

G.I.-30 SEPT. 1976

REMARKS: \_\_\_\_\_

# MEMORANDUM

(416) 235-3731

To: Volker Boehnke  
Head, Structural Section  
4th Floor, Atrium Tower  
1201 Wilson Avenue

1991 05 30

Attn: Augustine Liu

From: Foundation Design Section  
Room 315, Central Region, Downsview, Ontario  
Central Region

Re: High Mast Lighting and Overhead Traffic Signs  
CNR McMillan Yard Overpass  
W.P. 139-87-00 (B)  
Highway 407, District 6

CONT 94-36

GEOCRE # 30M13-112

In response to your memo dated April 18, 1991 please find enclosed soil parameters (Table 1) for the design of High Mast Lighting (HML) and Overhead Traffic Signs (OTS).

Soil information is obtained from our previous foundation investigation at this site (WP 139-87-01,03,04, Site No. 37-1317, dated November 30, 1990), which was carried out for the construction of Highway 407 bridge structure over MacMillan Yard. Borehole logs which were used to determine the parameters are attached with this memo.

In most cases the proposed locations for HML and OTS structures are very close to our previous boreholes. However, few of the proposed structures are up to 150m away from a closest borehole. Since the soil condition at the site is consistent, it is assumed that the subsurface condition will be similar to those encountered in the closest boreholes. We advise that during construction of HML and OTS if an unexpected soil condition is encountered then please inform Foundation Design Section for advise.

Groundwater condition given in Table 1 is approximate. In some boreholes water level was not established. Water level elevations are therefore, estimated based on visual observation of the soil.

The foundations for HML and OTS should be designed in accordance with the methods described by B.B. Broms in the following two papers:

Broms, B.B.; Lateral Resistance of Piles in Cohesive Soils, Journal of the Soil Mechanics and Foundations Division, ASCE, Vol.90, No.SM2, Paper 3825, March 1964.

Broms, B.B.; Lateral Resistance of Piles in Cohesionless Soils, Journal of the Soil Mechanics and Foundations Division, ASCE, Vol.90, No.SM3, Paper 3909, May 1964.

It should be assumed that soil in the zone of frost penetration does not provide any lateral resistance. The depth of frost penetration at this site is 1.2m.

Table 1

SOIL PARAMETERS AT EACH HML AND OTS LOCATIONS

Structure Locations	W.L. Elev (m)	Elev (m) From - To	Soil Type	$\phi$ (Deg)	$C_u$ kPa	$\gamma$ kN/m <sup>3</sup>
HML 1	204.0	206.2-204.0	Non-Cohesive	30	0	20.5
Reference		204.0-200.0	Cohesive	0	50	19.5
BH 26		200.0-196.0	Cohesive	0	75	19.5
		196.0-195.1	Non-Cohesive	35	0	20.5
HML 2	206.0	208.9-207.5	Non-Cohesive	30	0	20.0
Reference		207.5-203.0	Cohesive	0	100	20.0
BH 2		203.0-197.5	Cohesive	0	75	19.5
		197.5-194.7	Non-Cohesive	35	0	21.2
HML 3	206.0	210.6-201.0	Cohesive	0	125	20.0
Reference						
BH 20						
HML 4	207.0	210.0-200.4	Cohesive	0	150	20.5
Reference						
BH 21						

Structure Locations	W.L. Elev (m)	Elev (m) From - To	Soil Type	$\phi$ (Deg)	$C_u$ kPa	$\gamma$ kN/m <sup>3</sup>
OTS 1	204.0	206.2-204.0	Non-Cohesive	30	0	20.5
Reference		204.0-200.0	Cohesive	0	50	19.5
BH 26		200.0-196.0	Cohesive	0	75	19.5
		196.0-195.1	Non-Cohesive	35	0	20.5
OTS 2	203.0	205.5-204.1	Non-Cohesive	30	0	20.0
Reference		204.1-198.5	Cohesive	0	150	20.5
BH 25		198.5-195.9	Cohesive	0	250	21.2
OTS 3	206.6	209.7-207.0	Cohesive	0	75	19.5
Reference		207.0-198.0	Cohesive	0	200	20.5
BH 16		198.0-193.7	Cohesive	0	250	21.2
		193.7-192.5	Non-Cohesive	35	0	21.2
OTS 4	208.0	210.0-200.4	Cohesive	0	150	20.5
Reference						
BH 21						

Where:

HML = High Mast Lighting

OTS = Overhead Traffic Signs

$\phi$  = Apparent angle of internal friction for non-cohesive soils

$C_u$  = Undrained Shear Strength (kPa)

$\gamma$  = Unit weight (kN/m<sup>3</sup>)

### Construction Considerations:

It is recommended that a special provision for the construction of HML foundations should be incorporated in the contract. The contractor should be advised that variable types of subsurface material may be encountered at the high mast light pole, and Overhead Traffic Signs locations; for additional information regarding soil conditions the Contractor should be referred to the attached borehole logs BH 2, BH 16, BH 20, BH 21, BH 25 and BH 26). For construction planning purposes it may be assumed that;

- Groundwater is at or near the surface.
- Cohesionless material may be encountered and it would be susceptible to disturbance under conditions of unbalanced hydrostatic head.
- Glacial deposits are anticipated and there is a probability that occasional cobbles and boulders may be encountered within the deposit.

The Contractor is responsible for constructing the high mast light pole foundations without disturbing the material at the sides or bases of the foundations. His proposal should be capable of dealing with the above-noted site condition. The Contractor shall submit eight copies of his proposed construction method to the Engineer for review a minimum of 15 working days prior to the commencement of construction of these foundation elements.

Should you have any questions, please advise.



Ken Ahmad, P. Eng.  
Foundation Engineer

For

Dave Dundas, P. Eng.  
Senior Foundation Engineer

# RECORD OF BOREHOLE No 2

1 OF 1 METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 702.5, E 303 962.0 ORIGINATED BY BL  
DIST 5 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY MJR,BB  
DATUM GEODETIC DATE 90 06 13-14 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT		UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W <sub>P</sub>	W		
208.9	Ground Surface												
0.0	GRAVELLY SAND Trace Silt Trace Clay Very Dense (Fill Material)		1	SS	74	*	208						0 24 (78)
207.5			2	SS	12								
1.4	Trace Organics		3	SS	22								
			4	SS	22								
			5	SS	27								
			6	SS	27								
	Brown		7	SS	20								
	Grey		8	SS	7								
	CLAYEY SILT TILL												
	With Sand												
	Trace Gravel		9	SS	12								
	Occ. Sandy Silt seams												
	Stiff to Hard		10	SS	12								
197.5			11	SS	43								
11.4	SILT to SANDY SILT TILL												
	Trace Gravel		12	SS	85								
	Trace Clay												
	Occ. Clayey Silt zones												
194.7	Very Dense		13	SS	88								
14.2	End of Borehole												
	* Not established												

# RECORD OF BOREHOLE No 16

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 834.0, E 304 262.0 ORIGINATED BY KA  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BLB  
DATUM GEODETIC DATE 90 06 11 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER + CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa • UNCONFINED + FIELD VANE • QUICK TRIAXIAL * LAB VANE 20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W <sub>p</sub> W W <sub>L</sub> WATER CONTENT (%)	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										
209.7	Ground Surface														
0.0	Trace Organics		1	SS	9										
			2	SS	17						1 7 37 55				
			3	SS	25						1 34 40 25				
			4	SS	24										
			5	SS	40										
	Brown		6	SS	51										
	Gray		7	SS	60										
			8	SS	41										
	CLAYEY SILT TILL With Sand Trace Gravel Occ. Sandy Silt seams Stiff to Hard		9	SS	33										
			10	SS	70										
			11	SS	24						4 32 44 20				
			12	SS	102						4 36 47 13				
			13	SS	67										
193.7			14	SS	64										
18.0	SILT to SANDY SILT TILL Trace Gravel Trace Clay Occ. CL. seams Very Dense		15	SS	52										
182.5															
17.2	End of Borehole														
<p>* GROUND WATER CONDITIONS</p> <table border="1"> <tr> <td>PIEZO. NO.</td> <td>GROUND WATER ELEVATION (Metres)</td> </tr> <tr> <td>1</td> <td>206.6</td> </tr> </table>												PIEZO. NO.	GROUND WATER ELEVATION (Metres)	1	206.6
PIEZO. NO.	GROUND WATER ELEVATION (Metres)														
1	206.6														

# RECORD OF BOREHOLE No 20

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 800.7, E 304 362.0 ORIGINATED BY BL  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, SOLID STEM AUGER COMPILED BY BB  
DATUM GEODETIC DATE 90 06 12 CHECKED BY QD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT		UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>		
210.6	Ground Surface											
0.0			1	SS	7							
			2	SS	18							
			3	SS	51							
			4	SS	70							
			5	SS	43							
			6	SS	26							
			7	SS	20							
			8	SS	25							
			9	SS	24							
201.0			10	SS	20							
9.6	End of Borehole * Not Established											



# RECORD OF BOREHOLE No 21

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 815.3, E 304 407.5 ORIGINATED BY BL  
DIST 5 HWY 407 BOREHOLE TYPE CONE TEST, SOLID STEM AUGER COMPILED BY BB  
DATUM GEODETIC DATE 90 06 12 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT			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			20 40 60 80 100	20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>	10 20 30			
210.0	Ground Surface													
0.0			1	SS	11									
			2	SS	26									
			3	SS	26									
			4	SS	34									
			5	SS	48									
			6	SS	27									
			7	SS	25									
			8	SS	26									
			9	SS	33									
200.4			10	SS	17									
9.6	End of Borehole													
	* Not Established													

# RECORD OF BOREHOLE No 25

1 OF 1 METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 733.5, E 303 900.0 ORIGINATED BY BL  
 DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, SOLID STEM AUGER COMPILED BY BB  
 DATUM GEODETIC DATE 90.06.19 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
205.5	Ground Surface													
0.0	SAND Trace Gravel Very Dense (Fill Material)		1	SS	143									
204.1			2	SS	20									
1.4	CLAYEY SILT TILL With Sand Trace Gravel		3	SS	9									6 40 36 18
			4	SS	34									
			5	SS	42									
			6	SS	47									
	Brown		7	SS	25									8 34 (58)
	Grey		8	SS	27									
	Occ. Sandy Silt seams Stiff to Hard		9	SS	45									
195.9			10	SS	53									
9.8	End of Borehole													

# RECORD OF BOREHOLE No 26

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 712.6, E 303 833.5 ORIGINATED BY BL  
DIST 5 HWY 407 BOREHOLE TYPE CONE TEST, SOLID STEM AUGER COMPILED BY BB  
DATUM GEODETTIC DATE 90 06 20 CHECKED BY DD

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 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
206.2	Ground Surface						206							
0.0	SAND AND GRAVEL Some Silt Trace Asphalt Dense (Fill Material)		1	SS	36		206							
204.8			2	SS	48		204							
1.4	ORGANIC SILT to CLAYEY SILT Some Sand Trace Gravel Trace Organics/Wood Chips Trace Asphalt Very Soft to Stiff (Fill Material)		3	SS	1		204							0 17 71 12
202.5			4	SS	10		202							0 13 62 25
3.7	Brown Grey  CLAYEY SILT TILL With Sand Trace Gravel Occ. Sandy Silt seams Firm to Very Stiff		5	SS	8		202							
			6	SS	6		200							
			7	SS	7		200							
			8	SS	13		198							
			9	SS	18		196							
196.3			10	SS	25		196							
9.9	SILT to SANDY SILT Trace Gravel Trace Clay Occ. CL zones Dense		11	SS	39									3 39 46 12
195.1														
11.1	End of Borehole  • Not Established •• Bouncing on piece of wood													

DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 30M13-112

DIST. 6 REGION         

W.P. No. 139-87-01, 03, 04

CONT. No. 94-36

W. O. No.         

STR. SITE No. 37-1317

HWY. No. 407

LOCATION  Hwy 407 / CNR  
 MacMillan Yard

No of PAGES -         

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.         

