



**FOUNDATION INVESTIGATION AND DESIGN REPORT  
for  
HIGHWAY 404 – SBL NOISE BARRIER WALL  
FROM GREEN LANE EAST TO 250 M NORTH OF FARR AVENUE  
TOWNSHIP OF EAST GWILLIMBURY, ONTARIO  
AGREEMENT NO.: 2013-E-0039  
TASK NO. 2013-E-0039-009**

**PREPARED FOR MINISTRY OF TRANSPORTATION, ONTARIO**

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PML Ref.: 15TF012  
Index No.: 011FIR and 012FDR  
GEOCRES No.: 31D-615  
August 19, 2015



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**FOUNDATION INVESTIGATION REPORT**

For

Highway 404 – SBL Noise Barrier Wall

From Green Lane East to 250 m North of Farr Avenue

Township of East Gwillimbury, Ontario

Agreement No.: 2013-E-0039, Task No.: 2013-E-0039-009

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**1. INTRODUCTION**

This Foundation Investigation Report (FIR) summarizes the results of the foundation investigation carried out for the proposed noise barrier wall alignment along the west side of Highway 404 Southbound from Green Lane East to 250 m north of Farr Avenue in East Gwillimbury, Ontario. The study was carried out by Peto MacCallum Ltd. (PML) for the Ministry of Transportation of Ontario (MTO).

The proposed noise barrier wall is to be located within the approximately 2.3 km section of Highway 404 extending from Station 27+200 to 29+500 (noted in Drawings SBW-1 to SBW-5). The height of the noise barrier wall is assumed to be 5 m.

The purpose of this report was to summarize the subsurface stratigraphy encountered at the site.

The terms of reference and scope of work for the foundation engineering service are outlined in MTO's Work Item Order Form for Agreement No. 2013-E-0039, Task No. 2013-E-0039-009, issued on June 2, 2015. A site plan was prepared by MTO (MTO Reference Drawing: NC Standard) and received on July 6, 2015.

All elevations in this report are expressed in metres.

**2. SITE DESCRIPTION AND GEOLOGY**

The site is located along the west side of Highway 404 Southbound and east side of existing fence line, from Green Lane East to 250 m north of Farr Avenue in Township of East Gwillimbury, Ontario. The site photographs along the proposed noise barrier wall are included in Appendix FIR-A.



The topography is variable along the proposed alignment consisting of gently rolling hills. The ground surface relief of the site at the borehole locations is approximately 20 m between approximate elevation 270.0 and elevation 290.0, referenced to geodetic datum.

According to the Physiography of Southern Ontario, the study area is situated within the Peterborough Drumlinized Field, which is characterized by the drumlinized till. The till is typically sandy, and covered by shallow silt and fine sand (Chapman, L.J. and Putnam, D.F., The Physiography of Southern Ontario, 3<sup>rd</sup> Edition, Ontario Research Foundation, 1984).

Within the limits of this investigation, the land west of the existing fence line along the proposed noise barrier wall alignment has a residential use. A stormwater management pond is located at the south end of project limit, approximately 600 m north of Highway 404 and Green Lane East interchange. The land at the east of the existing fence line is the Highway 404 Right-of-Way (ROW).

In accordance with the provided MTO Contract Drawings (Contract No. 2010-2001 Book 2 of 4, Central Region, sheets 166 to 173 and Addendum No. 2 sheets 25A, 170A to 172A, and 228A to 230A), cut and fill activities were conducted for the construction of Highway 404 Extension. However, in general, the ground surface elevation at borehole locations along the existing fence line, which is approximately 15 m away from the westerly edge of Highway 404 Southbound, is similar to the original ground profile in the Contract Drawings.

### **3. PREVIOUS INVESTIGATIONS**

Previous geotechnical investigations conducted by other consultants within the project limits along the proposed alignment of noise barrier wall are documented in the following reports provided by MTO:

- Foundation Investigation and Design Report “Highway 404 Extension from Green Lane to Queensville Sideroad, High Fills and Deep Cuts at 27+775 – 27+875, 30+075 – 30+225, 30+975 – 31+100, 33+200 – 33+700, QSR 9+550 – 9+750, QSR 9+750 – 10+300, Region of York, G.W.P. 2109-05-00”, Geocres Number: 31D-492, Thurber Engineering Ltd. (Thurber), February 26, 2010.



- Foundation Investigation and Design Reports “Proposed Highway 404 Extension Advance Structures at Mount Albert Road, Town of East Gwillimbury, Ontario, MTO Central Region, W.O. 04-20024”, Agreement No. 2004-E-0051, Shaheen & Peaker Limited (SPL), Project: SPT1178, April 24, 2007.

The previous geotechnical investigation reports were reviewed. Generally, the subsurface conditions consist of sand and sandy silt deposit from Station 27+675 to 27+850 (Thurber, 2010), and silt deposit interlayered with clayey silt to sandy silt deposit at Mount Albert Road Overpass from Station No. 28+800 to 28+850 (SPL, 2007).

#### **4. INVESTIGATION PROCEDURES**

The field work for this study was carried out in the period of June 19 to June 26, 2015. The investigation included twenty-four boreholes advanced to either a minimum depth equivalent to the height of the noise barrier wall or to the depth where the soil is competent to support the noise barrier wall foundation in accordance with the requirement indicated in MTO's Work Item Order Form. The borehole depths ranged from 2.9 m to 8.2 m below ground surface.

It is noted that the fieldwork has carried out prior to receiving the MTO Reference Drawing and the chainage had been assumed in the reverse direction. For quality control purposes, the borehole numbering remained unchanged after the fieldwork was completed.

The borehole locations were proposed by PML in the proposal dated on June 9, 2015 to supplement selected previous boreholes, minimize traffic disruption and interference with private properties, and all boreholes were established in the field by PML. Where the accessibility for a drill rig was limited, boreholes (i.e. boreholes 9 and 24) were moved to the nearest accessible locations in the MTO ROW as agreed with MTO, since the permission to enter private properties was not obtained.

Upon completion of drilling, all boreholes were staked and labelled in the field. Although preliminary borehole ground surface elevations and coordinates were obtained by PML, the final



ground surface elevations and borehole coordinates were provided by MTO and are listed in the table below.

The boreholes were advanced using continuous flight hollow stem augers, powered by a track-mounted CME-55 drill rig, supplied and operated by a specialist drilling contractor, working under the full-time supervision of a PML field supervisor.

Soil samples were recovered from the boreholes at regular 0.75 or 1.5 m depth intervals using a conventional split spoon sampler during drilling. Standard penetration tests were conducted to assess the strength characteristics of the substrata, in accordance with ASTM Standard D1586-11. 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 the drill rods as the samples were retrieved. Following drilling, the soil cave-in and groundwater level in the boreholes were measured. More details can be found in Section 5 and Record of Borehole sheets.

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

The recovered soil samples were returned to our laboratory in Toronto for detailed visual examination, laboratory testing and classification. The laboratory testing program included the following tests:

- Natural moisture content determinations;
- Grain size distribution analyses (i.e. Sieve Analyses and Hydrometer tests);
- Atterberg Limits tests.

The results of the laboratory grain size distribution analyses and Atterberg Limits tests are presented in Figures GS-1 to GS-6 and PC-1 to PC-5 respectively. All of the test results are presented on the Record of Borehole Sheets.



The locations and surface elevations are indicated in the following table.

BOREHOLE GROUND SURFACE ELEVATIONS AND MTM COORDINATES				
BOREHOLE STATION NUMBER	BOREHOLE NUMBER	GROUND SURFACE ELEVATIONS <sup>1</sup> (m)	MTM ZONE 10 COORDINATES <sup>1</sup>	
			NORTHING	EASTING
27+218	24 <sup>2</sup>	281.1	4883649.2	310744.7
27+256	23	284.1	4883682.2	310822.4
27+321	22	285.0	4883748.3	310836.6
27+390	21	287.0	4883818.7	310854.6
27+483	20	289.8	4883910.2	310886.4
27+612	19	289.4	4884031.8	310930.3
27+775	08-15A <sup>3</sup>	290.5	4884167.0	311038.8
27+825	08-16A <sup>3</sup>	289.6	4884213.7	311056.5
27+875	18	286.0	4884277.6	311023.3
27+933	17	283.8	4884331.2	311042.5
28+008	16	281.9	4884404.4	311060.5
28+083	15	279.0	4884474.2	311076.4
28+200	14	276.5	4884582.2	311095.0
28+300	13	272.2	4884679.0	311105.6
28+400	12	270.7	4884776.4	311109.1
28+500	11	269.7	4884874.4	311107.7
28+625	10	269.5	4884996.5	311097.5
28+700	9 <sup>2</sup>	269.6	4885072.9	311101.8
28+866	8	271.4	4885230.9	311074.9
28+925	7	272.3	4885286.8	311049.4
29+000	6	272.8	4885360.8	311036.3
29+075	5	272.2	4885434.7	311024.7
29+150	4	273.3	4885508.5	311009.1
29+266	3	273.5	4885622.4	310988.7
29+335	2	274.2	4885690.4	310972.9
29+410	1	276.1	4885764.2	310959.1

**Notes:**

1. Ground surface elevations and coordinates of boreholes were provided by MTO (E-mail dated July 20, 2015);
2. Due to the limited accessibility near the existing fence line, borehole 9 was advanced at the toe of embankment, and borehole 24 was at the toe of the slope approximately 5 m south of the fence line;
3. The information of boreholes 08-15A and 08-16A is extracted from Thurber report (2010).





## **5. SUMMARIZED SUBSURFACE CONDITIONS**

Reference is made to the appended Record of Borehole sheets for details of the subsurface conditions including soil classifications, inferred stratigraphy, standard penetration tests, soil cave-in, and groundwater observations. The results of laboratory grain size distributions analyses, Atterberg Limits testing and moisture content determinations are also shown on the Record of Borehole sheets.

The borehole locations and stratigraphic profile prepared from the borehole data are shown on Drawings SBW-1 to SBW-5. 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 subsurface stratigraphy revealed in the boreholes drilled at the site comprised a layer of topsoil over fill, sand, and clayey silt, underlain by silt deposit. The discussions of the findings documented in the Thurber report are included in the following section.

Upon completion of drilling, soil cave-in was encountered in open boreholes 4, 7, 9 and 10 at depths of 3.3 to 6.7 m (elevation 265.5 to 269.0).

### **5.1 Topsoil**

Topsoil consisting of clayey silt to sandy silt with roots and organic was encountered in all the boreholes except borehole 5, and the thickness is approximately ranging from 0.2 m to 0.7 m.

### **5.2 Fill**

Directly beneath the topsoil, a 1.4 to 2.0 m thick non-cohesive fill was encountered in boreholes 4 to 6 at depths of 0 to 0.3 m (elevation 272.2 to 273.0) that extending to depths of 1.4 to 2.2 m (elevation 270.6 to 271.1). The fill comprised of sandy silt to silty sand, which was loose to compact (SPT-'N' values of 4 to 14), and the moisture contents were 9 to 50 % (organic inclusions in borehole 5).



### **5.3 Sand**

A 0.6 to 2.1 m thick sand deposit was encountered below the topsoil and/or fill at the depths of 0.3 to 2.2 m (elevation 270.8 to 289.4) that extended to the depths of 0.9 to 3.0 m (elevation 269.8 to 288.6) in boreholes 4, 5, 14 to 18, and 20 to 22. The deposit was loose to compact (SPT-'N' values of 4 to 23). The moisture contents were ranging from 11 to 27%.

### **5.4 Clayey Silt**

The deposit has been described as Clayey Silt / Silty Clay on the borehole logs.

A 1.8 to 3.6 m thick clayey silt / silty clay deposit was encountered at depths of 1.4 to 3.2 m (elevation 269.6 to 272.8) in boreholes 2 to 7 directly underneath silt and/or sand deposit. This deposit extended to depths of 3.2 to 6.0 m (elevation 266.2 to 269.9) in boreholes 2, 3, 5, and 7, and it terminated at 5.2 m depth (elevations 267.6 to 268.1) in boreholes 4 and 6. The deposit was firm to hard (SPT-'N' values of 7 to 80).

The results of grain size distribution analyses are shown in Figures GS-1 and GS-2, and Atterberg Limits testing conducted are shown in Figures PC-1 and PC-2. The clayey silt /silty clay had liquid limits of 26 to 39%, plastic limits of 17 to 19% and a plasticity index of 9 to 20%. The moisture content of the clayey silt ranged from 21 to 24%.

### **5.5 Silt**

The deposit has been described as Silt / Sandy Silt / Silt with Sand to Silt and Sand on the borehole logs.

A 0.7 to 7.9 m thick silt deposit was encountered below the topsoil or fill or clayey silt at depths of 0.2 to 6.0 m (elevations 266.2 to 289.1) in all boreholes except borehole 4. The deposit extended to the depths of 1.4 to 4.8 m (elevation 265.4 to 272.2) in boreholes 6, 8, 11, 13, and 14, and to termination depths of 2.9 to 8.2 m (elevation 261.3 to 286.5) in boreholes 1 to 3, 5, 7, 9, 10, 12, 14



to 24. An upper layer of silt deposit was encountered at depths of 0.6 to 0.7 m (elevation 271.7 to 273.6) underlain by clayey silt / silty clay deposit in boreholes 2, 3, and 7. The deposit was very loose to very dense (SPT-'N' values of 3 to 100). The results of a grain size distribution analysis of the silt are presented on Figures GS-3 to GS-5, and the results of Atterberg Limits tests are shown on Figures PC-3 and PC-4. The selected samples had liquid limits of 14 to 23%, plastic limits of 11 to 16% and a plasticity index of 3 to 7%. The moisture contents ranged from 5 to 27%.

## **5.6 Till**

The deposit has been described as Clayey Silt / Silt with sand to sandy/Silt with gravel on the borehole logs.

A 0.4 to 0.9 m thick till deposit was penetrated in boreholes 8, 11, 13 and 14 at depths of 4.3 to 4.8 (elevation 265.4 to 272.2) directly underneath the silt deposit. This deposit extended to the borehole termination depth of 5.2 m (elevation 264.5 to 271.3). The SPT-'N' value of clayey silt till was 24, indicating very stiff consistency, and the SPT-'N' value of sandy silt to silt with sand till were 37 to 61, indicating dense to very dense state of compactness. The results of grain size distribution test and Atterberg Limits test are shown on Figures GS-6 and PC-5 respectively. The selected sample had liquid limit of 18%, plastic limit of 14% and a plasticity index of 4%. The moisture contents were ranging from 10 to 12%.

The sandy silt till deposit was encountered in two previous boreholes 08-15A and 08-16A advanced to 10.8 m below ground surface at the centerline of proposed Highway 404 Extension in 2009 by Thurber between Station 27+675 and 27+850 (refer to Appendix FIR-B for Record of Borehole sheets). The deposit was reported to be encountered at depths of 0.4 and 0.5 m (elevation 289.1 and 290.1) below a 0.1 and 0.2 m thick loose sand (SPT-'N' values of 6 and 7), which was overlain by 0.2 and 0.4 m thick topsoil. The SPT-'N' values of sandy silt / silt with sand were ranging from 28 to 105, indicating compact to very dense state of compactness.



## **5.7 Groundwater**

Refer to the Record of Borehole logs for groundwater levels measured at specific boreholes.

During augering, groundwater was noted in the boreholes at depths of 1.5 to 4.6 m (elevations 268.9 to 271.5). Upon completion of augering, groundwater was measured in the open boreholes at depths of 1.3 to 4.3 m (elevation 265.4 to 270.3). The groundwater levels are subject to seasonal fluctuation and rainfall patterns.

Based on the Thurber report, groundwater was encountered between Station 27+675 to 27+850 at the depth of 2.9 to 6.0 m upon completion of drilling, and the groundwater depth was ranging from 1.2 to 3.2 m within the piezometer in borehole 08-16A.



## 6. CLOSURE

Mr. C. Zhao, EIT and Mr. S. Aziz carried out the field investigation for this study under the direction and supervision of Ms. M. Kamranzadeh, EIT and Mr. C. M. P. Nascimento, P. Eng., Project Manager. Fisher Environmental Drilling Ltd. supplied the drill rig for the subsurface exploration. The laboratory testing of the selected samples was carried out in the PML laboratory in Toronto.

This Foundation Investigation Report was prepared by Mr. C. Zhao, MSc, EIT, and reviewed by Mr. Grigory Degil, MSc, PhD, P.Eng., Senior Engineer and Mr. David Dundas, P.Eng., Senior Engineer, Mr. C. M. P. Nascimento, P. Eng., MTO Designated Principal Contact, carried out an independent quality review of the report.

Yours very truly

Peto MacCallum Ltd.

A blue ink signature of Gary Zhao, written in a cursive style.

