



**PRELIMINARY FOUNDATION INVESTIGATION AND DESIGN REPORT
for**

**ROUGE RIVER BRIDGES
HIGHWAY 404 HOV LANE EXPANSION
FROM HIGHWAY 407 TO GREEN LANE
WO 03-20024
REGIONAL MUNICIPALITY OF YORK, ONTARIO**

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PML Ref.: 14TF003A-RR
Index No.: 039FIDR
Geocres No.: 30M14-416
May 27, 2015



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PART A
PRELIMINARY FOUNDATION INVESTIGATION REPORT

for
Rouge River Bridge, NBL and SBL Structures
Highway 404 HOV Lane Expansion
From Highway 407 to Green Lane
WO 03-20024,
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 the Rouge River. 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 for this site and 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.

Approximate borehole locations (previous and recent) are shown in Map-1. The borehole locations and soil strata for the recent field investigation are presented on the attached Drawing RR-1.

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



2. SOURCES OF INFORMATION

The following report, including drawings, was available for the Rouge River Bridge Structures. Reference 1 is the original report for the site and the subsequent foundation report that was produced based on the original field investigation. The General Arrangement drawing and Borehole Locations and Soil Strata are attached to this report.

Reference 1 - Foundation Investigation and Design Report For Proposed Structure at the Crossing of Highway 404 and the Rouge River Diversion, Site 37-347, W.P. 160-74-26, District 6, Toronto, by Soil Mechanics Section – Ministry of Transportation and Communications, dated February, 1971, GEOCREs 30M14-51.

Foundation Investigation Report For Rouge River Bridge, 1.8 miles North of Hwy. 7, Hwy. 404, District 6, Toronto, W.P. 160-74-26, Site 37-347, dated April 1977, GEOCREs 30M14-51.

Reference 2 - Borehole Locations and Soil Strata, Highway 404 Crossing at Rouge River, Site No. 37-347, Cont. No. 78-45, W.P. 160-74-26 by McCormick, Rankin & Associates Limited Consulting Engineers, dated February 4, 1971.

Reference 3 - General Layout, Drawing 1, Highway 404 Crossing at Rouge River, Site No. 37-347, Cont. No. 78-45, W.P. 160-74-26 by McCormick, Rankin & Associates Limited Consulting Engineers, dated July 1977.

Reference 4 - Foundation Layout, Drawing 3, Highway 404 Crossing at Rouge River, Site No. 37-347, Cont. No. 78-45, W.P. 160-74-26 by McCormick, Rankin & Associates Limited Consulting Engineers, dated June, 20 1977.

In addition to the above GEOCREs 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 at the crossing of Hwy. 404 over the Rouge River, approximately 1.0 km north of the 16th Avenue and Highway 404 interchange in the Regional Municipality of York.



The site is located in the Peel Plain physiographic region. The topography is gently flat and undulating. The topographic elevation of the area varies from 200 to 204 m. The soil cover in the region typically comprises glaciolacustrine deposits: silts and clays, minor sand and gravel. Upper Ordovician Shale of the Georgian Bay Formation is anticipated at an approximate depth of 50 m.

Land use in the vicinity of the site comprises industrial and residential areas. The Rouge River Bridge runs roughly west to east direction at the site location. The ground cover beyond the paved areas of the highway comprises grasses, bushes and stands of trees.

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 2 new boreholes.

The field work for the 2 new boreholes was carried out during the period October 5 to 8, 2014. The boreholes were drilled at the site (RR-1 at south abutment and RR-2 at north abutment) to depths of 20.0 and 20.1 m.

The locations of the boreholes were established in the field by Peto MacCallum Ltd. and the ground surface elevations were surveyed by MMM Group Ltd.

The boreholes were advanced using continuous flight hollow stem augers, 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.

Soil samples were recovered from the boreholes at regular 0.75 and 1.5 m intervals together with standard penetration testing that was conducted to assess the strength characteristics of the substrata. The recovered soils were identified in accordance with the MTO soil classification manual procedures.



The groundwater conditions in the boreholes were assessed during drilling by visual examination of the soil, the sampler and drill rods as the samples were retrieved. The groundwater levels in boreholes were obtained during and upon completion of drilling and in piezometers were installed in boreholes RR-1 and RR-2 upon completion of drilling.

The boreholes were backfilled with a bentonite/grout mixture where required in accordance with the MTO guidelines and MOE Reg. 903 for borehole abandonment procedures.

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 (31)
- Grain Size analyses (10)
- Atterberg Limits (5)

The results of the laboratory natural moisture content determinations, grain size analyses and Atterberg limits are shown on the Record of Borehole sheets. The grain size distribution charts are presented on Figures RR-GS-1 to RR-GS-3. The Atterberg limit results are presented on Figures RR-PC-1 to RR-PC-3.

5. SUMMARIZED SUBSURFACE CONDITIONS

5.1 General

According to the previous report (boreholes and relevant figures attached in Appendix A), the stratigraphy revealed in the previous boreholes generally included a layer of topsoil overlying silty sand layers with some gravel and a trace of clay. This stratum was not penetrated fully at any of the borehole locations. However, it was proven to extend to depths in excess of 9.4 m. The water levels measured in the open boreholes was found to be at depths between 1.2 to 1.7 m (elevation 192.3 to 193.2).



Refer to the attached Record of Borehole sheets RR-1 and RR-2 for details of the subsurface conditions at the site. The results of laboratory particle size distributions, Atterberg Limit Testing and moisture content determinations are also shown on the Record of Borehole Sheets and on associated figures.

The borehole locations and soil strata are presented on the attached Drawing RR-1.

The boundaries between soil strata have been established at the borehole locations only. Between and beyond the boreholes, the stratigraphic boundaries are assumed and may vary.

The boreholes drilled at site (BH's RR-1 and RR-2) revealed a stratigraphy consisting of approximately 8.5 to 8.7 m thick fill (generally clayey silt) underlain by approximately 7.0 to 9.2 m thick cohesionless soils (generally silty sand) overlying approximately 2.4 and 4.3 m thick clayey silt till that extended to the termination depths of 20.0 and 20.1 (elevation 182.9 and 183.1).

The piezometric water level were at depths ranging from 9.4 to 9.9 m (elevations 193.5 193.3 m) on December 18, 2014.

The strata encountered are summarised below:

5.2 Topsoil

A 300 mm thick topsoil was encountered surficially in previous boreholes No.1 to No.5 and extended to approximate elevation 193.4 to 194.2.

A 300 mm thick topsoil, consisting of a minor component of organic material, was contacted in borehole RR-2 and extended to elevation 202.9.

5.3 Fill

A 8.7 and 8.5 m thick clayey silt fill was encountered surficially in borehole RR-1 and below the topsoil at a depth of 0.3 m (elevation 202.9) in borehole RR-2 and extended to 8.7 and 8.5 m (elevation 194.2 and 194.7). The fill was composed of firm to stiff clayey silt (SPT-'N' values of 5



to 15), loose to compact (SPT-'N' values of 5 to 20) layers of cohesionless soils (silt and sand), organic inclusions and cobbles.

The results of grain size distribution analyses conducted on 3 samples of the fill are shown in Figure RR-GS-1.

The results of Atterberg Limit tests conducted on 2 cohesive samples of the fill are shown in Figure RR-PC-1. The clayey silt material within the fill had liquid limits of 20 to 29%, plastic limits of 13 to 15% and a plasticity index of 7 to 14. The moisture content of the fill varied between 8 and 24%.

5.4 Silty Sand

A 5.8 to 9.3 m thick cohesionless silty sand deposit was also contacted below the topsoil at 0.3 m (elevation 193.4 to 194.2) in all previous boreholes (Borehole No. 1 to No. 5) and extended to the termination depths of 6.0 to 9.6 m (elevation 184.9 to 188.3). The silty sand deposit was compact to very dense in relative density (SPT-'N' values of 13 to 187). Low N values of 3 and 9 at approximate depth of 0.9 m (elevation 193.3 and 193.5) in boreholes No.3 and No.5 indicated a locally loose layer.

A 7.0 to 9.2 m thick cohesionless silty sand deposit was contacted below the fill at depths of 8.7 and 8.5 m (elevation 194.2 and 194.7) in boreholes RR-1 and RR-2 respectively and extended to depths ranging from 15.7 and 17.7 m below ground surface (elevation 187.2 and 185.5). This stratum was generally dense to very dense in relative density (SPT-'N' values of 34 to 68). Low N values of 2 and 11 at depths of approximately 12.2 m (elevation 191.0) in borehole RR-2 indicate a probable hydrostatic disturbance during the sampling.

The results of grain size distribution analyses on 5 samples of the deposit are shown in Figure RR-GS-2. An inclusion of silt was encountered in borehole RR-2 near elevation 194.0. The silt had liquid limit of 19%, plastic limit of 16% and a plasticity index of 3, as shown in Plasticity Chart (Figure RR-PC-2). The moisture content of the cohesionless deposit varied between 13 and 22%.



5.5 Clayey Silt Till

A minimum 4.3 and 2.4 m thick cohesive clayey silt till deposit was encountered below the silty sand layer at 15.7 and 17.7 m (elevation 187.2 and 185.5) in boreholes RR-1 and RR-2 respectively and extended to the borehole termination depth of 20.0 and 20.1 m (elevation 182.9 and 183.1). The deposit was hard in consistency. The SPT-'N' values recorded were 50 to 104 blows for 8 to 23 cm penetration were refusal was met.

The results of grain size distribution analyses and Atterberg Limit test conducted on two cohesive samples are shown on Figures RR-GS-3 and RR-PC-3. The liquid limit of the clayey silt till was 19% and the plastic limit 13%, giving a plasticity index value of 6. An approximately 1.5 m thick layer of silty clay was encountered in borehole RR-2 near elevation 185.0 m. The liquid limit and plastic limit of the silty clay till was 35% and 18% respectively, giving the plasticity index value of 17. The moisture content of the clayey silt deposit was about 15 to 17%.

5.6 Groundwater

The previous investigation indicated that the groundwater level was located between elevations 192.3 and 193.2, which corresponds to depth of from 1.2 to 1.7 below existing ground surface. The river level at the time of the investigation (January 15, 1971) was at elevation 192.3.

In the process of augering, water was detected at 10.2 and 10.1 m (elevation 192.7 and 193.1) in boreholes RR-1 and RR-2 respectively. Piezometers were installed in boreholes RR-1 and RR-2, with respective filter sand and screens (below an impervious bentonite seal) extending from elevations 194.1 to 192.2 in borehole RR-1 and elevation 188.0 to the termination elevation 183.1 in borehole RR-2, as defined on the Record of Borehole Sheets.

The water level measured in the piezometer installed in boreholes RR-1 and RR-2 was at 9.4 and 9.9 m (elevation 193.5 and 193.3) respectively on December 18, 2014. The groundwater elevation at the site is expected to be controlled by the water level of Rouge River. The water level of Rouge River will undergo seasonal fluctuations, but is expected to be at approximately elevation 192.3.

All groundwater levels are subjected to fluctuations due to seasonal and rainfall patterns.