REMARKS:

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FILE No. \_\_\_\_\_ DATE \_\_\_\_\_

REMARKS \_\_\_\_\_

1✓	11✓	21✓ (Becca)
2✓ (Becca)	12✓	22✓
3✓	13✓	23✓
4✓ (Becca)	14✓	24✓
5	15✓	
6✓	16✓	
7	17✓	
8	18✓	
9	19✓	
10✓ (Becca)	20✓ (Becca)	

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## **FOUNDATION DESIGN SECTION**

**foundation  
investigation and  
design report**

ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

*CONT 94-36*

WP 139-87-01, 03, 04 DIST 6

HWY 407 STR SITE 37-1317

C.N.R. MacMillan Yard Overpass

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FOUNDATION INVESTIGATION REPORT  
For  
C.N.R. MacMillan Yard Overpass  
W.P. 139-87-01,03,04 Site No. 37-1317  
Highway 407, District 6, Toronto

INTRODUCTION

This report summarizes the results of a foundation investigation conducted for the proposed Highway 407 overhead at the C.N.R. MacMillan Yard. The investigation was carried out at the request of the Central Region Structural Section. The report applies to two bridge structures, their approaches and three retaining walls (northeast, southeast and northwest) between Sta. 21+235 and 21+900, Highway 407 chainage.

SITE DESCRIPTION

The proposed C.N.R. MacMillan Yard Overhead is located about 1 km south of Highway 7 and about 1 km west of Keele Street, in the Town of Vaughan, Regional Municipality of York.

The immediate area is a yard for the Canadian National Railway and consists of 20 sets of railway tracks.

The ground surface elevation at the site changes rapidly due to the grade of the existing CNR tracks. The CNR tracks are constructed in deep cuts which are up to 6 m deep and slope at approximately 2H:1V. The ground surface elevations at the site varies from 204 m to 211 m.

The site lies within the physiographical region known as the Peel Plain (Reference: Chapman and Putnam, 'The Physiography of Southern Ontario; 3rd Edition, 1984) and it consists largely of glacial till deposits.

INVESTIGATION PROCEDURES

The field investigation for the MacMillan Yard Overhead was conducted between 90 06 04 to 90 06 20. A total of twenty-seven boreholes (BH 1 through BH 27) were advanced for the proposed structures, all of which were



accompanied by dynamic cone penetration tests. Due to constraints with the drilling operation some of the boreholes were moved away from the proposed pier locations to a higher and flatter surface as two of the four proposed pier locations are on existing slopes. The boreholes were advanced using two track-mounted auger machines equipped with 83 mm ID hollow stem augers and solid stem augers.

Samples were recovered by means of a 50 mm OD split spoon sampler driven into the soil according to the specifications of the Standard Penetration Test (ASTM D 1586). Samples were retrieved at 0.75 m intervals for the first 6.0 m of the boring, then every 1.5 m.

Standpipe piezometers were installed in BH's 3, 4, 9, 10, 16 and 24 to facilitate periodic monitoring of the groundwater elevations.

The boreholes were staked out by the Central Region Surveys and Plans Section of the MTO. Locations and elevations were also provided by the Survey and Plan Section. Coordinates of each boreholes were determined from an E-Plan provided by DS-Lea Associates Ltd.

The laboratory testing program for representative samples consisted of:

- Grain Size Analyses
- Natural Moisture Content Determinations
- Atterberg Limit Determinations, and
- Unit Weight Determinations

The results of the laboratory testing are plotted on the Record of Borehole sheets (Appendix).

## SUBSURFACE CONDITIONS

### General

The record of Borehole sheets in the Appendix illustrate the subsurface conditions at the borehole locations. The locations and elevations of the

boreholes, along with stratigraphical profiles based on the borehole data are shown on Drawing No. 1398701,03,04-A and 1398701,03,04-B.

The ground level at the site is quite variable due to the grade of the existing CNR tracks. The ground level varies from elevations 204 m to 211 m. The sudden variations in ground surface elevations are due to existing cuts for the CNR tracks, which are up to 6 m deep and sloped at approximately 2H:1V.

The site is predominantly underlain by clayey silt till as a surficial layer which ranges in thickness from 6.2 m to 24.7 m. This layer is underlain by a silt to sandy silt till. All deep boreholes (boreholes for bridges) were terminated in the lower layer of silt to sandy silt till.

Within the limits of the structures, the overburden consists of the following generalized layers, in sequence, from the surface down.

Proposed Structure	CLAYEY SILT TILL		SILT TO SANDY SILT TILL	
	Top Elevation (m)	Thickness Range (m)	Top Elevation (m)	Penetration in Stratum* (m)
West Abutment	206.8 to 208.2	9.9 to 11.4	196.8 to 197.5	2.7 to 11.4
Pier 1	208.5 to 208.7	up to 16.0	192.5 to 192.6	5.2 to 7.2
Pier 2	209.4 to 209.6	12.6 to 15.7	195.0	3.9
Pier 3	209.2 to 210.0	9.9 to >15.4	198.6 to 200.1	2.6 13.3
Pier 4	209.1 to 209.4	14.5 to >24.7	187.3 to 194.6	7.3
East Abutment	209.7 to 210.7	11.4 to 23.6	187.1 to 199.2	8.5
Northeast Retaining Wall	209.7 to 210.7	>9.6		
Northwest Retaining Wall	202.5 to 204.1	6.2 to >8.2		
Southeast Retaining Wall	198.9 to 210.6	>7.7		

\*Note: Boreholes were terminated within this layer. Figures shown are the borehole penetration within the stratum. Actual thickness of this layer could be more than shown here.

Following are detailed descriptions of the soil strata encountered.

#### Clayey Silt Till

This cohesive material is a glacial till. This stratum was encountered in all boreholes usually as the surficial layer at the site. At some locations (BH's 2, 19, 26 and 27) this layer was found to be overlain by fill material varied in thickness from 1.4 m (BH 2) to 3.7 m (BH 26). The top elevation of this stratum varied from 198.9 m to 210.7 m. The thickness ranged from 6.2 m (BH 26) to more than 24 m (BH 14). Occasional non-cohesive zones of sand and silty sands from 1.5 m to 3 m thick were encountered within this layer.

The Standard Penetration test 'N' value ranged from 0 to 223 blows/0.3 m. The low 'N' values were occasional and may have been caused by disturbed silt layers. 'N' values between 15 and 40 blows/0.3 m were more frequent which indicates that the stratum is generally very stiff to hard. However, higher 'N' values between 50 and more than 100 blows/0.3 m were achieved at lower depths.

Typical properties of the material, as determined by laboratory tests of representative samples, are summarized as follows:

	<u>Range %</u>	<u>Average %</u>
Natural Moisture Content (w)	7-24	11
Liquid Limit (W <sub>p</sub> )	12-44	19
Plastic Limit (W <sub>L</sub> )	9-19	12
Plasticity Index (I <sub>p</sub> )	1-30	7

Figure 1 illustrates a typical plasticity envelope for this material.

Figure 2 illustrates a typical grain size distribution envelope for this material.

#### Silty to Sandy Silt Till

This non-cohesive stratum is a glacial till and is underlying the surficial layer of clayey silt till. The top elevation of this stratum varied from 187.1 m to 200.1 m. All deep boreholes (i.e. borehole for bridge structures) were terminated in this layer. Therefore, the exact thickness of this stratum is undetermined. However, the deep boreholes were advanced from 1.2 m to 13.3 m in this layer. Occasional cohesive zones (BH 4, BH 10 and BH 12) were also encountered within this stratum.

The Standard Penetration test 'N' value ranged from 27 to 175 blows/0.3 m. Occasionally lower 'N' values were recorded, but they were due to disturbed soil caused by unbalanced hydrostatic condition.

#### GROUNDWATER

The groundwater was recorded in six piezometers after the completion of the field work (1990 06 21) and several days after the piezometers were installed. The water levels are shown on individual log sheets and also in the Table given below. The groundwater stabilized at depths varying from 1.3 m to 6.9 m below the ground surface. The groundwater elevation therefore, ranged from 201.7 m to 207.7 m.

#### RECORD OF GROUNDWATER LEVEL

Borehole No.	Water Level Elevation (m)	Depth Below Surface (m)
3	205.5	1.3
4	201.7	6.9
9	203.6	6.0
10	202.7	6.5
16	206.6	3.1
24	207.7	2.5

It should be noted that the groundwater elevations are variable across the site. It is anticipated that the groundwater is present in water bearing non-cohesive deposits interbedded in the generally cohesive glacial till. Also, it should be noted that groundwater levels are subject to seasonal fluctuations and may therefore, change from what shown here. Normally, the permanent water table situates where the soil changes its colour from brown to grey.

## DISCUSSION AND RECOMMENDATIONS

### General

It is proposed to construct a twin 5-span structure to carry Highway 407 across the CN Railway tracks at MacMillan Yard. The structures will be approximately 327.0 m in length with span lengths from east to west, of 53.0 m 67.0 m, 65.5 m, 77.4 m, and 64.0 m for the eastbound structure and 58.0 m, 62.0 m, 75.2 m, 72.8 m and 58.9 m for the westbound structure. The piers are numbered from west to east, as Pier 1 through Pier 4. Pier 3 will be skewed at 17° 30' to accommodate the alignment of the railway tracks.

The two bridges will be 24 m wide and will have provision of future widening to increase the width to 28 m. There will be at present four lanes and two shoulders on each bridge. The two centre lanes will be 3.75 m wide and the two side lanes will be 3.5 m wide. The shoulders on each bridge will be 3 m and 2 m wide.

The forward slopes of approaches will be at 2H:1V with provision for benches up to 2 m wide for slopes higher than 8 m. It is understood that the maximum fill height at east and west approaches will be 10 m and 12 m respectively.

### Structure Foundations

Abutments can be founded on spread footings on Granular 'A' pads or supported on deep foundations. The piers can be perched on spread footings or on deep foundations (either piles or caissons). It has been assumed that there will be no changes to track alignment and profile.

Retaining walls can be constructed on spread footings. At some locations unsuitable material will have to be replaced with engineered fill to provide a base for retaining wall spread footings. As an alternative to conventional retaining walls Reinforced Earth walls or reinforced slopes are also possible. Details are as follows:

## SPREAD FOOTING (Alternative 1)

### Abutments

The abutment footings may be perched within the approaches and founded on compacted Granular 'A' material. The granular pads should have a minimum thickness of 2.0 m and should be constructed as follows:

At the east abutment the soil above elevation 208 m should be removed. At the west abutment on the south side, material should be removed to elevation 206 m, while at the centre and on the north side, material should be removed to elevation 206.5 m. Therefore, the excavation for the west abutment will be in step form. After the removal of existing material to the specified depths, any additional soft areas identified by proof-rolling should be removed and replaced with compacted free-draining granular material.

