

G.I.-30 SEPT. 1976

GEOCRES No. 30M3-217

DIST. CR REGION

W.P. No. 349-98-00

CONT. No.

W. O. No.

STR. SITE No.

HWY. No. QEW

LOCATION HML - QEW FROM

LUNDY'S LANE TO MCLEOD RD

No. of PAGES - 1

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FOUNDATION INVESTIGATION REPORT  
FOR  
HIGH MAST LIGHT FOUNDATIONS  
QEW FROM LUNDY'S LANE TO MCLEOD ROAD  
W.P. 349-98-00  
NIAGARA FALLS, ONTARIO

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PML Ref: 00HF001

June, 2000

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## **FOUNDATION INVESTIGATION REPORT**

For

High Mast Light Foundations  
QEW from Lundy's Lane to McLeod Road  
W.P. 349-98-00  
Niagara Falls, Ontario

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### **INTRODUCTION**

This report summarizes the results of the foundation investigation carried out for construction of 23 High Mast Light Foundations within the median of the QEW from Lundy's Lane to approximately 500 m south of McLeod Road, as well as within the interchange at McLeod Road in Niagara Falls, Ontario. The investigation was conducted for Delcan Corporation. Authorization to proceed with this project was provided verbally by Mr. Bob Bower, P.Eng.

The purpose of this investigation was to define the subsurface conditions at the site and to provide geotechnical parameters for design of the high mast light foundations from Station 16+785 to 19+545 along the QEW.

### **SITE DESCRIPTION**

The site is located along the QEW from Lundy's Lane to approximately 500 m south of McLeod Road in Niagara Falls, Ontario.

The site is located in the broad physiographic region known as the Haldimand Clay Plain. In general, the topography on the plain is relatively flat to undulating. The overburden is some 10 to 15 m thick and typically comprises deposits of glaciolacustrine clay, silt and sand.

Bedrock consists of dolostone of the Lockport Formation.

## **INVESTIGATION PROCEDURES**

The fieldwork was carried out during the period January 11 to January 20, 2000 and comprised six boreholes drilled along the median shoulder of the southbound lanes of the QEW, and two boreholes (Nos. 6 and 7) drilled within the interchange ramps at McLeod Road. The boreholes were extended to depths of 8.2 to 9.8 m. The borehole locations are shown on Drawing 1. The light pole locations relative to the respective boreholes are presented on Table I.

The borehole locations were selected by Peto MacCallum Ltd., subject to access limitations in the field. The MTO co-ordinates of, and ground surface elevations at the boreholes were subsequently interpolated from untitled and undated drawings provided by Delcan Corporation.

The boreholes were advanced using continuous flight solid stem augers, powered by truck-mounted CME-75 drillrig, supplied and operated by a specialist drilling contractor, working under the full-time supervision of a member of our engineering staff.

Representative samples of the overburden were recovered at frequent depth intervals using a conventional split spoon sampler during drilling. Standard penetration tests were conducted simultaneously with the sampling operation to assess the strength characteristics of the substrata.

Pocket penetrometer testing was carried out on the recovered samples to determine the undrained shear strength of the cohesive soils.

In situ vane shear tests were conducted to further assess the shear strength of the soils encountered.

The groundwater conditions in the boreholes were closely monitored during the course of the fieldwork.

All of the recovered samples were returned to our laboratory for detailed visual examination, classification and routine moisture content determinations. Grain size distribution analyses and Atterberg Limit tests were carried out on selected samples.

### **SUMMARIZED SUBSURFACE CONDITIONS**

Reference is made to the appended Log of Borehole sheets for details of the subsurface conditions including soil classifications, inferred stratigraphy, standard penetration test "N" values, penetrometer and vane shear values, and groundwater observations. The results of laboratory grain size distribution analyses and moisture content determinations are also shown.

Information contained on Department of Highways – Ontario drawing No. 67-F-13A, Titled "McLeod Road" dated 5 April, 1967, was used for reference of subsurface conditions and overburden thickness. The drawing revealed a clay layer over silt till mantling bedrock at an approximate depth of 12 m.

The subsurface stratigraphy revealed along the site generally comprised a discontinuous pavement/fill/topsoil layer overlying native loose to very dense silts and soft to hard clays, underlain by a discontinuous hard/dense till unit. The strata encountered are summarized below:

#### **Pavement and Shoulder Structure**

A pavement structure was encountered in borehole 1, and consisted of 120 mm asphaltic concrete over 310 mm Granular "A" crushed limestone.

A 0.6 to 1.4 m thick layer of non-cohesive sand and gravel fill was encountered surficially in boreholes 2, 4, 5 and 8. The sand and gravel fill was generally compact.

### Fill

A 2.1 m thick layer of loose non-cohesive silt fill was encountered surficially in borehole 6. The silt had a moisture content range of 18 to 21%.

Cohesive clay fill was encountered surficially in borehole 3, beneath topsoil in borehole 7 and sand/sand and gravel in boreholes 4 and 5. The clay fill ranged in thickness from 0.4 to 1.2 m. The moisture content of the clay typically ranged from 19 to 24%.

The combined sand and gravel, silt and clay fill was penetrated at depths of 0.8 to 2.1 m (elevation 193.1 to 181.2).

### Topsoil

A discontinuous layer of cohesive silty clay/alluvium topsoil ranging from 150 to 450 mm in thickness was encountered in five of the eight boreholes. The topsoil was encountered surficially in borehole 7, and beneath the fill in boreholes 3, 4, 5 and 8. The topsoil was penetrated at depths of 1.4 to 2.1 m (elevation 189.6 to 180.9).

### Sand

A thin unit of non-cohesive sand was encountered beneath the pavement structure in borehole 1. This layer was loose and was penetrated at a depth of 1.4 m (elevation 193.8). The moisture content of one sample was 5%.

The result of a grain size distribution analysis conducted on a sample of the sand is presented on Figure 1D.

### Clay

A native cohesive clay unit was revealed below the fill/topsoil in boreholes 3 to 8 as well as below silt units in boreholes 2 and 6. The layer ranged in thickness from 0.7 to 3.0 m thick, and was penetrated at depths of 2.1 to 6.9 m (elevation 188.9 to 181.9). The clay unit was very stiff to hard in boreholes 3 to 5 and had a moisture content range of 7 to 24%, typically 20 to 24%. The "N" values of the clay typically ranged from 17 to 47. The liquid limit and plastic limit for the material ranged between about 38 to 46 and 19 to 22, respectively. The clay deposit is heavily overconsolidated.

The clay layer became much thicker (7.1 to 7.5 m) in boreholes 6 to 8, contacted at depths ranging from 1.4 to 2.1 m (elevation 182.1 to 180.9). The clay was generally very stiff, with "N" values ranging from 20 to 25, becoming only soft, "N" values typically ranging from 2 to 4, below depths of 5.4 to 7.1 m. The moisture content ranged from 23 to 35%, typically 23 to 29% for the upper stiffer clay soil, and increasing to 25 to 40%, typically 29% in the soft clay at depth. The liquid limit and plastic limit for the soft clay ranged between about 30 to 48 and 18 to 23, respectively. The moisture content of the soft clay at depth was generally slightly below the liquid limit.

Drilling was terminated within the clay unit in boreholes 6 and 7 at depths of 9.6 m and 8.7 m.

The results of grain size distribution analyses conducted on samples of the clay are presented on Figure 1A. The results of Atterberg Limits tests conducted on samples exhibiting plasticity are presented on Figure 2A and 2B. The deposit is essentially medium plastic with zones of low plasticity.



### Silt

A deposit of non-cohesive silt was encountered below the fill and sand in boreholes 1 and 2, and beneath/within the clay in the remaining boreholes. The silt ranged in thickness from 0.7 to 5.8 m, where fully penetrated. The moisture content ranged from 11 to 43%, typically 21 to 24%. The silt was generally compact to very dense, loose below 5.7 and 8.7 m depth in boreholes 5 and 8, respectively. A thin seam of silt within the clay layer was encountered in boreholes 6 and 7 at depths of 4.0 and 6.3 m (elevation 179.2 and 177.2). The silt layer was 0.7 and 0.8 m thick.

The silt was penetrated at depths of 3.9 to 7.1 m (elevation 189.9 to 176.4) in five of the eight boreholes. Drilling was terminated within the silt layer in three of the boreholes at depths of 9.1 to 9.8 m (elevation 186.1 to 172.7).

The results of grain size distribution analyses conducted on samples of the silt are presented on Figure 1B. The results of Atterberg Limits tests conducted on samples exhibiting plasticity are presented on Figure 2C. The deposit is typically non to slightly plastic.

### Silt Till

A deposit of non-cohesive to slightly cohesive dense/hard silt till was encountered below the clay in borehole 2 and silt in borehole 5, at 6.9 m depth. The moisture content ranged from 6 to 11%. Drilling was terminated within the silt till in borehole 2 at 9.6 m depth (elevation 184.2).

Borehole 5 was terminated upon refusal to auger at a depth of 8.2 m (elevation 176.5). Borehole 5 is approximately 250 m north of McLeod Road and from Bedrock Profiles noted in Drawing No. 67-F-13A, bedrock is at approximate depth of 12.0 m (elevation 17.0.0). Therefore, it is assumed refusal to auger in borehole 5 is on a probable boulder.

The results of grain size distribution analyses conducted on two samples of the silt till are presented on Figure 1C. The results of Atterberg Limits tests conducted on samples exhibiting plasticity are presented on Figure 2C. The deposit is non to slightly plastic.

#### Layered Silts and Clays

A unit of layered silts and clays was encountered in borehole 4 beneath the silt at a depth of 6.9 m (elevation 181.1). The layer was loose/firm to soft in consistency. Drilling was terminated within the unit at a depth of 9.8 m (elevation 178.2).

#### Groundwater

Perched water was observed in boreholes 2, 4, 6 and 8 in the surficial granular/silt fill during augering. Cave was observed in boreholes 1 and 5 at depths of 4.2 and 4.4 m respectively (elevation 191.0 to 180.3). No free water was encountered in boreholes 3 and 7 upon completion of augering.

Observed groundwater levels are subject to seasonal variations and rainfall patterns.

**CLOSURE**

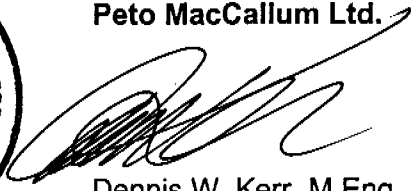
The fieldwork was carried out under the supervision of Mr. M. Rapsey and direction of Mr. M.R. Anderson, P.Eng. The equipment was supplied by Elite Drilling.

The report was prepared by Mr. P. Cullen, B.Eng., and Mr. M.R. Anderson, P.Eng., Project Engineer. It was reviewed by Mr. D.W. Kerr, P.Eng., Manager of Geotechnical and Geo-Environmental Services, Hamilton.