6. CLOSURE

Mr. F. Portela (Senior Technician) carried out the field investigation for this study under the supervision of Mr. N. Rahman, P. Eng., Project Engineer. The laboratory testing of the selected samples was carried out in the PML laboratory in Toronto. The equipment was supplied by Atcost Soil Drilling Inc.

This Foundation Investigation Report was prepared by Ms. M. Kamranzadeh, MSc, EIT., 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

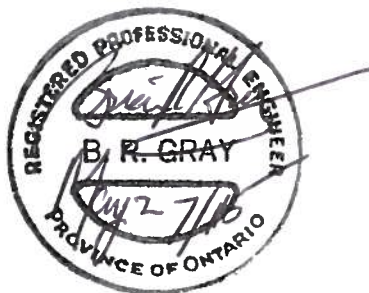
Peto MacCallum Ltd.

A handwritten signature in blue ink, appearing to read "Marzieh", is written over a circular professional engineer's stamp.

Marzieh Kamranzadeh, MSc, EIT
Project Supervisor, Geotechnical Services



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Senior Engineer, Geotechnical Services



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MTO Designated Principal Contact

MK/DD/BRG.mk-mi-jk-nk

MAP 1 – PREVIOUS AND RECENT BOREHOLE LOCATIONS (APPROXIMATE)



- Notes:** (1) Boreholes No. 1 to No. 5 are the previous boreholes. (GEOCRES No. 30M14-51)
(2) Boreholes RR-1 and RR-2 are PML boreholes advances during the field investigation in December 2014.

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 RR-1

1 of 2

METRIC

G.W.P.	03-20024	LOCATION	Coords: 4 859 313.0 N; 314 655.4 E	ORIGINATED BY	F.P.
DIST	Central	HWY	404	BOREHOLE TYPE	Continuous Flight Hollow Stem Augers
DATUM	Geodetic	DATE	October 6-8, 2014	COMPILED BY	N.R.
				CHECKED BY	D.D.



[illegible]

RECORD OF BOREHOLE No RR-1

2 of 2

METRIC

G.W.P.	03-20024	LOCATION	Coords: 4 859 313.0 N; 314 655.4 E	ORIGINATED BY	F.P.
DIST	Central	HWY	404	BOREHOLE TYPE	Continuous Flight Hollow Stem Augers
DATUM	Geodetic	DATE	October 6-8, 2014	COMPILED BY	N.R.
				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 (%)												
								20	40	60	80	100																		
187.9	Silty sand trace clay, trace gravel																													
187.2	Very dense Grey Wet (Cont'd.)		15	SS	68																									
15.7	Clayey silt some sand, trace gravel Hard Grey Moist sandy silt seams (TILL)						187																							
			16	SS	103/23cm		186																							
							185																							
			17	SS	102																									
						184																								
182.9			18	SS	50/8cm	183																								
20.0	End of borehole																													
<div><div><div>*20141006 to 08</div><div>▽Water level observed during drilling</div><div>Water Level Readings:<table><tr><td>Date</td><td>Depth (m)</td><td>Elev.</td></tr><tr><td>Dec.18/2014</td><td>9.4</td><td>193.5</td></tr></table></div><div>Piezometer Legend:<table><tr><td></td><td>Bentonite</td></tr><tr><td></td><td>Filter sand</td></tr><tr><td></td><td>Screen</td></tr><tr><td></td><td>Bentonite Seal</td></tr></table></div></div></div>																	Date	Depth (m)	Elev.	Dec.18/2014	9.4	193.5		Bentonite		Filter sand		Screen		Bentonite Seal
Date	Depth (m)	Elev.																												
Dec.18/2014	9.4	193.5																												
	Bentonite																													
	Filter sand																													
	Screen																													
	Bentonite Seal																													

RECORD OF BOREHOLE No RR-2

1 of 2

METRIC

G.W.P.	03-20024	LOCATION	Coords: 4 859 398.1 N; 314 621.9 E	ORIGINATED BY	F.P.
DIST	Central	HWY	404	BOREHOLE TYPE	Continuous Flight Hollow Stem Augers
DATUM	Geodetic	DATE	October 5 & 6, 2014	COMPILED BY	N.R.
				CHECKED BY	D.D.

[illegible]

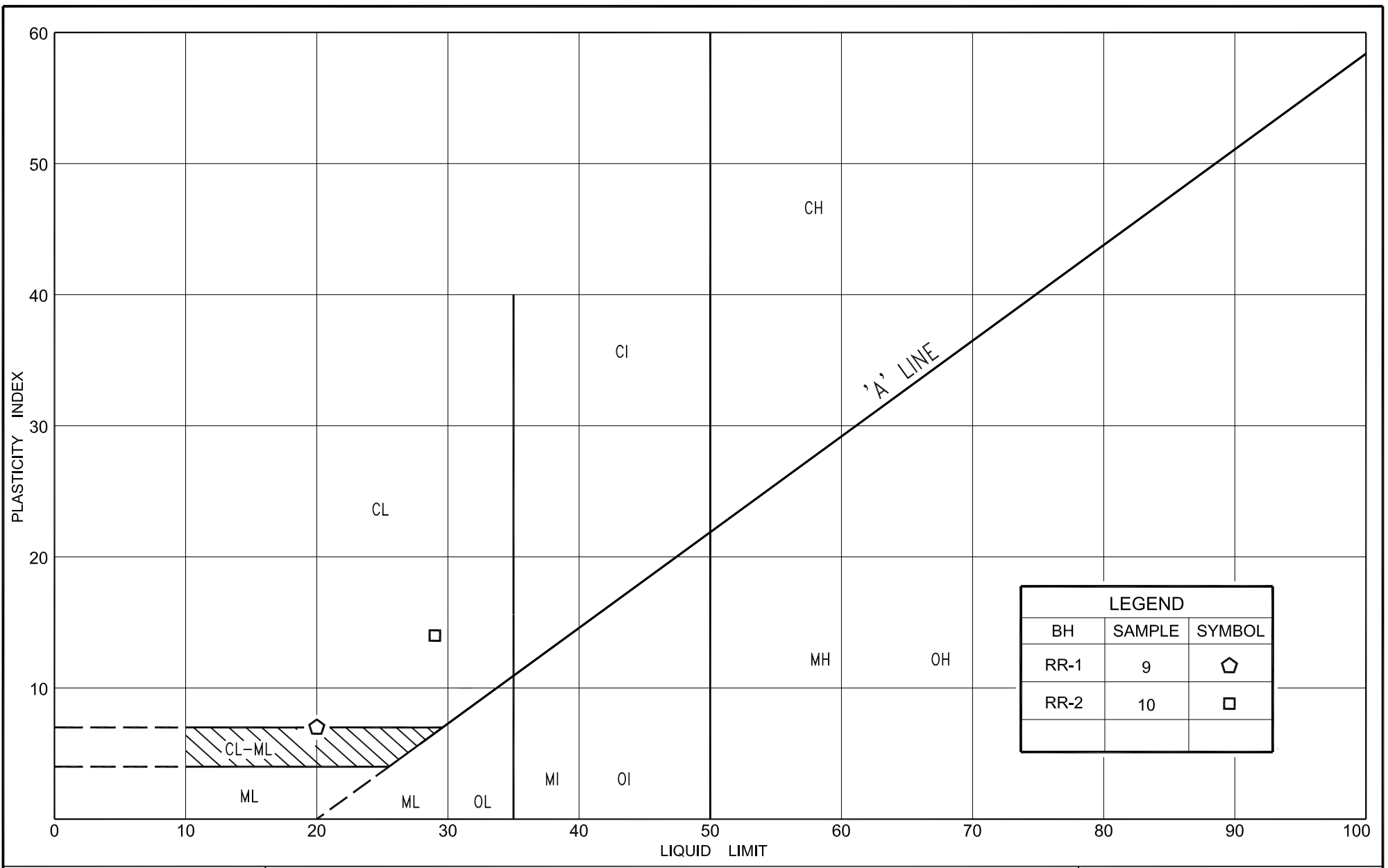
RECORD OF BOREHOLE No RR-2

2 of 2

METRIC

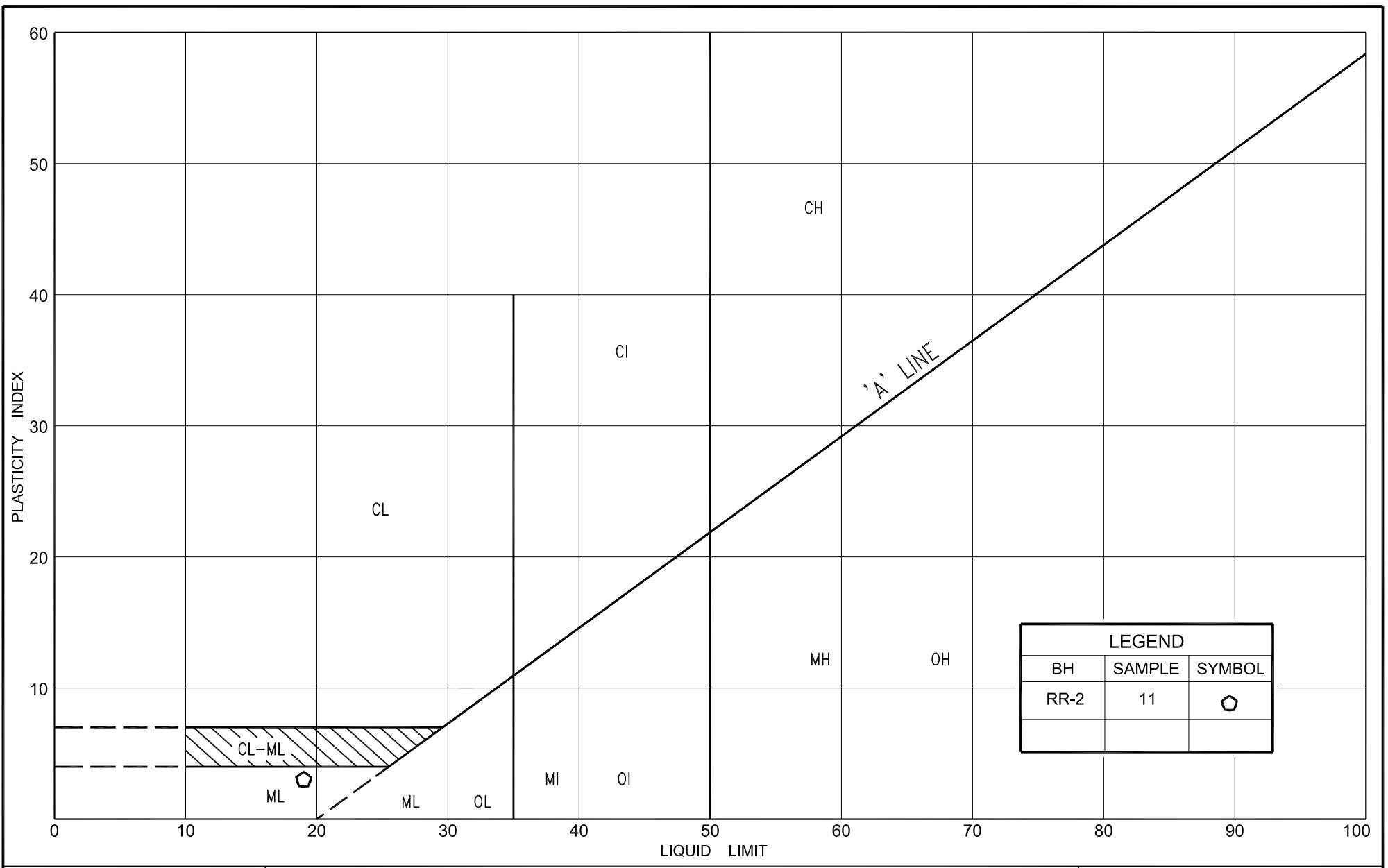
G.W.P.	<u>03-20024</u>	LOCATION	<u>Coords: 4 859 398.1 N; 314 621.9 E</u>	ORIGINATED BY	<u>F.P.</u>
DIST	<u>Central</u>	HWY	<u>404</u>	BOREHOLE TYPE	<u>Continuous Flight Hollow Stem Augers</u>
COMPILED BY					<u>N.R.</u>
DATUM	<u>Geodetic</u>	DATE	<u>Ocotober 5 & 6, 2014</u>	CHECKED BY	<u>D.D.</u>

