltd.



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MTO Designated Principal Contact

NR/DD/BRG:mi-jk-nk