The granular pad will extend 1 m beyond the plan limits of the abutment footing at the surface and will slope at 1H:1V as illustrated in Figure 3.

The recommended bearing capacities for the footings on a granular pad, as per the OHBDC are as follows:

Factored Bearing Capacity at U.L.S.	900 kPa
Bearing Capacity at S.L.S. Type II	350 kPa

A friction angle of 35 degrees may be assumed to determine sliding resistance between the footing and compacted Granular 'A' pad.

A minimum of 1.2 m of earth cover is required for frost protection.

### Piers

The piers may be founded on spread footings on original ground within 1.5 m to 2.0 m of the existing ground surface. The following bearing capacities, as per the OHBDC, may be assumed:

Factored Bearing Capacity at U.L.S.	450 kPa
Bearing Capacity at S.L.S. Type II	300 kPa

The founding elevation at each pier location is given in Table 1.

Table 1

<u>Foundation Location</u>	<u>Founding Elevation (m)</u>
Pier No. 1	206.0
Pier No. 2	206.0
Pier No. 3	208.0
Pier No. 4	208.0

NOTE: Pier numbers are increasing from west to east direction.

A minimum of 1.2 m of earth cover is required for frost protection.

Upon excavation of the footing base, a 150 mm concrete working slab should be poured within six hours of exposure.

Temporary excavation for placement of footings should be maintained at 1H:1V or flatter.

An unfactored friction angle of 28 degrees may be assumed to calculate sliding resistance between the concrete footing and the clayey silt deposit.

#### PILE FOUNDATIONS (Alternative 2)

Alternatively, the abutments and piers may be founded on end-bearing piles equipped with driving shoes.

From a foundation perspective deep foundations are not required at the abutments. However recommendations have been included as an alternative if required for structural reasons such as launching segmental bridge elements.

Table 2

Foundation Location	Minimum Pile Penetration Elevation (m)			Estimated Tip Elevations (m)		
	N. Side	Centre	S. Side	N. Side	Centre	S. Side
W. Abutment	197.0	195.0	196.0	195.0	192.0*	193.0*
Pier No. 1	195.0	199.0	195.0	187.0	193.0	187.0
Pier No. 2	197.0	197.0	197.0	195.0	195.0	195.0
Pier No. 3	198.0	197.0	197.0	196.0	195.0	190.0
Pier No. 4	186.0	185.0	192.0	184.0	183.0	190.0
E. Abutment	197.0	190.0	182.0	194.0*	187.0*	179.0

\*NOTE: During the field investigation it was not anticipated that deep foundations would be considered at the abutments and hence the boreholes were terminated above end bearing strata. Also, it should be noted that the subsurface conditions are extremely variable with respect to end-bearing strata and that it would be difficult to accurately predict pile tip elevations. Hence, the behaviour of the pile during driving, as measured by the Hiley Formula, will have to serve as the criteria for pile lengths. The pile tip elevations given in Table 2 are for estimation purposes only especially at those locations marked by \*.

After the piles are advanced to the minimum pile penetration elevation (Table 2), pile driving should be controlled by the Hiley Formula as per MTO Standards SS 103-10 or SS 103-11, assuming ultimate capacities as indicated below. For design purposes, the following values, according to the OHBDC, are recommended for piles at pier locations only:

	<u>HP 310x110</u>	<u>HP 310x79</u>
Factored Axial Capacity at U.L.S.	1600 kN/pile	1150 kN/pile
Axial Capacity at S.L.S. Type II	1150 kN/pile	825 kN/pile
Factored Lateral Capacity at U.L.S.	80 kN/pile	60 kN/pile
Lateral Capacity at S.L.S. Type II	60 kN/pile	40 kN/pile



For piles at abutments, following values, according to the O.H.B.D.C., are recommended:

	<u>HP 310x110</u>	<u>HP 310x79</u>
Factored Axial Capacity at U.L.S.	1230 kN/pile	880 kN/pile
Axial Capacity at S.L.S. Type II	880 kN/pile	630 kN/pile
Factored Lateral Capacity at U.L.S.	60 kN/pile	45 kN/pile
Lateral Capacity at S.L.S. Type II	45 kN/pile	30 kN/pile

Ultimate Capacities for Hiley Formula

	<u>HP 310x110</u>	<u>HP 310x79</u>
Piles at Pier Locations	3450 kN/pile	2475 kN/pile
Piles at Abutments	2640 kN/pile	1890 kN/pile

The pile tip elevations and overburden depths, given in Table 2, are for estimating purposes only:

CAISSONS (Alternative 3)

To minimize shoring in the vicinity of the CN railway tracks, it may be advantageous to consider founding the abutments and piers on caissons. However, due to relatively high water table at this site and due to the presence of silt and sand seams, it is possible that instability may occur at the bases of caissons due to unbalanced hydrostatic pressure. If the bases of the caissons are disturbed due to boiling, it will drastically reduce the bearing capacities of the caissons. This situation can be controlled by techniques such as mud drilling but this will require extreme care and at this site where railway tracks may interfere, it will be very difficult. It is therefore, suggested that this alternative should be given least priority.

The reinforced concrete caissons will be based on hard or very dense glacial till ('N' values more than 100 blows/0.3 m. The recommended founding elevations are shown in Table 3.

Table 3

<u>Foundation Location</u>	Estimated Caisson Founding Elevations (m)		
	<u>N. Side</u>	<u>Centre</u>	<u>S. Side</u>
W. Abutment	197.0	196.0*	193.0*
Pier No. 1	195.0	199.0	189.0*
Pier No. 2	197.0	197.0	197.0
Pier No. 3	198.0	196.0	197.0*
Pier No. 4	186.0	185.0	192.0
E. Abutment	197.0*	190.0*	182.0

\*NOTE: At the time of the field investigation, it was not anticipated that deep foundations would be considered at the abutments. Consequently, boreholes were terminated before end-bearing strata were defined. Where elevations are noted by (\*) the bearing capacities at those locations should be reduced by 25 percent.

It is estimated that the caissons will be in the order of 12.5 m to 24.5 m in length.

The following OHBDC capacities are recommended for 0.9 m, 1.2 m and 1.5 m diameter caissons:

<u>Caisson Diameter</u>	<u>Factored Capacity at U.L.S.</u>		<u>Capacity at S.L.S. Type II</u>	
	<u>Axial</u>	<u>Lateral</u>	<u>Axial</u>	<u>Lateral</u>
0.9 m (36")	2850 kN	285 kN	1900 kN	190 kN
1.2 m (48")	5100 kN	510 kN	3400 kN	340 kN
1.5 m (60")	7950 kN	795 kN	5300 kN	530 kN

The horizontal component of battered caissons can be applied to resist lateral forces. Battered caissons can be installed at slopes up to 1H:5V.

## RETAINING STRUCTURES

Conventional retaining walls, reinforced earth walls or reinforced slopes can be considered where property or space constraints preclude 2H:1V slope.

Retaining structures may be supported on shallow foundations. The construction of the northeast and southeast retaining structures are feasible without any major preparation. However, at the site of the northwest retaining structure subexcavation will be required. At the northwest location a deposit of organic material up to 2.3 m thick was discovered which was underlain by clayey silt till. The organic and fill material was encountered only in borehole (BH 26) which was approximately located in the centre of the proposed wall. Therefore, the extent of the organic material will have to be determined at the time of removal of this material. All organic/fill material as well as weak native soil will have to be removed beneath the plan limits of the footings. The sub-excavation will be required down to elevation 200.0 m at Station 21+331.4 m offset 51.0 m Lt. (vicinity of BH 26). It is expected that the excavation will be shallower in both directions (east-west) away from Station 21+331.4 m. Therefore, a bowl shaped pit will develop after the unexceptable material is removed. After the excavation, any compressible materials identified by proof rolling should be replaced with granular material and compacted.

After the excavation, backfilling should be performed as per MTO standards using Granular 'A'.

All spread footings for retaining walls may be founded on spread footings on original ground (or engineered fill where specified) within 1.5 m to 2.0 m of the existing ground surface. The following bearing capacities, as per the OHBDC, may be achieved:

For Native Ground:

Factored Bearing Capacity at U.L.S.	375 kPa
Bearing Capacity at S.L.S. Type II	250 kPa

For Engineered Fill:

Factored Bearing Capacity at U.L.S.	900 kPa
Bearing Capacity at S.L.S. Type II	350 kPa

A friction angle of 28 degrees may be assumed as the lateral resistance between the concrete footing and the clayey silt deposit. Lateral resistance between concrete footing and compacted Granular 'A' will be calculated using an angle of friction of 35 degrees.

If Reinforced Earth walls or reinforced slopes are considered, please contact the Foundation Design Section for design details.

It should be noted that design comments regarding reinforced slopes, future sloping requirement and the configuration/geometry of Reinforced Earth walls have been provided in a meeting with D.S.-LEA Associates Ltd. on 90 10 25. Reference is made to minutes of that meeting for design details.

A minimum of 1.2 m of earth cover would be required for frost protection for conventional walls. Frost protection for Reinforced Earth walls would be determined by their design but is anticipated to be in the order of 0.6 m. Frost protection for reinforced slopes would be minimal.

#### Dewatering and Construction Considerations

Due to the proximity of the CNR tracks, it will be necessary to protect the railway tracks from any disturbance during construction of the foundations.

The bases and sides of footing, pile cap and caisson excavations should be protected against any disturbance during construction. As there is a relatively high water table at this site, and occasional silt and sand seams were encountered above the founding elevation, there is a possibility that seepage zones will be encountered and that instabilities and material flows may occur under conditions of unbalanced hydrostatic head. There is also a possibility that unstable conditions may be encountered at the bases of excavations, which are critical to bearing capacity. At excavations

dewatering may be required and could consist of oversized excavations and sump pumping. At caissons the disturbances could be prevented by maintaining a sufficient head in the excavation (with drilling mud) and placing the concrete by the tremie methods.

The contractor will be responsible for method of construction and dewatering. In any case, the contract should include a special provision indicating the presence of boulders, the potential instabilities, and the dewatering requirement that the water table should be lowered below any excavation prior to excavation. The contractor should submit a construction method and dewatering proposal for review at a minimum of 10 working days prior to the commencement of caisson construction.

The proposed locations for Pier 1 and Pier 4 are on existing cut surfaces which slope at about 25 degrees. In each case a railway line runs near the base of the slope. This situation will create construction difficulties since there will be no flat surface to operate the machinery, and there will be concern of safety when working in the proximity of track and trains. These concerns should be addressed in the contract documents.

#### Lateral Earth Pressure

Backfill to abutments or retaining wall should consist of Granular 'A' or Granular 'B' material for which the following unfactored properties are recommended.

Light weight fill (slag) may be used to reduce the pressure of the abutments.

Granular 'A'	$\gamma = 22.8 \text{ kN/m}^3$	$\phi = 35^\circ$	$K_a = 0.27$	$K_o = 0.43$
Granular 'B'	$\gamma = 21.2 \text{ kN/m}^3$	$\phi = 30^\circ$	$K_a = 0.33$	$K_o = 0.50$
Light weight Slag	$\gamma = 11.5 \text{ kN/m}^3$	$\phi = 35^\circ$	$K_a = 0.27$	$K_o = 0.43$

Lateral pressure should be computed in accordance with Section 6.6.1.2.1 of the OHBDC. From a geotechnical perspective a yielding foundation condition

may be assumed and hence the active condition will govern the design. If the structure cannot tolerate movement then the at rest condition will govern the design.