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 + FIELD VANE												
								● QUICK TRIAXIAL × LAB VANE												
188.2							20	40	60	80	100	20	40	60						
	Silty sand trace to some clay trace gravel clayey silt seams Dense Brown Wet Cont'd.) Gravelly sand layers some silt, trace clay Very dense Grey Wet		15	SS	34															
			16	SS	50/8cm															
185.5																				
17.7	Clayey silt trace sand, trace gravel Hard Grey Moist silty clay layers		17	SS	104/23cm															
	silty sand layers (TILL)																			
183.1			18	SS	50/10cm															
20.1	End of borehole																			



PLASTICITY CHART
CLAYEY SILT, Silt and sand layers
(FILL)

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

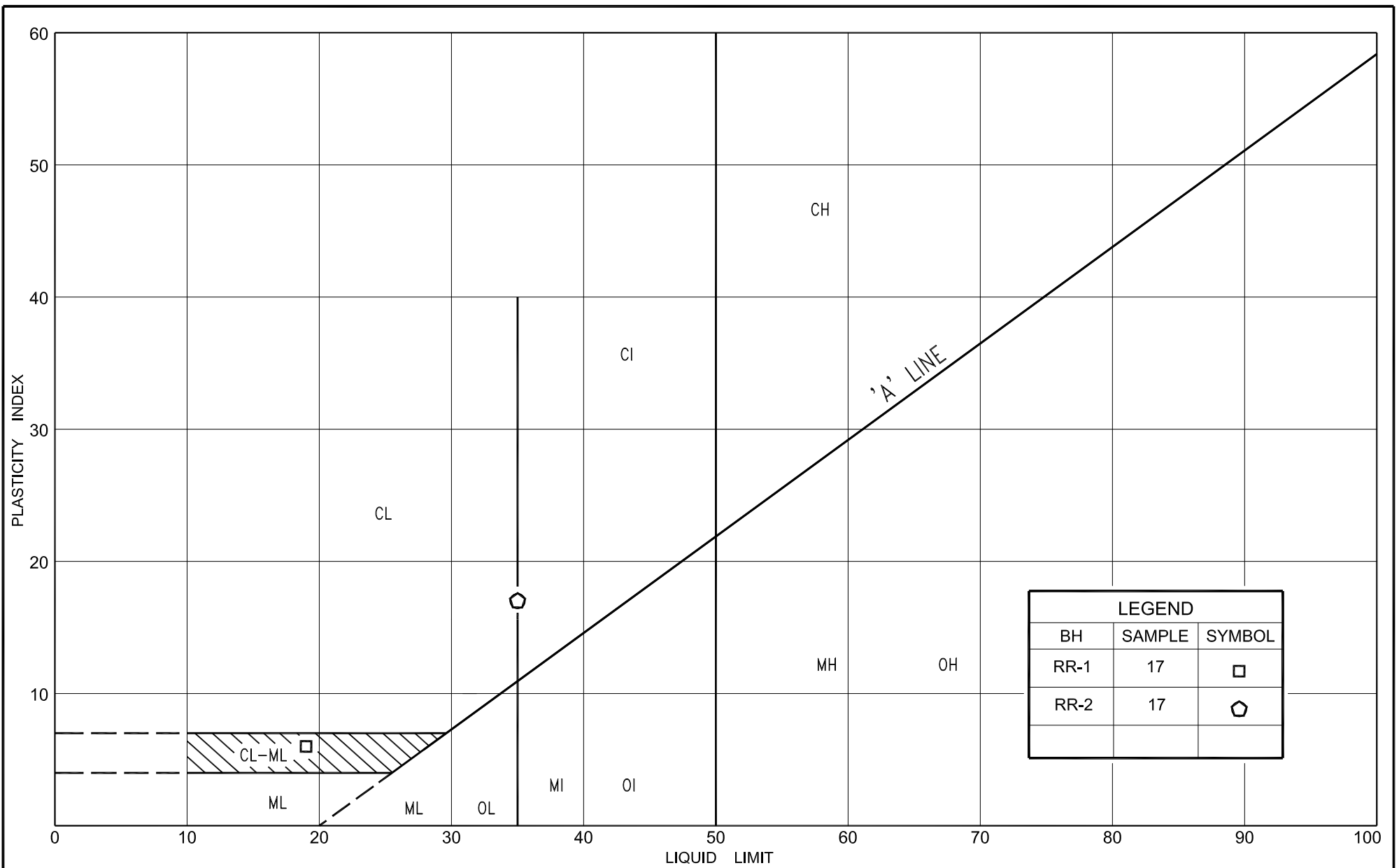


LEGEND		
BH	SAMPLE	SYMBOL
RR-2	11	⬠



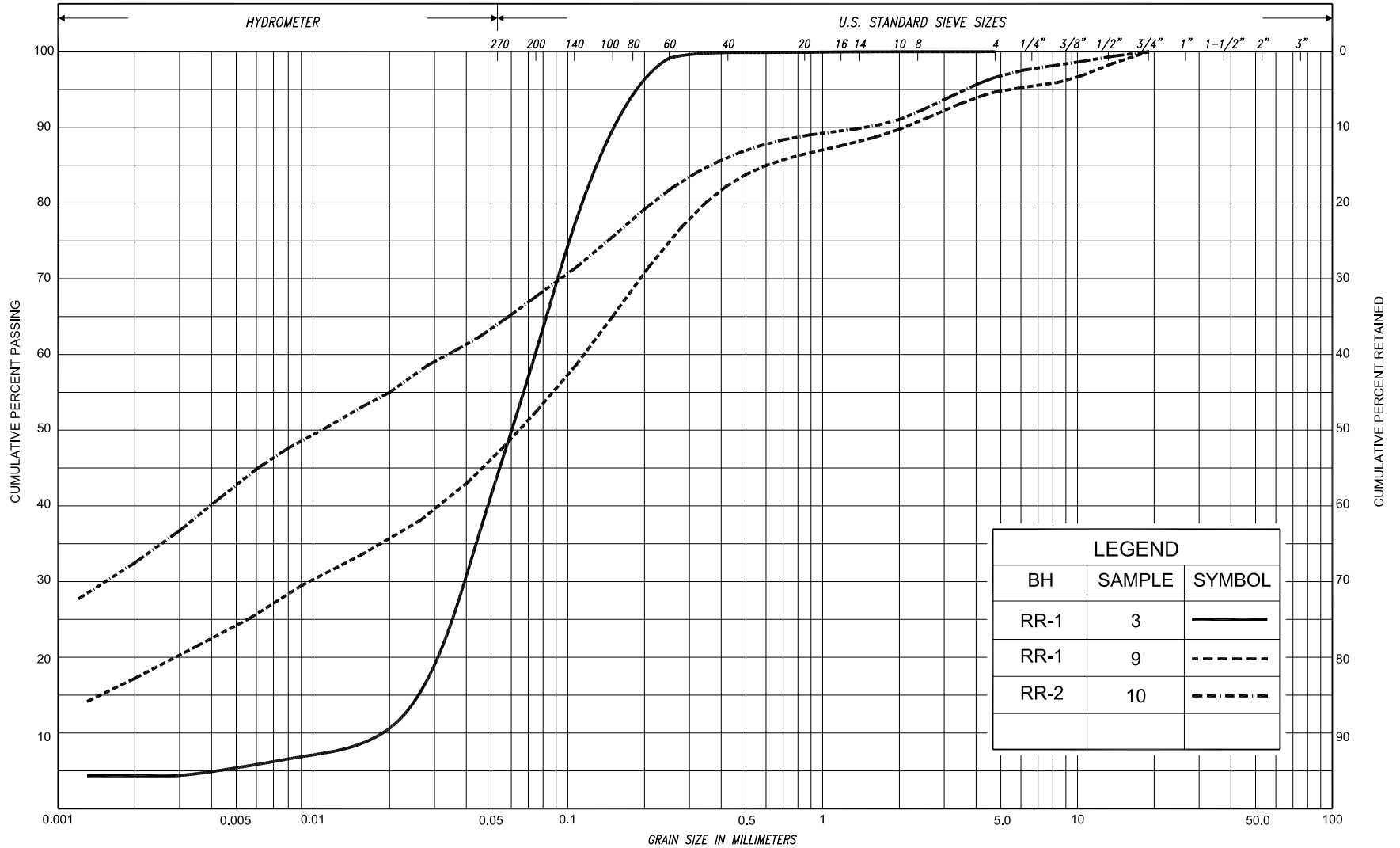
PLASTICITY CHART
 SILTY SAND, trace clay, trace gravel
 silt and gravelly sand layers

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



PLASTICITY CHART
CLAYEY SILT, trace sand, trace gravel (CL)
silty clay layers
(TILL)