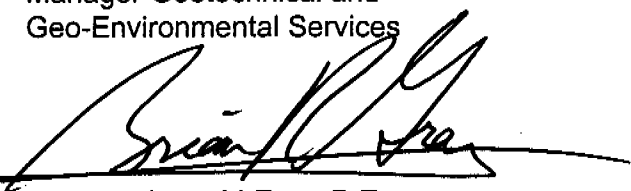
Yours very truly

**Peto MacCallum Ltd.**



  
Dennis W. Kerr, M.Eng., P.Eng.  
Manager Geotechnical and  
Geo-Environmental Services



  
Brian R. Gray, M.Eng., P.Eng.  
Vice-President  
Geotechnical and  
Geo-Environmental Services

PC:ld

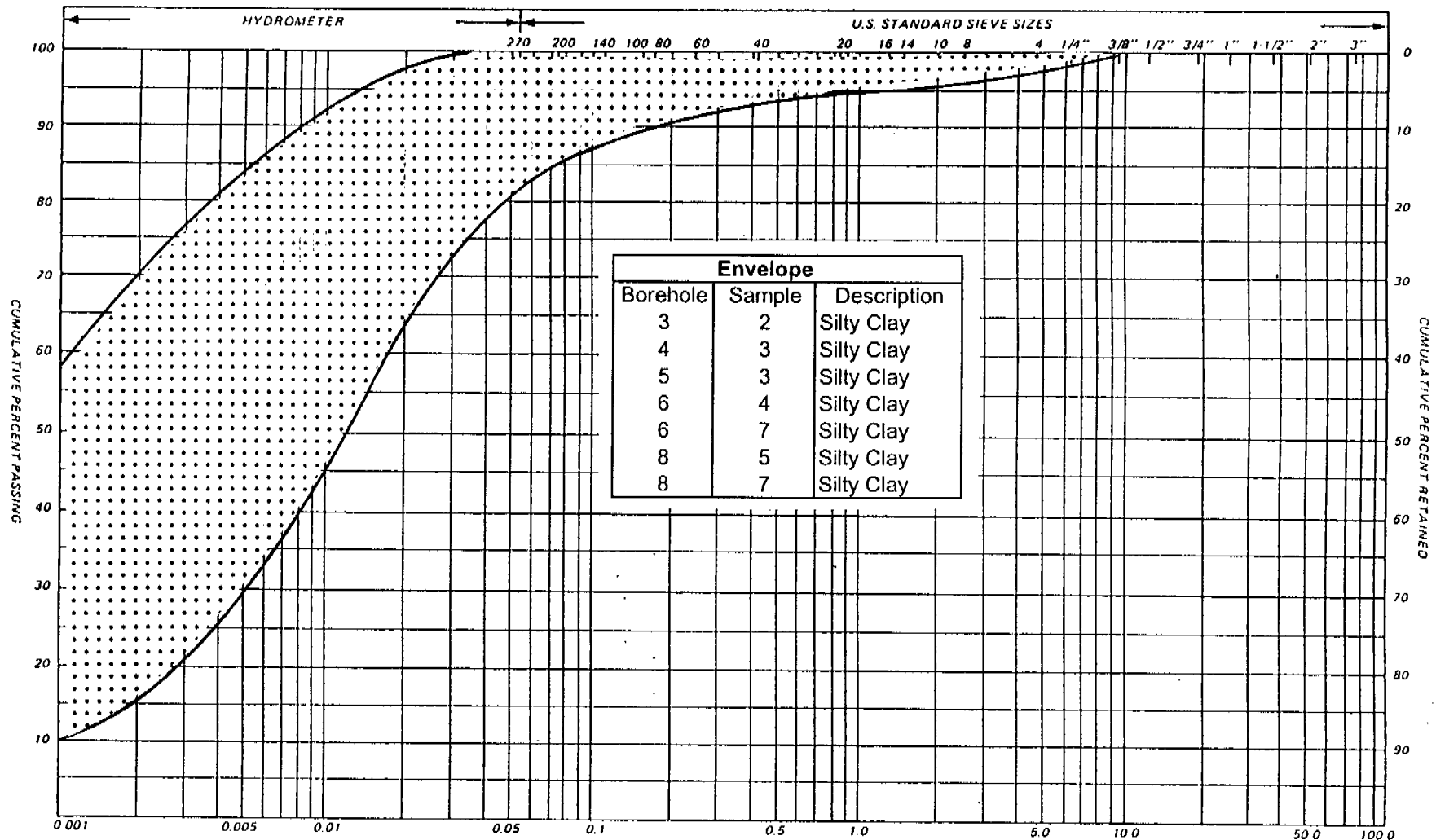
**TABLE I**  
**BOREHOLE AND LIGHT POLE LOCATIONS**

**HIGH MAST LIGHT FOUNDATIONS  
QEW FROM LUNDY'S LANE TO McLEOD ROAD  
W.P. 349-98-00  
NIAGARA FALLS, ONTARIO**

High Mast Light			Borehole		
Pole No.	Station	Offset	No.	Station	Offset
P1	16+785	0	1	16+910	4 m RT
P2	16+912				
P3	17+057				
P4	17+200	0	2	17+340	4 m RT
P5	17+340				
P6	17+480				
P7	17+620	0	3	17+760	4 m RT
P8	17+760				
P9	17+900				
P10	18+045	0	4	18+190	4 m RT
P11	18+190				
P12	18+335				
P13	18+485	0	5	18+645	4 m RT
P14	18+645				
P15	18+815				
P17	18+910	83 m RT	6	18+910	83 m RT
P19	19+000	63 m RT			
P16	18+906	107 m LT	7	19+003	85 m LT
P18	19+003	85 m LT			
P20	19+105	0	8	19+535	4 m RT
P21	19+245				
P22	19+395				
P23	19+545				

# PARTICLE SIZE DISTRIBUTION CHART

PML REF. 00HF001  
REPORT NO. -  
FIGURE 1A



Envelope		
Borehole	Sample	Description
3	2	Silty Clay
4	3	Silty Clay
5	3	Silty Clay
6	4	Silty Clay
6	7	Silty Clay
8	5	Silty Clay
8	7	Silty Clay

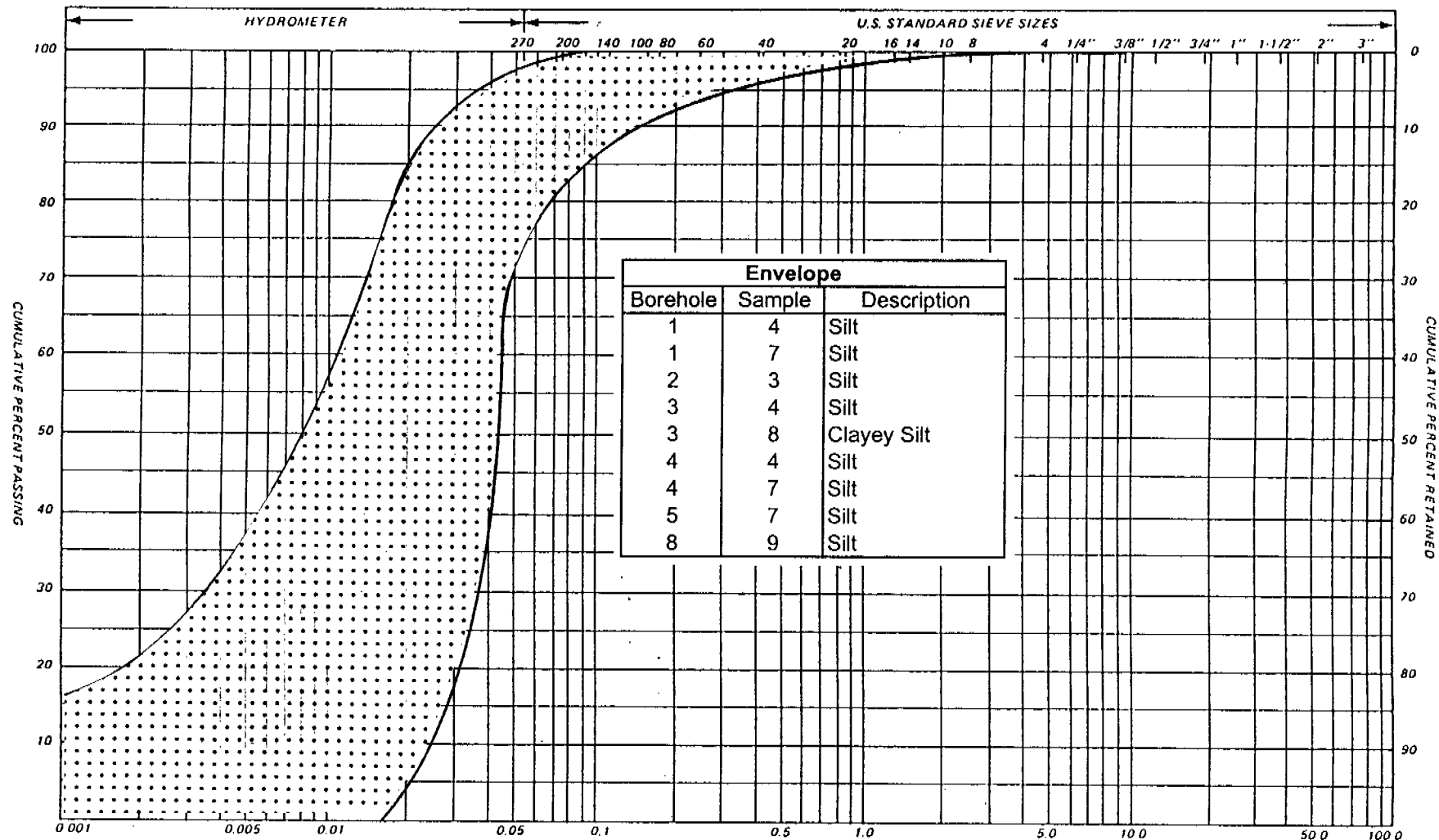
GRAIN SIZE IN MILLIMETERS									
SILT & CLAY				FINE	MEDIUM	COARSE	GRAVEL		
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	GRAVEL		
SILT				V. FINE	FINE	MED.	COARSE	GRAVEL	
CLAY				SAND				GRAVEL	
								COBBLES	

REMARKS \_\_\_\_\_

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## PARTICLE SIZE DISTRIBUTION CHART



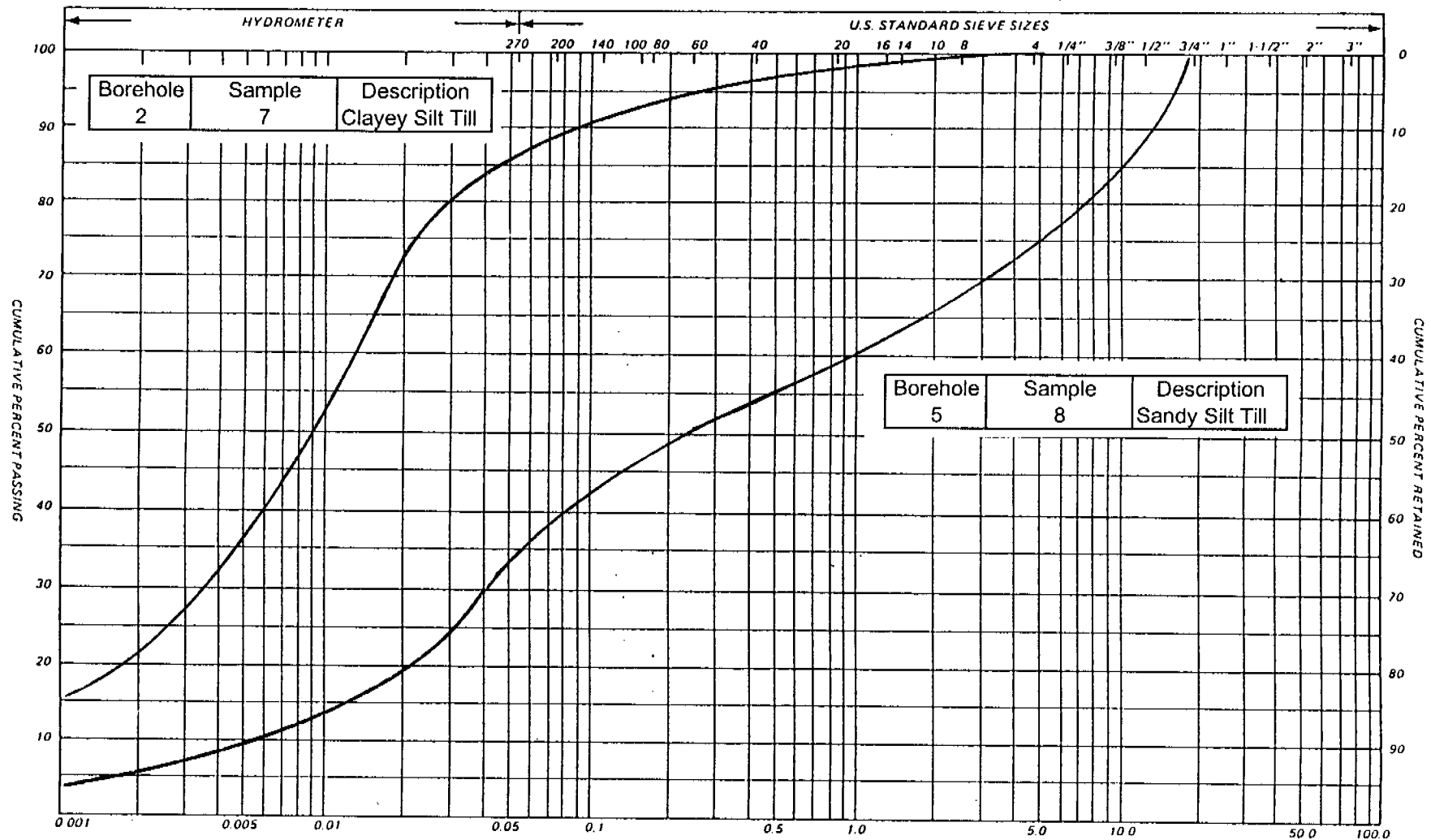
GRAIN SIZE IN MILLIMETERS													UNIFIED				
SILT & CLAY				FINE		MEDIUM SAND		COARSE		GRAVEL				COB BLES			
CLAY	FINE		MEDIUM SILT		COARSE		FINE		MEDIUM SAND		COARSE		GRAVEL			M I T	
CLAY			SILT			V. FINE		FINE		MED.		COARSE		SAND GRAVEL			U S BUREAU