Cheng (Gary) Zhao, MSc, E.I.T.  
Project Supervisor, Geotechnical Services

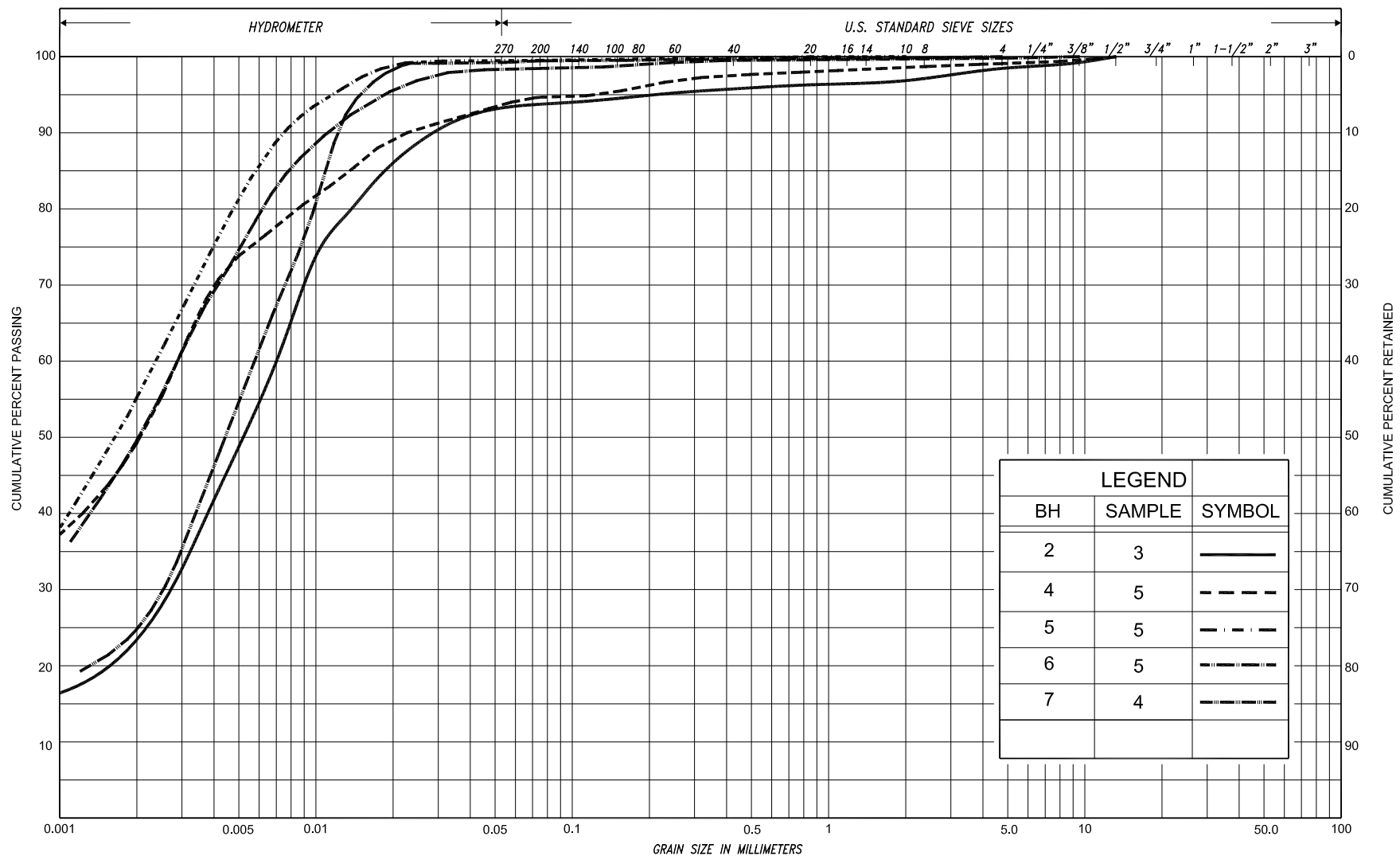


Mr. David Dundas, P.Eng.  
Senior Engineer, Geotechnical Services



Carlos M.P. Nascimento, P.Eng.  
Project Manager and  
MTO Designated Principal Contact

CZ/GD/CN:nk-JK



SILT & CLAY					FINE		MEDIUM		COARSE		GRAVEL			COB BLES	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												



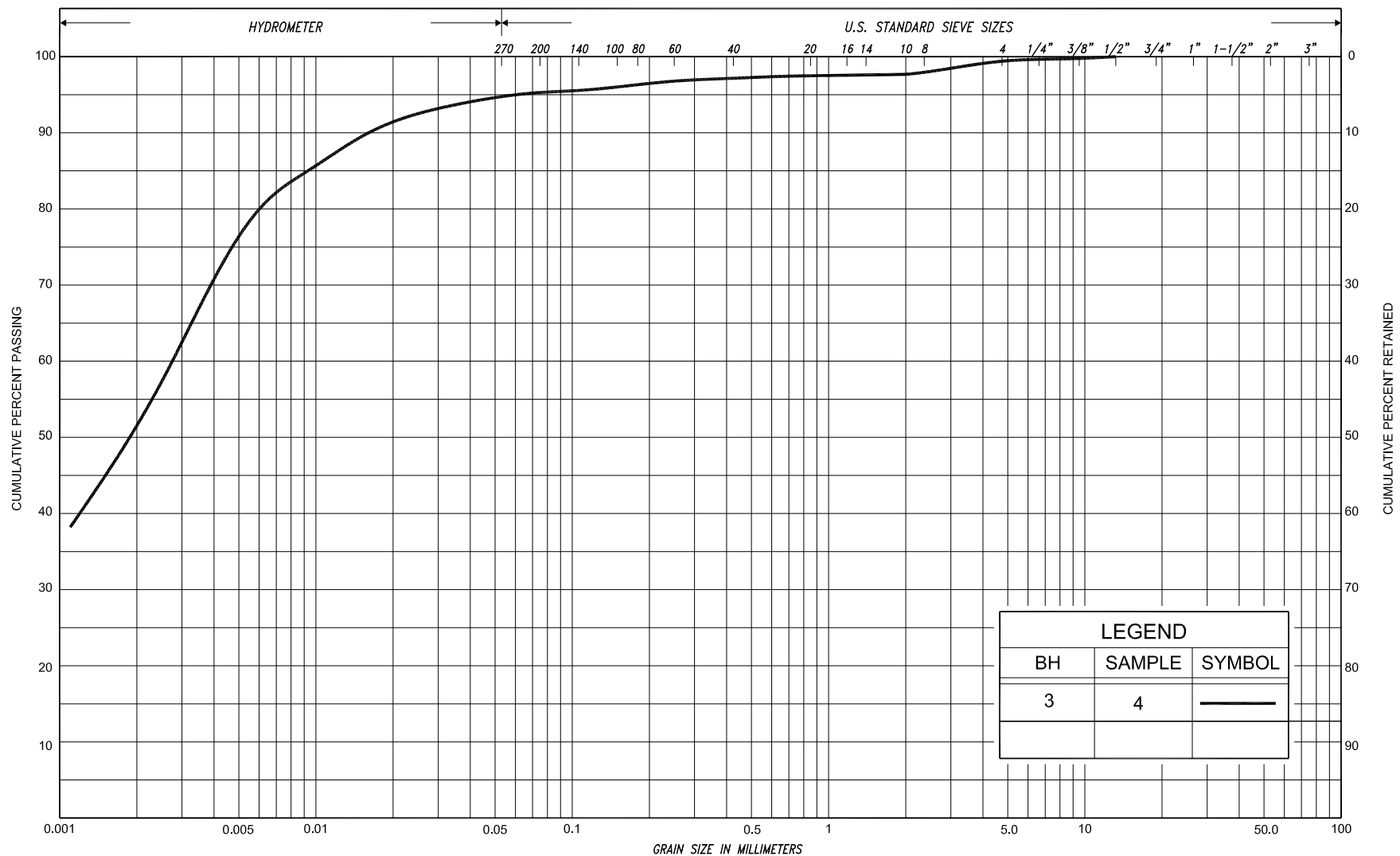
## GRAIN SIZE DISTRIBUTION

CLAYEY SILT, trace sand, trace gravel (CL)

FIG No. GS-1

HWY: 404

Task No. 2013-E-0034-009



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											



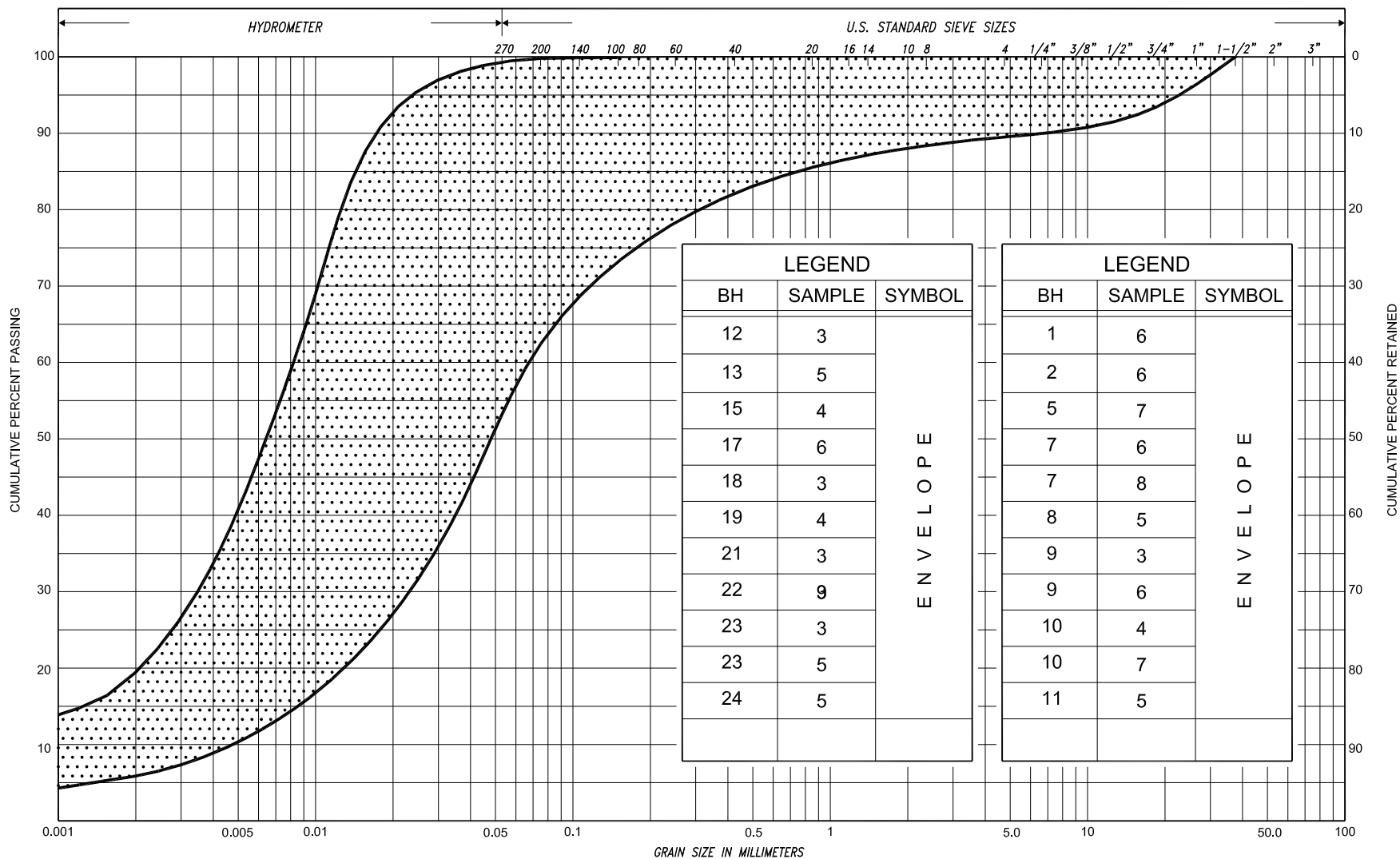
## GRAIN SIZE DISTRIBUTION

SILTY CLAY, trace sand, trace gravel (CI)

FIG No. GS-2

HWY: 404

Task No. 2013-E-0034-009



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

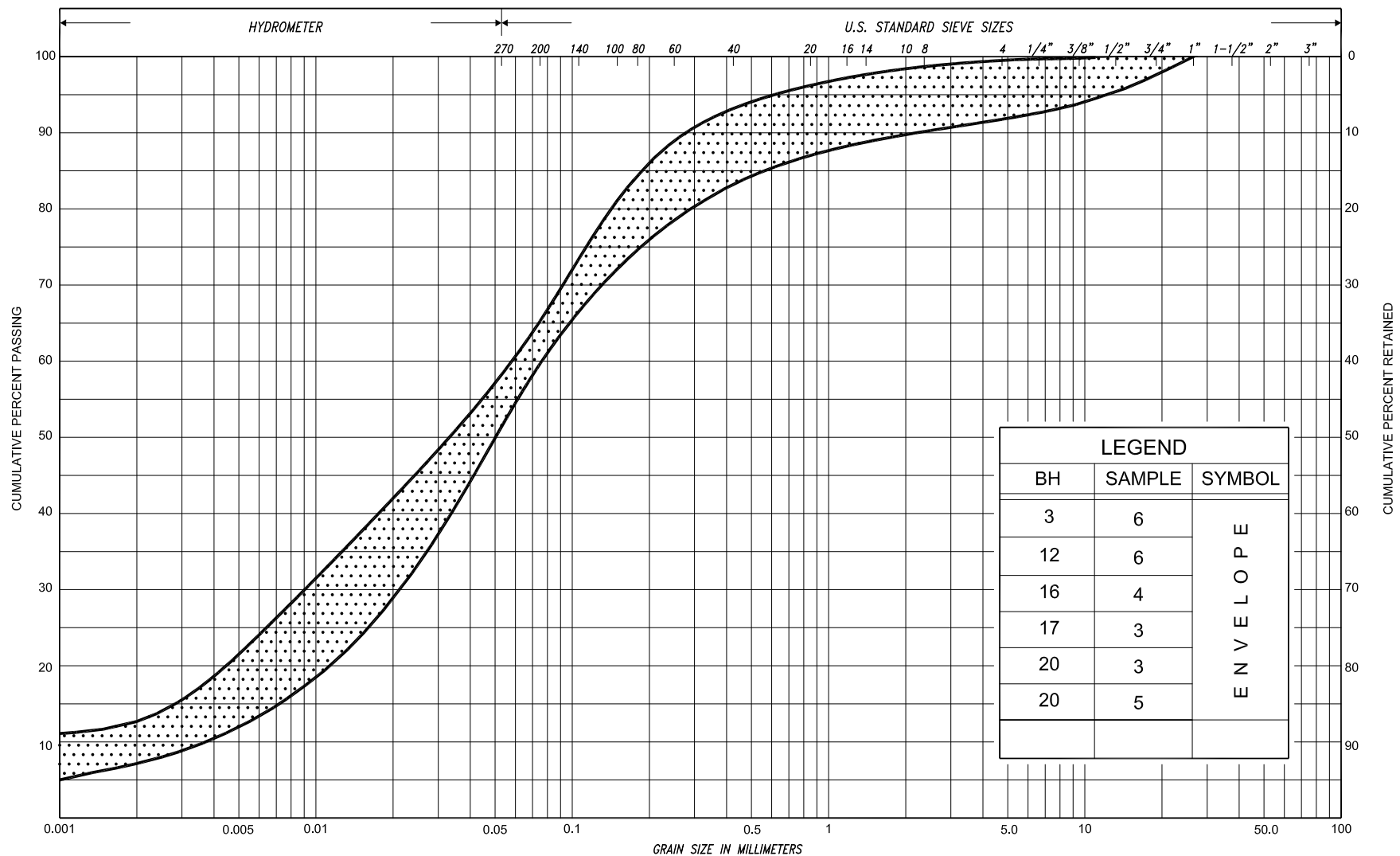
SILT, trace to with sand, trace to some gravel (CL-ML/ML)

FIG No. GS-3

HWY: 404

Task No. 2013-E-0034-009





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



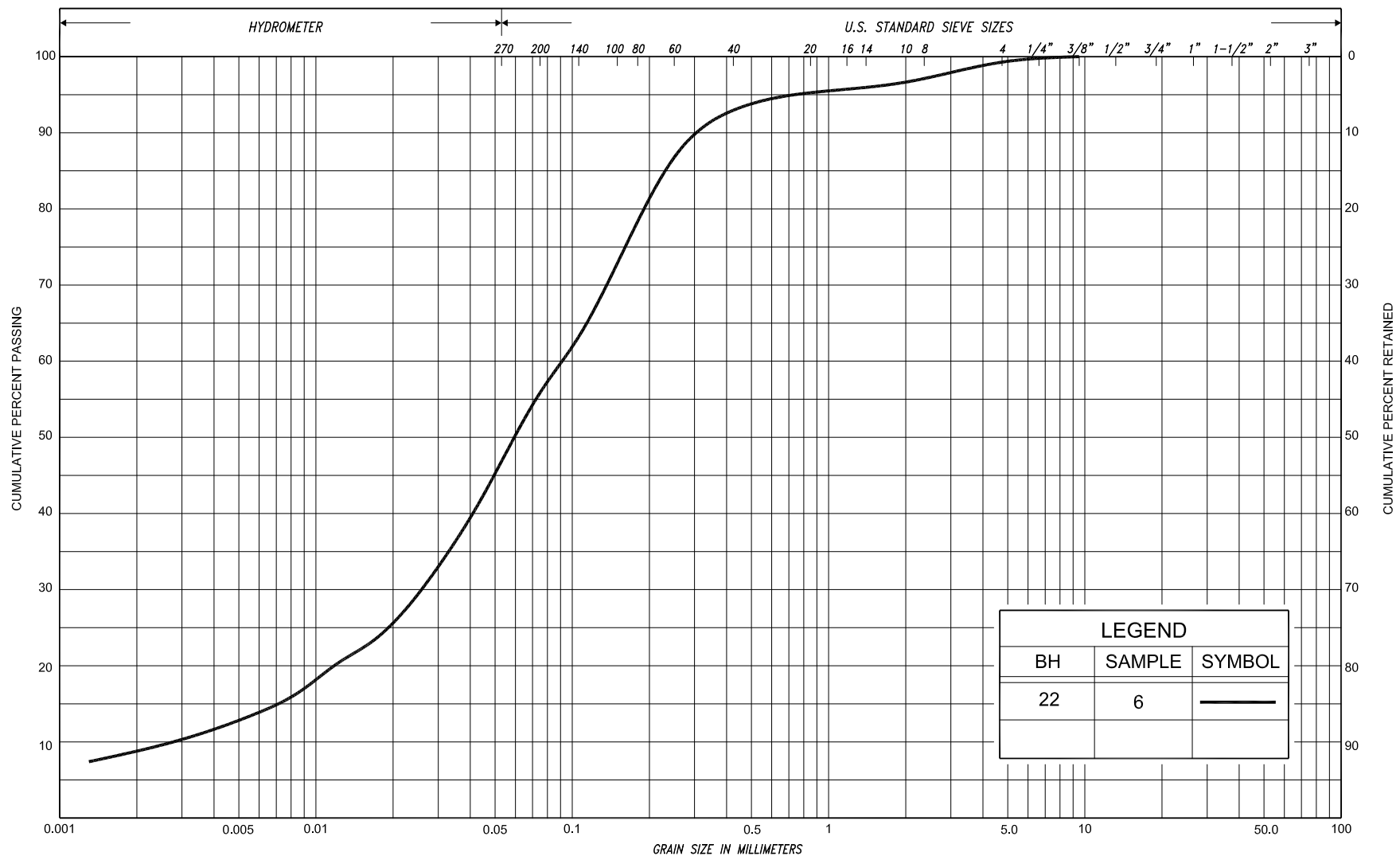
## GRAIN SIZE DISTRIBUTION

SANDY SILT, trace clay, trace gravel (CL-ML)