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

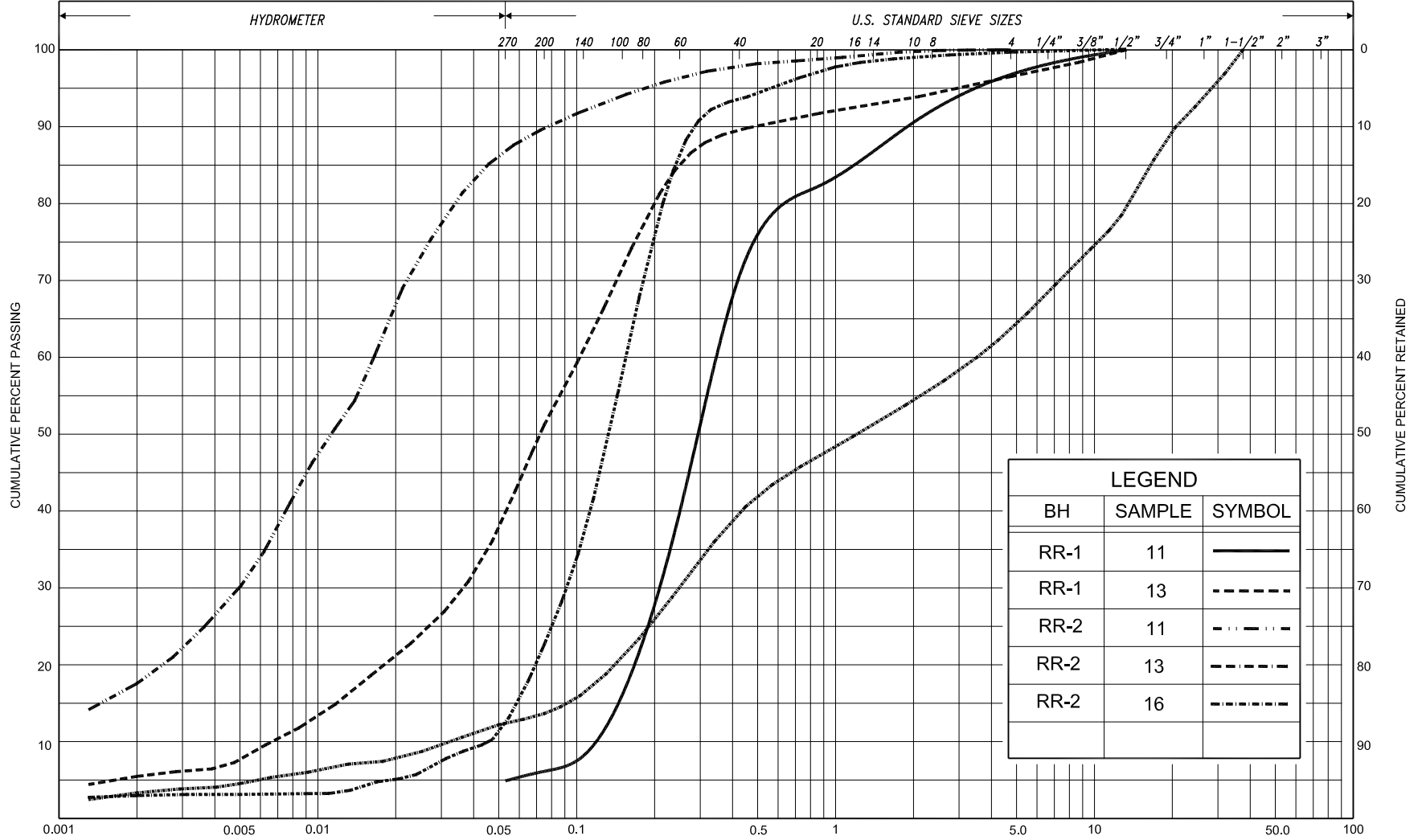


SILT & CLAY				FINE		MEDIUM		COARSE	GRAVEL		COBBLES	UNIFIED
				SAND								
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	GRAVEL				COBBLES	M.I.T.
		SILT										
CLAY		SILT		V. FINE	FINE	MED.	COARSE	GRAVEL				U.S. BUREAU
				SAND								



GRAIN SIZE DISTRIBUTION CLAYEY SILT, Silt and sand layers (FILL)

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

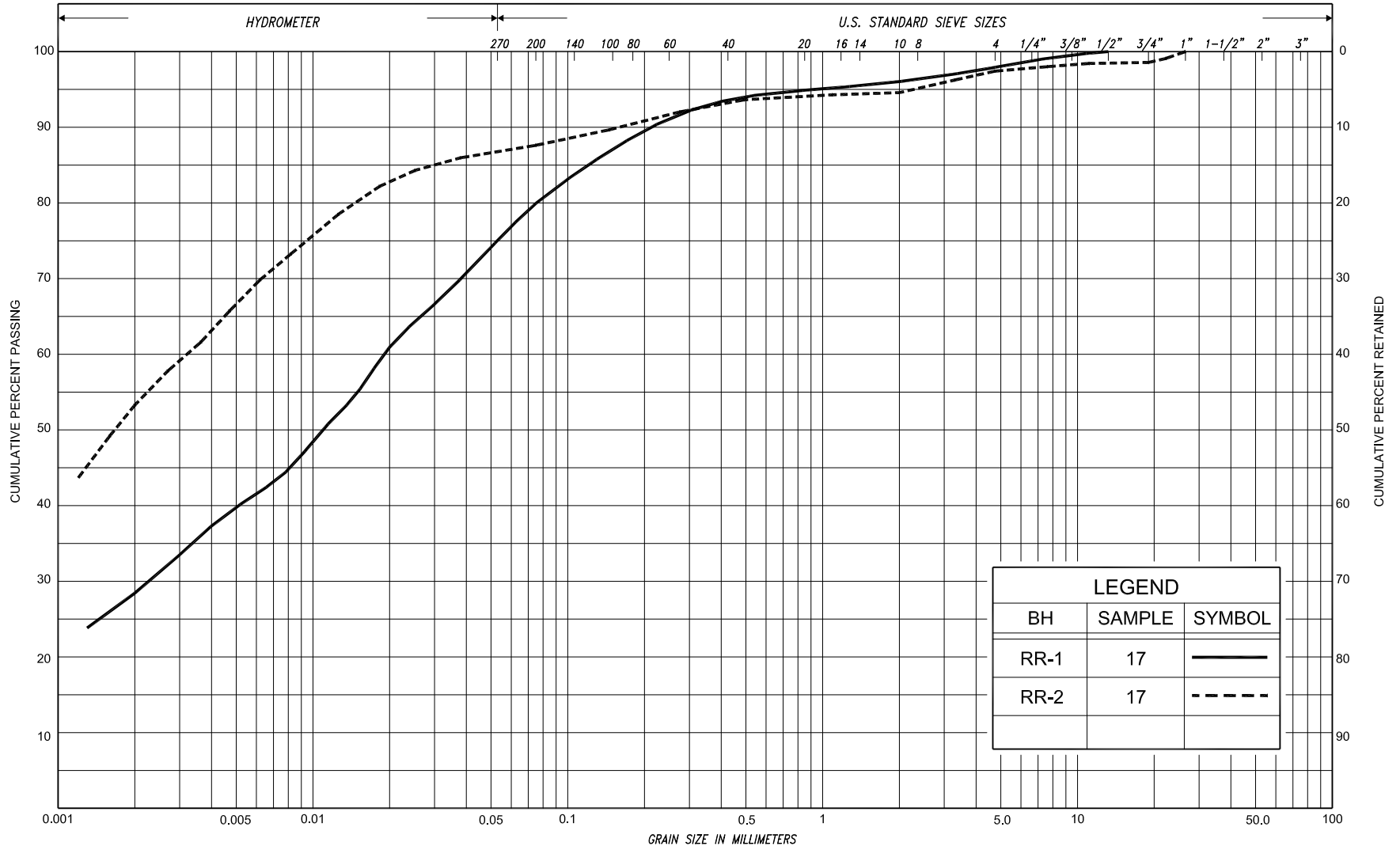


SILT & CLAY				FINE		MEDIUM		COARSE	GRAVEL		COBBLES	UNIFIED	
CLAY	FINE		MEDIUM	COARSE	FINE		MEDIUM		COARSE	GRAVEL		COBBLES	M.I.T.
	SILT			SAND						GRAVEL		COBBLES	U.S. BUREAU
CLAY		SILT		V. FINE	FINE	MED.	COARSE	GRAVEL					U.S. BUREAU
				SAND									



GRAIN SIZE DISTRIBUTION
 SILTY SAND, trace clay, trace gravel
 silt and gravelly sand layers

FIG No. RR-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									
CLAY		SILT		V. FINE	FINE	MED.	COARSE	GRAVEL					U.S. BUREAU
				SAND									



GRAIN SIZE DISTRIBUTION
 CLAYEY SILT, trace sand, trace gravel (CL)
 silty clay layers
 (TILL)

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

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

CONT No
WO No: 03-20024
ROUGE RIVER BRIDGE WIDENING
HIGHWAY 404 (HOV LANES)
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET

PML Peto MacCallum Ltd.
CONSULTING ENGINEERS



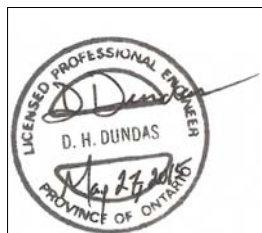
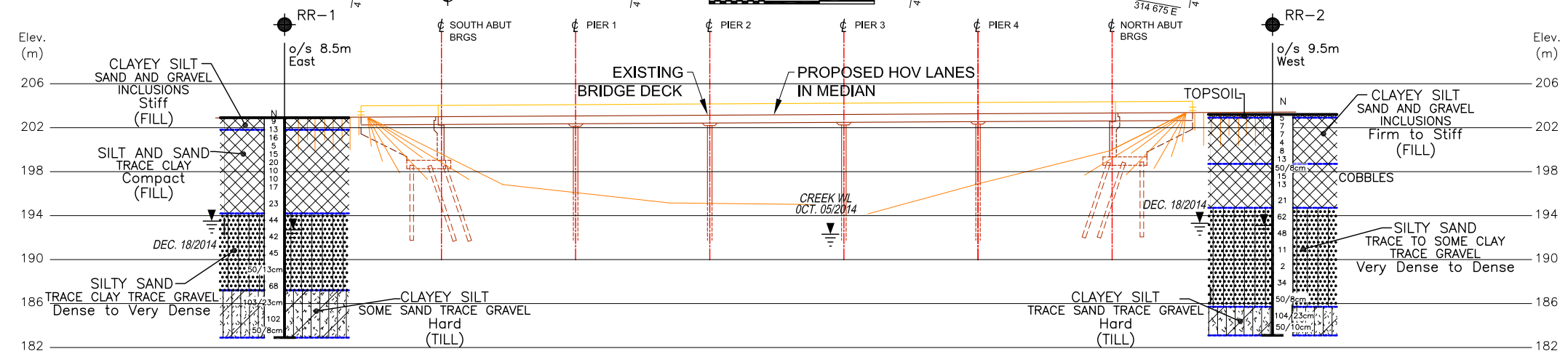
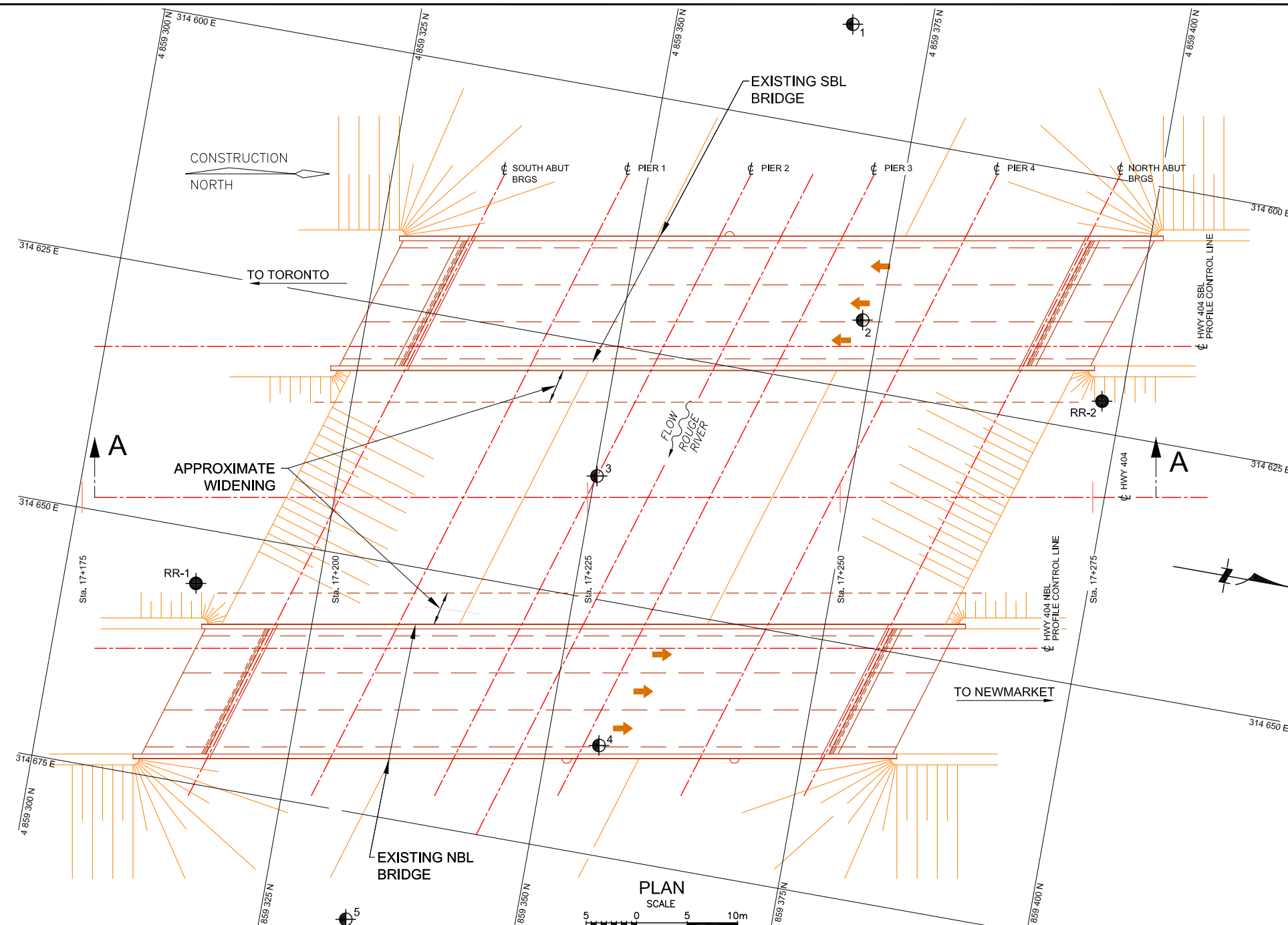
- LEGEND**
- Borehole
 - Dynamic Cone Penetration Test (Cone)
 - Borehole & Cone
 - Geocres Report Boreholes (30M14-51)
 - N Blows/0.3m (Std. Pen Test, 475 J/blow)
 - CONE Blows/0.3m (60° Cone, 475 J/blow)
 - WL at time of investigation Oct. 2014
 - Head
 - ARTESIAN WATER Encountered
 - PIEZOMETER