REMARKS \_\_\_\_\_

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# PARTICLE SIZE DISTRIBUTION CHART



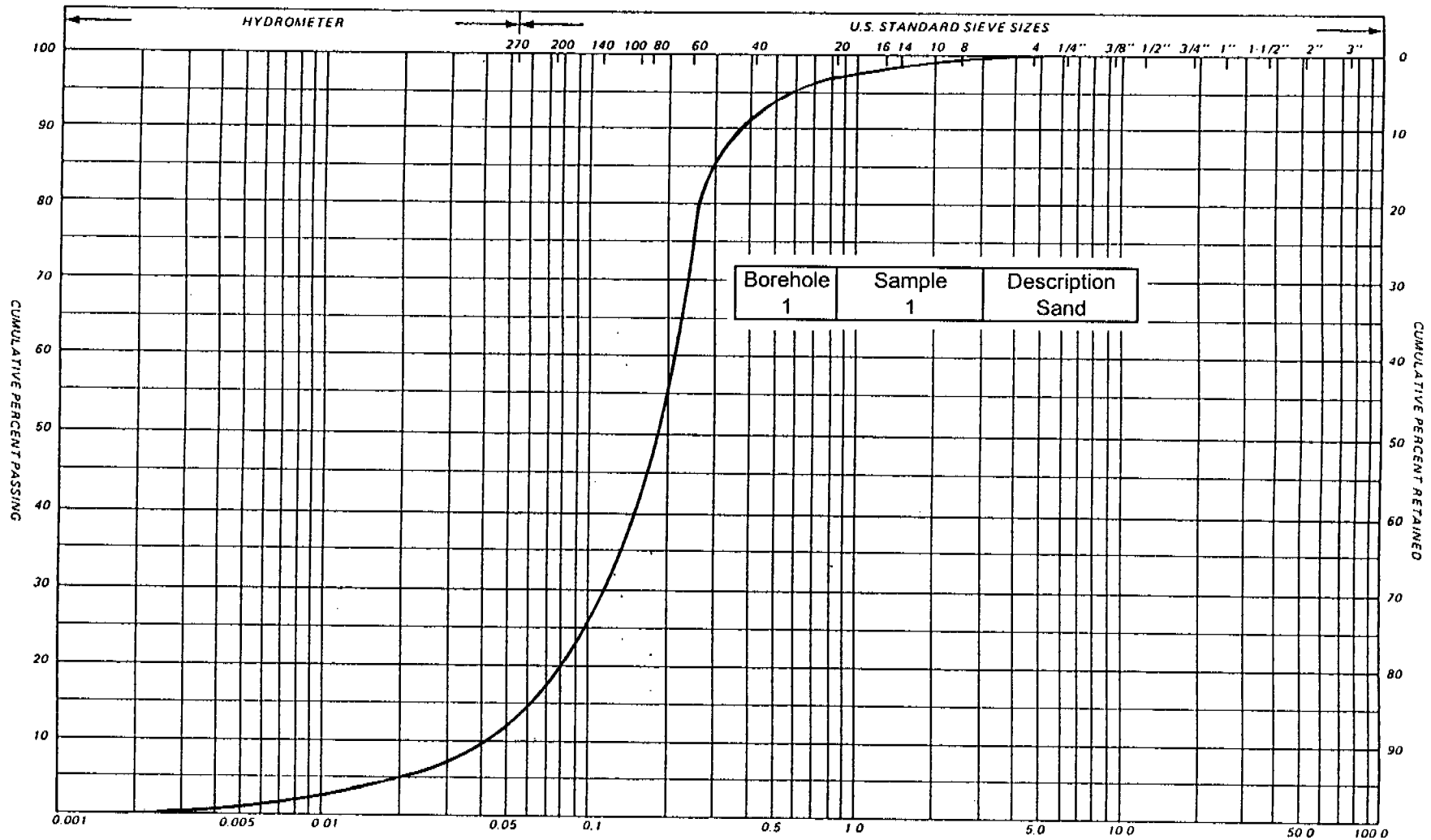
GRAIN SIZE IN MILLIMETERS										UNIFIED MIT US BUREAU				
SILT & CLAY				FINE		MEDIUM SAND		COARSE	GRAVEL		LOG FILES			
CLAY	FINE		MEDIUM		COARSE		FINE		MEDIUM SAND		COARSE	GRAVEL	COBBLES	
	SILT		SAND		SAND		SAND		SAND		GRAVEL		COBBLES	
CLAY		SILT		V. FINE	FINE	MED.	COARSE	SAND		GRAVEL		COBBLES		

REMARKS \_\_\_\_\_

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# PARTICLE SIZE DISTRIBUTION CHART



Borehole	Sample	Description
1	1	Sand

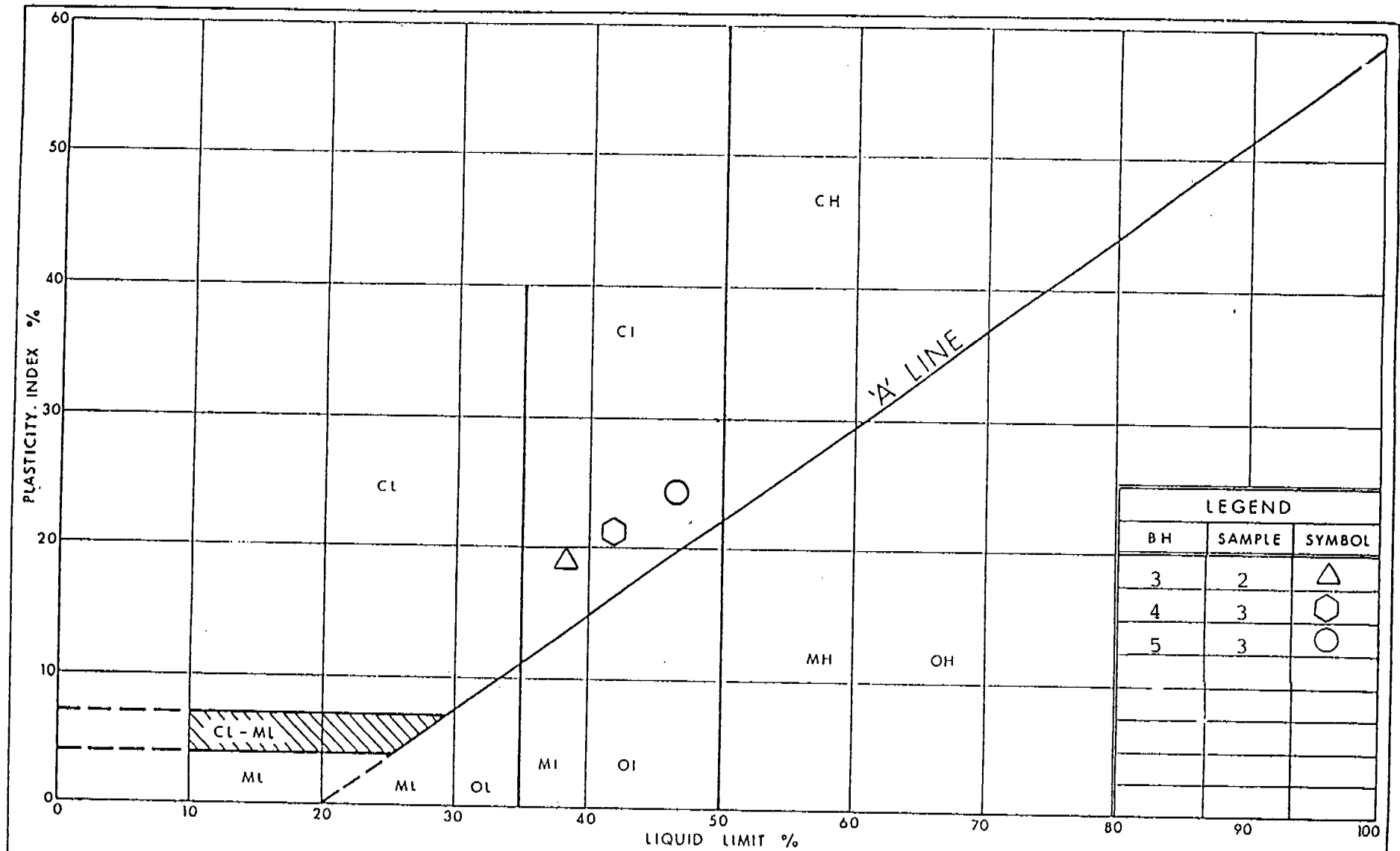
GRAIN SIZE IN MILLIMETERS											
SILT & CLAY				FINE			MEDIUM SAND		COARSE	GRAVEL	
CLAY	FINE	MEDIUM SILT	COARSE	FINE	MEDIUM SAND	COARSE	GRAVEL				COBBLES
CLAY	SILT		V. FINE	FINE	MED.	COARSE	GRAVEL				

REMARKS \_\_\_\_\_

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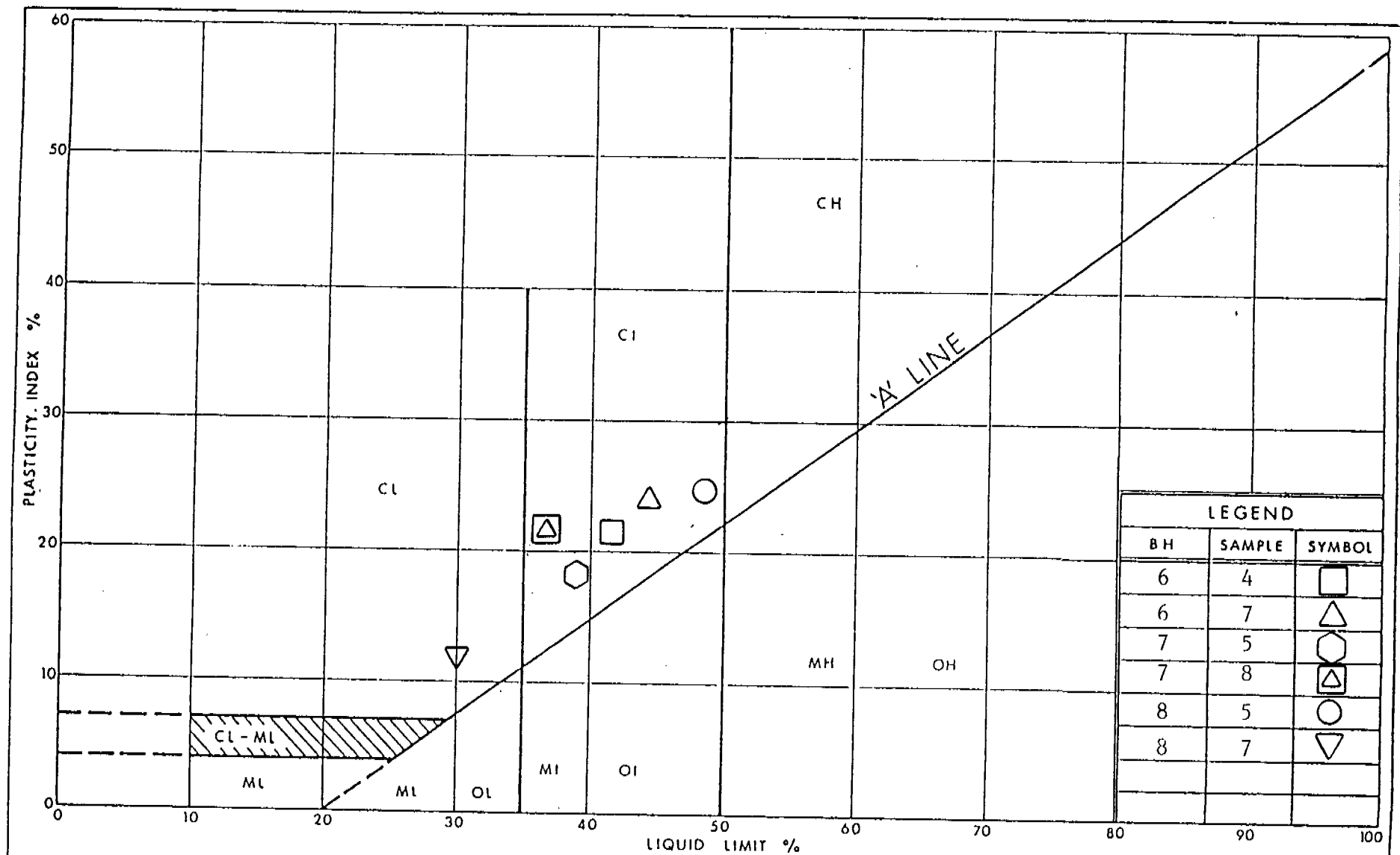
# PLASTICITY CHART