#### Stability of Slopes and Settlement

It is understood that fill up to 12 m high will be placed at each approach. There are no concerns of deep seated slope failure. Total and differential settlements will be negligible for structure foundations and approaches constructed in accordance with the recommendations provided.

Where conventional 2H:1V slope exceeds a 8 m height, a 2 m berm will be required for structure stability. Steeper slopes (up to 1H:1V) are feasible but would require reinforcement as discussed previously.

Temporary slopes should be maintained at 1H:1V or flatter up to 5 m, slopes between 5 m and 10 m high should be at 1.5 H:1V or flatter.

#### MISCELLANEOUS

The field work for this project was carried out under the supervision of K. Ahmad, Foundation Engineer and B. Lane, Engineering Student.

The equipment used was owned and operated by Master Soil Investigation Ltd.

The report was written by K. Ahmad and B. Bennett, Foundation Engineers, reviewed by D. Dundas, Senior Foundation Engineer and approved by M. Devata, Chief Foundation Engineer.



A handwritten signature in cursive script, appearing to read "K. Ahmad".

K. Ahmad, P.Eng.  
Foundation Engineer

A handwritten signature in cursive script, appearing to read "M. Devata".

M.S. Devata, P.Eng.  
Chief Foundation Engineer

## APPENDIX

## 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 1" 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

**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 (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	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	MID 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

### MECHANICAL PROPERTIES OF SOIL

$m_v$	$kPa^{-1}$	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	$m^2/s$	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	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
$S_t$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

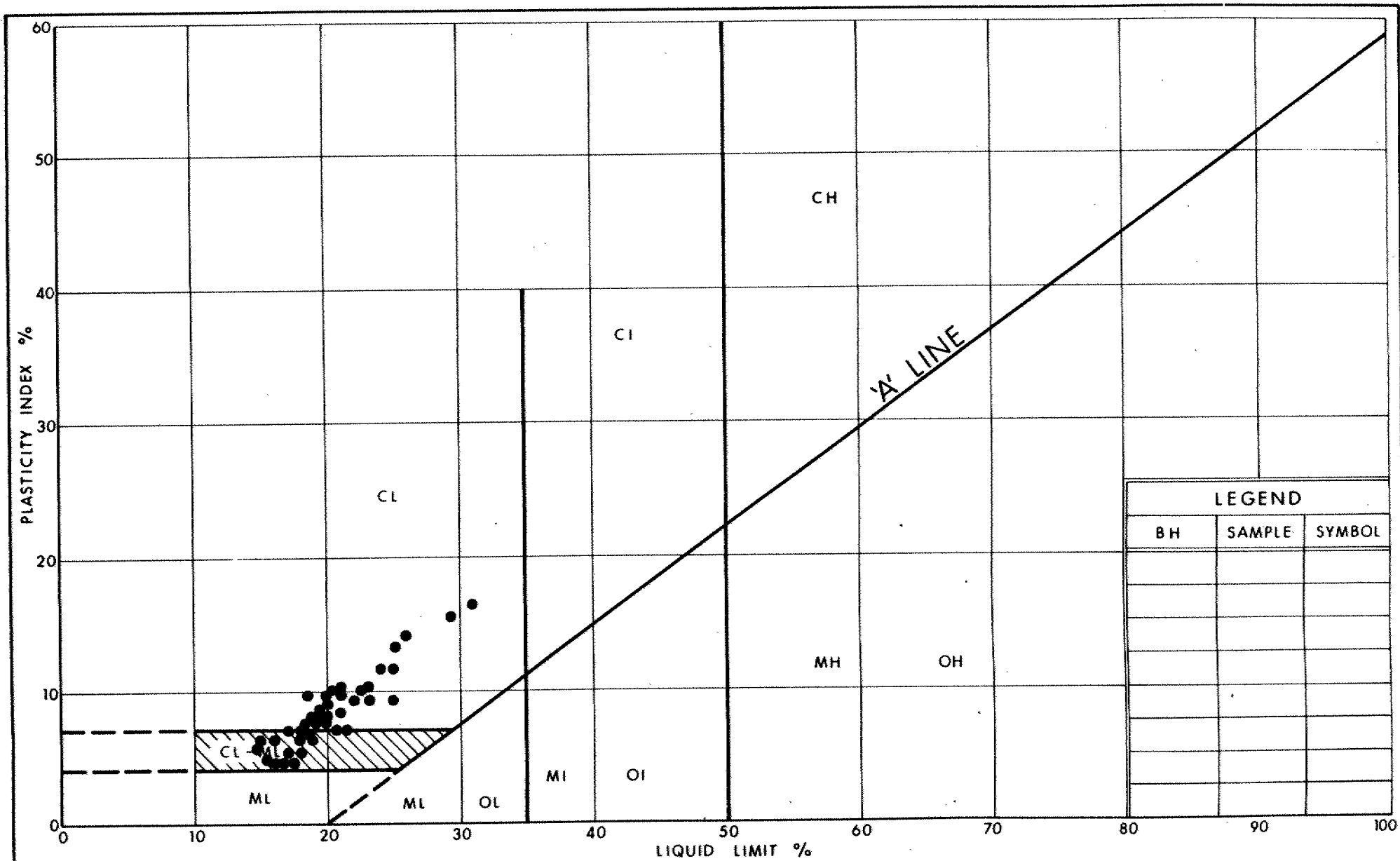
### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$r_u$	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

### PHYSICAL PROPERTIES OF SOIL

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



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Ontario

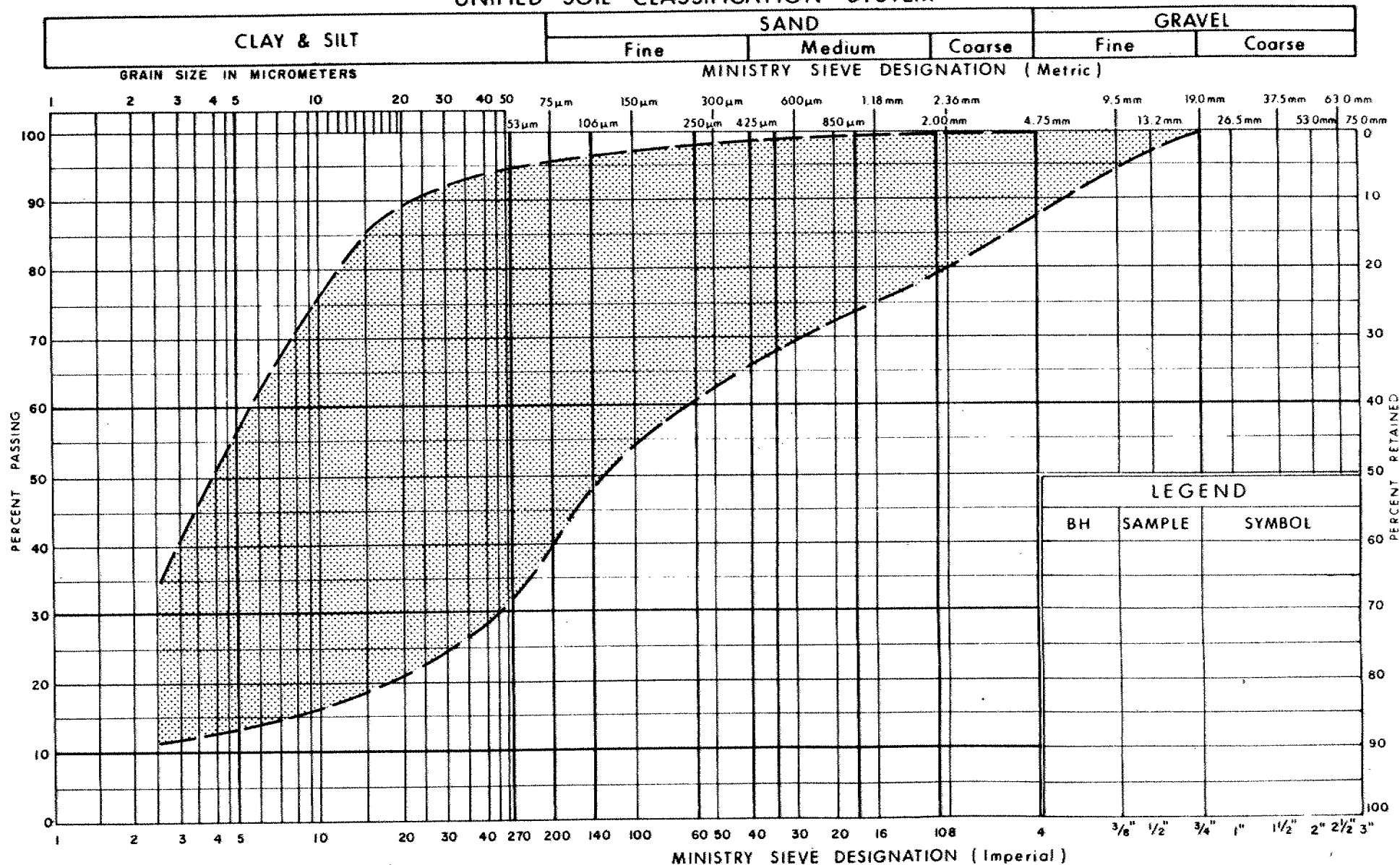
PLASTICITY CHART  
CLAYEY SILT TILL

WITH SAND, TRACE GRAVEL, OCC SANDY SILT SEAMS

FIG No 1

W P 139-87-01,03,04

## UNIFIED SOIL CLASSIFICATION SYSTEM



**Ontario**

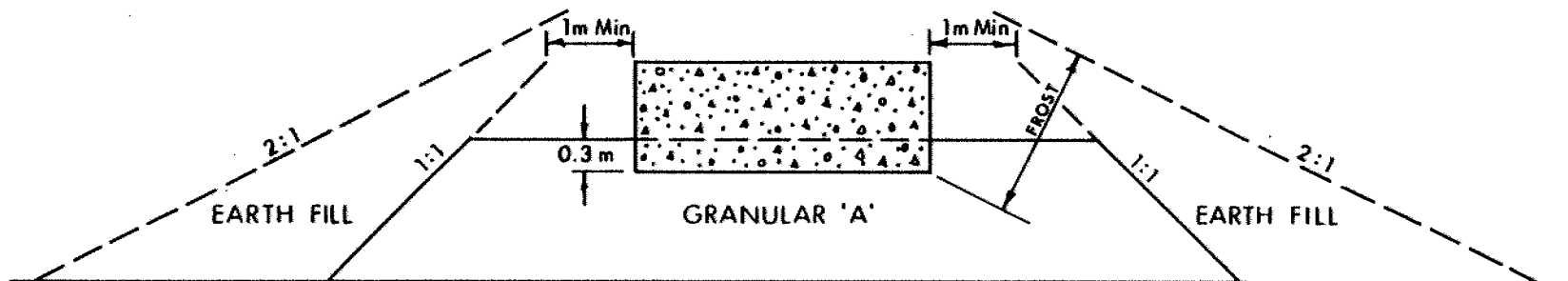
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## GRAIN SIZE DISTRIBUTION CLAYEY SILT TILL