BH No	ELEVATION	COORDINATES	
		NORTHINGS	EASTINGS
RR-1	202.9	4 859 313.0	314 655.4
RR-2	203.2	4 859 398.1	314 621.9
1	194.5	4 859 367.3	314 589.5
2	194.5	4 859 373.4	314 618.2
3	194.4	4 859 350.2	314 638.0
4	193.7	4 859 355.1	314 664.2
5	194.2	4 859 333.4	314 685.5

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. 30M14-416			
HWY No	404	CHECKED MK	DATE MAY 27, 2015
SUBM'D NA			DIST CENTRAL
DRAWN NA			SITE 37-347
		APPROVED BRG	IDWG RR-1



Reference MMM Drawing:
S37-347-001GA-Global Coord-Existing.dwg dated May 2015

- 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.



APPENDIX A

Record of Previous Borehole Sheets (BH No. 1 to BH No. 5)

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 1

WP 160-74-26 LOCATION Co-ords. N 15 942 080; E 1 032 064
 DIST 6 HWY 404 BORING DATE January 15, 1971
 DATUM Geodetic BOREHOLE TYPE Washboring-WK Casing; Cone
 ORIGINATED BY VK
 COMPILED BY VK
 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w w_p w w_L WATER CONTENT %	UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES					
638.2	Ground Level									
1.0	Topsoil		1	SS	17					
	Silty sand with some gravel		2	SS	16					
	Compact to Very Dense Brown Grey		3	SS	40					
623.2			4	SS	66					
15.0	Gravel		5	SS	26					
16.5			6	SS	34					
612.2			7	SS	45					
25.0	Clayey Silt									
27.0										
606.7			8	SS	187					
31.5	End of Borehole									

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 2

W/P 160-74-26 LOCATION Co-ords. N 15 942 100; E 1 032 158 ORIGINATED BY VK
 DIST 6 HWY 404 BORING DATE Jan. 20, 1971 COMPILED BY VK
 DATUM Geodetic BOREHOLE TYPE Washboring-MX Casing; Cone 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. FLOT	NUMBER	TYPE	VALUES		20	40	60	80	100	w_p	w		
638.0	Ground Level														GR SA SI CL
1.0	Silty sand with some gravel-trace of clay		1	SS	23										
			2	SS	16										7 72 19 2
	Brown		3	SS	24										
	Grey		4	SS	60										9 79 10 2
			5	SS	48										
			6	SS	64										
			7	SS	167										
607.0			8	SS	165										
31.0	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 160-74-26 LOCATION Co-ords N 15 942 024; E 1 032 223 ORIGINATED BY VK
 DIST 6 HWY 404 BORING DATE January 21, 1971 COMPILED BY VK
 DATUM Geodetic BOREHOLE TYPE Washboring-MX Casing; Cone CHECKED BY JK

SOIL PROFILE		STRAT. PLOT	SAMPLES		GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w w_p — w — w_L WATER CONTENT %	UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION		NUMBER	TYPE					
637.9	Ground Level								
1.0	Topsoil								
	Silty sand with gravel-trace of clay		1	SS	3				
			2	SS	19				
	Loose - Very Dense		3	SS	64				
	Brown		4	SS	42				
			5	SS	67				
617.9	Boulder		6	SS	106.6"				
20.0	End of Borehole								

20
15 G-5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 4

WP 160-74-26 LOCATION Co-ords. N 15 942 040; E 1 032 309 ORIGINATED BY VK
 DIST 6 HWY 404 BORING DATE January 21, 1971 COMPILED BY VK
 DATUM Geodetic BOREHOLE TYPE Washboring-WX Casing; Cone CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT Y	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100		
635.5	Ground Level												
	Topsoil												
1.0	Silty sand with some gravel-trace of clay		1	SS	15	630							
			2	SS	17								8 82 (10)
	Compact to Very Dense		3	SS	44								
	Brown		4	SS	60								
			5	SS	91	620							34 55 10 1
617.5													
18.0	Clayey silt												
19.5			6	SS	156	6"							
609.0													
26.5	End of Borehole		7	SS	157	6" 610							

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 5

WP 160-74-26 LOCATION co-ords N 15 941 969; E 1 032 379 ORIGINATED BY VK
 DIST 6 HWY 404 BORING DATE Jan. 20, 1971 COMPILED BY VK
 DATUM Geodetic BOREHOLE TYPE Washboring-NX Casing; Cone CHECKED BY FC