FIG No. GS-4

HWY: 404

Task No. 2013-E-0034-009



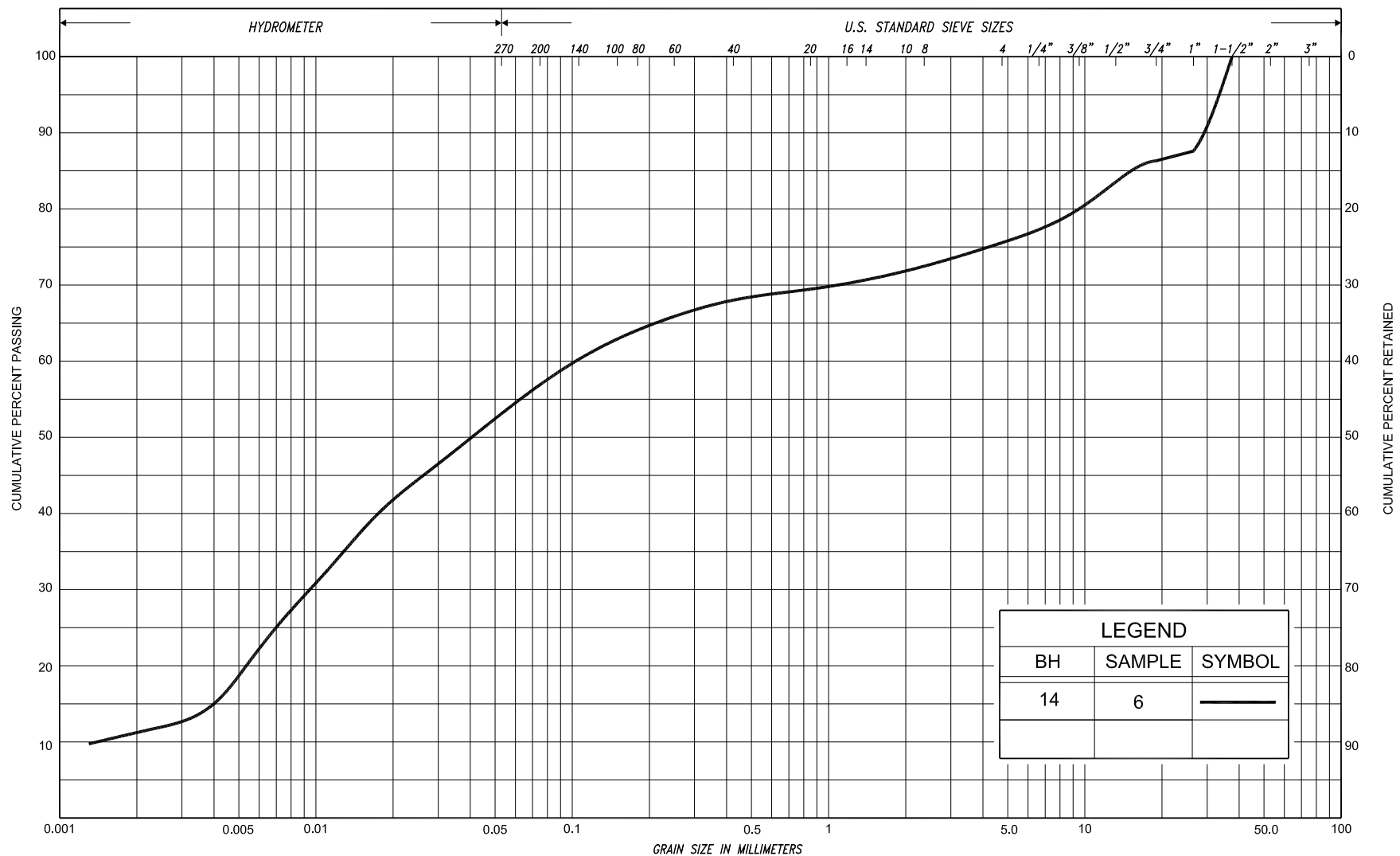
LEGEND		
BH	SAMPLE	SYMBOL
22	6	—

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



# GRAIN SIZE DISTRIBUTION SILT AND SAND, trace clay, trace gravel

FIG No.	GS-5
HWY:	404
Task No.	2013-E-0034-009



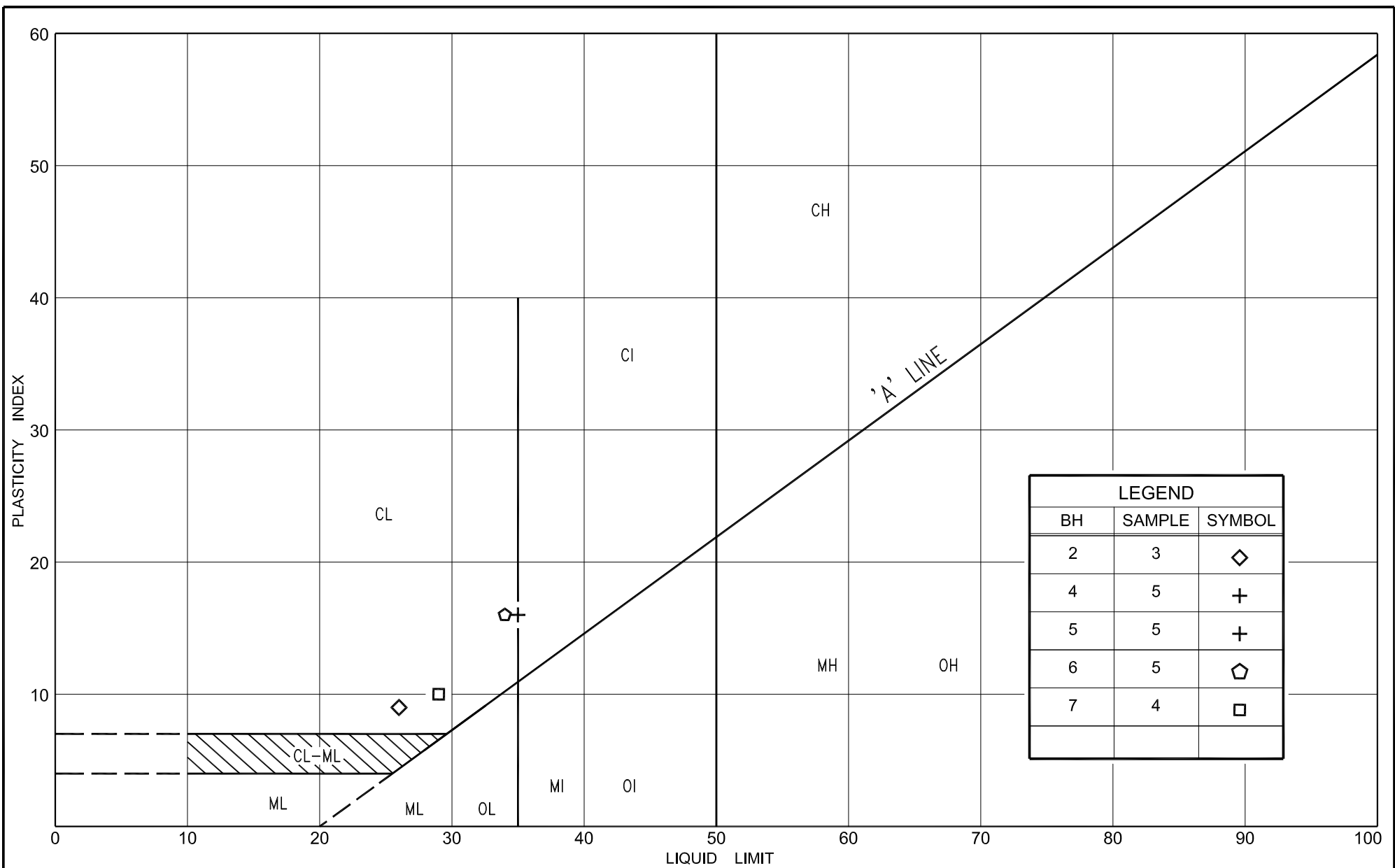
LEGEND		
BH	SAMPLE	SYMBOL
14	6	—

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



# **GRAIN SIZE DISTRIBUTION** SILT, with gravel, some sand, some clay (TILL)

FIG No.	GS-6
HWY:	404
Task No.	2013-E-0034-009



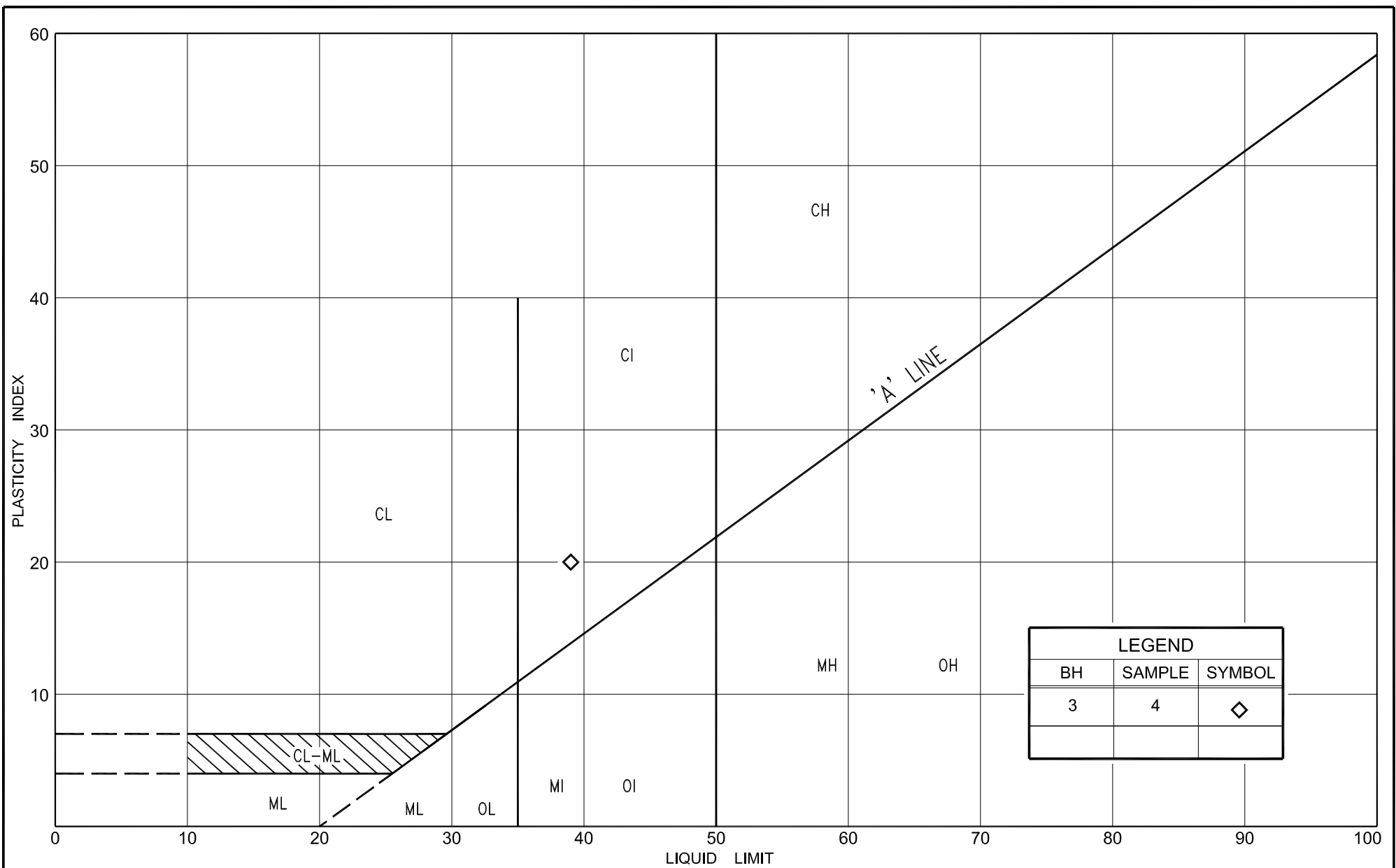
## PLASTICITY CHART

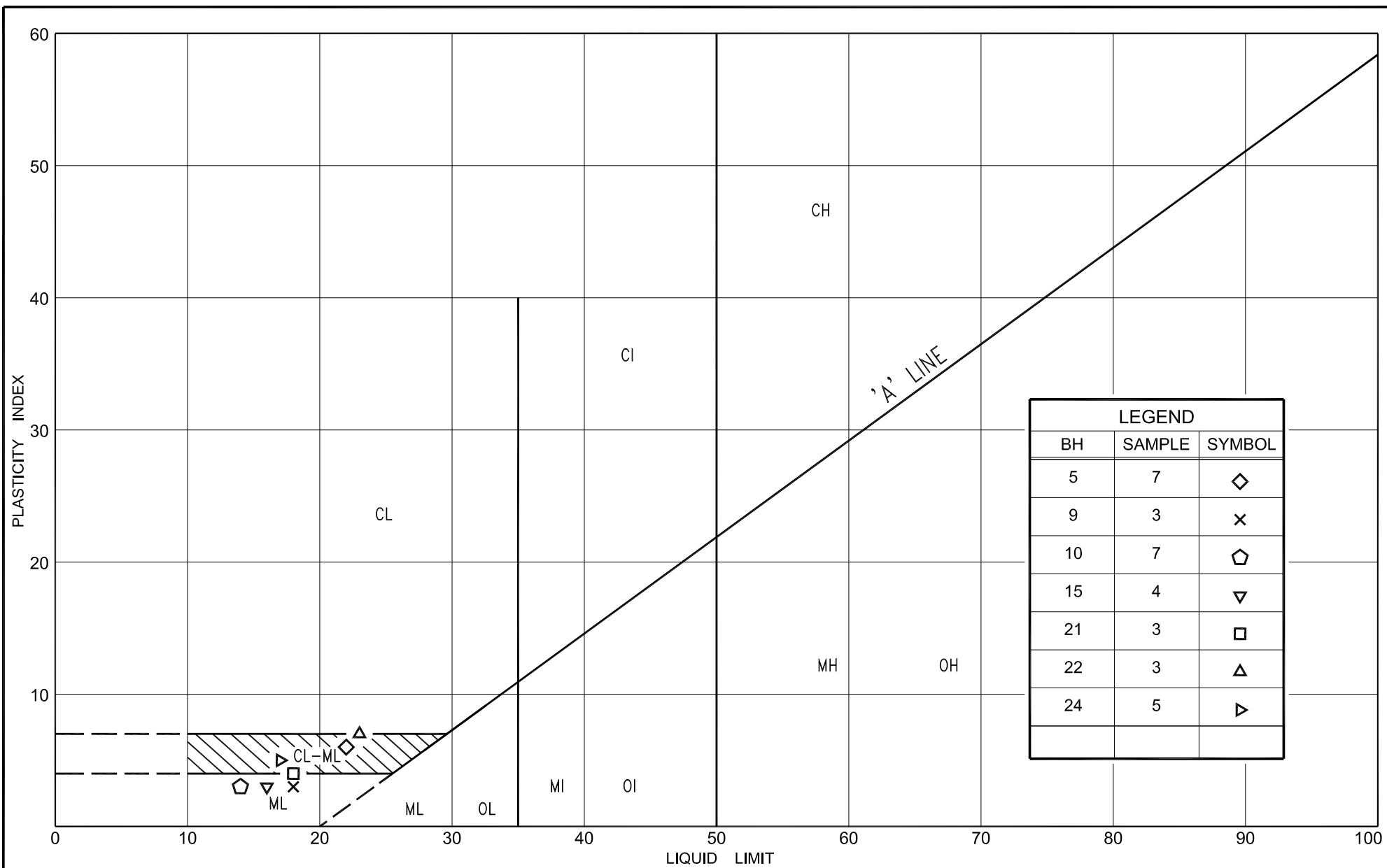
CLAYEY SILT, trace sand, trace gravel (CL)