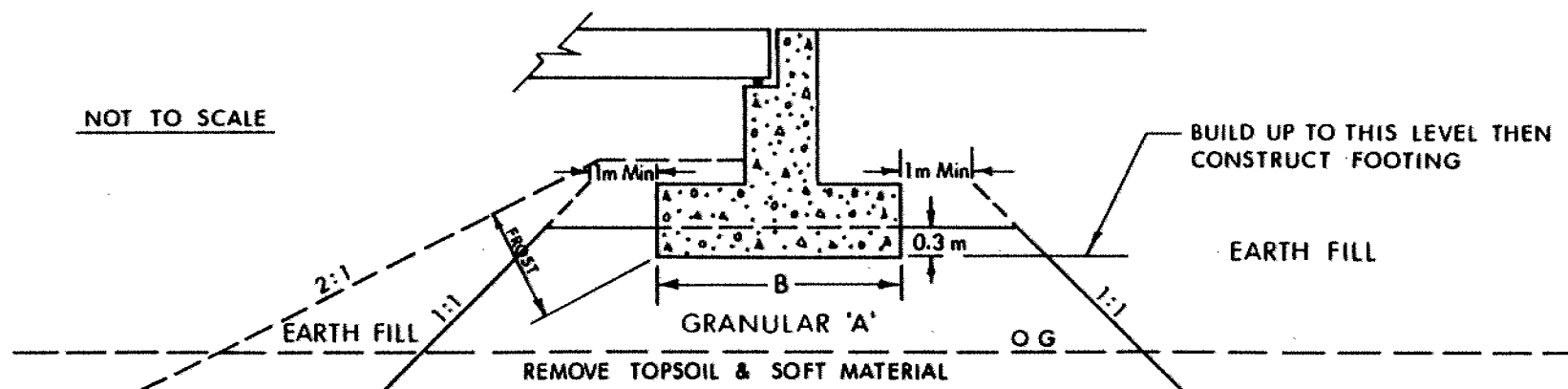
WITH SAND, TRACE GRAVEL, OCC SANDY SILT SEAMS

FIG No 2

W P 139-87-01,03,04



X SECTION



LONGITUDINAL SECTION

NOTES:

- 1- REMOVE TOPSOIL &/OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' & EARTH FILL.
- 2- PLACE GRANULAR 'A' & EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M TO STANDARDS.
- 3- CONSTRUCT CONCRETE FOOTING.
- 4 - PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED.



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ABUTMENT ON COMPACTED FILL  
SHOWING GRANULAR 'A' CORE

FIG No 3

W P 139-87-01,03,04

# RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 729.0, E 303 953.0 ORIGINATED BY KA  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY MJB,BB  
DATUM GEODETTIC DATE 90 06 13 CHECKED BY DD

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 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20 40 60 80 100	20 40 60 80 100					
208.2	Ground Surface												
0.0													
	Trace Organics		1	SS	22								
			2	SS	26								
			3	SS	37								
			4	SS	44								
	Brown		5	SS	40								
	Gray		6	SS	11								2 32 58 8
			7	SS	14								
	CLAYEY SILT TILL		8	SS	11								
	With Sand												
	Trace Gravel												
	Occ. Sandy Silt seams		9	SS	19								
	Stiff to Hard												
			10	SS	36								16 29 (55)
196.8			11	SS	116								4 29 49 18
11.4	SILT to SANDY SILT TILL												
	Trace Gravel		12	SS	143	/23cm							0 25 68 7
	Trace Clay												
	Occ. Clayey Silt zones												
194.1	Very Dense		13	SS	116	/26cm							
14.1	End of Borehole												
	• Not established												

# RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 702.5, E 303 962.0 ORIGINATED BY BL  
DIST 5 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY MJR,BB  
DATUM GEODETIC DATE 90 06 13-14 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT UNIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT UNIT		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			20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>p</sub>	W	W <sub>L</sub>	W		
208.9	Ground Surface																
0.0	GRAVELLY SAND Trace Silt Trace Clay Very Dense (Fill Material)		1	SS	74	*	208										
207.5			2	SS	12												
1.4	Trace Organics		3	SS	22												0 24 (76)
			4	SS	22												
			5	SS	27												
			6	SS	27												
	Brown		7	SS	20												
	Gray		8	SS	7											22.0	4 30 42 24
	CLAYEY SILT TILL With Sand Trace Gravel Occ. Sandy Silt seams Stiff to Hard		9	SS	12												
			10	SS	12												
197.5			11	SS	43											24.0	7 32 41 20
11.4	SILT to SANDY SILT TILL Trace Gravel Trace Clay Occ. Clayey Silt zones Very Dense		12	SS	85												0 15 75 10
194.7			13	SS	88												
14.2	End of Borehole  * Not established																

# RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 139-87-01.03.04

LOCATION N 4 849 675.3, E 303 971.5

ORIGINATED BY KA

DIST 5 HWY 407

BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER

COMPILED BY BLBB

DATUM GEODETIC

DATE 90 06 12-13

CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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	20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W		
206.8	Ground Surface												
0.0	CLAYEY SILT TILL With Sand Trace Gravel Occ. Sandy Silt seams Stiff to Hard  Brown Gray		1	SS	14								12 38 35 15
			2	SS	18								
			3	SS	16								
			4	SS	18								
			5	SS	20								
			6	SS	16								
			7	SS	22								
			8	SS	23								
			9	SS	18								
196.9				10	SS	53							
9.9	SILT to SANDY SILT TILL Trace Gravel Trace Clay Occ. Clayey Silt zones Occ. Sand Zones  Dense to Very Dense		11	SS	71								5 31 50 14
			12	SS	40								
			13	SS	88								
			14	SS	71								
			15	SS	86								
			16	SS	42								
185.5													4 38 45 13
													2 85 (13)
21.3	End of Borehole												
* GROUND WATER CONDITIONS													
PIEZO. NO.		GROUND WATER ELEVATION (Metres)											
1		205.5											

## METRIC

+3, x3: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 5

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 723.0, E 304 024.5 ORIGINATED BY BL  
DIST 5 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY MJR,BB  
DATUM GEODETTIC DATE 90 06 19 CHECKED BY DD

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 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
208.7	Ground Surface																
0.0	Trace Organics		1	SS	21		208										
			2	SS	22												
			3	SS	22												
			4	SS	31												
	Brown		5	SS	25												
	Grey		6	SS	9												
			7	SS	8												
	CLAYEY SILT TILL		8	SS	13												
	With Sand																
	Trace Gravel																
	Occ. Sandy Silt seams		9	SS	19												
	Stiff to Hard																
198.8			10	SS	100												
9.9	SILT to SANDY SILT TILL		11	SS	94												
	Trace Gravel Trace Clay																
	Very Dense																
	Occ. Clayey Silt Zones		12	SS	74												
194.7			13	SS	22.5												
14.0	End of Borehole																
	* Not Established																



# RECORD OF BOREHOLE No 6

1 OF 1 METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 695.0, E 304 029.0 ORIGINATED BY KA  
DIST 5 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BLBB  
DATUM GEODETIC DATE 90 06 18 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC UNIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID UNIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
208.5	Ground Surface													
0.0	CLAYEY SILT		1	SS	20	*	208							
			2	SS	10		206							
			3	SS	36		204							
			4	SS	39		202							
			5	SS	43		200							
			6	SS	32		198							
			7	SS	16		196							
			8	SS	18		194							
	CLAYEY SILT TILL with Sand Trace Gravel Occ. Sandy Silt Seams Stiff to Hard		9	SS	26		192							
			10	SS	27		190							
			11	SS	50		188							
			12	SS	70		186							
			13	SS	137	/23cm								
192.3			14	SS	48									
16.2	SILT TO SANDY SILT Occ. Sand Zones Trace Gravel V. Dense		15	SS	3	**								
			16	SS	59	**								
			17	SS	127									
			18	SS	121	/23cm								
185.3			19	SS	147									
23.2	End of Borehole • Not Established •• Disturbed													

# RECORD OF BOREHOLE No 7

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 767.5, E 304 066.0 ORIGINATED BY KA  
DIST 5 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BLBB  
DATUM GEODETIC DATE 90 06 20 CHECKED BY DD

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		20 40 60 80 100	20 40 60 80 100	w <sub>p</sub>	w	w <sub>L</sub>		
208.5	Ground Surface												
0.0	CLAYEY SILT TILL With Sand Trace Gravel Occ. Sandy Silt seams Stiff to Hard		1	SS	23								
			2	SS	15								
			3	SS	28								
			4	SS	26								
			5	SS	48	/18cm							
			6	SS	18								
			7	SS	19								
			8	SS	19								
			9	SS	26								
			10	SS	84								
			11	SS	0**								
			12	SS	144	/23cm							
			13	SS	120	/10cm							
195.0													
14.5	SILTY SAND TO SANDY SILT TILL Trace Gravel Trace Clay Very Dense		14	SS	98								
			15	SS	113								
191.1			16	SS	125	/15cm							
18.4	End of Borehole  • Not Established ** Disturbed												

# RECORD OF BOREHOLE No 8

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 741.0, E 304 076.0 ORIGINATED BY KA  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BLBB  
DATUM GEODETTIC DATE 90 06 19 CHECKED BY DD

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			20	40	60	80	100					
209.4	Ground Surface																
0.0						*											
	Trace Organics		1	SS	11												
			2	SS	15		208										
	CLAYEY SILT TILL		3	SS	25												
	With Sand		4	SS	29		206										
	Trace Gravel		5	SS	30												
	Occ. Sandy Silt seams		6	SS	36												
	Stiff to Hard		7	SS	28		204						120/			21.0	4 38 (58)
	Brown		8	SS	20								25cm				
	Grey		9	SS	21		202										
			10	SS	16		200										4 35 44 17
	Silt to Sandy Silt Zone		11	SS	32												0 23 71 6
	Trace Gravel Trace Clay																
	Dense						198										
196.8			12	SS	120												
12.6	End of Borehole																
	Not Established																

# RECORD OF BOREHOLE No 9

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 713.0, E 304 084.5 ORIGINATED BY KA  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BLBB  
DATUM GEODETTIC DATE 90 06 19 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER + CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL * LAB VANE 20 40 60 80 100	PLASTIC LIMIT W <sub>P</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub> WATER CONTENT (%) 10 20 30	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						
209.6	Ground Surface										
0.0			1	SS	12						
			2	SS	8						
			3	SS	6						
			4	SS	23						
			5	SS	25						
			6	SS	22						
			7	SS	14						
			8	SS	12						
			9	SS	20						
			10	SS	20						
			11	SS	41						
			12	SS	139						
			13	SS	136						
			14	SS	124						
193.9	End of Borehole										
15.7											

Brown  
Grey

CLAYEY SILT TILL  
With Sand  
Trace Gravel  
Occ. Sandy Silt seams  
Firm to Hard

Sand Zone  
Trace Silt Trace Clay  
Dense

PI

27cm

120/  
23cm

2 42 42 14

1 87 9 3

5 23 57 15

0 6 60 34

• GROUND WATER CONDITIONS

PIEZO NO.	GROUND WATER ELEVATION (Metres)
1	203.6

## METRIC

SOIL PROFILE		SAMPLES			GROUND WATER • CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W		
209.2	Ground Surface												
0.0													
			1	SS	21								
			2	SS	25								
			3	SS	21								
			4	SS	38								
			5	SS	38								
	Brown		6	SS	37								
	Gray		7	SS	22								
			8	SS	25								
	CLAYEY SILT TILL												
	With Sand												
	Trace Gravel		9	SS	27								
	Occ. Sandy Silt seams												
	Very Stiff to Hard		10	SS	17								
			11	SS	55								
	Occ. Cobbles/Boulders												
196.9			12	SS	116								
12.3	SILT to SANDY SILT TILL												
	Trace Gravel Trace Clay												
	Very Dense		13	SS	201								
	Clayey Silt Zone												
193.8			14	SS	120								
15.4	End of Borehole												