CLAY

FIG No 2A

00HF001

HIGH MAST LIGHTING



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Transportation

Ontario

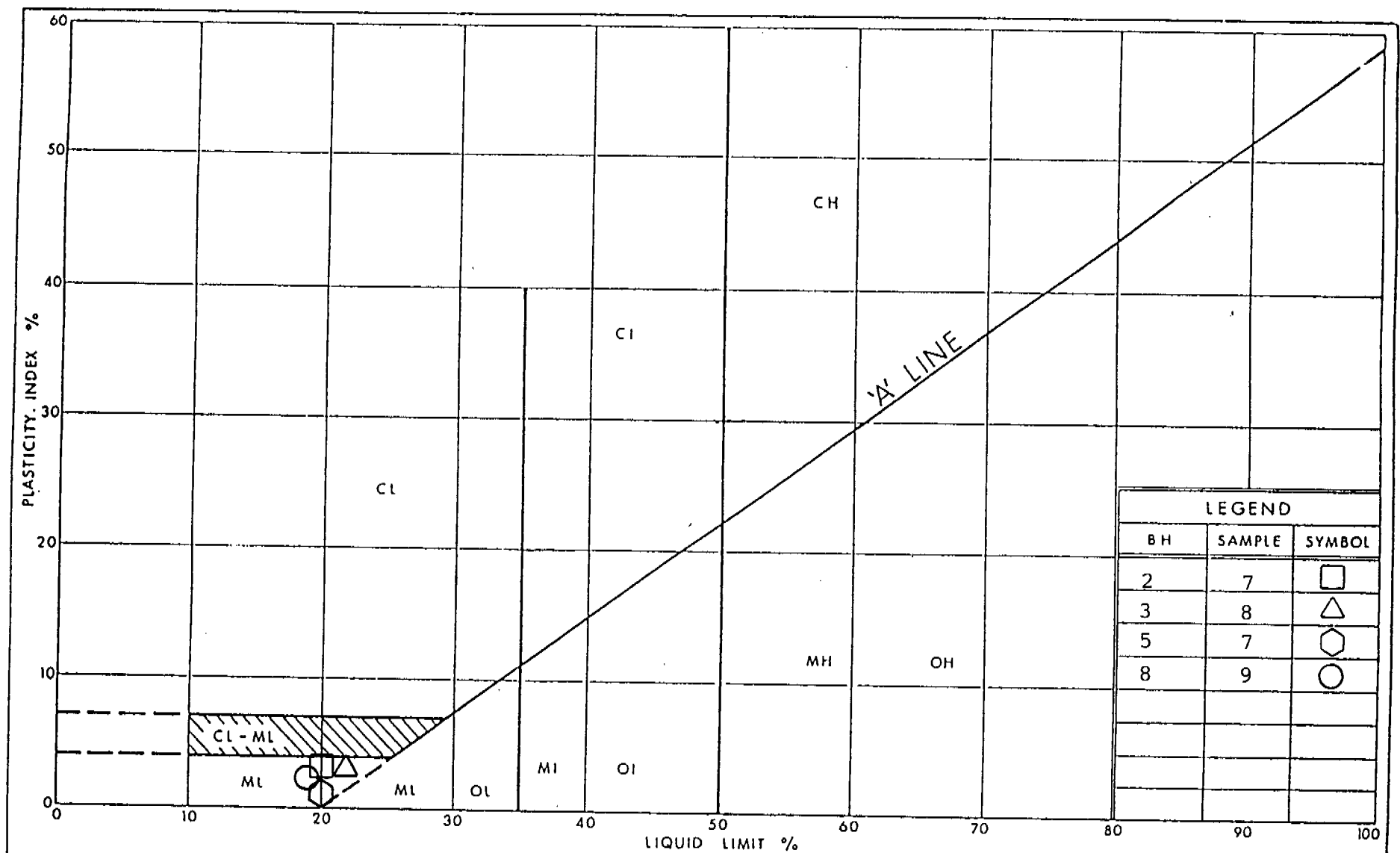
## PLASTICITY CHART

CLAY

FIG No 2B

00HF001

HIGH MAST LIGHTING



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Ontario

## PLASTICITY CHART

SILT/SILT TILL

FIG No 2C

00HF001

HIGH MAST LIGHTING

## LIST OF ABBREVIATIONS

### PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 0.3 m INTO THE SUBSOIL. DRIVEN BY MEANS OF A 63.5 kg HAMMER FALLING FREELY A DISTANCE OF 0.76 m.

DYNAMIC PENETRATION RESISTANCE: - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 51 mm, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS. 0.3 m INTO THE SUBSOIL. THE DRIVING ENERGY BEING 475 J PER BLOW.

### DESCRIPTION OF SOIL

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

<u>CONSISTENCY</u>	<u>'N' BLOWS/0.3 m</u>	<u>c kPa</u>	<u>DENSENESS</u>	<u>'N' BLOWS/0.3 m</u>
VERY SOFT	0 – 2	0 – 12	VERY LOOSE	0 – 4
SOFT	2 – 4	12 – 25	LOOSE	4 – 10
FIRM	4 – 8	25 – 50	COMPACT	10 – 30
STIFF	8 – 15	50 – 100	DENSE	30 – 50
VERY STIFF	15 – 30	100 – 200	VERY DENSE	> 50
HARD	> 30	> 200		
W.T.P.L. WETTER THAN PLASTIC LIMIT			D.T.P.L. DRIER THAN PLASTIC LIMIT	
A.P.L. ABOUT PLASTIC LIMIT				

### TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
P.H.	SAMPLE ADVANCED HYDRAULICALLY		
P.M.	SAMPLE ADVANCED MANUALLY		

### SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL		

▲, Δ - UNDISTURBED AND REMOULDED SHEAR STRENGTH DETERMINED FROM IN SITU VANE TEST.

■ - UNDRAINED SHEAR STRENGTH DETERMINED FROM POCKET PENETROMETER TEST.

## LOG OF BOREHOLE NO. 1

N 4 771 935

E 335 810

PROJECT W.P. 349-98-00 QEW-HIGH MAST LIGHTING

PML REF. 00HF001

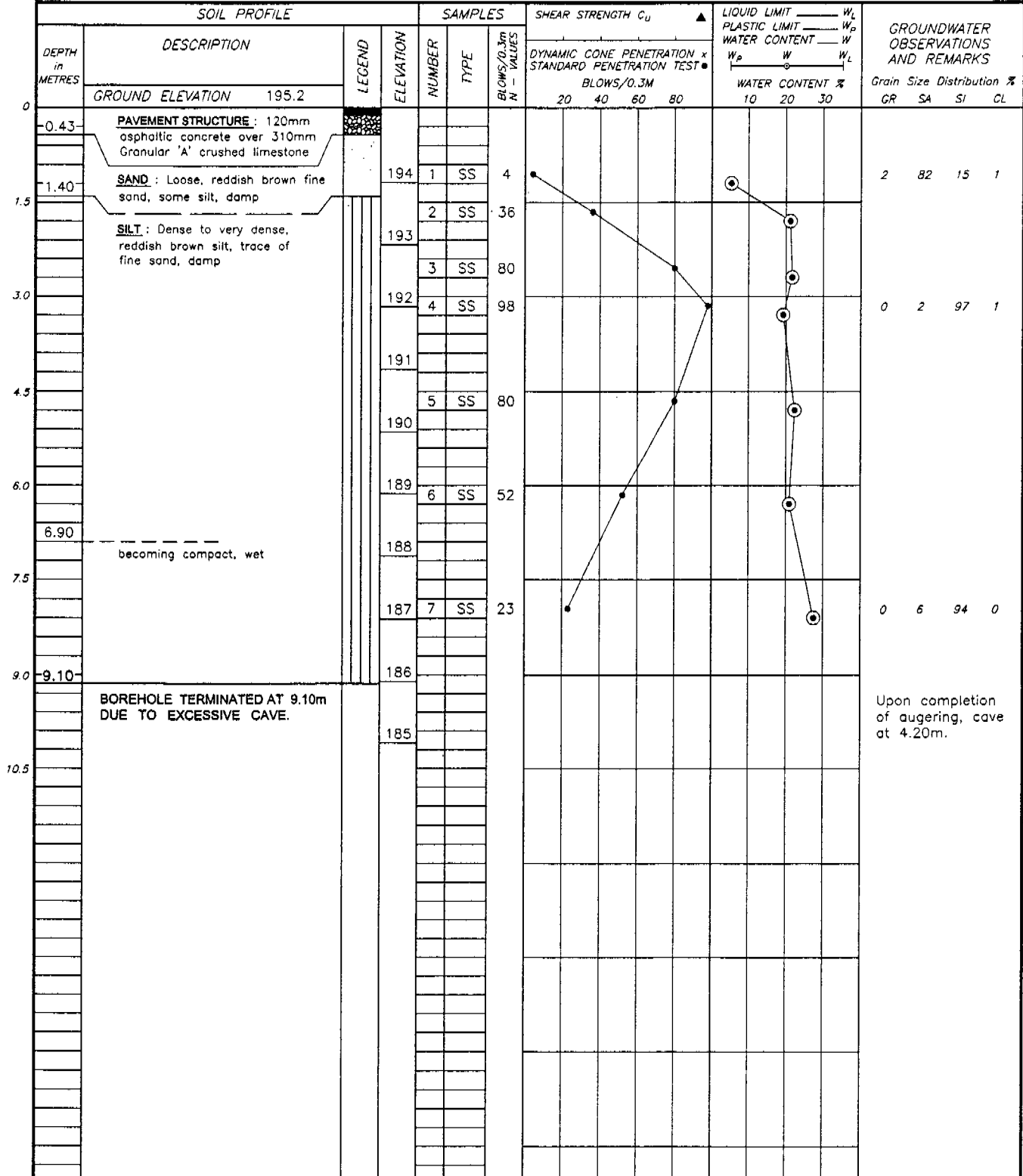
LOCATION Niagara Falls, Ontario

BORING DATE January 11, 2000

ENGINEER P. Cullen

BORING METHOD Continuous Flight Solid Stem Augers

TECHNICIAN M. Rapsey



NOTES:

CHECKED BY: 