FIG No. PC-1

HWY: 404

Task No. 2013-E-0034-009





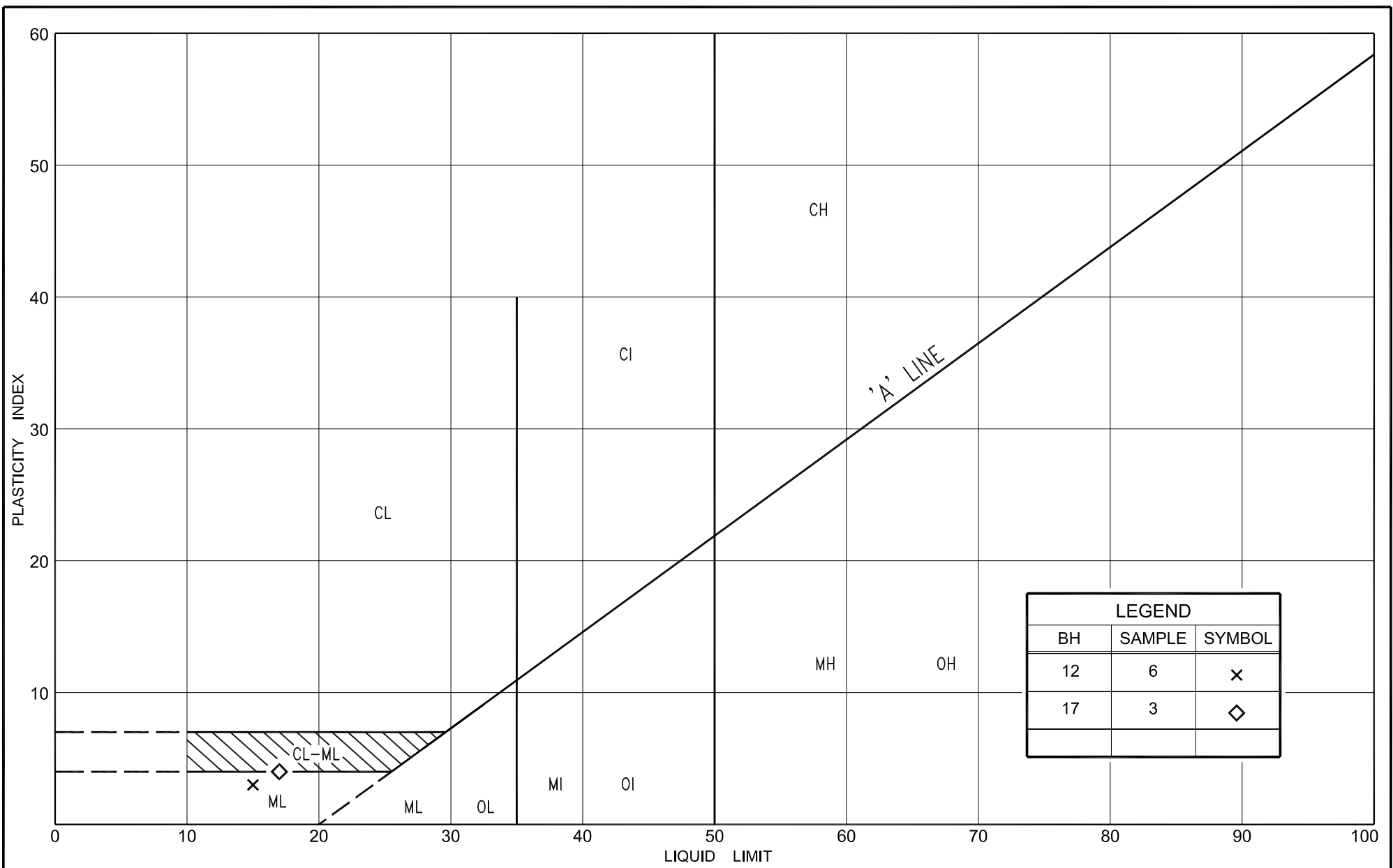
## PLASTICITY CHART

SILT, trace to with sand, some clay, trace to some gravel (CL-ML/ML)

FIG No. PC-3

HWY: 404

Task No. 2013-E-0034-009



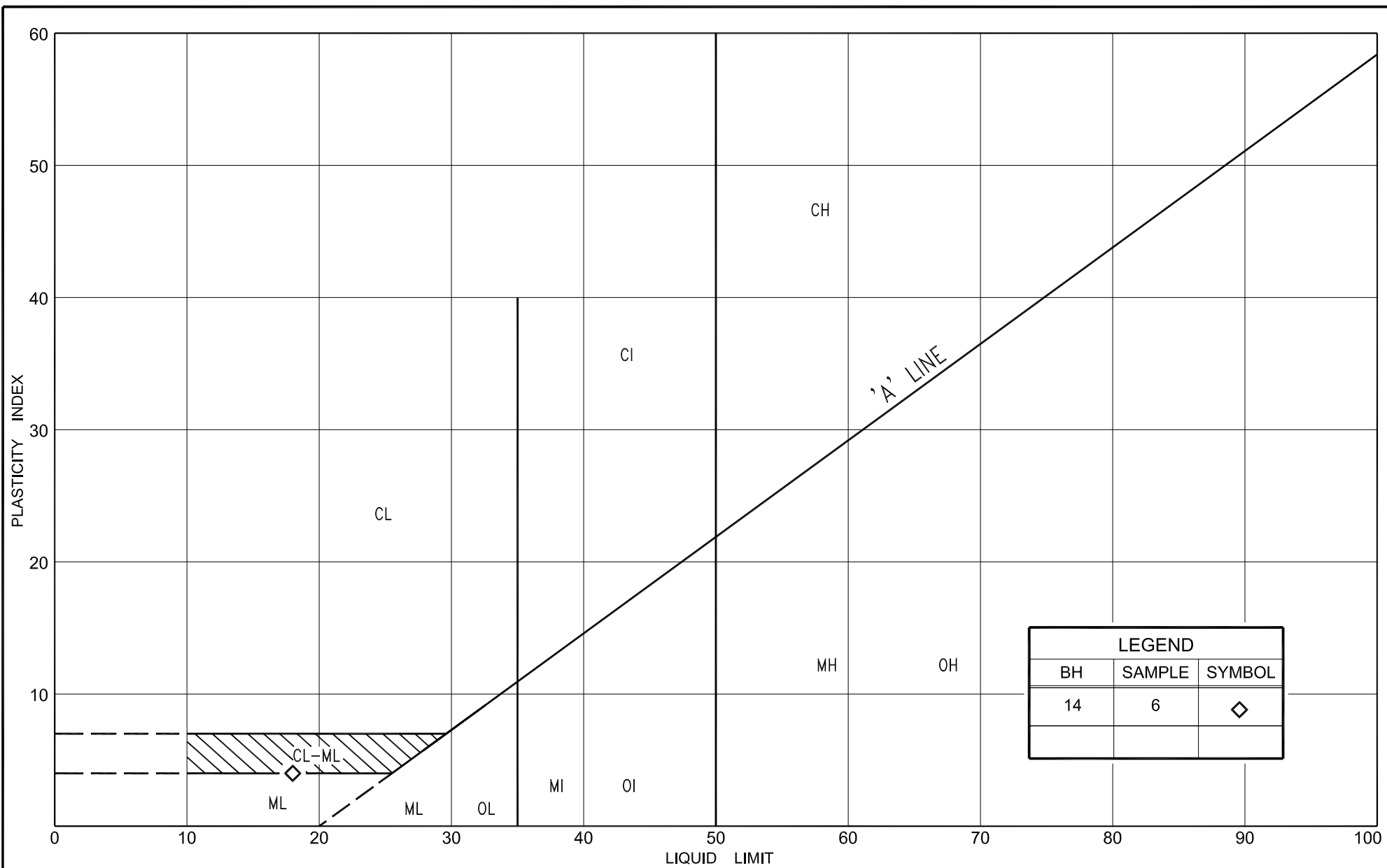
## PLASTICITY CHART

SANDY SILT, trace to some clay, trace gravel (CL-ML/ML)

FIG No. PC-4

HWY: 404

Task No. 2013-E-0034-009



**PLASTICITY CHART**  
 SILT, with gravel, some sand, some clay (CL-ML)  
 (TILL)

FIG No.	PC-5
HWY:	404
Task No.	2013-E-0034-009



## 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
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	1	COEFFICIENT OF FRICTION

### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{v0}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_i$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL

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

**RECORD OF BOREHOLE No 1**

1 of 1

**METRIC**

G.W.P. 2013-E-0039-009 LOCATION Coords: 4 885 764.2 N; 310 959.1 E ORIGINATED BY S.A./C.Z  
DIST Central HWY 404 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY C.Z.  
DATUM Geodetic DATE June 19, 2015 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	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		
276.1	Ground Surface							20	40	60	80	100								
0.0	Topsoil		1	SS	36		276													
275.8	Sandy silt, trace clay rootlets																			
0.3	Dense to Brown/ Moist loose grey		2	SS	7		275													
274.7	Silt trace to some clay, trace sand, trace gravel		3	SS	11															
1.4	Compact to Brown/ Moist very dense grey		4	SS	18		274													
			5	SS	35		273													
							272													
271.0	End of borehole		6	SS	80		271										0 1 80 19			
5.1																				
	* Borehole dry																			
	NOTE: No cave-in																			

**RECORD OF BOREHOLE No 2**


1 of 1

**METRIC**

G.W.P. 2013-E-0039-009 LOCATION Coords: 4 885 690.4 N; 310 972.9 E ORIGINATED BY S.A./C.Z  
DIST Central HWY 404 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY C.Z.  
DATUM Geodetic DATE June 19, 2015 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	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									
274.2	Ground Surface							20	40	60	80	100								
0.0	Topsoil		1	SS	5		274													
273.6	Sandy silt rootlets, organics																			
0.6	Loose Brown Moist		2	SS	8		273													
272.8	Clayey silt trace sand, trace gravel		3	SS	7															
1.4	Firm to Brown/ very stiff grey Moist		4	SS	9		272													
			5	SS	18		271													
269.9	Silt, some clay, trace sand						270													
4.3	Dense Brown Moist		6	SS	47		269													
269.0	End of borehole																			
5.2																				

\* 2015 06 19

 Water level measured  
after drilling

NOTE: No cave-in

**RECORD OF BOREHOLE No 3**

1 of 1

**METRIC**

G.W.P. 2013-E-0039-009 LOCATION Coords: 4 885 622.4 N; 310 988.7 E ORIGINATED BY S.A.  
DIST Central HWY 404 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY C.Z.  
DATUM Geodetic DATE June 19, 2015 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	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												
273.5	Ground Surface						20	40	60	80	100									
0.0	Topsoil		1	SS	4								○							
272.8																				
0.7	Sandy silt, rootlets		2	SS	10								○							
272.1	Loose      Brown/      Moist grey																			
1.4	Silty clay trace sand, trace gravel		3	SS	7						175		○							
	Firm to      Mottled      Moist stiff           brown/      grey		4	SS	11						225		○			1   4   42   53				
270.3																				
3.2	Clayey silt, trace sand		5	SS	15								○							
	Stiff to      Brown      Moist very stiff																			
269.0																				
4.5	Sandy silt trace clay, trace gravel		6	SS	16								○			1   33   59   7				
268.3	Compact      Grey      Wet																			
5.2	End of borehole																			
<div>*      2015   06   19</div> <div>▽      Water level observed          during drilling</div> <div>■      Penetrometer test</div> <div>NOTE: No cave-in</div>																				

## RECORD OF BOREHOLE No 4

1 of 1

**METRIC**

G.W.P.	2013-E-0039-009	LOCATION	Coords: 4 885 508.5 N; 311 009.1 E	ORIGINATED BY	S.A.
DIST	Central	HWY	404	BOREHOLE TYPE	Continuous Flight Hollow Stem Augers
DATUM	Geodetic	DATE	June 19, 2015	CHECKED BY	G.D.

[illegible]

## RECORD OF BOREHOLE No 5

1 of 1

**METRIC**

G.W.P. <u>2013-E-0039-009</u>	LOCATION <u>Coords: 4 885 434.7 N; 311 024.7 E</u>	ORIGINATED BY <u>S.A.</u>
DIST <u>Central</u> HWY <u>404</u>	BOREHOLE TYPE <u>Continuous Flight Hollow Stem Augers</u>	COMPILED BY <u>C.Z.</u>
DATUM <u>Geodetic</u>	DATE <u>June 22, 2015</u>	CHECKED BY <u>G.D.</u>

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS  *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT  w <sub>p</sub>	NATURAL MOISTURE CONTENT  w	LIQUID LIMIT  w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED		+ FIELD VANE							
								● QUICK TRIAXIAL		× LAB VANE							
272.2	Ground Surface																
0.0	Sandy silt, rootlets	⊠	1	SS	6												
	Loose      Brown/      Moist dark brown	⊠															
	Organics	⊠															
	(FILL)	⊠	2	SS	4												
270.8	Silty sand, trace clay	•															
1.4	Loose      Brown/      Moist grey	•	3	SS	7												
		•															
		•															
		•															
269.8	Clayey silt	⊠	4	SS	12												
2.4	trace sand, trace gravel	⊠															
	Stiff      Brown/      Moist grey	⊠	5	SS	11												
		⊠															
		⊠															
		⊠	6	SS	14												
		⊠															
		⊠															
266.2	Silt	⊠	7	SS	15												
6.0	some clay, trace sand	⊠															
	Compact      Grey      Moist to wet	⊠															
		⊠															
		⊠															
		⊠	8	SS	22												
264.0	trace gravel	⊠															
8.2	End of borehole																

## RECORD OF BOREHOLE No 6

1 of 1

**METRIC**

G.W.P. <u>2013-E-0039-009</u>	LOCATION <u>Coords: 4 885 360.8 N; 311 036.3 E</u>	ORIGINATED BY <u>S.A.</u>
DIST <u>Central</u> HWY <u>404</u>	BOREHOLE TYPE <u>Continuous Flight Hollow Stem Augers</u>	COMPILED BY <u>C.Z.</u>
DATUM <u>Geodetic</u>	DATE <u>June 22, 2015</u>	CHECKED BY <u>G.D.</u>

SOIL PROFILE					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES	GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT
			NUMBER	TYPE	"N" VALUES
272.8	Ground Surface				
272.6	Topsoil				
0.2	Silty sand organic inclusions, rootlets	X	1	SS	4
		X			
	Loose to compact Brown/dark brown Moist to wet brown (FILL)	X	2	SS	4
		X			
		X	3	SS	13
		X			
270.6	Sandy silt, trace clay	.			
2.2	Very loose Brown/grey Wet grey	.	4	SS	2
		.			
		.			
269.6	Clayey silt, trace sand	.			
3.2	Very stiff Grey Moist	/	5	SS	12
		/			
		/			
		/			
		/	6	SS	19
267.6	End of borehole				
5.2					
	*    2015   06   22				
	▽ Water level observed during drilling				
	■ Penetrometer test				
	NOTE: No cave-in				

**RECORD OF BOREHOLE No 7**

1 of 1

**METRIC**

G.W.P. 2013-E-0039-009 LOCATION Coords: 4 885 286.8 N; 311 049.4 E ORIGINATED BY S.A.  
DIST Central HWY 404 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY C.Z.  
DATUM Geodetic DATE June 22, 2015 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	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		
272.3	Ground Surface						20	40	60	80	100									
0.0	Topsoil		1	SS	2								○							
271.7																				
0.6	Sandy silt organic inclusions, rootlets		2	SS	12								○							
270.9	Compact      Brown/      Moist grey																			
1.4	Clayey silt, trace sand rootlets		3	SS	11								○							
	Stiff              Grey/      Moist brown																			
			4	SS	12															
269.1																				
3.2	Silt trace to some clay trace to some sand trace gravel		5	SS	11								○							
	Compact to Grey      Moist very dense              to wet																			
			6	SS	19								○							
			7	SS	23								○							
264.3			8	SS	90/25cm								○							
8.0	End of borehole																			

\* 2015 06 22

▽ Water level observed during drilling

▽ Water level measured after drilling

■ Penetrometer test

NOTE: Borehole caved-in at 6.7m



## RECORD OF BOREHOLE No 8

1 of 1

**METRIC**

G.W.P. <u>2013-E-0039-009</u>	LOCATION <u>Coords: 4 885 230.9 N; 311 074.9 E</u>	ORIGINATED BY <u>C.Z.</u>
DIST <u>Central</u> HWY <u>404</u>	BOREHOLE TYPE <u>Continuous Flight Hollow Stem Augers</u>	COMPILED BY <u>C.Z.</u>
DATUM <u>Geodetic</u>	DATE <u>June 23, 2015</u>	CHECKED BY <u>G.D.</u>

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT  w <sub>p</sub>	NATURAL MOISTURE CONTENT  w	LIQUID LIMIT  w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	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												
271.4	Ground Surface					271										0 3 88 9				
0.0	Topsoil																			
271.1	Sandy silt, trace clay rootlets		1	SS	4															
0.3																				
270.7	Loose Brown Moist Silt trace sand, trace clay rootlets, organics		2	SS	22															
0.7	Compact Brown Moist to wet		3	SS	18															
			4	SS	15															
			5	SS	13															
266.9	Clayey silt trace sand, some gravel					268														
4.5	Very stiff Grey (TILL) Moist	6	SS	24																
266.2	End of borehole					267														
5.2																				
<div>* 2015 06 23</div> <div> Water level measured after drilling</div> <div>NOTE: No cave-in</div>																				

**RECORD OF BOREHOLE No 9**

1 of 1

**METRIC**

G.W.P. 2013-E-0039-009 LOCATION Coords: 4 885 072.9 N; 311 101.8 E ORIGINATED BY C.Z.  
DIST Central HWY 404 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY C.Z.  
DATUM Geodetic DATE June 23, 2015 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE									
								● QUICK TRIAXIAL × LAB VANE									
					WATER CONTENT (%)												
269.6	Ground Surface						20	40	60	80	100						
0.0	Topsoil		1	SS	2												
269.0	Silt trace to some clay, trace to some sand, trace gravel		2	SS	26												
0.6	Compact to Brown Moist very dense		3	SS	51												
	Grey		4	SS	59												
	Compact		5	SS	43												
			6	SS	20												
264.4	End of borehole																
5.2																	
	* Borehole dry																
	NOTE: Borehole caved-in at 4.1m																

**RECORD OF BOREHOLE No 10**

1 of 1

**METRIC**

G.W.P. 2013-E-0039-009 LOCATION Coords: 4 884 996.5 N; 311 097.5 E ORIGINATED BY C.Z.  
DIST Central HWY 404 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY C.Z.  
DATUM Geodetic DATE June 23, 2015 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  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		
269.5	Ground Surface						20	40	60	80	100									
0.0	Topsoil		1	SS	22		269										2 22 62 14			
269.2	Silt, with sand some clay, trace gravel																			
0.3	Compact Brown Wet to to loose moist		2	SS	20		268													
			3	SS	12															
			4	SS	9		267													
			5	SS	21		266													
			6	SS	21		265													
			7	SS	19		264													
	some gravel					263														
	Very dense		8	SS	85	262														
261.3	End of borehole																			
8.2																				
	<div>* 2015 06 23</div> <div> Water level measured after drilling</div> <div>NOTE: Borehole caved-in at 3.3m</div>																			

## RECORD OF BOREHOLE No 11

1 of 1

METRIC

G.W.P. 2013-E-0039-009	LOCATION	Coords: 4 884 874.4 N; 311 107.7 E	ORIGINATED BY C.Z.
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DIST	Central	HWY	404	BOREHOLE TYPE	Continuous Flight Hollow Stem Augers	COMPILED BY	C.Z.
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DATUM Geodetic DATE June 23, 2015 CHECKED BY G.D.