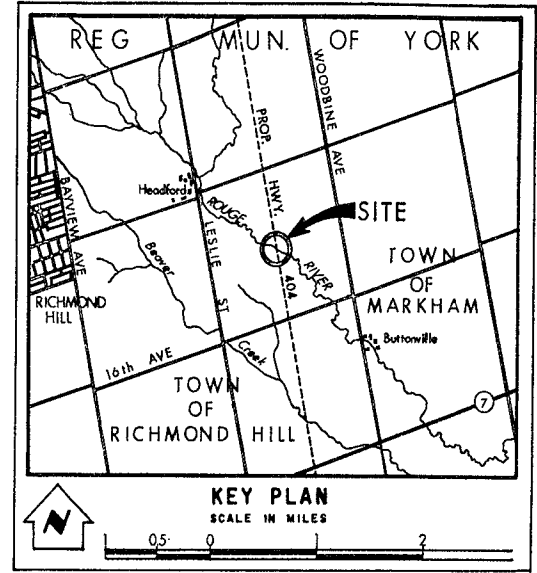
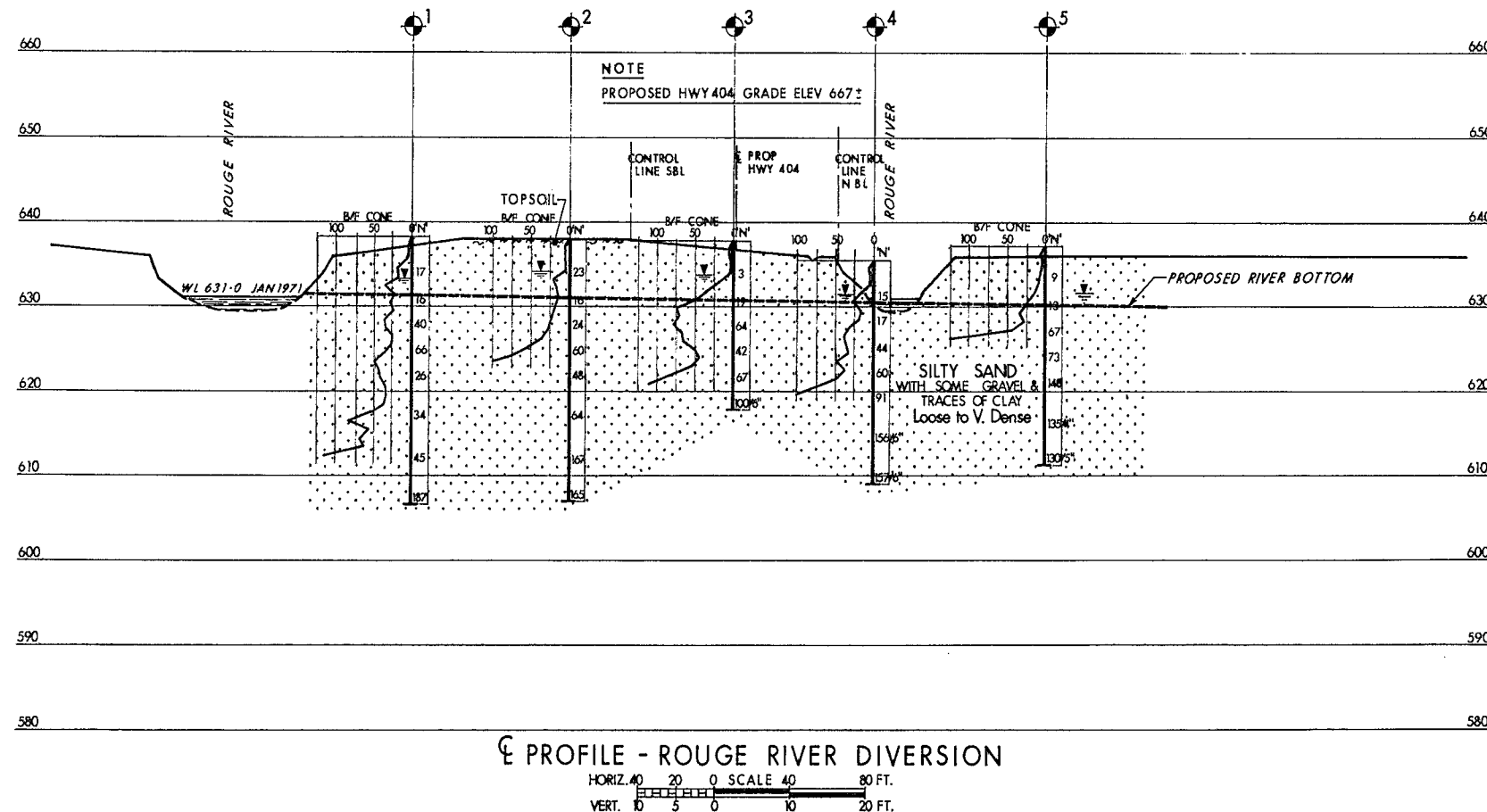
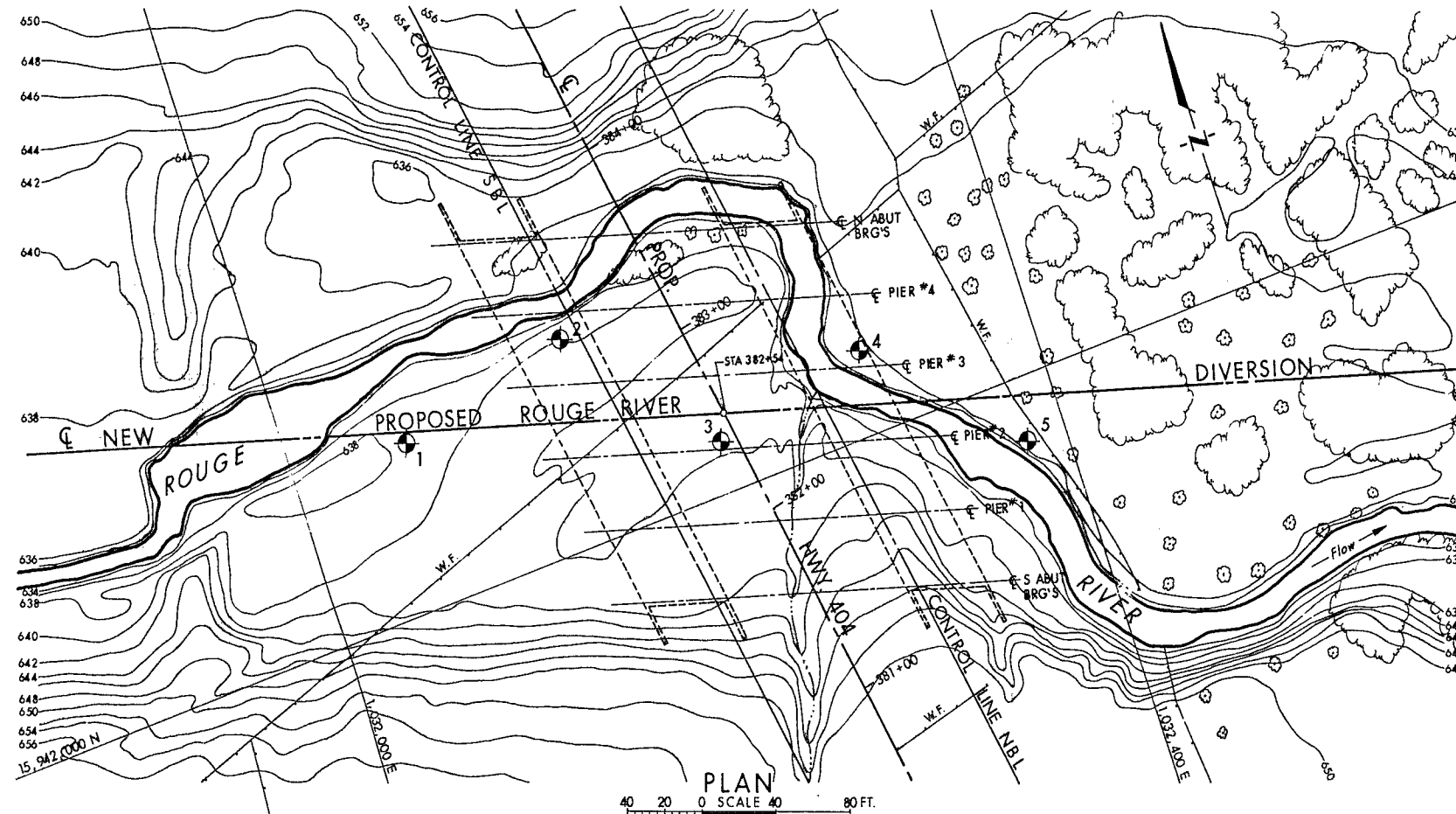
SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w w_p w w_L WATER CONTENT %	UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES					
637.1	Ground Level									
	Topsoil									
1.0	Silty sand with some gravel-trace of clay		1	SS	9					
			2	SS	13					
	Loose to Very Dense		3	SS	67					16 73 (11)
			4	SS	73					
	Brown		5	SS	148					1 57 38 4
			6	SS	135/4"					
611.1			7	SS	130/5"					
26.0	End of Borehole									

OFFICE REPORT ON SOIL EXPLORATION



APPENDIX B

Previous Borehole Locations and Soil Strata



LEGEND			
	Bore Hole		
	Cone Penetration Hole		
	Bore & Cone Penetration Hole		
	Water Levels established at time of field investigation, JANUARY 1971		
NO.	ELEVATION	CO - ORDINATES	
		NORTH	EAST
1	638.2	15,942,080	1,032,064
2	638.0	15,942,100	1,032,158
3	637.9	15,942,024	1,032,223
4	635.5	15,942,040	1,032,309
5	637.1	15,941,969	1,032,379

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
13 APR 77	R S		PROP DIVERSION & PROFILE GROUND LINE REVISED.

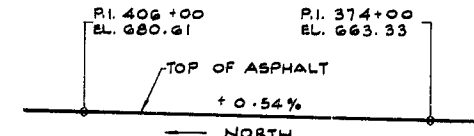
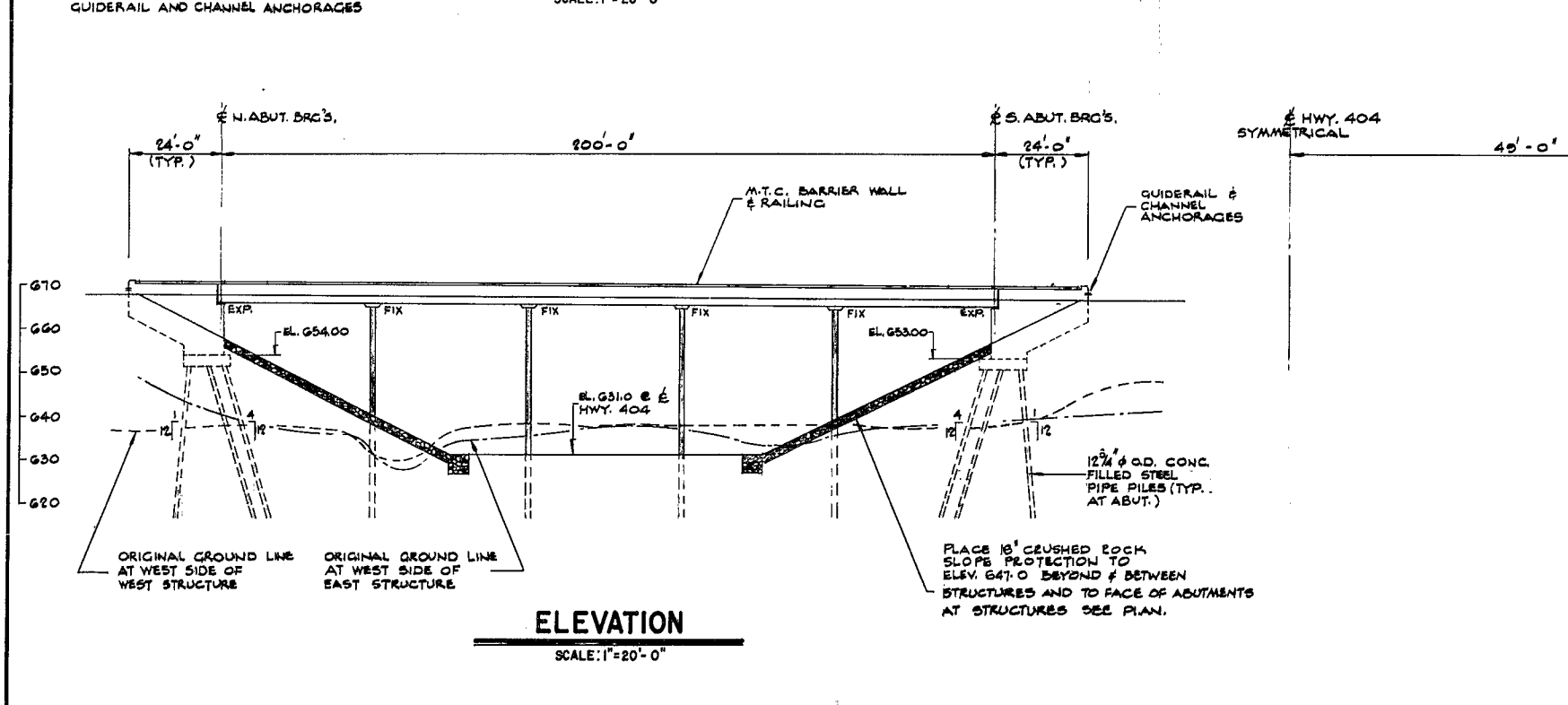
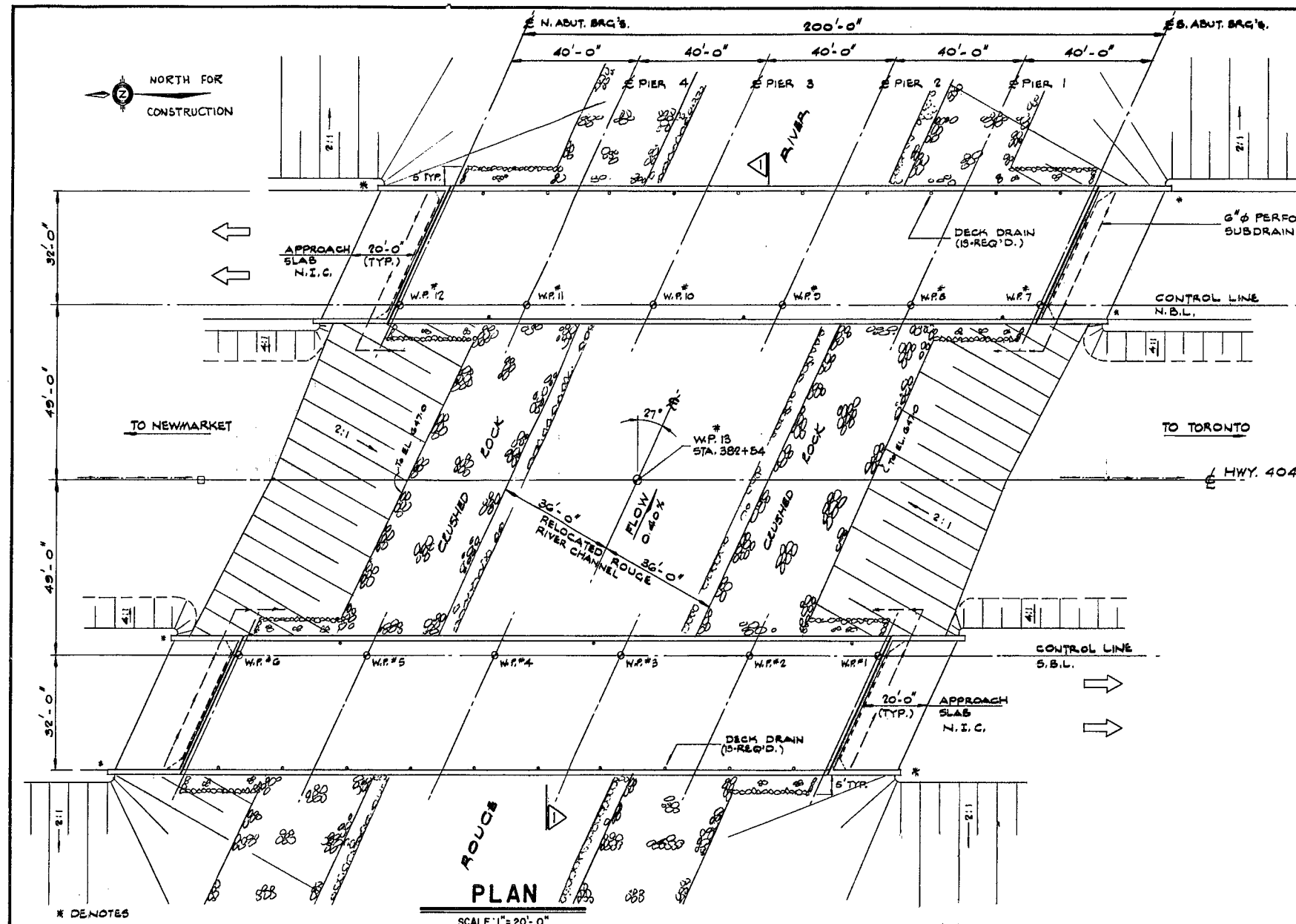
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION			
ROUGE RIVER (1.7 MILES NORTH OF HWY 7)			
KING'S HIGHWAY NO. PROP. 404		DIST. NO. 6	
Regional Municipality of YORK, Town of MARKHAM		LOT 18 CON. 3	
BORE HOLE LOCATIONS & SOIL STRATA			
SUBMITT. V. K.	CHECKED <input checked="" type="checkbox"/>	W.P. NO. 160-74-26	DRAWING NO.
DRAWN S. R.	CHECKED <input checked="" type="checkbox"/>	JOB NO.	BRIDGE DRAWING NO.
DATE FEBRUARY 4, 1971		SITE NO. 37-347	
APPROVED		CONT. NO. 78-45	37-347-2