## LOG OF BOREHOLE NO. 2

N 4 771 500

E 335 830

PROJECT W.P. 349-98-00 QEW-HIGH MAST LIGHTING

PML REF. 00HF001

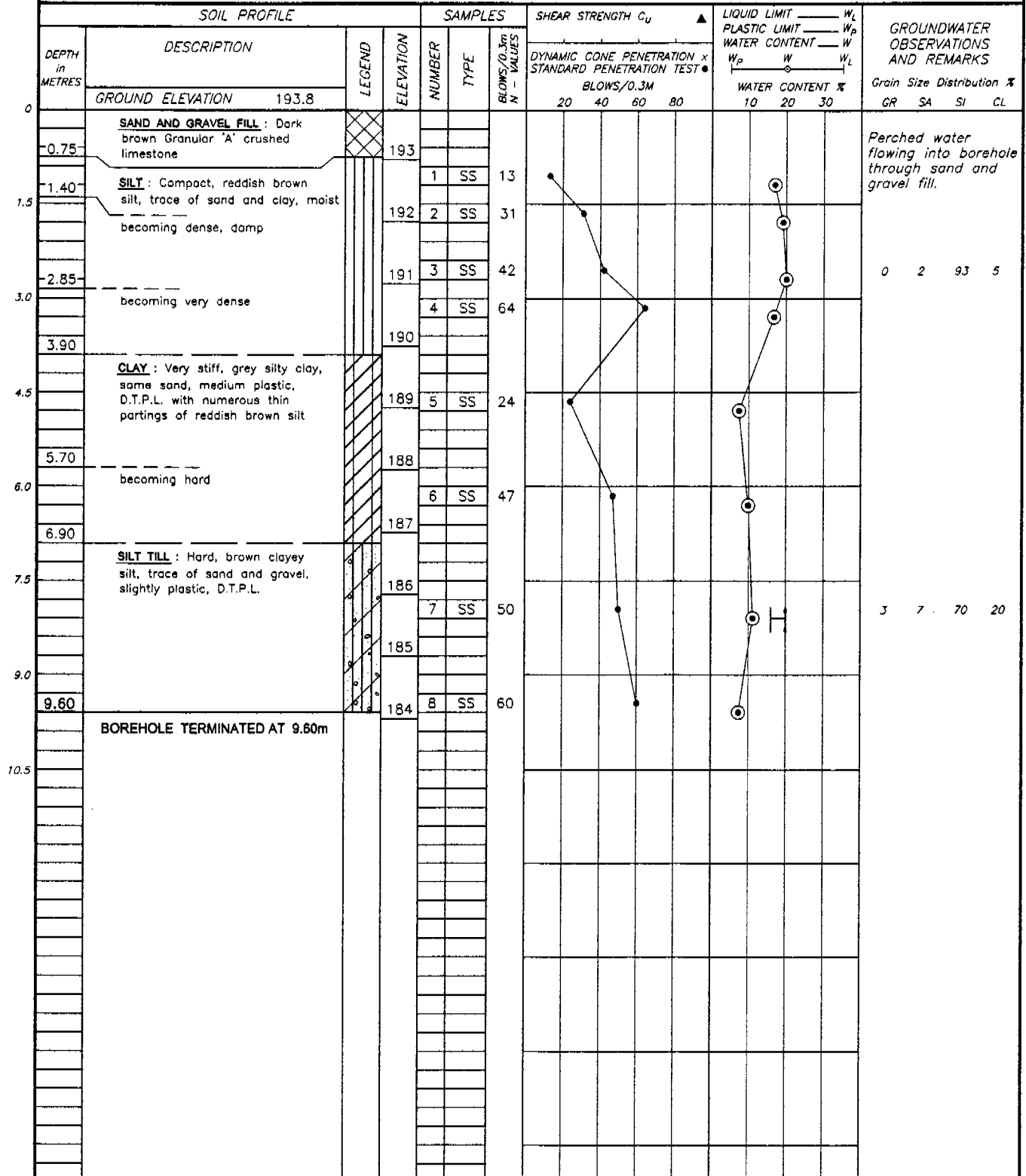
LOCATION Niagara Falls, Ontario

BORING DATE January 11, 2000

ENGINEER P. Cullen

BORING METHOD Continuous Flight Solid Stem Augers

TECHNICIAN M. Rapsey



NOTES:

CHECKED BY:

## LOG OF BOREHOLE NO. 3

PROJECT W.P. 349-98-00 QEW-HIGH MAST LIGHTING

LOCATION Niagara Falls, Ontario

BORING METHOD Continuous Flight Solid Stem Augers

N 4 771 060

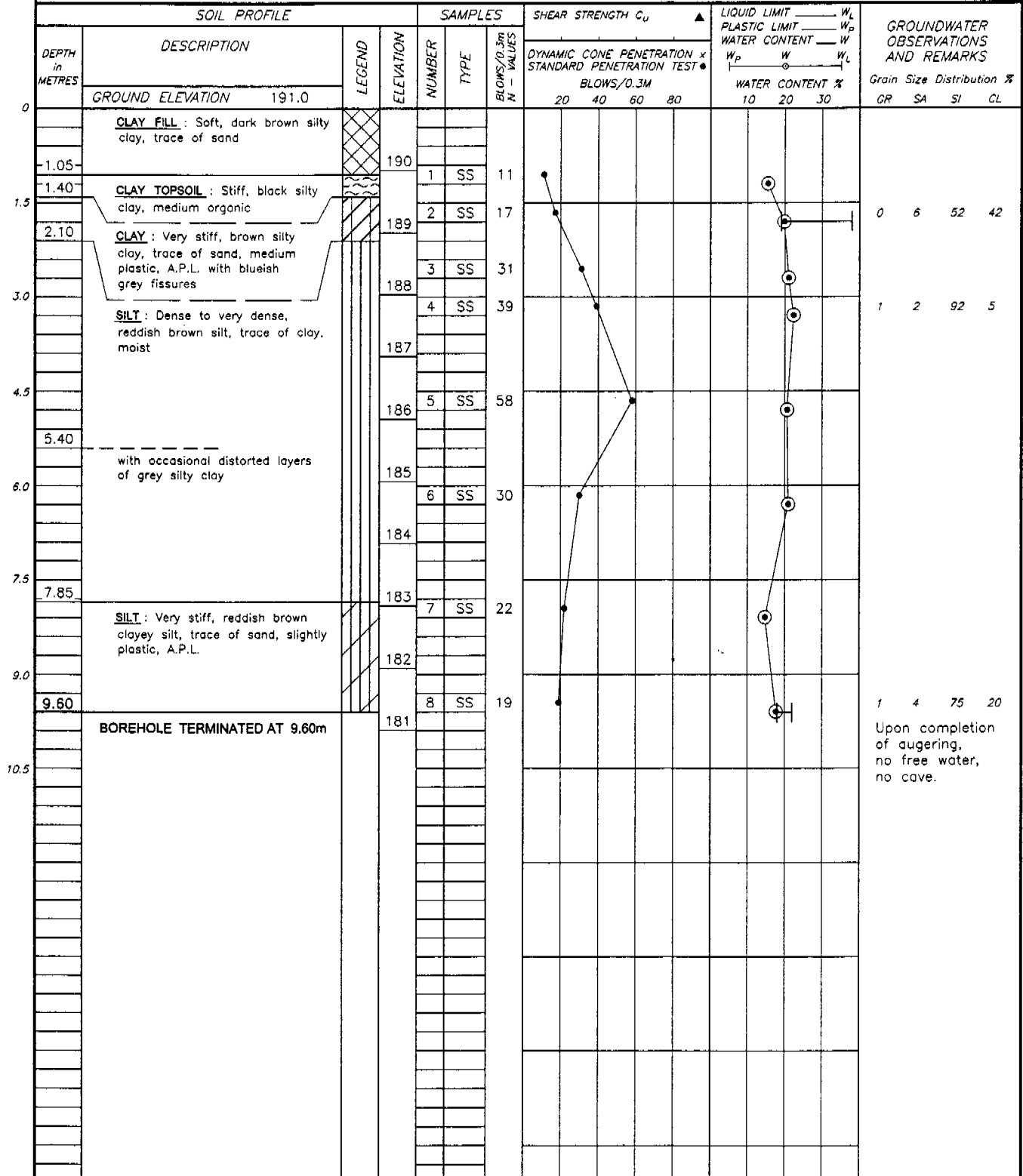
E 335 850

PML REF. 00HF001

BORING DATE January 11, 2000

ENGINEER P. Cullen

TECHNICIAN M. Rapsey



NOTES:

CHECKED BY: 

## LOG OF BOREHOLE NO. 4

N 4 770 635

E 335 800

PROJECT W.P. 349-98-00 QEW-HIGH MAST LIGHTING

PML REF. 00HF001

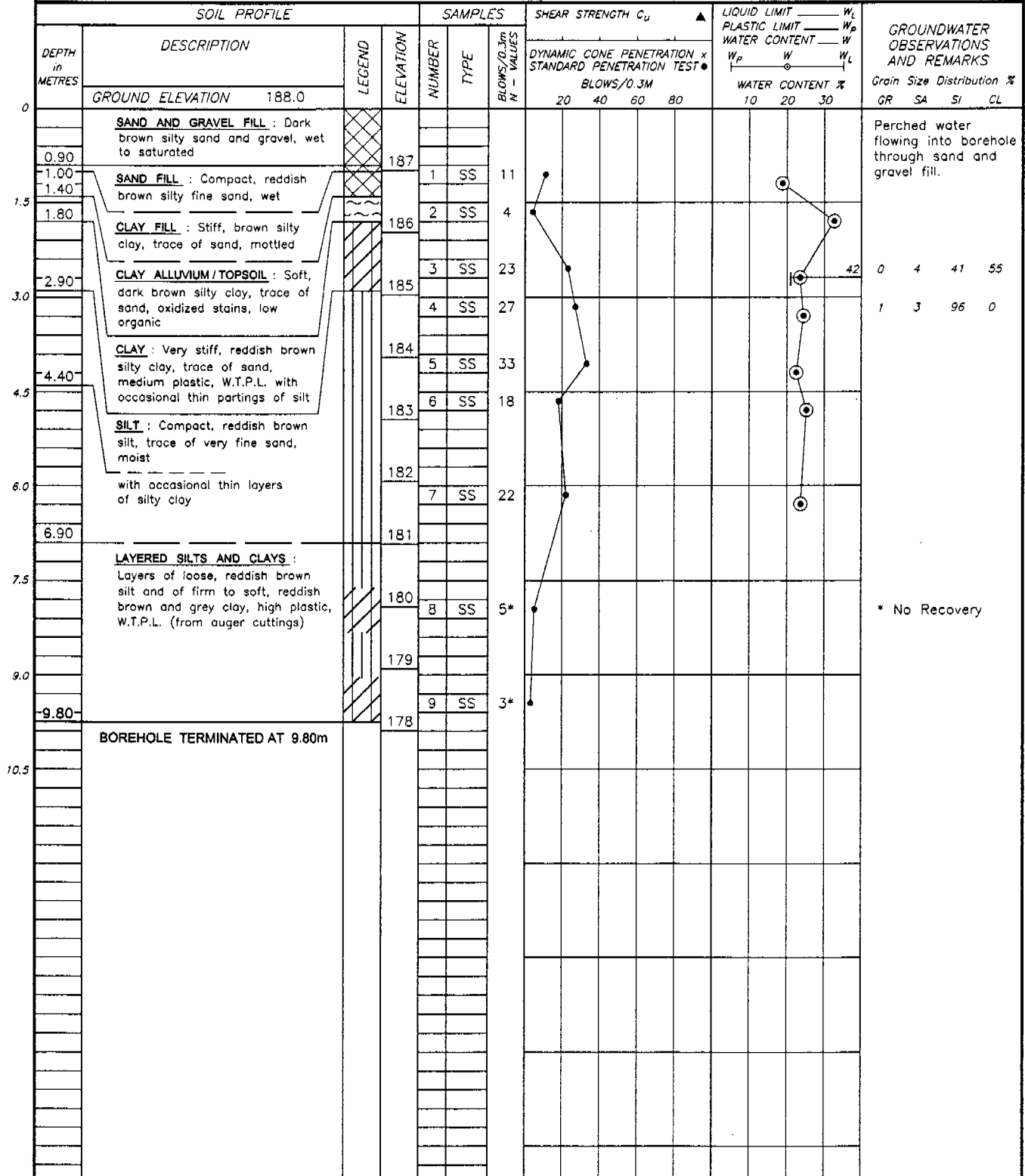
LOCATION Niagara Falls, Ontario

BORING DATE January 11, 2000

ENGINEER P. Cullen

BORING METHOD Continuous Flight Solid Stem Augers

TECHNICIAN M. Rapsey



NOTES:

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## LOG OF BOREHOLE NO. 5

N 4 770 195

E 335 710

PROJECT W.P. 349-98-00 QEW-HIGH MAST LIGHTING

PML REF. 00HF001

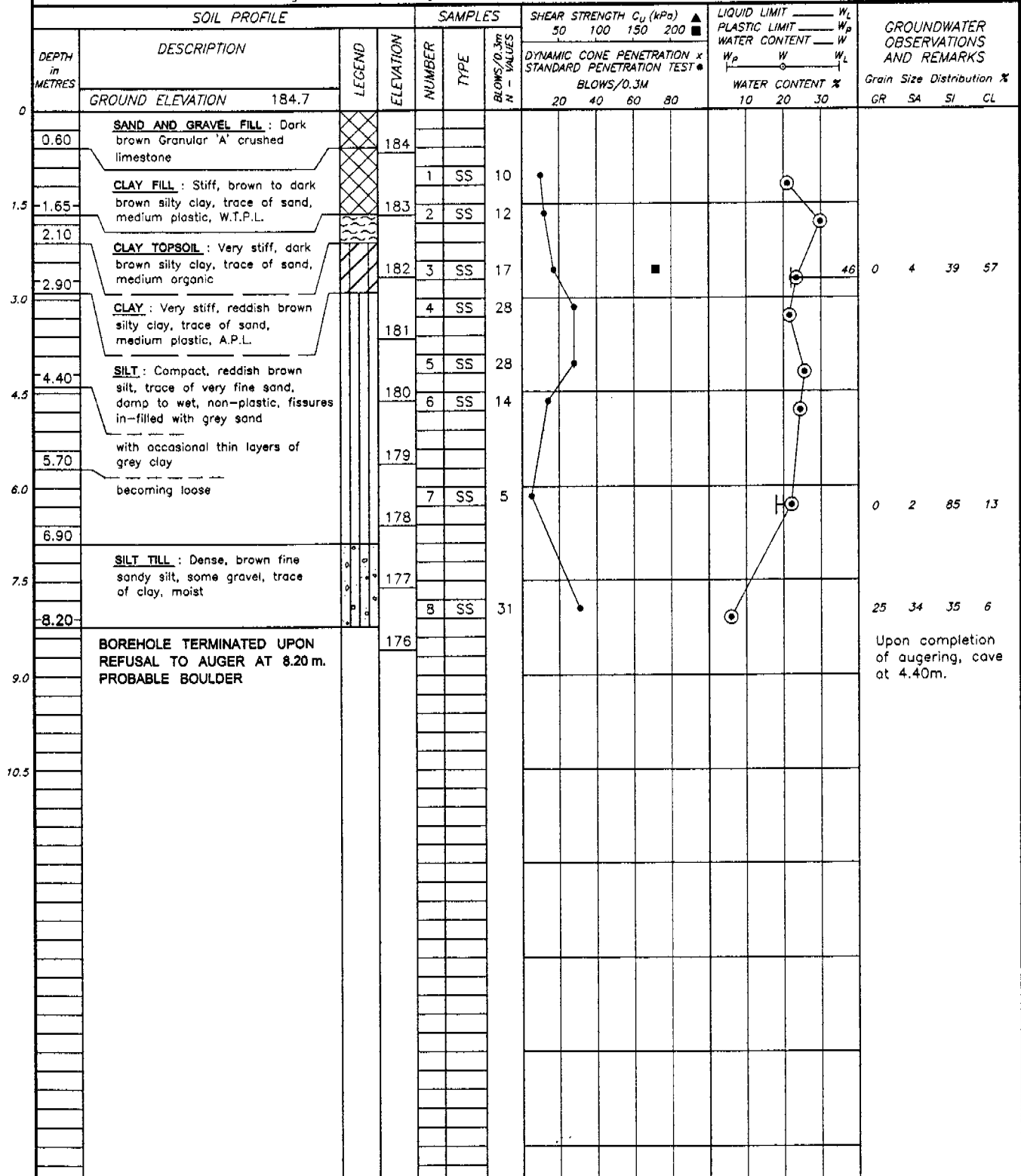
LOCATION Niagara Falls, Ontario

BORING DATE January 12, 2000

ENGINEER P. Cullen

BORING METHOD Continuous Flight Solid Stem Augers

TECHNICIAN M. Rapsey



NOTES:

CHECKED BY:

## LOG OF BOREHOLE NO. 6

N 4 769 960

E 335 580

PROJECT W.P. 349-98-00 QEW-HIGH MAST LIGHTING

PML REF. 00HF001

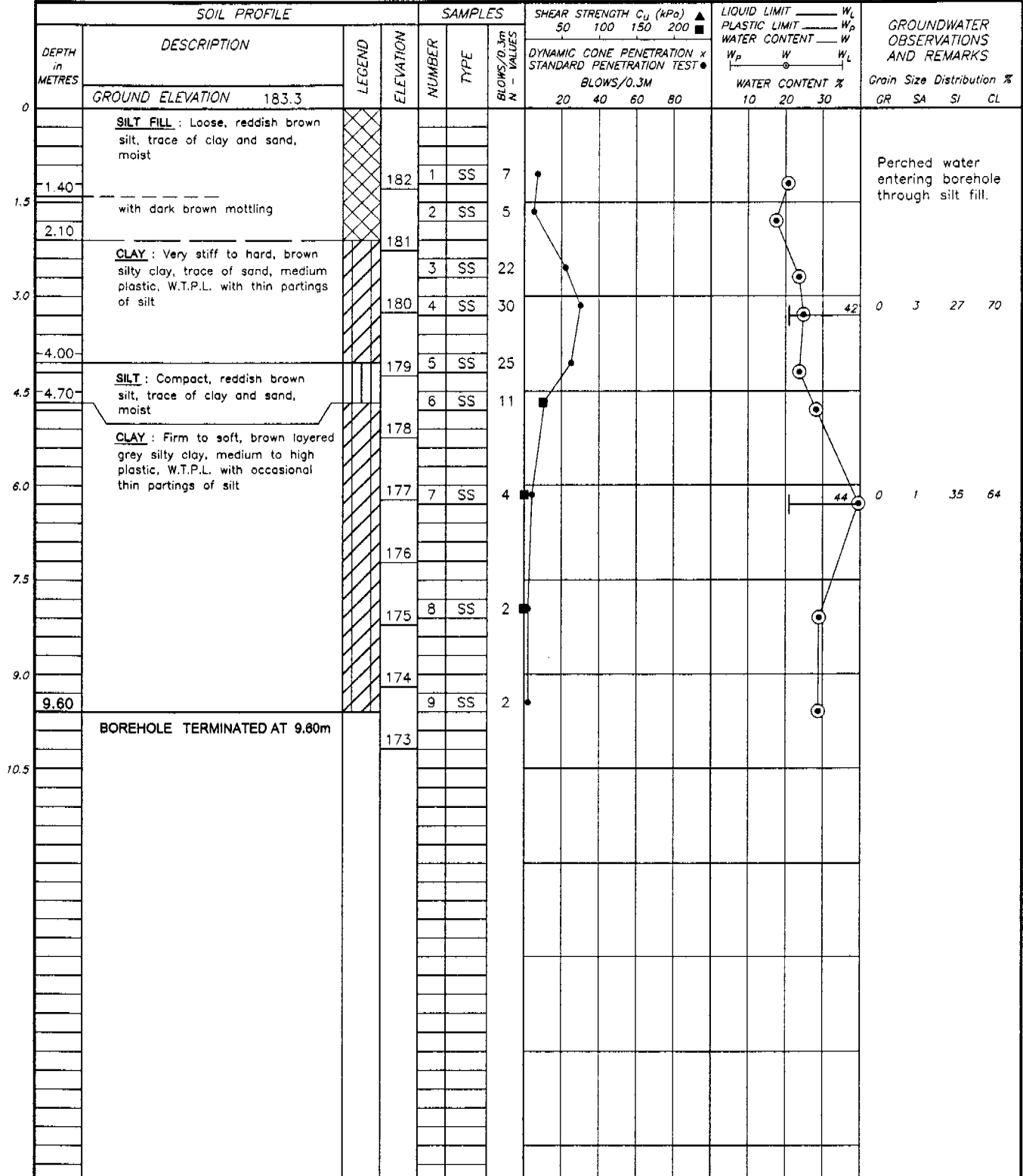
LOCATION Niagara Falls, Ontario

BORING DATE January 12, 2000


ENGINEER P. Cullen

BORING METHOD Continuous Flight Solid Stem Augers

TECHNICIAN M. Rapsey



NOTES:

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## LOG OF BOREHOLE NO. 7

N 4 769 840  
E 335 725

PROJECT W.P. 349-98-00 QEW-HIGH MAST LIGHTING

PML REF. 00HF001

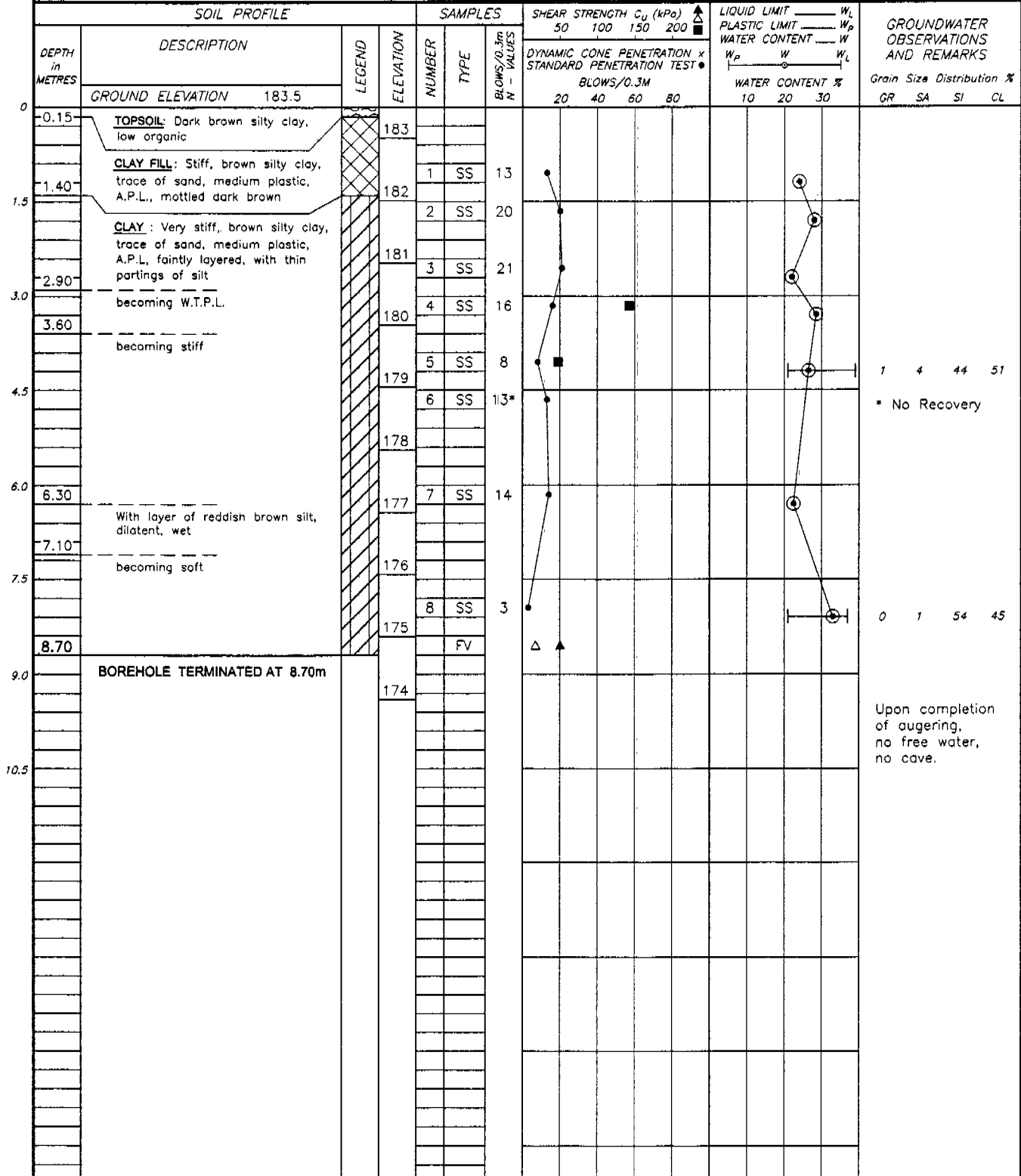
LOCATION Niagara Falls, Ontario

BORING DATE January 20, 2000


ENGINEER P. Cullen

BORING METHOD Continuous Flight Solid Stem Augers

TECHNICIAN M. Rapsey



NOTES:

CHECKED BY 

## LOG OF BOREHOLE NO. 8

PROJECT W.P. 349-98-00 QEW-HIGH MAST LIGHTING

LOCATION Niagara Falls, Ontario

BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE January 12, 2000

PML REF.