• GROUND WATER CONDITIONS

PIEZO NO.	GROUND WATER ELEVATION (Metres)
1	202.7

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

RECORD OF BOREHOLE No 11

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 761.5, E 304 138.5 ORIGINATED BY KA  
DIST 5 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BB  
DATUM GEODETIC DATE 90 06 15 CHECKED BY DD

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			20	40	60	80	100					
210.0	Ground Surface																
0.0																	
	Trace Organics		1	SS	21												
			2	SS	17												
			3	SS	27												
			4	SS	29												
	Brown		5	SS	35												
	Grey		6	SS	18												
			7	SS	14												
	CLAYEY SILT TILL		8	SS	13												
	With Sand																
	Trace Gravel																
	Occ. Sandy Silt seams		9	SS	16												
	Stiff to Hard																
198.6			10	SS	13												
11.4			11	SS	29												
	SILT to SANDY SILT TILL																
	Trace Gravel		12	SS	130												
	Trace Clay																
	Very Dense																
196.0			13	SS	175												
14.0	End of Borehole																
	Not Established																

# RECORD OF BOREHOLE No 12

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 731.5, E 304 139.0 ORIGINATED BY KA  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BLBB  
DATUM GEODETIC DATE 90 06 14 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT		LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>		
210.0	Ground Surface												
0.0	Trace Organics		1	SS	12								
			2	SS	25								
			3	SS	20								
			4	SS	28								
			5	SS	38								
	Brown		6	SS	26								
	Grey		7	SS	16								
	CLAYEY SILT TILL		8	SS	19								
	With Sand												
	Trace Gravel		9	SS	19								
	Stiff to Hard												
200.1			10	SS	22							22.9	9 33 43 15
9.9			11	SS	48								0 69 (31)
			12	SS	116	/28cm							
			13	SS	104	/15cm							
	Clayey Silt Zone		14	SS	74								0 1 66 33
			15	SS	70								
	SILT to SANDY SILT TILL		16	SS	55								0 48 42 10
	Trace Gravel												
	Trace Clay												
	Occ. Clayey Silt zones		17	SS	125	/21cm							
	Very Dense		18	SS	109								
186.8			19	SS	131	/21cm							
23.2	End of Borehole												
	* Not Established												

# RECORD OF BOREHOLE No 14

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 790.0, E 304 220.5 ORIGINATED BY KA  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BLB  
DATUM GEODETIC DATE 90 06 05 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT		UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20 40 60 80 100	20 40 60 80 100	w <sub>p</sub>	w	w <sub>p</sub>	w	w <sub>L</sub>	w		
209.2	Ground Surface															
0.0					*											
			1	SS	28											
			2	SS	40											
			3	SS	19											
			4	SS	17											
	Brown														22.7	7 31 44 18
	Grey															
			5	SS	26											
			6	SS	22											
			7	SS	21											
			8	SS	36											4 41 44 11
			9	SS	15											
			10	SS	12											3 35 49 13
			11	SS	34											
	CLAYEY SILT TILL															
	With Sand															
	Trace Gravel															
	Occ. Sandy Silt seams															
	Stiff to Hard															
			12	SS	56											
			13	SS	74											
			14	SS	51											0 29 56 15
			15	SS	49											
184.5			16	SS	127	18cm										
24.7	End of Borehole															
	* Not Established															

+3, x3 Numbers refer to  
Sensitivity

20  
15-5 (%) STRAIN AT FAILURE  
10



## 1 OF 1

METRIC

LOCATION N 4 849 762.0 E 304 227.0

ORIGINATED BY KA

BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER

COMPILED BY BLBB

DATUM GEODETIC

DATE 90 06 06

CHECKED BY DD

+3, x5: Numbers refer to Sensitivity

# RECORD OF BOREHOLE No 16

1 OF 1

METRIC

W.P. 139-87-01.03.04

LOCATION N 4 849 834.0, E 304 262.0

ORIGINATED BY KA

DIST 6 HWY 407

BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER

COMPILED BY BLBB

DATUM GEODETIC

DATE 90 06 11

CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT		UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100	20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>	WATER CONTENT (%)		
209.7	Ground Surface										7	GR SA SI CL
0.0	Trace Organics		1	SS	9							
			2	SS	17							1 7 37 55
			3	SS	25							1 34 40 25
			4	SS	24							
			5	SS	40							
	Brown		6	SS	51							
	Gray		7	SS	60							
			8	SS	41							
	CLAYEY SILT TILL		9	SS	33							
	With Sand											
	Trace Gravel											
	Occ. Sandy Silt seams		10	SS	70							
	Stiff to Hard											
			11	SS	24							4 32 44 20
			12	SS	102							4 36 47 13
			13	SS	67							
193.7			14	SS	64							
18.0	SILT to SANDY SILT TILL											
	Trace Gravel Trace Clay											
192.5	Occ. CL seams Very Dense		15	SS	52							
17.2	End of Borehole											
• GROUND WATER CONDITIONS												
PIEZO. NO.												
GROUND WATER ELEVATION (Metres)												
1												
206.6												

+3, x5: Numbers refer to  
Sensitivity

20  
15-5 (x) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 17

1 OF 1

METRIC

W.P. 139-87-01.03.04

LOCATION N 4 849 807.0, E 304 271.0

ORIGINATED BY KA

DIST 5 HWY 407

BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER

COMPILED BY BLBB

DATUM GEODETIC

DATE 90 06 11

CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT		UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20 40 60 80 100	20 40 60 80 100	w <sub>p</sub> w w <sub>L</sub>	WATER CONTENT (%) 10 20 30		
210.6	Ground Surface											
0.0	Trace Organics		1	SS	15							
			2	SS	12							
	CLAYEY SILT TILL		3	SS	40							
	With Sand		4	SS	28							
	Trace Gravel		5	SS	28							
	Occ. Sandy Silt seams		6	SS	32							
	Stiff to Hard		7	SS	44							
	Brown		8	SS	20							
	Grey		9	SS	19							
			10	SS	24							
199.2			11	SS	19							
11.4	SILT to SANDY SILT TILL											
	Trace Gravel Trace Clay											
198.0	Occ. Clayey Silt Seams Dense		12	SS	44							
12.6	End of Borehole											
	Not Established											

# RECORD OF BOREHOLE No 18

1 OF 2

METRIC

W.P. 139-87-01,03,04

LOCATION N 4 849 780.0, E 304 280.0

ORIGINATED BY KA

DIST 6 HWY 407

BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER

COMPILED BY BLBB

DATUM GEODETIC

DATE 90 06 07-11

CHECKED BY DO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT $w_p$	NATURAL MOISTURE CONTENT $w$	LIQUID LIMIT $w_L$	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100	20 40 60 80 100					
210.7	Ground Surface												
0.0													
	Trace Organics		1	SS	9								
	Sandy Silt zone		2	SS	12								
			3	SS	30								
			4	SS	25								
			5	SS	31								
			6	SS	39								
			7	SS	31								
			8	SS	17								
	CLAYEY SILT TILL												
	With Sand												
	Trace Gravel												
	Occ. Sandy Silt seams												
	Stiff to Hard												
			9	SS	22								
			10	SS	17								
			11	SS	20								
			12	SS	40								
			13	SS	85								
	Sandy Silt zone												
			14	SS	28								
			15	SS	30								
			16	SS	30								
			17	SS	23								
			18	SS	47								
			19	SS	26								
187.1													
23.6			20	SS	8*								
	SILT to SANDY SILT TILL												
	Trace Gravel												
	Trace Clay												
	Occ. Clayey Silt zones												
	Loose to very Dense												
			21	SS	20								
			22	SS	30								
			23	SS	128								
180.2													

30.5

Continued

\*3, \*5: Numbers refer to  
Sensitivity

20  
15-5 (X) STRAIN AT FAILURE  
10

Continued

# RECORD OF BOREHOLE No 18

2 OF 2

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 848 780.0, E 304 280.0 ORIGINATED BY KA  
 DIST 5 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BL, BB  
 DATUM GEODETIC DATE 90 06 07-11 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT			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	20	40	60	80	100	W <sub>p</sub>	W		
180.2	Continued															
30.5	SILT to SANDY SILT TILL Trace Gravel Trace Clay Occ. Clayey Silt zones Loose to Very Dense		24	SS	148	/26cm	180									
178.6			25	SS	130	/11cm										
32.1	End of Borehole * Disturbed ** Not Established															

# RECORD OF BOREHOLE No 19

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 789.0, E 304 319.5 ORIGINATED BY BL  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BB  
DATUM GEODETIC DATE 90 06 12 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	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								
210.8	Ground Surface												
0.0	CLAYEY SILT (FILL) Brown Trace Organics Firm to Stiff		1	SS	10		210						
208.9			2	SS	7								
1.9			3	SS	12								
			4	SS	22								
			5	SS	32								
	Brown		6	SS	32								
	Grey		7	SS	16								
	CLAYEY SILT TILL With Sand Trace Gravel Occ. Sandy Silt seams Firm to Hard		8	SS	18								
			9	SS	17								
201.2			10	SS	17								
9.6	End of Borehole												

# RECORD OF BOREHOLE No 20

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 800.7, E 304 362.0 ORIGINATED BY BL  
DIST 5 HWY 407 BOREHOLE TYPE CONE TEST, SOLID STEM AUGER COMPILED BY BB  
DATUM GEODETIC DATE 90 06 12 CHECKED BY DD

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						
210.6	Ground Surface							20 40 60 80 100	20 40 60 80 100					
0.0			1	SS	7		210							
			2	SS	18									
			3	SS	51		208							
			4	SS	70									
			5	SS	43									
			6	SS	26		206							
			7	SS	20									
			8	SS	25		204							
			9	SS	24									
201.0			10	SS	20		202							
9.6	End of Borehole • Not Established													

Brown  
Grey

CLAYEY SILT TILL  
With Sand  
Trace Gravel  
Occ. Sandy Silt seams  
Firm to Hard

# RECORD OF BOREHOLE No 21

1 OF 1 METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 815.3, E 304 407.5 ORIGINATED BY BL  
 DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, SOLID STEM AUGER COMPILED BY BB  
 DATUM GEODETIC DATE 90 06 12 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
210.0	Ground Surface												
0.0			1	SS	11								
			2	SS	26								
			3	SS	26								
			4	SS	34								
			5	SS	48								
			6	SS	27								
			7	SS	25								
			8	SS	26								
			9	SS	33								
200.4			10	SS	17								
9.6	End of Borehole												
	Not Established												