[illegible]

## RECORD OF BOREHOLE No 12

1 of 1

**METRIC**

G.W.P. <u>2013-E-0039-009</u>	LOCATION <u>Coords: 4 884 776.4 N; 311 109.1 E</u>	ORIGINATED BY <u>C.Z.</u>
DIST <u>Central</u> HWY <u>404</u>	BOREHOLE TYPE <u>Continuous Flight Hollow Stem Augers</u>	COMPILED BY <u>C.Z.</u>
DATUM <u>Geodetic</u>	DATE <u>June 23, 2015</u>	CHECKED BY <u>G.D.</u>

[illegible]

## RECORD OF BOREHOLE No 13

1 of 1

METRIC

G.W.P. 2013-E-0039-009	LOCATION	Coords: 4 884 679.0 N; 311 105.6 E	ORIGINATED BY C.Z.
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DIST	Central	HWY	404	BOREHOLE TYPE	Continuous Flight Hollow Stem Augers	COMPILED BY	C.Z.
------	---------	-----	-----	---------------	--------------------------------------	-------------	------

DATUM Geodetic DATE June 24, 2015 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
272.2	Ground Surface						20	40	60	80	100									
0.0	Topsoil		1	SS	11								○							
271.5													○							
0.7	Silt, trace sand trace clay, trace gravel		2	SS	8								○							
	Loose to Brown Moist very dense		3	SS	5								○							
			4	SS	44								○							
			5	SS	41								○							
	cobbles/boulders																			
267.4																				
4.8	Sandy silt		6	SS	56								○							
267.0	some clay, some gravel																			
5.2	Very dense Brown/ Moist grey (TILL)																			
	End of borehole																			
	* 2015 06 24																			
	Water level measured after drilling																			
	NOTE: No cave-in																			

**RECORD OF BOREHOLE No 14**

1 of 1

**METRIC**

G.W.P. 2013-E-0039-009 LOCATION Coords: 4 884 582.2 N; 311 095.0 E ORIGINATED BY C.Z.  
DIST Central HWY 404 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY C.Z.  
DATUM Geodetic DATE June 24, 2015 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	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												
276.5	Ground Surface						20	40	60	80	100									
0.0	Topsoil		1	SS	11								○							
275.9	Sand some silt, trace clay		2	SS	12								○							
0.6	Compact      Brown      Moist		3	SS	20								○							
			4	SS	10								○							
273.8	Silt some clay, some gravel trace to some sand		5	SS	5								○							
2.7	Compact      Brown      Moist to loose      to grey		6	SS	61								○H			25 18 45 12				
272.2	Silt, with gravel some sand, some clay																			
4.3	Very dense Grey      Moist (TILL)																			
271.3	End of borehole																			
5.2																				
	*      Borehole dry																			
	NOTE: No cave-in																			

## RECORD OF BOREHOLE No 15

1 of 1

**METRIC**

G.W.P. <u>2013-E-0039-009</u>	LOCATION <u>Coords: 4 884 474.2 N; 311 076.4 E</u>	ORIGINATED BY <u>C.Z.</u>
DIST <u>Central</u> HWY <u>404</u>	BOREHOLE TYPE <u>Continuous Flight Hollow Stem Augers</u>	COMPILED BY <u>C.Z.</u>
DATUM <u>Geodetic</u>	DATE <u>June 24, 2015</u>	CHECKED BY <u>G.D.</u>

[illegible]



**RECORD OF BOREHOLE No 16**

1 of 1

**METRIC**

G.W.P. 2013-E-0039-009 LOCATION Coords: 4 884 404.4 N; 311 060.5 E ORIGINATED BY C.Z.  
DIST Central HWY 404 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY C.Z.  
DATUM Geodetic DATE June 24, 2015 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	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		
281.9 0.0	Ground Surface						20	40	60	80	100									
281.3 0.6	Topsoil		1	SS	15															
279.9 2.0	Sand, some silt some gravel, trace clay																			
	Compact Grey Moist to loose to wet		2	SS	20															
			3	SS	8															
	Sandy silt some clay, trace gravel																			
	Dense to Grey Moist very dense		4	SS	47															
			5	SS	71															
	Compact Brown Moist		6	SS	22															
276.7 5.2	End of borehole																			
	* Borehole dry																			
	NOTE: No cave-in																			

**RECORD OF BOREHOLE No 17**

1 of 1

**METRIC**

G.W.P. 2013-E-0039-009 LOCATION Coords: 4 884 331.2 N; 311 042.5 E ORIGINATED BY C.Z.  
DIST Central HWY 404 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY C.Z.  
DATUM Geodetic DATE June 24, 2015 CHECKED BY G.D.












SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
283.8	Ground Surface							20	40	60	80	100					
0.0 283.5	Topsoil		1	SS	13												
0.3	Sand, with gravel some silt, trace clay																
282.8	Compact Brown Moist		2	SS	18		283										
1.0	Sandy silt to silt, with sand trace to some clay trace to some gravel																
	Compact to Brown Moist very dense		3	SS	22		282										4 33 60 3
			4	SS	56		281										
			5	SS	100/28cm		280										
279.0 4.8	End of borehole		6	SS	50/10cm		279										10 27 52 11
	* Borehole dry																
	NOTE: No cave-in																

**RECORD OF BOREHOLE No 18**

1 of 1

**METRIC**

G.W.P. 2013-E-0039-009 LOCATION Coords: 4 884 277.6 N; 311 023.3 E ORIGINATED BY C.Z.  
DIST Central HWY 404 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY C.Z.  
DATUM Geodetic DATE June 24, 2015 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	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												
286.0	Ground Surface																			
0.0 285.7	Topsoil																			
0.3	Sand some silt, some gravel		1	SS	13															
285.1 0.9	Compact Brown Moist																			
	Silt with sand trace to some clay, trace to some gravel		2	SS	23		285													
	Compact to Brown Moist very dense																			
			3	SS	28		284									4 23 63 10				
																				
			4	SS	82															
							283													
282.5 3.5	End of borehole		5	SS	86															
	* Borehole dry																			
	NOTE: No cave-in																			

**RECORD OF BOREHOLE No 19**

1 of 1

**METRIC**

G.W.P. 2013-E-0039-009 LOCATION Coords: 4 884 031.8 N; 310 930.3 E ORIGINATED BY C.Z.  
DIST Central HWY 404 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY C.Z.  
DATUM Geodetic DATE June 25, 2015 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	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												
289.4	Ground Surface						20	40	60	80	100									
0.0	Topsoil		1	SS	16															
289.1	Silt, with sand trace to some gravel trace clay  Compact to Brown Moist very dense																			
0.3			2	SS	30															
			3	SS	46															
			4	SS	75															
286.5	End of borehole																			
2.9																				
	* Borehole dry																			
	NOTE: No cave-in																			

## RECORD OF BOREHOLE No 20

1 of 1

METRIC

G.W.P. 2013-E-0039-009	LOCATION	Coords: 4 883 910.2 N; 310 886.4 E	ORIGINATED BY C.Z.
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DIST	Central	HWY	404	BOREHOLE TYPE	Continuous Flight Hollow Stem Augers	COMPILED BY	C.Z.
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DATUM Geodetic DATE June 25, 2015 CHECKED BY G.D.

[illegible]

## RECORD OF BOREHOLE No 21

1 of 1

METRIC

G.W.P. 2013-E-0039-009	LOCATION	Coords: 4 883 818.7 N; 310 854.6 E	ORIGINATED BY C.Z.
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DIST	Central	HWY	404	BOREHOLE TYPE	Continuous Flight Hollow Stem Augers	COMPILED BY	C.Z.
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DATUM Geodetic DATE June 25, 2015 CHECKED BY G.D.

SOIL PROFILE			SAMPLES		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES
287.0	Ground Surface				
0.0	Topsoil	~~~~~			
286.7	Sand, some silt trace clay, trace gravel	•••••	1	SS	7
0.3	Loose to compact Brown Moist	•••••	2	SS	12
285.6	Silt with sand some clay, trace gravel		3	SS	9
1.4	Loose to very dense Brown Moist		4	SS	13
	some _____ gravel		5	SS	58/23cm
282.1			6	SS	50/15cm
4.9	End of borehole				
	* Borehole dry				
	NOTE: No cave-in				

## RECORD OF BOREHOLE No 22

1 of 1

METRIC

G.W.P. 2013-E-0039-009	LOCATION	Coords: 4 883 748.3 N; 310 836.6 E	ORIGINATED BY C.Z.
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DIST	Central	HWY	404	BOREHOLE TYPE	Continuous Flight Hollow Stem Augers	COMPILED BY	C.Z.
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DATUM Geodetic DATE June 25, 2015 CHECKED BY G.D.

SOIL PROFILE			SAMPLES		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES
285.0	Ground Surface				
0.0	Topsoil		1	SS	11
284.4	Silty sand, trace gravel				
283.6	Loose Brown Moist		2	SS	6
1.4	Silt, some clay some sand, trace gravel		3	SS	3
	Very loose Brown Moist to loose		4	SS	8
			5	SS	8
280.5	Silt and sand, trace clay, trace gravel		6	SS	84
280.0	Very dense Brown Moist				
5.0	End of borehole				
*					
Borehole dry					
NOTE: No cave-in					

**RECORD OF BOREHOLE No 23**

1 of 1

**METRIC**

G.W.P. 2013-E-0039-009 LOCATION Coords: 4 883 682.2 N; 310 822.4 E ORIGINATED BY C.Z.  
DIST Central HWY 404 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY C.Z.  
DATUM Geodetic DATE June 26, 2015 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	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												
284.1	Ground Surface						20	40	60	80	100									
0.0	Topsoil	~~~~~	1	SS	7		284													
283.8	Silt some clay, trace sand																			
0.3	Loose to Brown Moist compact		2	SS	17		283													
			3	SS	18		282									0 1 88 11				
	some to with sand, trace clay																			
	compact to very dense		4	SS	23		281													
			5	SS	14		280									2 20 64 14				
279.5	cobbles		6	SS	50/8cm															
4.6	End of borehole																			
						</														




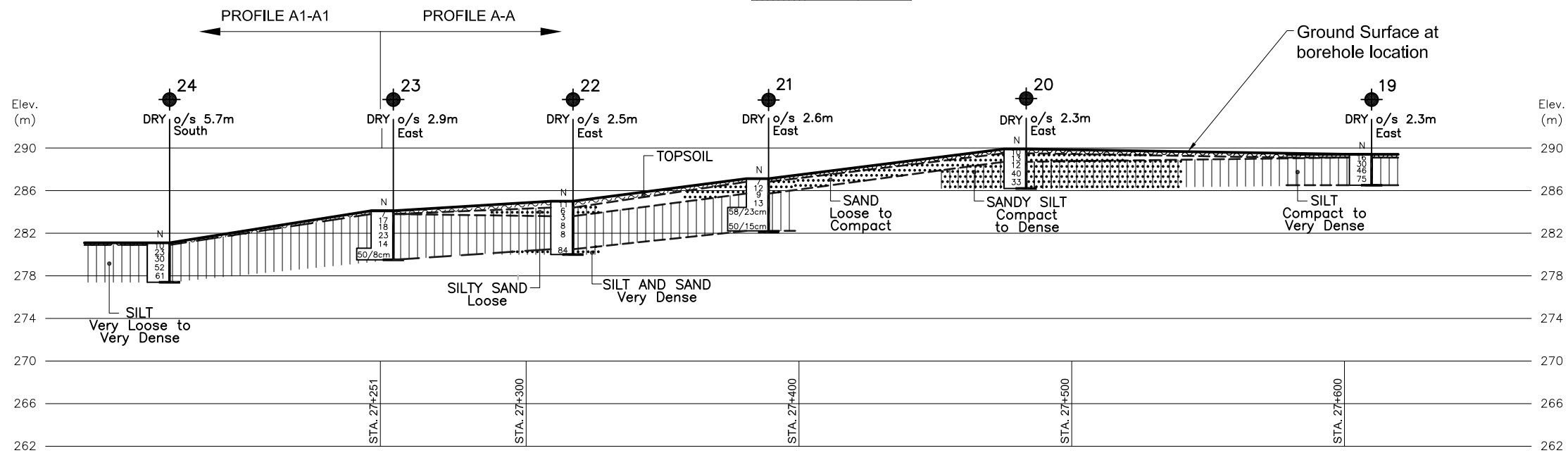
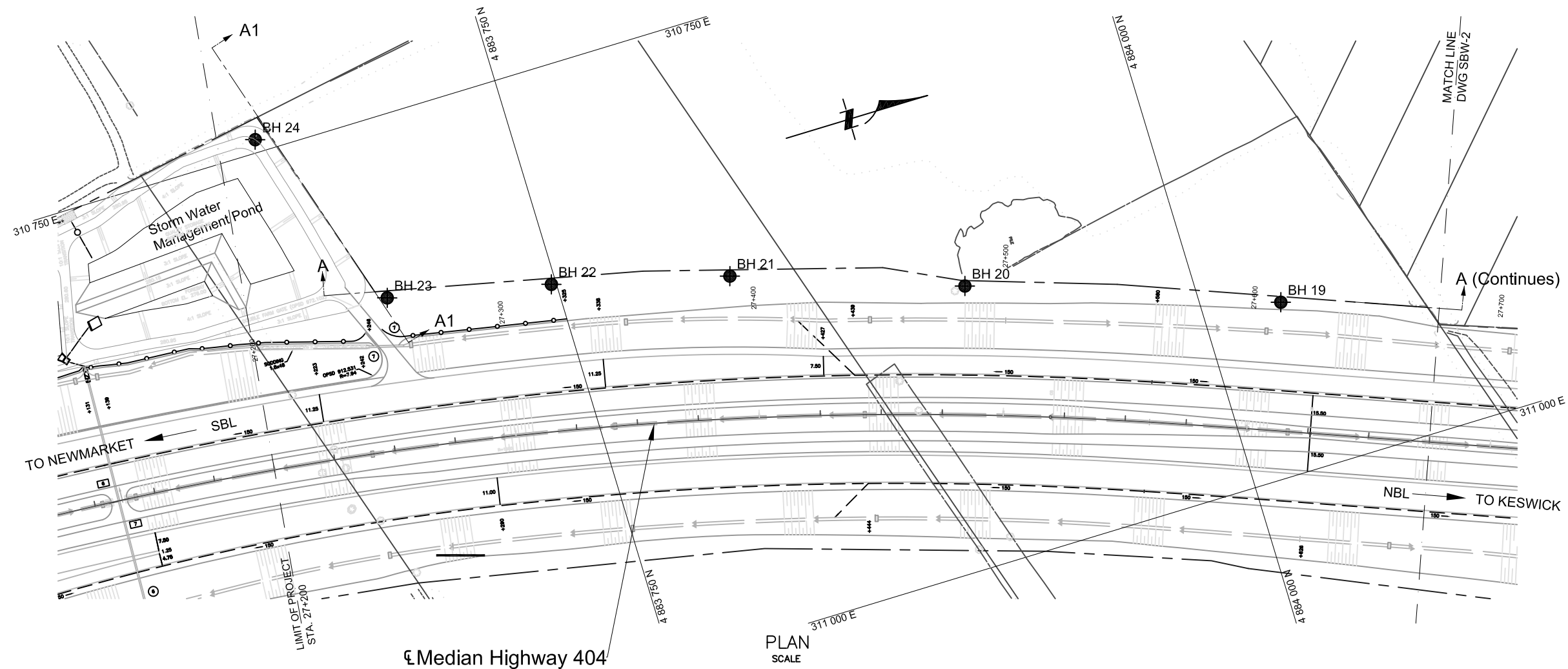
**RECORD OF BOREHOLE No 24**