ENGINEER

TECHNICIAN

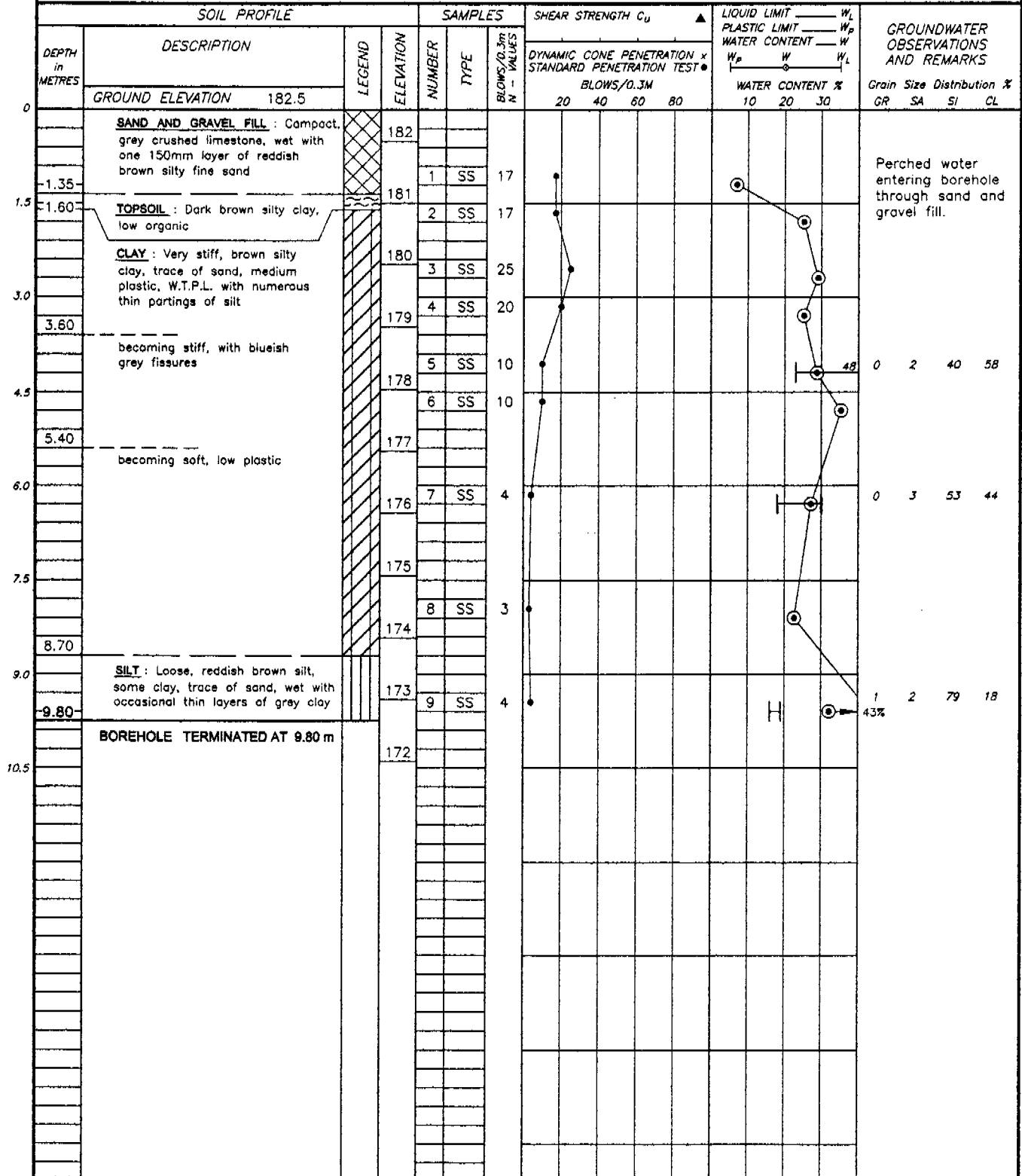
N 4 769 430

E 335 440

00HF001

P. Cullen

M. Rapsey

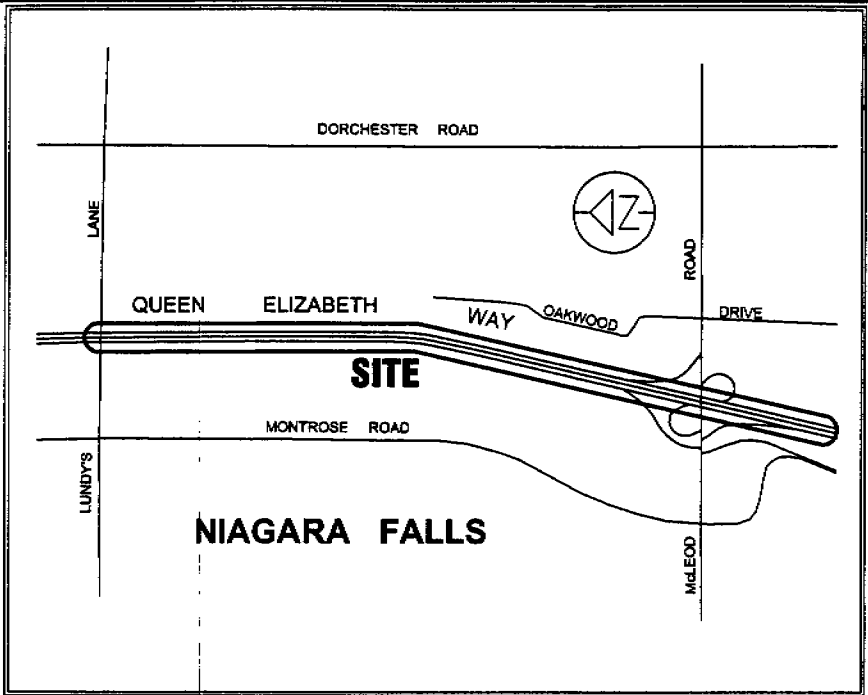


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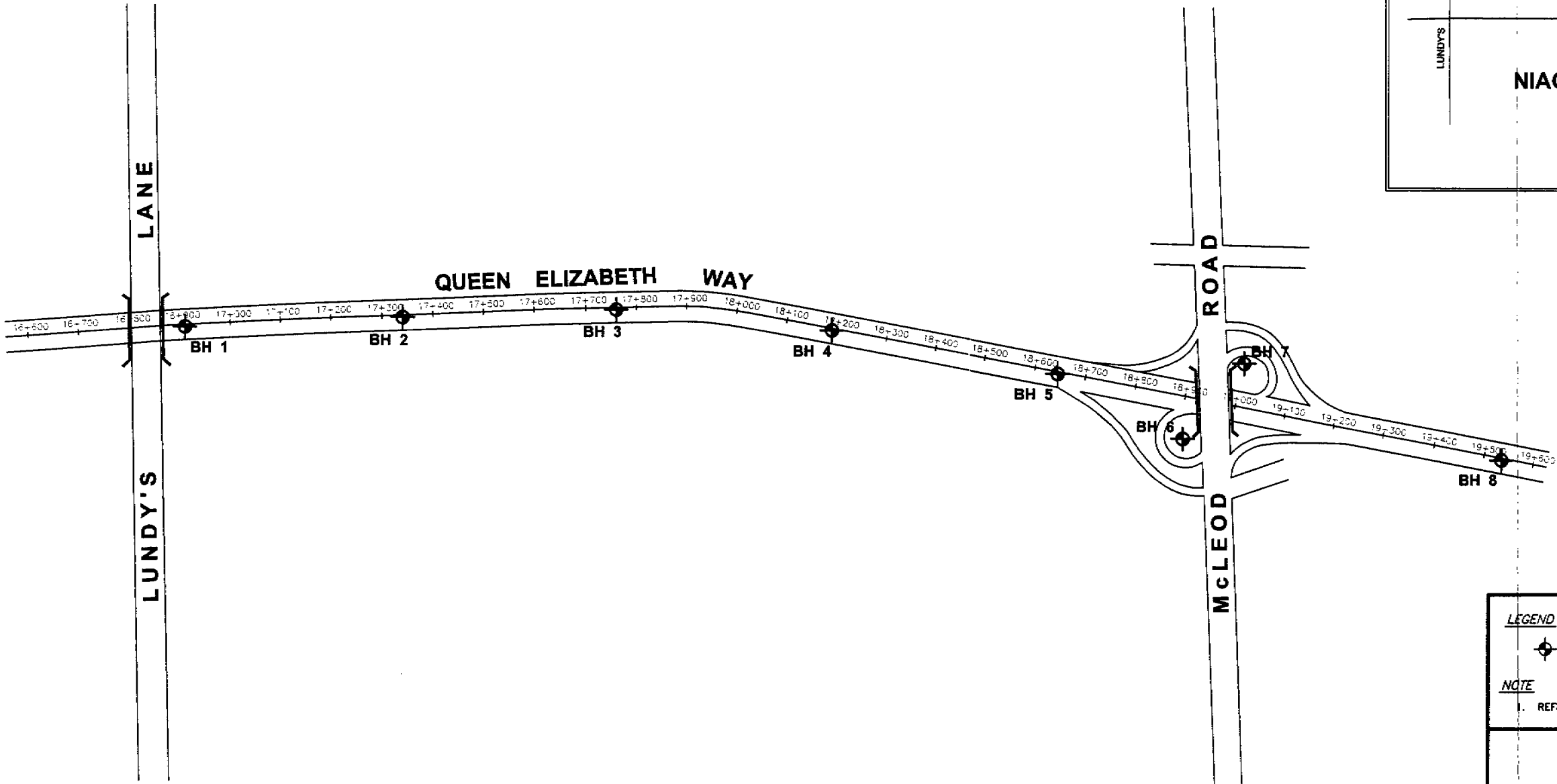
CHECKED BY *[Signature]*

BOREHOLE	NORTHING	EASTING	ELEVATION
BH 1	N 4 771 935	E 335 810	195.2
BH 2	N 4 771 500	E 335 830	193.8
BH 3	N 4 771 060	E 335 850	191.0
BH 4	N 4 770 635	E 335 800	188.0
BH 5	N 4 770 195	E 335 710	184.7
BH 6	N 4 769 960	E 335 580	183.3
BH 7	N 4 769 840	E 335 725	183.5
BH 8	N 4 769 430	E 335 440	182.5

W.P. 349-98-00  
**METRIC**  
 DIMENSIONS ARE IN METRES  
 AND/OR MILLIMETRES  
 UNLESS OTHERWISE SHOWN



**KEY PLAN**  
 SCALE N.T.S.



**BOREHOLE LOCATION PLAN**



**LEGEND**

BOREHOLE

**NOTE**

1. REFER TO LOG OF BOREHOLE SHEETS FOR DETAILED SUBSURFACE CONDITIONS.

**Q.E.W – HIGH MAST LIGHTING**  
 FROM  
**LUNDY'S LANE to McLEOD ROAD**  
 NIAGARA FALLS, ONTARIO

**Peto MacCallum Ltd.**  
 CONSULTING ENGINEERS  
 45 BURFORD ROAD, HAMILTON, ONTARIO L8E 3C8

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**BOREHOLE LOCATION PLAN**

**FOUNDATION DESIGN REPORT  
FOR  
HIGH MAST LIGHT FOUNDATIONS  
QEW FROM LUNDY'S LANE TO MCLEOD ROAD  
W.P. 349-98-00  
NIAGARA FALLS, ONTARIO**

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**FOUNDATION DESIGN REPORT**  
For  
High Mast Light Foundations  
QEW from Lundy's Lane to McLeod Road  
W.P. 349-98-00  
Niagara Falls, Ontario

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**INTRODUCTION**

Construction of 23 High Mast Light Foundations within the median of the QEW from Lundy's Lane to approximately 500 m south of McLeod Road, as well as within the interchange at McLeod Road in Niagara Falls, Ontario is planned. The investigation was conducted for Delcan Corporation. Authorization to proceed with this project was provided verbally by Mr. Bob Bower, P.Eng.

This report provides geotechnical comments/recommendations and geotechnical parameters for design of the high mast light foundations from Station 16+785 to 19+545 along the QEW.

The subsurface stratigraphy along the site generally comprised a discontinuous pavement/fill/topsoil layer overlying native loose to very dense silts and soft to hard clays, underlain by a discontinuous hard/dense till unit.

**ENGINEERING DISCUSSION AND RECOMMENDATIONS**

The borehole information indicates that the high mast light pole foundations will generally extend through various fill and topsoil layers and into native clays and silts.



Geotechnical parameters governing the design of HML pole foundations are as follows:

For Cohesive Soil:

$q_u$  = unconfined compressive strength (kPa)

For Cohesionless Soil:

$\phi$  = angle of internal friction (degree)

$n_h$  = coefficient of horizontal subgrade reaction (kN/m<sup>3</sup>)

$\gamma$  = unit weight of soil (kN/m<sup>3</sup>)  
(taken as submerged unit weight if soil is below  
water table and wet unit weight if the soil is above  
the water table)

The geotechnical parameters recommended for design of the proposed foundation units for poles 1 through 23 are provided in Table I. Groundwater elevations inferred from the borehole observations and moisture content determinations are also provided on Table I.

The caissons should be designed in accordance with the MTO "Procedures for the Design of High Mast Pole Foundations", June 1994. The lateral earth pressure,  $p$ , developed along the length of caisson, may be computed using the following equations. A resistance factor of 0.5 should be applied to the computed earth pressure to calculate the ULS resistance.