# RECORD OF BOREHOLE No 22

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 860.5, E 304 275.0 ORIGINATED BY BL  
DIST 5 HWY 407 BOREHOLE TYPE CONE TEST, SOLID STEM AUGER COMPILED BY BB  
DATUM GEODETIC DATE 90.06.04 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 20 40 60 80 100	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								
209.7	Ground Surface											
0.0	Topsoil		1	SS	5							
			2	SS	22							
			3	SS	42							
			4	SS	43							
	Brown		5	SS	56							
	Gray		6	SS	36							
			7	SS	32							
			8	SS	42							
	CLAYEY SILT TILL		9	SS	32							
	Some Sand											
	Trace Gravel		10	SS	24							
	Occ. Sandy Silt zones											
	Very Stiff to Hard		11	SS	31							
198.6			12	SS	41							
11.1	End of Borehole											
	Not Established											

# RECORD OF BOREHOLE No 23

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 872.7, E 304 318.0 ORIGINATED BY BL  
DIST 5 HWY 407 BOREHOLE TYPE CONE TEST, SOLID STEM AUGER COMPILED BY BB  
DATUM GEODETTIC DATE 90 06 12 CHECKED BY DD

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 7 KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20						40
209.7	Ground Surface													
0.0	Brown Grey  CLAYEY SILT TILL With Sand Trace Gravel Occ. Sandy Silt seams Firm to Hard		1	SS	7									
			2	SS	5									4 31 42 23
			3	SS	20									
			4	SS	28									4 33 45 18
			5	SS	15									
			6	SS	16									
			7	SS	31									
			8	SS	20									1 33 43 23
			9	SS	21									
200.1					10	SS	21							
9.6	End of Borehole													

# RECORD OF BOREHOLE No 24

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 886.8, E 304 364.0 ORIGINATED BY BL  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BB  
DATUM GEODETTIC DATE 90 06 12 CHECKED BY DD

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 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20						40	60
210.2	Ground Surface														
0.0			1	SS	12										
			2	SS	22										
			3	SS	25										
			4	SS	28										
	Brown		5	SS	38										
	Grey		6	SS	24										
			7	SS	19										
	CLAYEY SILT TILL With Sand Trace Gravel Occ. sandy silt seams Stiff to Hard		8	SS	18										
			9	SS	22										
200.6			10	SS	19										
9.6	End of Borehole														
* GROUND WATER CONDITIONS PIEZO. NO. GROUND WATER ELEVATION (Metres) 1 207.7															

# RECORD OF BOREHOLE No 25

1 OF 1

METRIC

W.P. 139-87-01.03.04

LOCATION N 4 849 733.5 E 303 900.0

ORIGINATED BY BL

DIST 5 HWY 407

BOREHOLE TYPE CONE TEST, SOLID STEM AUGER

COMPILED BY BB

DATUM GEODETIC

DATE 90 06 19

CHECKED BY DD

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			20	40	60	80	100				
205.5	Ground Surface															
0.0	SAND Trace Gravel Very Dense (Fill Material)		1	SS	143											
204.1			2	SS	20											
1.4	CLAYEY SILT TILL With Sand Trace Gravel		3	SS	9											
			4	SS	34											
			5	SS	42											
			6	SS	47											
	Brown		7	SS	25											
	Gray		8	SS	27											
	Occ. Sandy Silt seams Stiff to Hard		9	SS	45											
195.9			10	SS	53											
9.6	End of Borehole															

# RECORD OF BOREHOLE No 26

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 712.6, E 303 833.5 ORIGINATED BY BL  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, SOLID STEM AUGER COMPILED BY BB  
DATUM GEODETIC DATE 90.06.20 CHECKED BY DD

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 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100					
206.2	Ground Surface														
0.0	SAND AND GRAVEL Some Silt Trace Asphalt Dense (Fill Material)		1	SS	36		206								
204.8			2	SS	49		204								
1.4	ORGANIC SILT to CLAYEY SILT Some Sand Trace Gravel Trace Organics/Wood Chips Trace Asphalt Very Soft to Stiff (Fill Material)		3	SS	1		202								0 17 71 12
202.5			4	SS	10		200								
3.7	Brown Gray CLAYEY SILT TILL With Sand Trace Gravel Occ. Sandy Silt seams Firm to Very Stiff		5	SS	8		198								0 13 62 25
			6	SS	6		196								
			7	SS	7										
			8	SS	13										
			9	SS	18										
196.3			10	SS	25										
9.9	SILT to SANDY SILT Trace Gravel Trace Clay Occ. CL zones Dense		11	SS	39										3 39 46 12
195.1															
11.1	End of Borehole  * Not Established  ** Bouncing on piece of wood														

# RECORD OF BOREHOLE No 27

1 OF 1

METRIC

W.P. 139-87-01.03.04

LOCATION N 4 849 684.5, E 303 742.5

ORIGINATED BY BL

DIST 6 HWY 407

BOREHOLE TYPE CONE TEST, SOLID STEM AUGER

COMPILED BY BB

DATUM GEODETTIC

DATE 90 06 20

CHECKED BY DD

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
205.1	Ground Surface													
0.0	SAND													
203.7	Some Gravel Some/With Silt Trace Clay Very Stiff (Fill Material)		1	SS	21									8 43 33 16
1.4	CLAYEY SILT TILL		2	SS	27									9 22 (69)
	With Sand		3	SS	30									
	Trace Gravel		4	SS	34									
	Occ. Sandy Silt seams		5	SS	31									
	Very Stiff to Hard		6	SS	32									
	Brown		7	SS	25									
	Grey		8	SS	33									
			9	SS	116									7 31 47 15
195.7			10	SS	161	31cm								
9.4	End of Borehole													
	Not Established													

**METRIC**

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

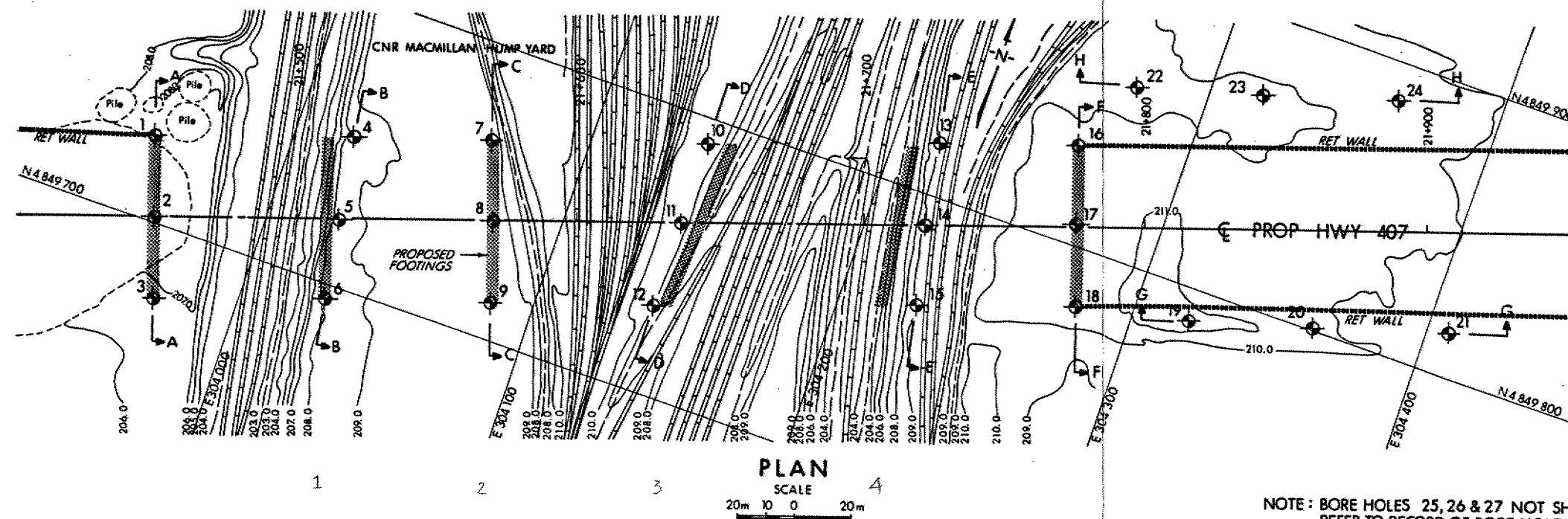
CONT No  
WP No 139-87-01,03,04

CNR MACMILLAN YARD

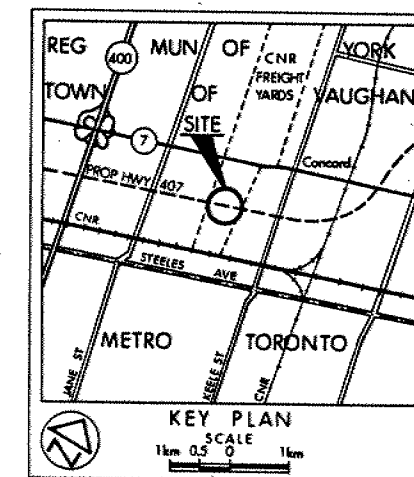
BORE HOLE LOCATIONS & SOIL STRATA



SHEET

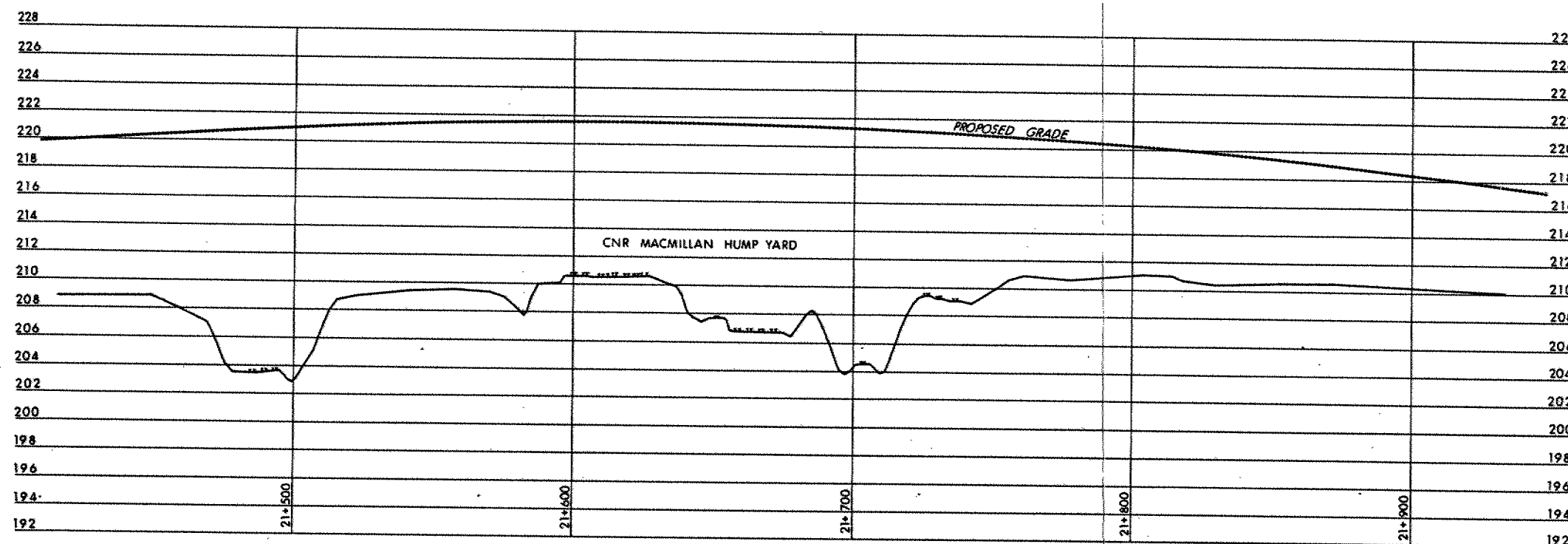


NOTE: BORE HOLES 25, 26 & 27 NOT SHOWN ON PLAN  
REFER TO RECORD OF BORE HOLE FOR SUBSOIL  
INFORMATION. FOR SECTIONS SEE DWG NO  
1398701,03,04-B