REF No: B 200-40 &
McCORMICK, RANKIN & ASSOC
DWG N° M-404-RR, Dec 1976



APPENDIX C

Previous General Arrangement Drawing



CONCRETE QUANTITIES

(FOR LUMP SUM CONCRETE TENDER ITEMS)	N.B. STRUCT.	S.B. STRUCT.
CONCRETE IN ABUTMENTS & WINGWALLS	150 CU. YDS.	152 CU. YDS.
CONCRETE IN DECK	532 "	532 "
CONCRETE IN BARRIER WALLS	38 "	38 "
CONCRETE IN APPROACH SLABS	44 "	44 "

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

DIST. No 6
CONT. No 78-45
WP. No 160-74-26

HWY. 404 CROSSING
AT ROUGE RIVER
GENERAL LAYOUT

SHEET
264

McCORMICK, RANKIN & ASSOCIATES
LIMITED
consulting engineers

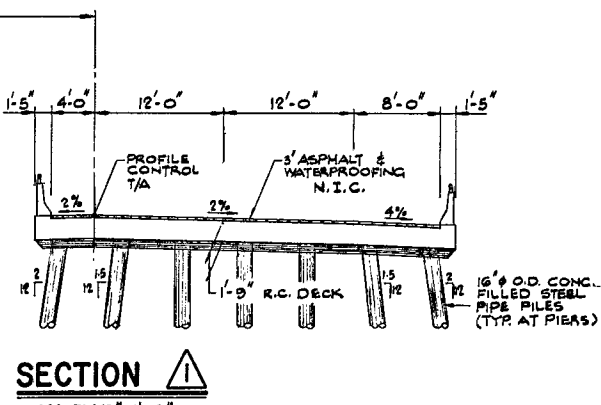
B.M. ELEV. 665.30
NAIL AND WASHER IN NORTH-WEST FOOT OF 1.5 FOOT BASSWOOD 141 FEET RIGHT OF STATION 387+53

GENERAL NOTES:
CLASS OF CONCRETE
DECK AND BARRIER WALLS - 4,000 PSI
REMAINDER - 3,000 PSI

CLEAR COVER ON REINFORCING STEEL
FOOTINGS AND ABUTMENTS (TOP) - 3"
DECK (BOT.) - 2"
BARRIER WALLS - 1 1/2"
APPROACH SLABS - 2"
REINFORCING STEEL SHALL BE C.S.A. G30 SERIES, GRADE 60.
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.

CONSTRUCTION NOTES
THE CONTRACTOR SHALL FINISH THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS TO A TOLERANCE OF ± 1/8".
NO CONCRETE SHALL BE PLACED ABOVE THE ABUTMENT BEARING SEATS UNTIL THE CONCRETE IN THE DECK HAS BEEN PLACED.

- LIST OF DRAWINGS
1. GENERAL LAYOUT
 2. BOREHOLE LOCATIONS AND SOIL STRATA
 3. FOUNDATION LAYOUT
 4. ABUTMENTS
 5. WINGWALLS
 6. SCREED ELEVATIONS
 7. DECK DIMENSIONS AND REINFORCING
 8. APPROACH SLABS
 9. CONCRETE BARRIER WALL
 10. STEEL RAILING (SINGLE TUBE)
 11. AS CONSTRUCTED ELEV. & DIMEN.
 12. STANDARDS
 13. STANDARDS



FOR REDUCED PLAN
USE SCALE BELOW
1" = 3' ON ORIGINAL PLAN

REVISIONS	DATE BY	DESCRIPTION
1	DESIGN R.S.	CHECK J.W.T. LOADING HS-20-44 DATE JULY, 77
2	DRAWING J.A.	CHECK J.W.T. SITE No 37-347 DWS

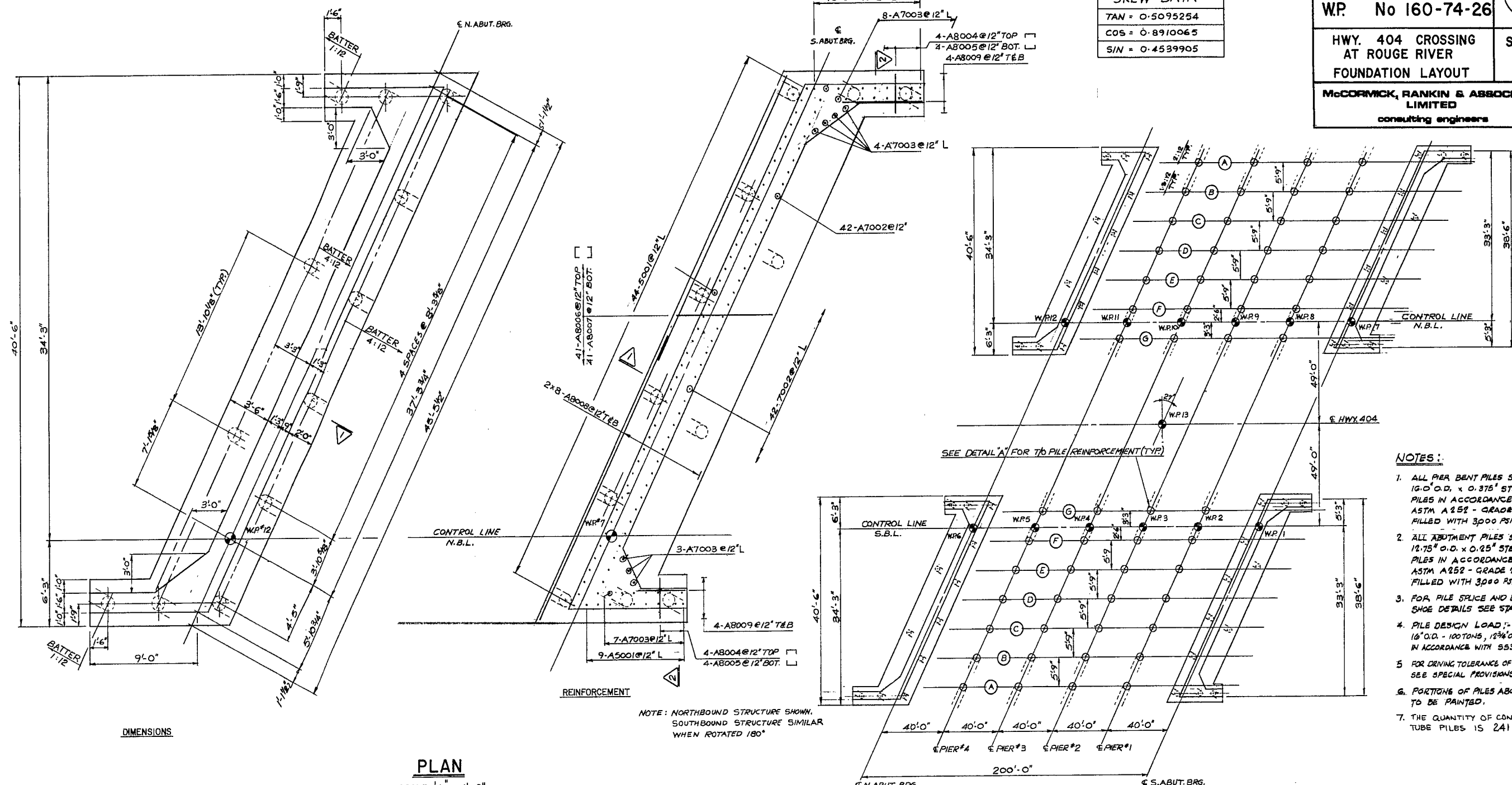


APPENDIX D

Previous Foundation Layout



SKEW DATA	
TAN =	0.5095254
COS =	0.8910065
SIN =	0.459905



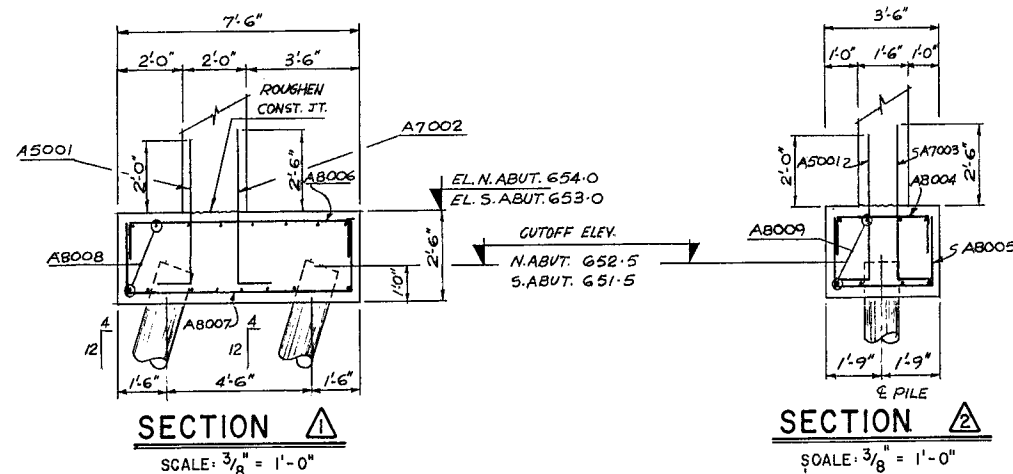
NOTES:

1. ALL PIER BENT PILES SHALL BE 16" O.D. x 0.375" STEEL PIPE PILES IN ACCORDANCE WITH ASTM A252 - GRADE 2 AND FILLED WITH 3000 PSI CONCRETE.
2. ALL ABUTMENT PILES SHALL BE 12.75" O.D. x 0.25" STEEL PIPE PILES IN ACCORDANCE WITH ASTM A252 - GRADE 2 AND FILLED WITH 3000 PSI CONCRETE.
3. FOR PILE SPICE AND DRIVING SHOE DETAILS SEE STANDARDS.
4. PILE DESIGN LOAD: 16" O.D. - 100 TONS, 12.75" O.D. - 70 TONS IN ACCORDANCE WITH S53-11
5. FOR DRIVING TOLERANCE OF PILES SEE SPECIAL PROVISIONS.
6. PORTIONS OF PILES ABOVE GROUND TO BE PAINTED.
7. THE QUANTITY OF CONCRETE IN TUBE PILES IS 241 CU.YD.

PLAN

SCALE: 1/4" = 1'-0"

DIMENSIONS



TOP OF PIER BENT PILE ELEVATIONS

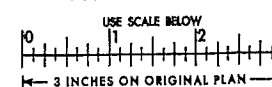
NORTH BOUND STRUCTURE							
	A	B	C	D	E	F	G
PIER #1	664.63	664.87	665.03	665.16	665.29	665.43	665.42
PIER #2	664.84	665.09	665.38	665.51	665.64	665.64	665.64
PIER #3	665.06	665.30	665.46	665.60	665.72	665.86	665.85
PIER #4	665.27	665.52	665.68	665.81	665.94	666.07	666.07
SOUTH BOUND STRUCTURE							
	A	B	C	D	E	F	G
PIER #1	665.07	665.28	665.41	665.51	665.61	665.71	665.67
PIER #2	665.28	665.50	665.62	665.73	665.82	665.93	665.89
PIER #3	665.50	665.71	665.84	665.94	666.04	666.14	666.10
PIER #4	665.72	665.93	666.05	666.16	666.25	666.36	666.32

PILE TABLE

N.B. STRUCTURE			
LOCATION	NO. REQ'D	TYPE	LENGTH
N. ABUT.	12	12 3/4" φ	50'
PIERS	28	16" φ	62'
S. ABUT.	12	12 3/4" φ	49'
S.B. STRUCTURE			
N. ABUT.	12	12 3/4" φ	50'
PIERS	28	16" φ	62'
S. ABUT.	12	12 3/4" φ	49'

NOTE: PILE LENGTHS ARE APPROX. ONLY

FOR REDUCED PLAN



REVISIONS	DATE BY	DESCRIPTION
DESIGN RS	CHECK J.W.T.	LOADING HS-20-44 DATE 20/6/77
DRAWING JS	CHECK J.W.T.	SITE No 37-347 DWG 3





PRELIMINARY FOUNDATION DESIGN REPORT

for

**ROUGE RIVER BRIDGES
HIGHWAY 404 HOV LANE EXPANSION
FROM HIGHWAY 407 TO GREEN LANE
WO 03-20024
REGIONAL MUNICIPALITY OF YORK, ONTARIO**

PETO MacCALLUM LTD.
165 CARTWRIGHT AVENUE
TORONTO, ONTARIO
M6A 1V5
Phone: (416) 785-5110
Fax: (416) 785-5120
Email: toronto@petomaccallum.com

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PART B
PRELIMINARY FOUNDATION DESIGN REPORT
for
Rouge River Bridge, NBL and SBL Structures
Highway 404 HOV Lane Expansion
From Highway 407 to Green Lane
WO 03-20024,
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 Rouge River Bridge structures, associated with the proposed HOV lanes widening of Highway 404 in the Regional Municipality of York. The recommendations are intended for preliminary design and planning purposes only and are based on the factual subsurface and groundwater conditions obtained from the current investigation. Further foundation engineering services will be required to provide detail design level recommendations.

It is expected that the existing highway platform will be widened throughout the project length and will require the widening of the existing Rouge River Bridge structures. It is understood that the widening will be achieved by adding one HOV lane in each direction of the Highway 404 NBL and SBL lanes in the existing median area. This will require filling of the median and possibly construction of a new barrier along the centreline of the median.

The grade of Highway 404 in the vicinity of the bridge structures is at about elevation 203.6.

Based on the available General Arrangement Drawings (Appendices C and D) for the existing bridge structures, the abutments and piers are founded on steel pipe piles driven into the very dense silty/sandy stratum to approximate elevation 184.0 and subsequently filled with concrete. The pipe pile lengths ranged from approximately 15 to 19 m. The original bridges consisted of 75.6±m long, 9.8± m wide, 5-span bridges with span geometries of approximately 12.2 m. The existing abutment and piers are founded on concrete-filled steel pipe piles with nominal outside diameter of 323.9 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.

Structure	Location	Number of Piles	Cut-off Elevation (m)	Length (m)	Pile Tip Elevation (m)
North Bound Structure	North Abutment	12	199.3	15.2	184.1
	Piers	23	202.5 to 203.0	18.9	183.6 to 184.1
	South Abutment	12	199.0	14.9	184.1
South Bound Structure	North Abutment	12	199.3	15.2	184.1
	Piers	28	202.7 to 203.1	18.9	183.8 to 184.2
	South Abutment	12	199.0	14.9	184.1



7.2 Foundation Options

FOUNDATION TYPE	ADVANTAGES	DISADVANTAGES	RELATIVE COST	RISKS/CONSEQUENCES
Spread Footings at abutment locations (placed on native soils or structural fill)	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.	Low	Differential settlement between widened and existing portions of structure.
Driven H-Piles (at abutment and pier locations)	Driven H-piles cause small soil displacement and less risk to disturbing existing foundations.	Vibration induced during pile driving. Potential interference with existing piles. Driving difficulties due to possible presence of cobbles and boulders in the glacial till soils.	Moderate	Disturbance to existing foundations through physical contact with existing piles during driving of new piles could cause settlement of existing structure. Pile driving induced vibrations could cause disturbance to ground supporting existing piles and subsequent settlement of existing structure.
Caissons (at abutment and pier locations)	Larger bearing capacity than for other options.	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. Construction difficulties due to possible presence of cobbles and boulders in the glacial till soils	High	Loss of ground during installation that could cause settlement of existing foundations. Flowing soils under along shaft and base could cause necking of concrete in caisson and subsequent reduction in resistance of caisson foundation.

A foundation system consisting of steel H-piles driven into the very dense silty/sandy stratum is the recommended means of supporting the abutments, piers and retaining walls of the widening structures in view of the need to preserve the existing pile foundations during construction. Steel H-piles are preferred over driven 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 in the order of 10 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.

Caissons were given consideration as a foundation option, but it was concluded that the noncohesive 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 H-piles are the preferred options for foundations for the proposed widenings.

7.3 Pile Foundation

Refer to the Foundation Layout Drawing in Appendix D for details for the foundation for the existing bridges. It is anticipated that the base of any widened portions of pile caps would match the elevations of the existing pile caps. Note that the existing pier bents have pile construction.

At the abutments, it is anticipated that the driven steel H-Piles will encounter practical refusal at approximately elevation 184 yielding a pile length of approximately 15 m. At the piers, assuming the top of pier bent piles are at approximately elevation 202.7, it is anticipated that the driven steel H-Piles will encounter practical refusal at approximately elevation 184 yielding a pile length of approximately 19 m.

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

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



The resistance at SLS normally allows for 25 mm of compression of the pile and founding medium.

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.

To avoid undermining the adjacent existing abutments, all excavations for pile cap construction would have to be adequately supported by protection systems.

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. Vibration and settlement monitoring provisions for the existing foundations would have to be developed during the detail design phase of the project. The existing piles would have to be located and avoided during driving of new piles.

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 Retaining 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 slope angle of the existing earth embankment side and front slopes was not determined but are expected to be in the order of 2H:1V slope. The height of the embankment is up to 9.8 m. The geometry of embankment slopes should be determined during detail design. It is expected that embankment slopes after median widening should maintain a geometry of 2H:1V or flatter. However, if the prescribed safe slope geometry cannot be realized, retaining walls may be required. Further, where the height of the embankments is greater than 8 m for earth fill, it is anticipated that a 2.0 m wide berm will be required in accordance with OPSD 202.010.

The existing compressible materials within 20 m of the abutments in the widening zone should be excavated prior to placement of the embankment fill and backfill. Benching of the existing embankment front slopes (at the abutments) should be carried out to key in the new fill. The new fill should be keyed into the existing fill as per MTO standards.

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 excavation 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

Based on foundation investigations, the water levels measured in the open boreholes was found to be at depths between 9.4 and 9.9 m (elevation 193.5 and 193.3), below ground surface.

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. Conventional sump pumping will most probably be adequate for this site location. Surface water run-off should be diverted away from excavation to ensure that the foundation is constructed in the dry. If however, more positive groundwater control is required at the site location, consideration could be given to using adequate perimeter ditching or cofferdams if necessary.

8. SCOPE OF ADDITIONAL FOUNDATION INVESTIGATION

The recommendations in this report are preliminary. Detailed foundation engineering services will be required during the Detail Design phase of the project.

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

The extent of further subsurface investigations at this site may be limited to 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 to one additional borehole at proposed pier widenings.



9. CLOSURE

The Preliminary Foundation Design portion of this report was prepared by Ms. M. Kamranzadeh, MSc, EIT, 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.

A handwritten signature in blue ink, appearing to be "Marzieh", is located below the "Yours very truly," text.

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