1 of 1

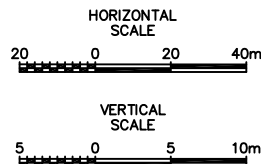
**METRIC**

G.W.P. 2013-E-0039-009 LOCATION Coords: 4 883 649.2 N; 310 744.7 E ORIGINATED BY C.Z.  
DIST Central HWY 404 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY C.Z.  
DATUM Geodetic DATE June 26, 2015 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										
								○ UNCONFINED      + FIELD VANE										
								● QUICK TRIAXIAL      × LAB VANE										
WATER CONTENT (%)																		
281.1	Ground Surface		1	SS	10		281											
280.9	Topsoil						280											
0.2	Silt, with sand some clay, trace gravel  Compact to Brown      Moist very dense   cobbles		2	SS	23													
			3	SS	30													
			4	SS	52													
			5	SS	61													
277.4	End of borehole																	
3.7																		
	*      Borehole dry																	
	NOTE: No cave-in																	



PROFILES A1-A1 and A-A



## NOTES:

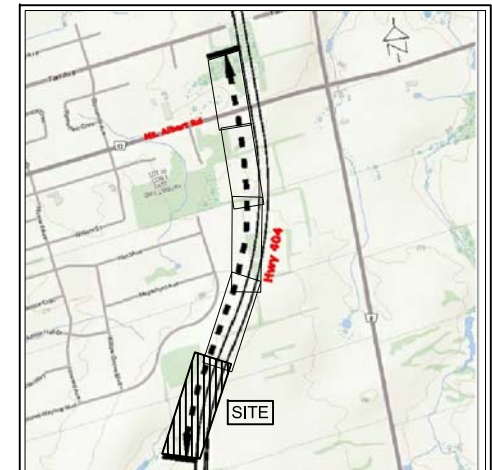
- THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT AND RECORD OF BOREHOLE LOGS.
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
- DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND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

CONT No  
TASK No. 2013-E-0034-009  
HIGHWAY 404 SBL  
NOISE BARRIER WALL  
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET

**PML Peto MacCallum Ltd.**  
CONSULTING ENGINEERS

KEY PLAN  
NTS

## LEGEND

- Borehole
- ⊙ Borehole and Cone
- ⊕ Geocres Borehole (31D-492)
- N Blows/0.3m (Std. Pen Test, 475 J/blow)
- CONE Blows/0.3m (60 Cone, 475 J/blow)
- WL at time of investigation (June 2015)
- PM Pushed Mechanically
- PH Pushed Hydraulically
- Head
- ARTESIAN WATER
- Encountered
- PIEZOMETER

BH No	ELEVATION	COORDINATES	
		NORTHINGS	EASTINGS
19	289.4	4 884 031.8	310 930.3
20	289.8	4 883 910.2	310 886.4
21	287.0	4 883 818.7	310 854.6
22	285.0	4 883 748.3	310 836.6
23	284.1	4 883 682.2	310 822.4
24	281.1	4 883 649.2	310 744.7

## - NOTE -

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

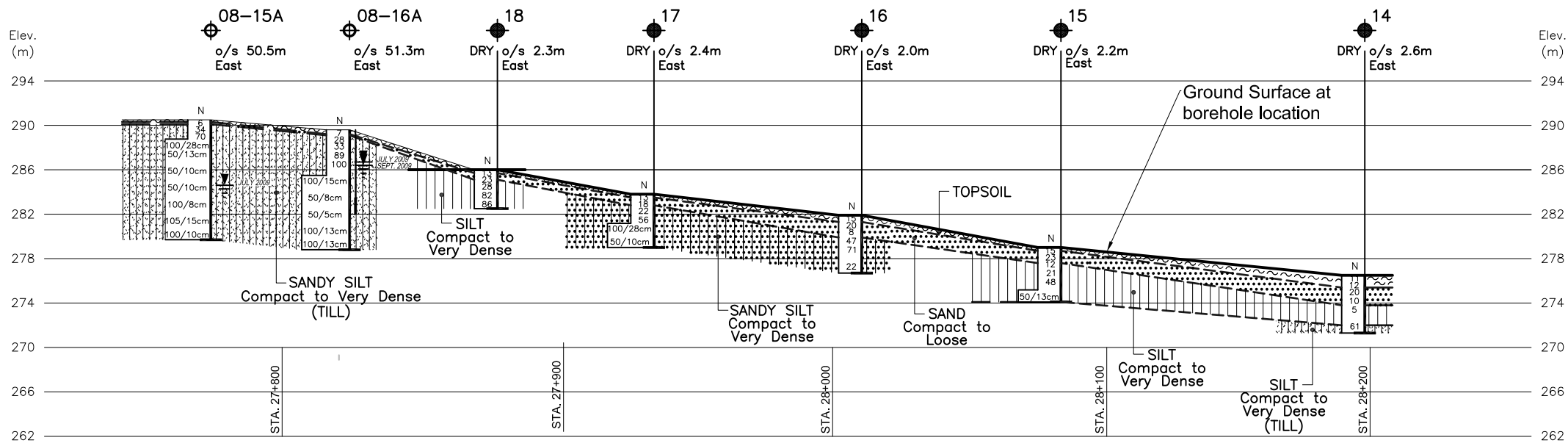
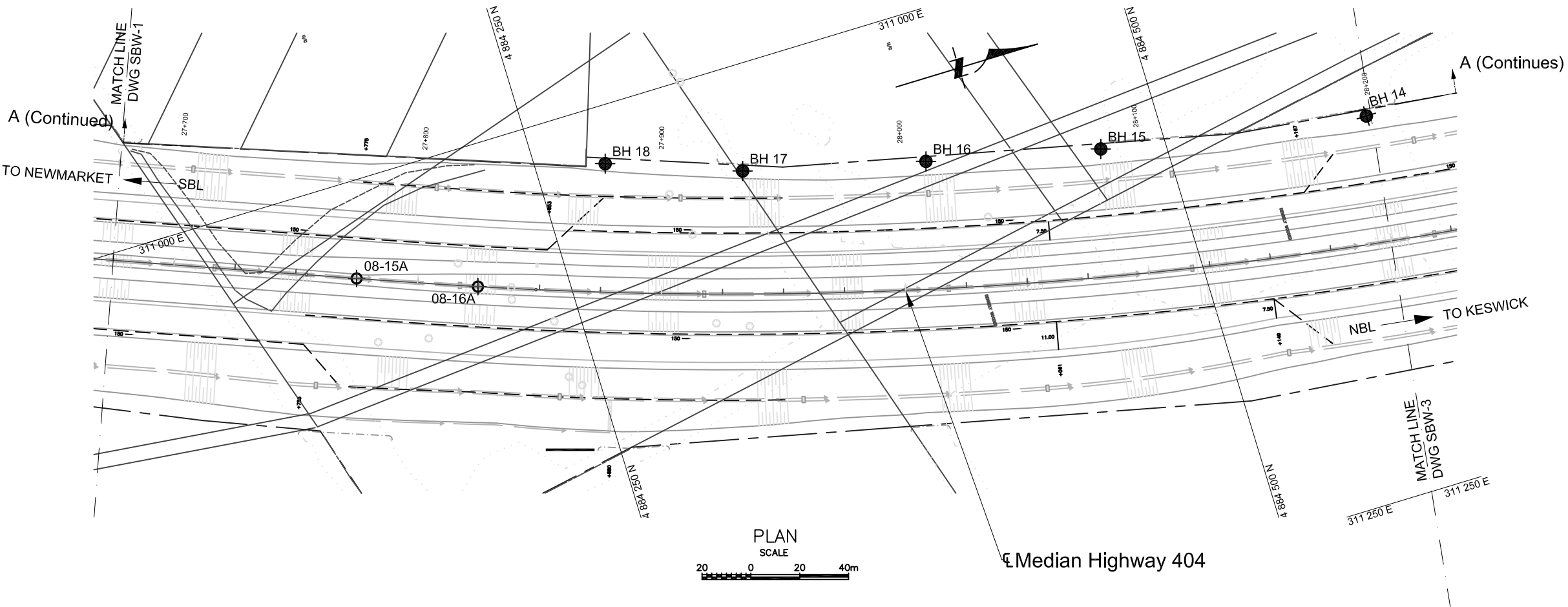
DATE	BY	DESCRIPTION

Geocres No. 31D-615

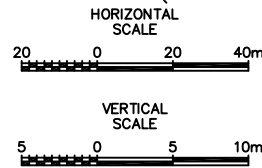
HWY No	404	DIST	CENTRAL
SUBM'D	NA	CHECKED	CZ
DATE	AUGUST 19, 2015	SITE	
DRAWN	NA	CHECKED	DD
APPROVED	CN	LDG	SBW-1



Reference MTO Drawing: NC-Standard.dwg undated



PROFILE A-A (Continued)



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.

CONT No  
TASK No. 2013-E-0034-009  
HIGHWAY 404 SBL  
NOISE BARRIER WALL  
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET

**PML Peto MacCallum Ltd.**  
CONSULTING ENGINEERS



KEY PLAN  
NTS

LEGEND

- Borehole
- Borehole and Cone
- Geocres Borehole (31D-492)
- N Blows/0.3m (Std. Pen Test, 475 J/blow)
- CONE Blows/0.3m (60 Cone, 475 J/blow)
- WL at time of investigation (June 2015)
- PM Pushed Mechanically
- PH Pushed Hydraulically
- Head
- ARTESIAN WATER
- Encountered
- PIEZOMETER

BH No	ELEVATION	COORDINATES	
		NORTHINGS	EASTINGS
14	276.5	4 884 582.2	311 095.0
15	279.0	4 884 474.2	311 076.4
16	281.9	4 884 404.4	311 060.5
17	283.8	4 884 331.2	311 042.5
18	286.0	4 884 277.6	311 023.3

GEOCRES REPORT (31D-492) BOREHOLES

08-15A	290.5	4 884 167.0	311 038.8
08-16A	289.6	4 884 213.7	311 056.5

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

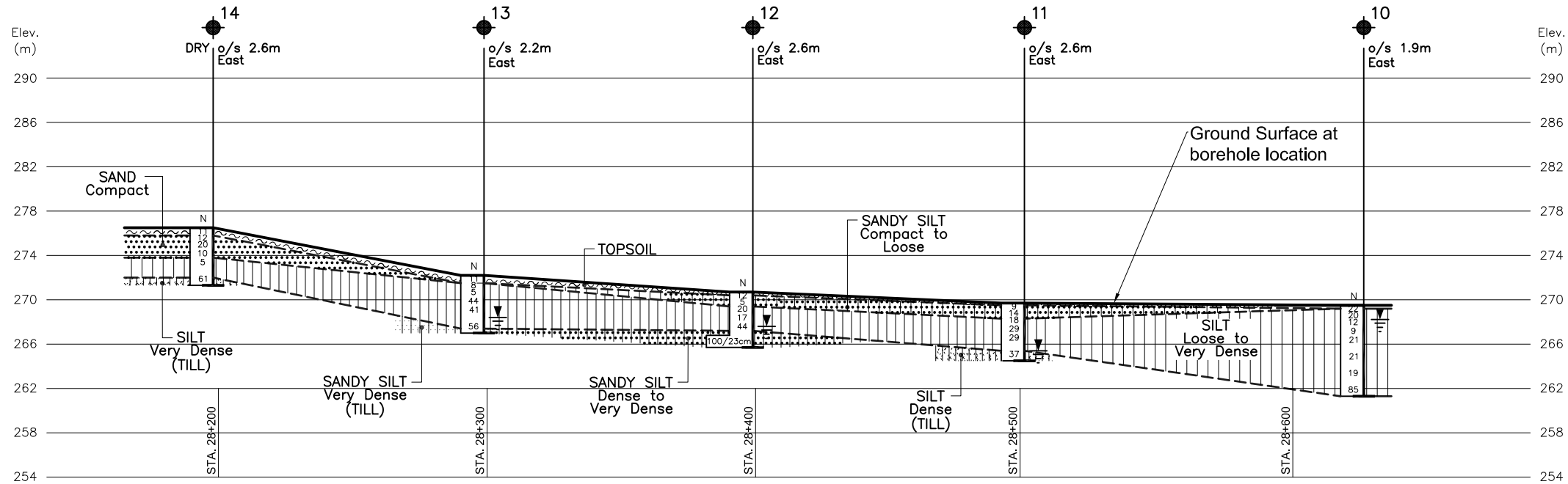
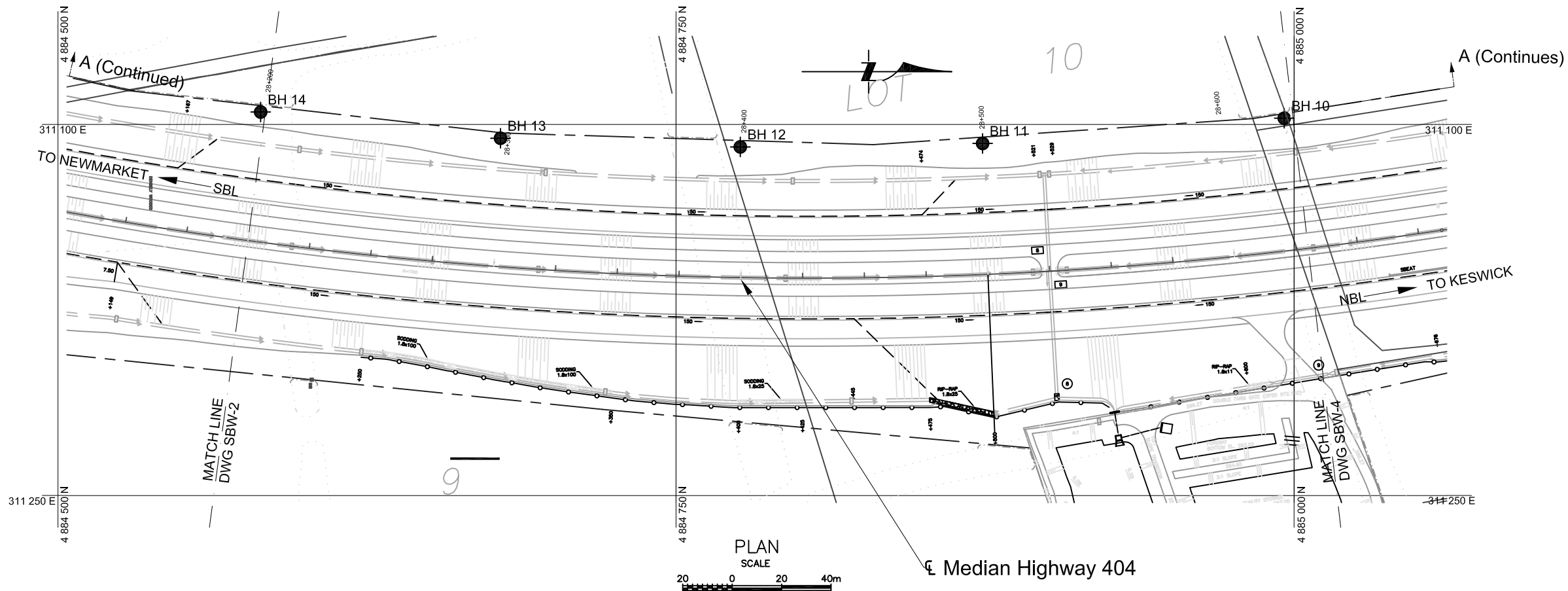
Geocres No. 31D-615

HWY No	404	CHECKED	CZ	DATE	AUGUST 19, 2015	DIST	CENTRAL
SUBM'D	NA	CHECKED	DD	APPROVED	CN	DWG	SBW-2



Reference MTO Drawing: NC-Standard.dwg undated





NOTES:

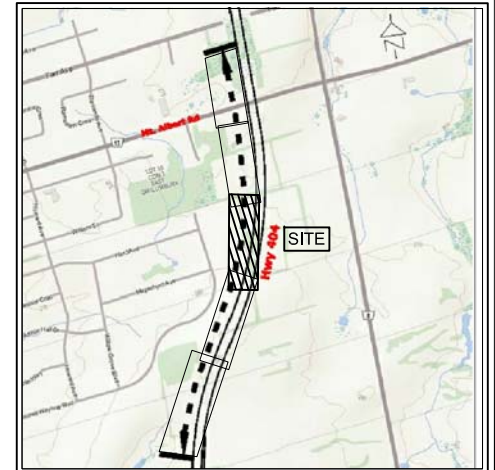
- THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT AND RECORD OF BOREHOLE LOGS.
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
- DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND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

CONT No  
TASK No. 2013-E-0034-009  
HIGHWAY 404 SBL  
NOISE BARRIER WALL  
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET

**PML Peto MacCallum Ltd.**  
CONSULTING ENGINEERS



LEGEND

- Borehole
- Borehole and Cone
- Geocres Borehole (31D-492)
- N Blows/0.3m (Std. Pen Test, 475 J/blow)
- CONE Blows/0.3m (60 Cone, 475 J/blow)
- WL at time of investigation (June 2015)
- PM Pushed Mechanically
- PH Pushed Hydraulically
- Head
- ARTESIAN WATER
- Encountered
- PIEZOMETER

BH No	ELEVATION	COORDINATES	
		NORTHINGS	EASTINGS
10	269.5	4 884 996.5	311 097.5
11	269.7	4 884 874.4	311 107.7
12	270.7	4 884 776.4	311 109.1
13	272.2	4 884 679.0	311 105.6
14	276.5	4 884 582.2	311 095.0

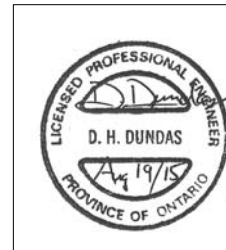
NOTE

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

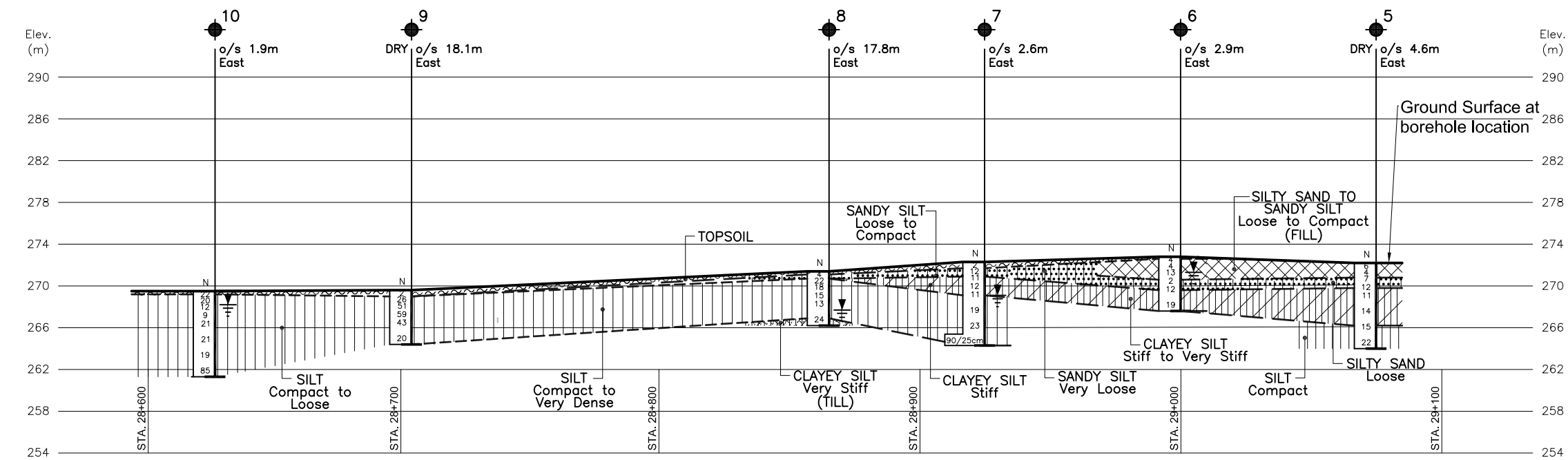
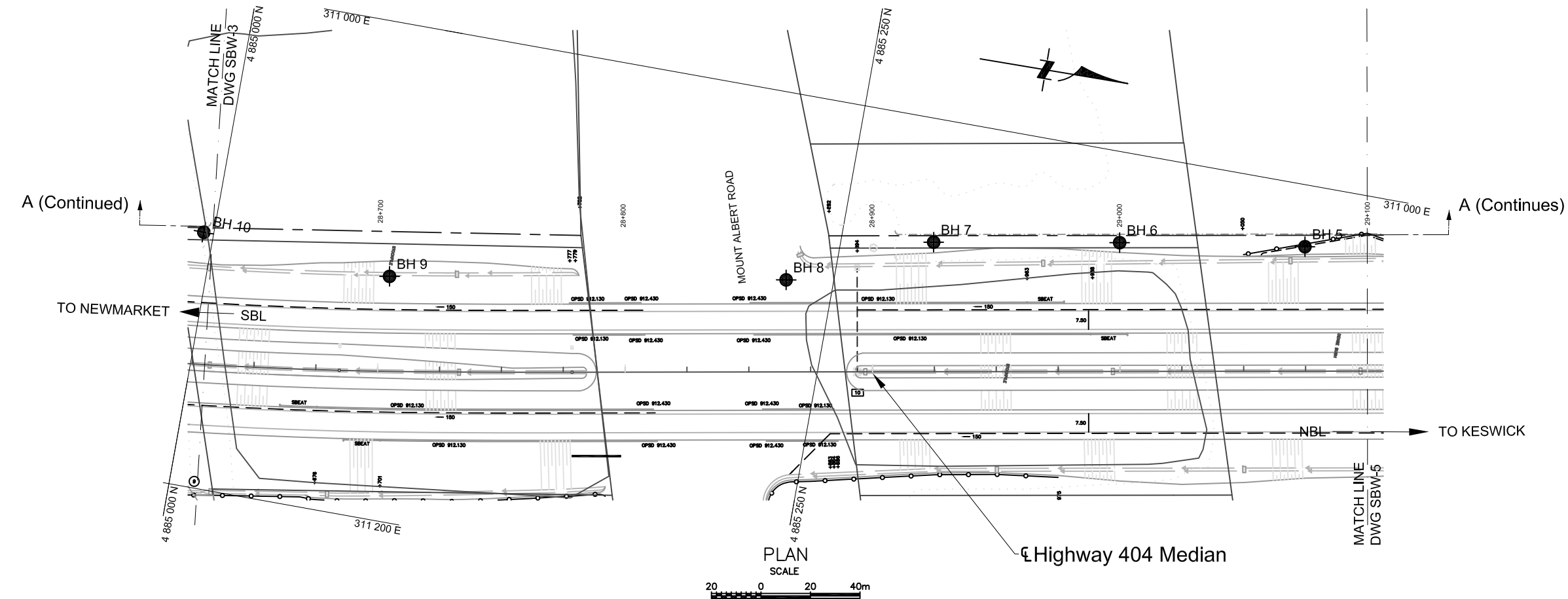
DATE	BY	DESCRIPTION

Geocres No. 31D-615

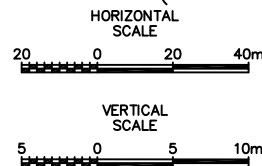
HWY No	404	DIST	CENTRAL
SUBM'D	NA	CHECKED	CZ
DRAWN	NA	CHECKED	DD
DATE	AUGUST 19, 2015	APPROVED	CN
SITE		DWG	SBW-3



Reference MTO Drawing: NC-Standard.dwg undated



PROFILE A-A (Continued)



NOTES:

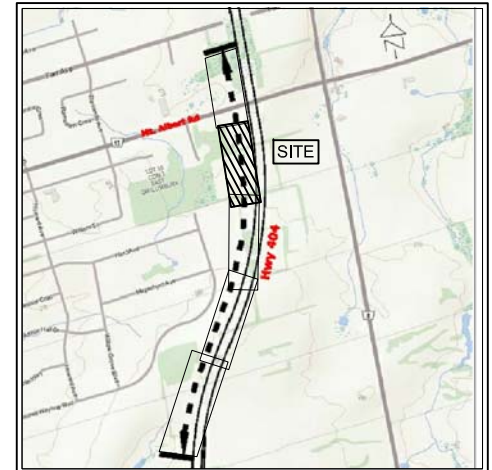
- THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT AND RECORD OF BOREHOLE LOGS.
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
- DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND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

CONT No  
TASK No. 2013-E-0034-009  
HIGHWAY 404 SBL  
NOISE BARRIER WALL  
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET

**PML Peto MacCallum Ltd.**  
CONSULTING ENGINEERS



KEY PLAN  
NTS

LEGEND

- Borehole
- Borehole and Cone
- Geocres Borehole (31D-492)
- N Blows/0.3m (Std. Pen Test, 475 J/blow)
- CONE Blows/0.3m (60 Cone, 475 J/blow)
- WL at time of investigation (June 2015)
- PM Pushed Mechanically
- PH Pushed Hydraulically
- Head
- ARTESIAN WATER
- Encountered
- PIEZOMETER

BH No	ELEVATION	COORDINATES	
		NORTHINGS	EASTINGS
5	272.3	4 885 434.7	311 024.7
6	272.8	4 885 360.8	311 036.3
7	272.3	4 885 286.8	311 049.4
8	271.4	4 885 230.9	311 074.9
9	269.6	4 885 072.9	311 101.8
10	269.5	4 884 996.5	311 097.5

NOTE

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

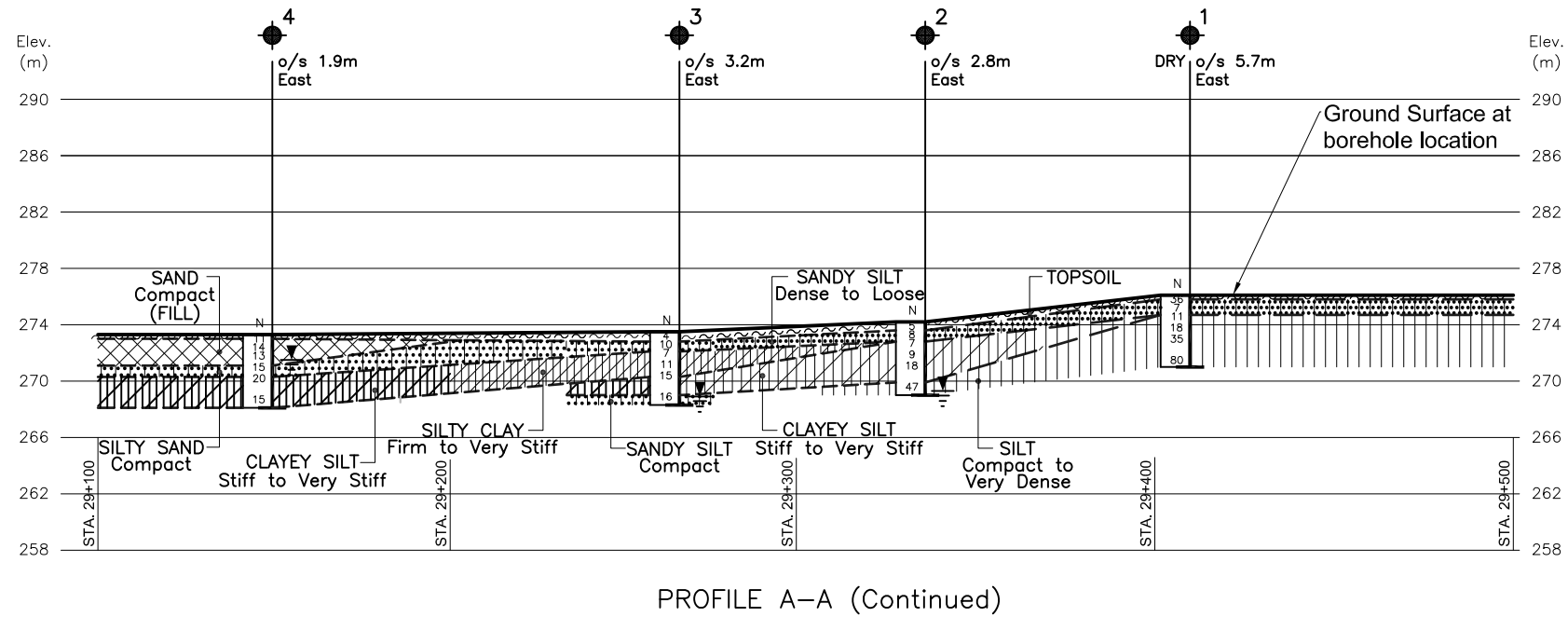
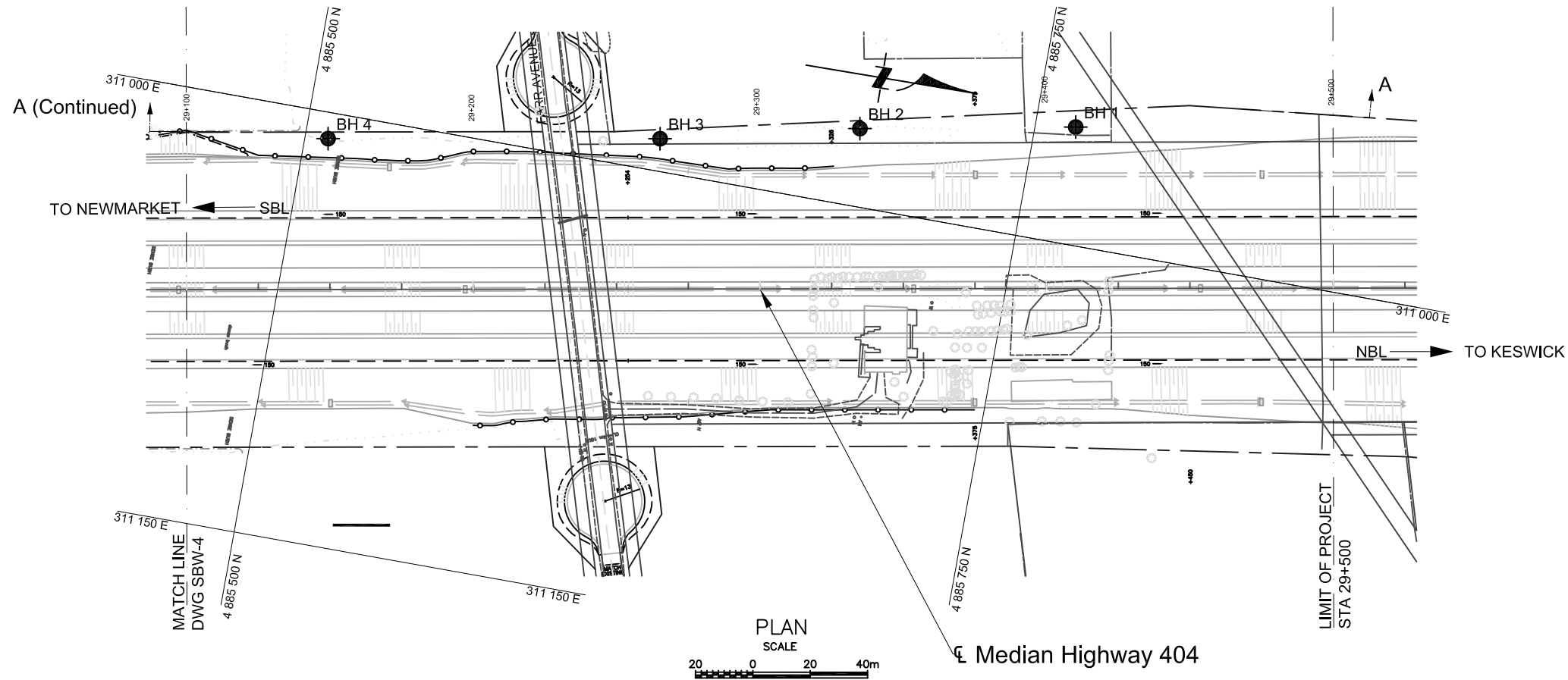
REVISIONS	DATE	BY	DESCRIPTION

Geocres No. 31D-615

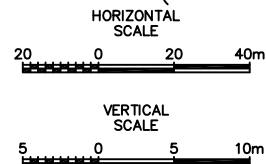
HWY No	404	DIST	CENTRAL
SUBM'D	NA	CHECKED	CZ
DATE	AUGUST 19, 2015	SITE	
DRAWN	NA	CHECKED	DD
APPROVED	CN	DWG	SBW-4



Reference MTO Drawing: NC-Standard.dwg undated



PROFILE A-A (Continued)



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.