For Cohesive Soil

$$p = 4.5 q_u D$$

where  $D$  = caisson diameter (m)

\* resistance to a depth of 1.5  $D$  or the frost depth, whichever is greater, is to be ignored

For Cohesionless Soil

$$p = 2K_p \gamma z D$$

where  $K_p =$  lateral earth pressure coefficient

$$= \frac{1 + \sin \phi}{1 - \sin \phi} \text{ for horizontal ground surface, or}$$

$$= \left[ \frac{\cos \phi}{1 - \sqrt{\sin \phi (\sin \phi - \cos \phi \tan \beta)}} \right]^2 \text{ for sloping ground surface}$$

$z =$  depth below grade (m)

$\beta =$  slope inclination

\* resistance to frost depth is to be ignored

For HML pole foundations on or near slopes in cohesive soil or fill, use the attached Figure 1 to determine the percentage of calculated lateral resistance.

It is understood the median will be filled using engineered fill prior to construction of the high mast lighting foundations. The following soil parameters should be used for design of HML poles constructed in well compacted engineered fill:

Cohesive Fill:

$$q_u = 100 \text{ kPa}$$

$$\gamma = 18 \text{ kN/m}^3$$

Non-Cohesive Fill:

$$\phi = 30 \text{ degrees}$$

$$n_h = 3.0 \text{ MN/m}^3$$

$$\gamma = 18 \text{ kN/m}^3$$

The foundations for high mast lighting poles are anticipated to be made of drilled cast-in place concrete caissons. The manual specifies the minimum caisson diameter as listed in the following table:

Minimum Allowable Foundation Diameters

POLE HEIGHT (m)	DIAMETER (m)
25	1.22
30	1.22
35	1.37
40	1.52
45	1.52

These values are the minimum sizes, allowing for the size of the base plate, anchorage and foundation reinforcement. Larger available caisson sizes are 1.83 m and 2.13 m, which should be used only if the smaller sizes are not adequate.

A frost penetration depth in soil of 1.2 m is recommended for design. Alternatively, equivalent thermal insulation should be provided. A 25 mm thick layer of polystyrene insulation is thermally equivalent to 600 mm of soil cover.

In general, installation of the foundations is expected to be relatively straightforward using conventional augering procedures and sump pumping techniques. Comments regarding potential construction concerns at each borehole location are presented on Table I.

The following potential construction concerns are noted:

- Perched water was observed in the shoulder granular material in several boreholes. Seepage from the surficial fill and/or ditches should be anticipated. The proposed median reconstruction and drainage work is expected to significantly reduce the potential for seepage from these deposits.

- The groundwater level was interpreted to range from elevation 179.9 to 181.5, rising to elevation 188.3 towards the north end of the project corridor. Considering the relatively low permeability of the overburden soils, seepage which enters the excavation should be readily handled by sump pumping, subject to the following comments regarding cave.
- Cave of the sidewalls of boreholes 1 and 5 was observed at depths of 4.2 and 4.4 m, respectively. The potential for instability in the cohesive silts and clays in borehole 4 and the loose silts in borehole 8 was also identified. Further, squeeze within the soft clay revealed in boreholes 6 and 8 may also be experienced.

A suitable caisson liner should be available on-site to support the sidewalls of the auger hole where required and minimize the potential for sloughing and groundwater in flow.

It is essential on this project that all foundation excavation operations be observed by qualified geotechnical personnel to verify that soil conditions at the pole locations are consistent with the recommended parameters and ensure that the geotechnical requirements presented in this report are properly implemented.

All work should be carried out in accordance with the Occupational Health and Safety Act (Ontario Regulation 213/91) and with local regulations.

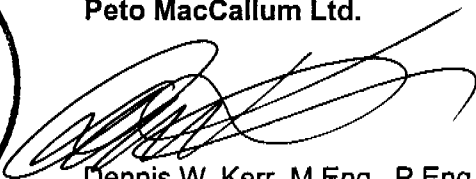
**CLOSURE**

The report was prepared by Mr. P. Cullen, B.Eng., and Mr. M.R. Anderson, P.Eng., Project Engineer. It was reviewed by Mr. D.W. Kerr, P.Eng., Manager of Geotechnical and Geo-Environmental Services, Hamilton.


Yours very truly

**Peto MacCallum Ltd.**



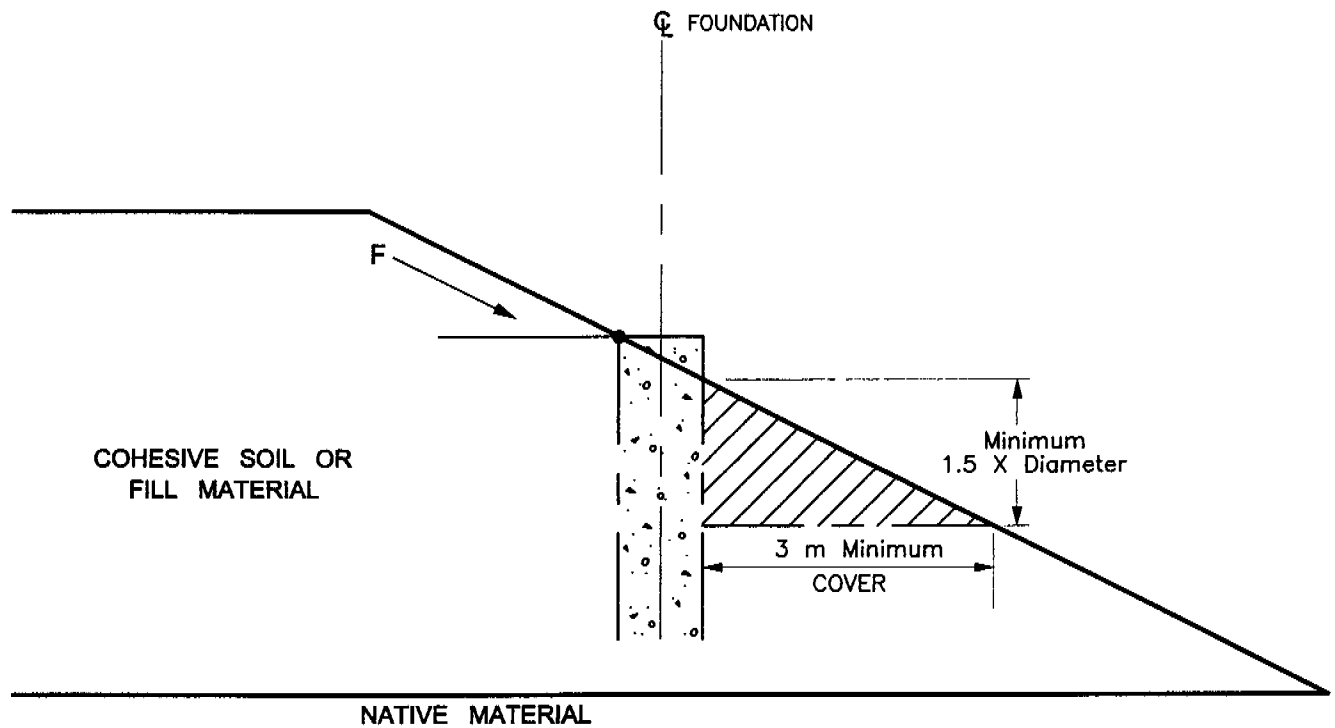
  
Dennis W. Kerr, M.Eng., P.Eng.  
Manager Geotechnical and  
Geo-Environmental Services




  
Brian R. Gray, M.Eng., P.Eng.  
Vice-President Geotechnical and  
Geo-Environmental Services

PC:mma

## HIGH MAST POLE FOUNDATION ON SLOPE



### LEGEND

- F**      ADDITIONAL EARTH PRESSURE  
FROM SLOPING SURFACE
-       ASSUME NO PASSIVE RESISTANCE  
DEVELOPED IN THIS ZONE

**Peto MacCallum Ltd.**  
CONSULTING ENGINEERS

45 BURFORD ROAD, HAMILTON, ONTARIO L8E 3G5  
Tel: (905) 581-2231 Fax (905) 581-6363

DATE	SCALE	JOB NO.	FIGURE NO.
MAY 2000	NTS	00HF001	<b>1</b>

**TABLE I**

**Summary of Geotechnical Conditions and Design Parameters**

**High Mast Light Foundations  
QEW from Lundy's Lane to McLeod Road  
W.P. 349-98-00  
Niagara Falls, Ontario**

Pole No.	Borehole			Soil and Rock							Ground Water Elevation	Comments
	No.	Station	Offset	Elevation	Type	Consistency or Denseness	q <sub>u</sub> (kPa)	φ°	η <sub>n</sub> (MN/m <sup>3</sup> )	γ (kN/m <sup>3</sup> )		
P1 P2 P3	1	16+910	4 m RT	195.2 – 194.8 194.8 – 193.8 193.8 – 186.1	Pavement Non Cohesive Sand Non Cohesive Silt	- Loose Dense to V. Dense	- - -	- 28 35	- 1.5 10	21 20 21	188.3	Potential for cave in augerhole.
P4 P5 P6	2	17+340	4 m RT	193.8 – 193.0 193.0 – 189.9 189.9 – 186.9 186.9 – 184.2	Non Cohesive Fill Non Cohesive Silt Cohesive Clay Cohesive Till	Compact Compact to Very Dense V. Stiff to Hard Hard	- - 400 500	30 35 - -	3.0 10 - -	20 20 21 21	-	-
P7 P8 P9	3	17+760	4 m RT	191.0 – 189.6 189.6 – 188.9 188.9 – 183.1 183.1 – 181.4	Cohesive Fill/Topsoil* Cohesive Clay Non Cohesive Silt Cohesive Silt	Soft V. Stiff Dense to V. Dense V. Stiff	25 200 - 250	- - 35 -	- - 10 -	20 20 21 20	-	-
P10 P11 P12	4	18+190	4 m RT	188.0 – 187.0 187.0 – 186.2 186.2 – 185.1 185.1 – 181.1 181.1 – 178.2	Non Cohesive Fill Cohesive Fill/Topsoil* Cohesive Clay Non Cohesive Silt Cohesive Silts/Clays	Compact Stiff to Soft V. Stiff Compact Firm/Loose to Soft	- 50 250 - 50	30 - - 33 -	3.0 - - 6.5 -	20 19 20 21 19	181.1	Perched water in granular fill. Potential instability in layered silts/clays.
P13 P14 P15	5	18+645	4 m RT	184.7 – 184.1 184.1 – 182.6 182.6 – 181.8 181.8 – 177.8 177.8 – 176.5	Non Cohesive Fill Cohesive Fill/Topsoil* Cohesive Clay Non Cohesive Silt Non Cohesive Till	- Stiff V. Stiff Compact to Loose Dense	- 125 200 - -	30 - - 30 35	3.0 - - 2.0 6.5	20 20 20 20 21	181.1	Potential for cave in augerhole.

\* fill and topsoil units were combined if both units were cohesive

**TABLE I (Cont'd)**

**Summary of Geotechnical Conditions and Design Parameters**

**High Mast Light Foundations  
QEW from Lundy's Lane to McLeod Road  
W.P. 349-98-00  
Niagara Falls, Ontario**

Pole No.	Borehole			Soil and Rock							Ground Water Elevation	Comments
	No.	Station	Offset	Elevation	Type	Consistency or Denseness	q <sub>u</sub> (kPa)	φ°	n <sub>h</sub> (MN/m <sup>3</sup> )	γ (kN/m <sup>3</sup> )		
P17 P19	6	18+910	83 m RT	183.3 – 181.2 181.2 – 179.3 179.3 – 178.6 178.6 – 173.7	Non Cohesive Fill Cohesive Clay Non Cohesive Silt Cohesive Clay	Loose V. Stiff Compact Firm to Soft	- 300 - 25	28 - 30 -	1.5 - 2.0 -	19 20 20 19	181.2	Perched water in fill. Potential for squeeze in soft clay.
P16 P18	7	19+003	85 m LT	183.5 – 182.1 182.1 – 176.4 176.4 – 174.8	Cohesive Topsoil/Fill* Cohesive Clay Cohesive Clay	Stiff V. Stiff to Stiff Soft	125 175 40	- - -	- - -	19 19 19	179.9	-
P20 P21 P22 P23	8	19+535	4 m RT	182.5 – 181.1 181.1 – 180.9 180.9 – 177.1 177.1 – 173.8 173.8 – 172.7	Non Cohesive Fill Cohesive Topsoil Cohesive Clay Cohesive Clay Non Cohesive Silt	Compact - V. Stiff to Stiff Soft Loose	- 25 200 40 -	32 - - - 28	5.0 - - - 1.0	20 19 19 19 19	181.5	Perched water in granular fill. Potential for squeeze in soft clay. Potential for heave in loose silt.

\* fill and topsoil units were combined if both units were cohesive