CONT No  
TASK No. 2013-E-0034-009  
HIGHWAY 404 SBL  
NOISE BARRIER WALL  
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET

**PML Peto MacCallum Ltd.**  
CONSULTING ENGINEERS



KEY PLAN  
NTS

LEGEND

- Borehole
- Borehole and Cone
- Geocres Borehole (31D-492)
- N Blows/0.3m (Std. Pen Test, 475 J/blow)
- CONE Blows/0.3m (60 Cone, 475 J/blow)
- WL at time of investigation (June 2015)
- PM Pushed Mechanically
- PH Pushed Hydraulically
- Head
- ARTESIAN WATER
- Encountered
- PIEZOMETER

BH No	ELEVATION	COORDINATES	
		NORTHINGS	EASTINGS
1	276.1	4 885 764.2	310 959.1
2	274.2	4 885 690.4	310 972.9
3	273.5	4 885 622.4	310 988.7
4	273.3	4 885 508.5	311 009.1

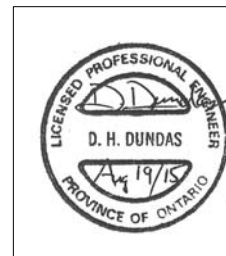
NOTE

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

DATE	BY	DESCRIPTION

Geocres No. 31D-615

HWY No	NA	CHECKED	CZ	DATE	AUGUST 19, 2015	DIST	CENTRAL
SUBM'D	NA	CHECKED	DD	APPROVED	CN	DWG	SBW-5



Reference MTO Drawing: NC-Standard.dwg undated



## **APPENDIX FIR-A**

Site Photographs along the Proposed Noise Barrier Wall





**Photograph P1:** Looking south at the north end of project limit at approx. Sta. 29+500 (Date: June 17, 2015)



**Photograph P2:** Looking north from Highway 404, SBL shoulder at approx. Sta. 29+250 (Date: June 17, 2015)





**Photograph P3:** Looking south from Highway 404 SBL shoulder at approx. Sta. 29+200 (Date: June 17, 2015)



**Photograph P4:** Looking north from the north end of Mt. Albert Road Overpass at approx. Sta. 28+825 (Date: June 17, 2015)





**Photograph P5:** Looking north from the existing fence line at approx. Sta. 28+700 (Date: June 18, 2015)



**Photograph P6:** Looking south from the location of borehole 9 at approx. Sta. 28+700 (Date: June 18, 2015)



**Photograph P7:** Looking north at Highway 404 SBL shoulder at approx. Sta. 28+625 Stake of borehole 10 is visible. (Date: June 18, 2015)



**Photograph P8:** Looking south from Highway 404 SBL shoulder to boreholes 11 and 12 at approx. Sta. 28+550 (Date: June 18, 2015)





**Photograph P9:** Looking south from Highway 404 SBL shoulder to boreholes 13 and 14 at approx. Sta. 28+400 (Date: June 18, 2015)



**Photograph P10:** Looking south from Highway 404 SBL shoulder to boreholes 15 and 16 at approx. Sta. 28+200 (Date: June 18, 2015)



**Photograph P11:** Looking south at the location of borehole 15 at approx. Sta. 28+100. The existing fence is visible. (Date (June 18, 2015)



**Photograph P12:** Looking south at the existing fence line to boreholes 17 and 18 at approx. Sta. 27+975. The wood fence of residential area is visible (Date: June 18, 2015)





**Photograph P13:** Looking south at Highway 404 SBL shoulder at approx. Sta. 27+875. The wood fence of residential area is visible. (Date: June 18, 2015)



**Photograph P14:** Looking north at Highway 404 SBL shoulder at approx. Sta. 27+675. The wood fence of residential area is visible. (Date: June 18, 2015)



**Photograph P15:** Looking south at Highway 404 SBL shoulder to boreholes 19 and 20 at approx. Sta. 27+675 (Date: June 18, 2015)



**Photograph P16:** Looking north at Highway 404 SBL shoulder to boreholes 20 to 22 at approx. Sta. 27+300 (Date: June 18, 2015)





**Photograph P17:** Looking west from Highway 404 SBL shoulder close to the south end of project limits at approx. Sta. 27+225. The stormwater management pond is visible. (Date: June 18, 2015)





## **APPENDIX FIR-B**

Record of Previous Borehole Sheets from Thurber (2010)

# RECORD OF BOREHOLE No 08-15A

1 OF 2

METRIC

G.W.P. 2109-05-00 LOCATION N 4 884 166.95 E 311 038.81 ORIGINATED BY ES  
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2009.07.30 - 2009.07.30 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	WATER CONTENT (%)
290.5																		
0.0	TOPSOIL: (200mm)																	
290.4	SAND, trace to some silt, occasional roots and rootlets Loose Dark Brown Damp		1	SS	6													
0.4	Sandy SILT, trace gravel, trace clay, occasional sand pockets, occasional cobbles Dense to Very Dense Brown Damp (TILL)		2	SS	34													1 39 51 9
			3	SS	70													1 34 56 9
			4	SS	100/ 0.275													
	Occasional sand pockets		5	SS	50/ 0.125													1 39 51 9
			6	SS	50/ 0.100													2 31 58 9
			7	SS	50/ 0.100													3 36 52 9
			8	SS	100/ 0.075													4 29 58 9
	Grey		9	SS	105/ 0.150													

Continued Next Page

+<sup>3</sup> X<sup>3</sup>: Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 08-15A

2 OF 2

METRIC

G.W.P. 2109-05-00 LOCATION N 4 884 166.95 E 311 038.81 ORIGINATED BY ES  
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2009.07.30 - 2009.07.30 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE		WATER CONTENT (%) W <sub>P</sub> W W <sub>L</sub>				
	Continued From Previous Page													
279.7	Sandy SILT, trace clay, trace gravel, occasional cobbles Very Dense Grey Wet (TILL)		10	SS	100/		280							
10.8	END OF BOREHOLE AT 10.8m. BOREHOLE OPEN TO 10.4m AND WATER LEVEL AT 6.8m UPON COMPLETION OF DRILLING IN MAY 2009. WATER LEVEL AT 5.9m UPON COMPLETION OF DRILLING IN JULY 2009. BOREHOLE BACKFILLED WITH HOLEPLUG TO 8.5m, THEN AUGER CUTTINGS TO SURFACE.				0.100									

**METRIC**

ORIGINATED BY ES

COMPILED BY AN

CHECKED BY RPR

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 08-16A

2 OF 2

METRIC

G.W.P. 2109-05-00 LOCATION N 4 884 213.73 E 311 056.48 ORIGINATED BY ES  
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2009.07.30 - 2009.07.30 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	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	W <sub>p</sub>	W	W <sub>L</sub>			
	Continued From Previous Page																
278.8	Sandy SILT, trace clay Very Dense Grey Damp (TILL)		10	SS	100/		279										
10.8	END OF BOREHOLE AT 10.8m. BOREHOLE OPEN TO 10.1m AND WATER LEVEL AT 2.9m UPON COMPLETION OF DRILLING IN MAY 2009. WATER LEVEL AT 6.0m UPON COMPLETION OF DRILLING IN JULY 2009. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEVATION(m) 2009.05.15 1.2 288.4 2009.06.05 1.4 288.2 2009.07.10 1.7 287.9 2009.09.21 3.2 286.4				0.125												



**FOUNDATION DESIGN REPORT  
for  
HIGHWAY 404 – SBL NOISE BARRIER WALL  
FROM GREEN LANE EAST TO 250 M NORTH OF FARR AVENUE  
TOWNSHIP OF EAST GWILLIMBURY, ONTARIO  
AGREEMENT NO.: 2013-E-0039  
TASK NO. 2013-E-0039-009**

**PREPARED FOR MINISTRY OF TRANSPORTATION, ONTARIO**

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

**Distribution:**

1 cc: MTO Project Manager + 1 digital copy  
1 cc: MTO, Pavements and Foundations Section  
+ 1 digital copy (pdf)  
1 cc: PML Toronto

PML Ref.: 15TF012  
Index No.: 012FDR  
GEOCRES No.: 31D-615  
August 19, 2015



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8. NOISE BARRIER WALL FOUNDATION DESIGN .....11

9. CONSTRUCTION CONSIDERATIONS.....14

10. CLOSURE .....15

Table FDR-1 – Standard Specifications Referenced in Report

Appendix FDR-A - Non-Standard Special Provisions

**FOUNDATION DESIGN REPORT**

For

Highway 404 – SBL Noise Barrier Wall

From Green Lane East to 250 m North of Farr Avenue

Township of East Gwillimbury, Ontario

Agreement No.: 2013-E-0039, Task No.: 2013-E-0039-009

---

**7. GENERAL**

It is anticipated that the noise barrier will be a proprietary design build component commissioned by the Contractor. The following recommendations do not apply to the proprietary design. The proprietary noise barrier company should be responsible for establishing the design and construction specifications based on the subsurface information provided in the Foundation Investigation Report for this project assuming that the subsurface conditions described in the boreholes closest to the specific noise barrier installation should be applied in the design.

The following recommendations and design parameters are provided for the purposes of design as per SP 799F01.

**8. NOISE BARRIER WALL FOUNDATION DESIGN**

The noise barrier walls should be founded on deep foundations such as piles installed in preaugered holes or caissons with a diameter in the order of 0.6 m. Geotechnical parameters for design, including equivalent angles of internal friction and unit weights of subsurface materials are provided in the table below (Table 8). The geotechnical parameters of previous boreholes 08-15A and 08-16A were extracted from the Thurber report (Geocres No. 31D492), and are consistent with the parameters provided by PML. The stratigraphy presented in the following table has been simplified for the purposes of the noise barrier wall foundation design. The stations included in the table are referenced to the station numbers at the centreline of median Highway 404 provided to PML by MTO. The boreholes closest to the installation should be assumed to define the ground conditions and geotechnical parameters for design at that location.

The resistance for deep foundations for ground within the frost penetration depth should be discounted. The design frost penetration depth for the area is 1.5 m.



**TABLE 8: GEOTECHNICAL DESIGN PARAMETERS FOR NOISE BARRIER WALL FOUNDATIONS**

BOREHOLE STATION NUMBER	BOREHOLE NUMBER	SOIL STRATUM	ELEVATION (m)	DESIGN PARAMETERS			
				GROUND WATER ELEVATION (m)	EQUIVALENT $\phi'$ (degrees)	$\gamma$ (kN/m <sup>3</sup> )	$\gamma'$ (kN/m <sup>3</sup> )
27+218	24	Silt	280.9 to 277.4	Dry	30	19	-
27+256	23	Silt	283.8 to 282.0	Dry	28	19	-
27+321	22	Sand	284.4 to 283.6	Dry	33	20	-
		Silt	283.6 to 280.0		28	19	-
27+390	21	Sand	286.7 to 285.6	Dry	33	20	-
		Silt	285.6 to 282.1		28	19	-
27+483	20	Sand	289.4 to 288.6	Dry	33	20	-
		Silt	288.6 to 286.1		28	19	-
27+612	19	Silt	289.1 to 286.5	Dry	28	19	-
27+775	08-15A	Sandy Silt (Till)	290.1 to 284.6	284.6	32	20	-
			284.6 to 279.7		32	-	10
27+825	08-16A	Sandy Silt (Till)	289.1 to 278.8	283.6	32	20	-
			283.6 to 278.8		32	-	10
27+875	18	Sand	285.7 to 285.1	Dry	33	20	-
		Silt	285.1 to 282.5		28	19	-
27+933	17	Sand	283.5 to 282.8	Dry	33	20	-
		Silt	282.8 to 279.0		28	19	-
28+008	16	Sand	281.3 to 279.9	Dry	33	20	-
		Silt	279.9 to 276.7		28	19	-
28+083	15	Sand	278.7 to 277.6	Dry	33	20	-
		Silt	277.6 to 274.1		28	19	-
28+200	14	Sand	275.9 to 273.8	Dry	33	20	-
		Silt	273.8 to 272.2		28	19	-
		Silt (Till)	272.2 to 271.3		32	20	-
28+300	13	Silt	271.5 to 268.4	268.4	28	19	-
			268.4 to 267.4		28	-	9
		Sandy Silt (Till)	267.4 to 267.0		32	-	10
28+400	12	Silt	270.4 to 267.7	267.7	28	19	-
			267.7 to 265.7		28	-	9
28+500	11	Silt	269.5 to 265.4	265.4	28	19	-
		Silt (Till)	265.4 to 264.4		32	-	10

**TABLE 8: GEOTECHNICAL DESIGN PARAMETERS FOR NOISE BARRIER WALL FOUNDATIONS**

BOREHOLE STATION NUMBER	BOREHOLE NUMBER	SOIL STRATUM	ELEVATION (m)	DESIGN PARAMETERS			
				GROUND WATER ELEVATION (m)	EQUIVALENT $\phi'$ (degrees)	$\gamma$ (kN/m <sup>3</sup> )	$\gamma'$ (kN/m <sup>3</sup> )
28+625	10	Silt	269.2 to 268.2	268.2	28	19	-
			268.2 to 261.3		28	-	9
28+700	9	Silt	269.0 to 264.4	Dry	28	19	-
28+866	8	Silt	271.1 to 267.7	267.7	30	19	-
			267.7 to 266.9		30	-	9
		Clayey Silt (Till)	266.9 to 266.2		32	-	10
28+925	7	Silt	271.7 to 270.9	268.0	30	19	-
		Clayey Silt	270.9 to 269.1		26	20	-
		Silt	269.1 to 268.0		28	19	-
			268.0 to 264.3		28	-	9
29+000	6	Silty Sand (Fill)	272.6 to 270.6	Dry	28	18	-
		Silt	270.6 to 269.6		28	20	-
		Clayey Silt	269.6 to 267.6		26	20	-
29+075	5	Sandy Silt (Fill)	272.2 to 270.8	Dry	28	18	-
		Sand	270.8 to 269.8		33	20	-
		Silty Clay	269.8 to 266.2		26	20	-
		Silt	266.2 to 264.0		28	19	-
29+150	4	Sand (Fill)	273.0 to 271.1	270.3	28	18	-
		Sand	271.1 to 270.3		33	20	-
		Clayey Silt	270.3 to 268.1		26	-	10
29+266	3	Silt	272.8 to 272.1	Dry	28	19	-
		Silty Clay	272.1 to 270.3		26	20	-
		Clayey Silt	270.3 to 269.0		26	20	-
		Silt	269.0 to 268.3		28	19	-
29+335	2	Silt	273.6 to 272.8	269.9	28	19	-
		Clayey Silt	272.8 to 269.9		26	20	-
		Silt	269.9 to 269.0		28	-	9
29+410	1	Silt	275.8 to 271.0	Dry	28	19	-

**Notes:**

- Groundwater elevations measured upon completion of borehole drilling;
- $\phi'$  = Equivalent effective angle of internal friction of soils (degrees);
- $\gamma$  = Bulk unit weight of soil (kN/m<sup>3</sup>); and
- $\gamma'$  = Submerged unit weight of soil below groundwater level (kN/m<sup>3</sup>).



## **9. CONSTRUCTION CONSIDERATIONS**

Construction of piles installed in preaugered holes or caissons should be in accordance with OPSS 903. The NSSP's that are provided in Appendix FDR-A should be included in the Contract Documents. These NSSP's address maintaining the sides and bases of excavations without disturbance, dewatering and obstructions.

The soils at the site are glacially-derived and may contain cobbles and boulders. An NSSP should be included in the Contract Documents to require that the Contractor shall be responsible for providing appropriate equipment and procedures to penetrate obstructions (cobbles and boulders) that are encountered during excavation for noise barrier wall foundations.

Excavations for deep foundations for noise barriers will extend through ground that is susceptible to disturbance under conditions of unbalanced hydrostatic head. The NSSP in Appendix FDR-A should be included in the Contract Documents to require that the sides and base of excavations for noise barrier foundations shall be maintained without disturbance until installation of that foundation is completed. Concrete for piles installed in preaugered holes or caissons should be poured as soon as practicable and within 4 hours after completion of excavation.

Although the construction methods should remain the responsibility of the Contractor, the NSSP should alert the Contractor of red flag issues to minimize the risk of claim. For construction in-the-dry, the prevailing groundwater level should be lowered below the base of excavation. For construction in-the-wet, tremie techniques may be required. Temporary liners or mud drilling may be considered to facilitate construction.



## 10. CLOSURE

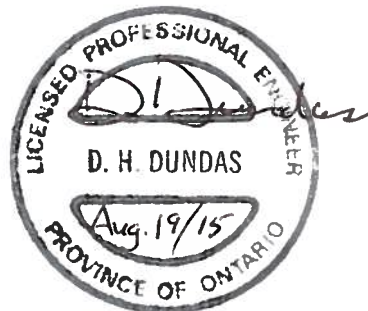
This report was prepared by Mr. C. Zhao, MSc, EIT, and reviewed by Mr. D. Dundas, P.Eng., Senior Engineer, Mr. C. M. P. Nascimento, P. Eng., Project Manager conducted an independent quality review of the report.

Yours very truly

Peto MacCallum Ltd.

A blue ink signature of Gary Zhao, written in a cursive style.

Cheng (Gary) Zhao, MSc, E.I.T.  
Project Supervisor, Geotechnical Services



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



Carlos M.P. Nascimento, P.Eng.  
Project Manager and  
MTO Designated Principal Contact

CZ/DD/CN:nk-jk



**TABLE FDR-1**  
**STANDARD SPECIFICATIONS REFERENCED IN REPORT**

<b>DOCUMENT</b>	<b>TITLE</b>
OPSS 903	Construction Specification for Deep Foundations
SP 799F01	Construction Specification for the Installation of Noise Barrier



## **APPENDIX FDR-A**

### Non-Standard Special Provisions



## **NSSP to OPSS 903**

### **Maintaining Sides and Bases of Excavations for Noise Barrier Wall Foundations Without Disturbance**

The Contractor is advised that excavations for deep foundations for noise barriers will extend through ground that is susceptible to disturbance under conditions of unbalanced hydrostatic head.

The sides and base of an excavation for noise barrier foundations shall be maintained without disturbance until installation of that foundation is completed. Although the construction methods remain the responsibility of the Contractor, consideration may be given to the following aspects:

- For construction in-the-dry, the prevailing groundwater level shall be lowered a minimum of 0.5 m below the base of excavation. For construction in-the-wet, tremie techniques would be required. Temporary liners or mud drilling may be considered to facilitate construction of the excavations.
- Concrete for piles installed in preaugered holes or caissons should be poured as soon as practicable and within 4 hours after completion of excavation.

### **Basis of Payment**

Payment at the lump sum contract price for this tender item shall be full compensation for all labour, equipment and materials for completion of the work.



## **NSSP to OPSS 903**

### **Obstructions from Cobbles and Boulders in Excavations for Noise Barrier Wall Foundations**

The soils at the site are glacially-derived and may contain cobbles and boulders. The Contractor shall be responsible for providing appropriate equipment and procedures to penetrate obstructions (cobbles and boulders) that are encountered during excavation for noise barrier wall foundation.

### **Basis of Payment**

Payment at the contract price for the above tender item shall include full compensation for all labour and materials for completion of the work.