**LEGEND**

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊙ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation



PROFILE PROP HWY 407

**NOTE**

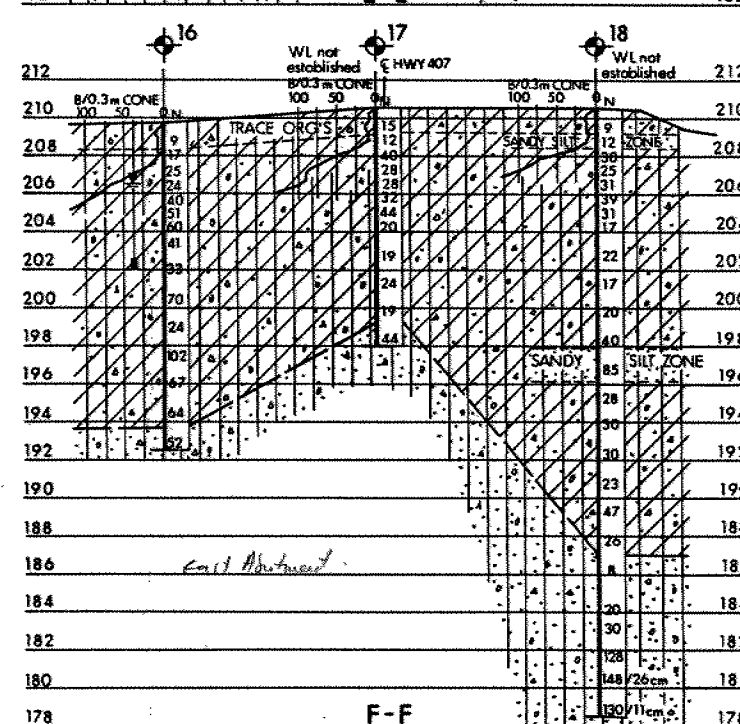
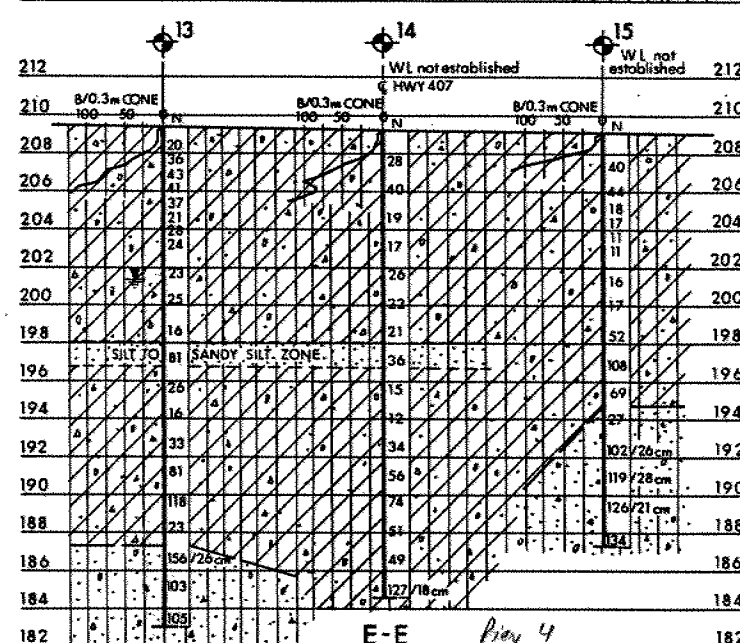
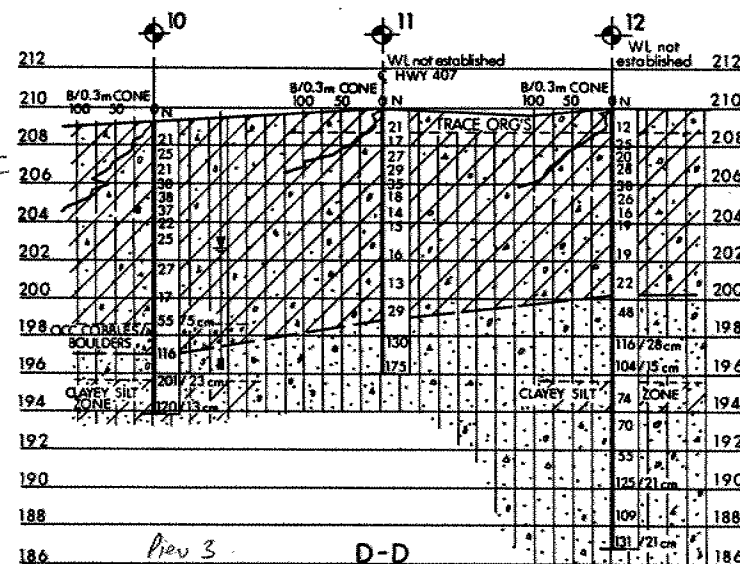
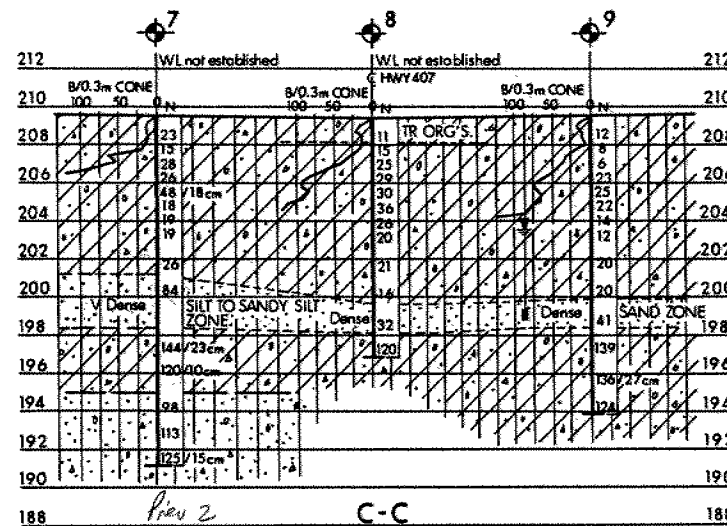
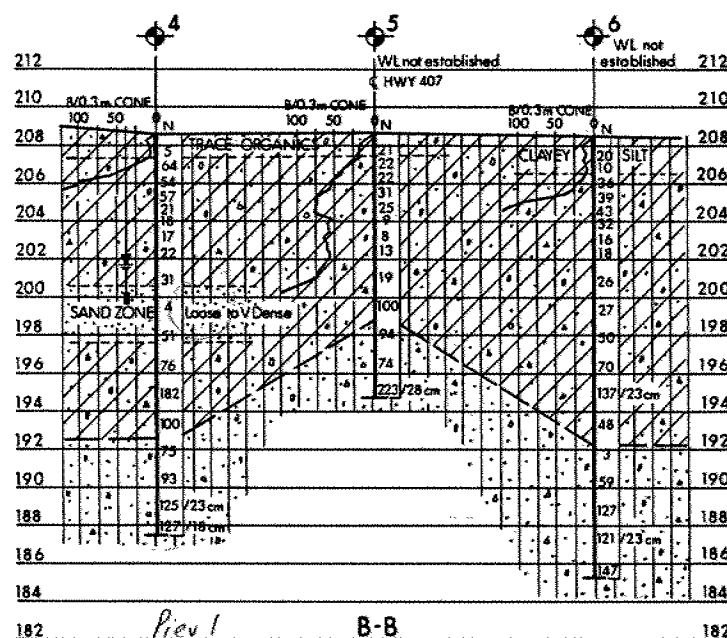
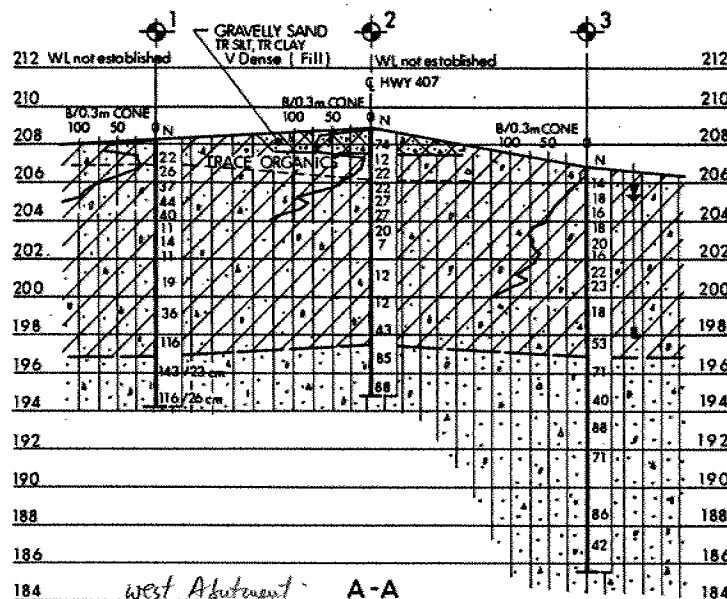
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

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

REV.	DATE	BY	DESCRIPTION

Geocres No 30M13-112

HWY No 407	CHECKED	DATE 1990 10 19	DIST 6
SUBM'D KA	CHECKED	DATE 1990 10 19	SITE 27- 1317
DRAWN SO	CHECKED	DATE 1990 10 19	DWG 1398701,03,04-A



## METRIC

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

CONT No  
WP No 139-87-01,03,04






CNR MACMILLAN YARD  
BORE HOLE LOCATIONS & SOIL STRATA

**SHEET**

SEE DWG NO 1398701.03.04-A

KEY PLAN  
SCALE

### LEGEND

- |   |                                       |
|---|---------------------------------------|
|    | Bore Hole                             |
|    | Dynamic Cone Penetration Test {Cone}  |
|    | Bore Hole & Cone                      |
| N   | Blows/0.3m (Std Pen Test, 475 J/blow) |
| CONE  | Blows/0.3m (60° Cone, 475 J/blow)     |
|  | WL at time of investigation 90.06     |
|  | WL in piezometer                      |

[illegible]

**NOTE**

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

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

REV.			
	DATE	BY	DESCRIPTION

Geocres No 30M13-112

HWY No 407		DIST 6	
SUBM'D KA	CHECKED	DATE 1990 10 19	SITE 27-1317
DRAWN SO	CHECKED	APPROVED	DWG 1987010304-H

## SECTIONS

SCALE

10 m 5 0 10 m Hor

4 m 2 0 4 m Ver

### SOIL STRATIGRAPHY LEGEND

-  **CLAYEY SILT TILL**  
WITH SAND, TRACE GRAVEL,  
OCC SANDY SILT SEAMS  
**Firm to Hard**
-  **SILT TO SANDY SILT TILL**  
TRACE GRAVEL, TRACE CLAY,  
OCC CLAYEY SILT ZONES  
**Dense to V Dense**



# **FOUNDATION INVESTIGATION REPORT**

**CONTRACT NO. 94-36**



Ministry of  
Transportation

1

INDEX

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3 - 46	Foundation Investigation Report for  CNR MacMillan Yard W.P. 139-87-01/04, Site 37-1317 Hwy. 407, District 6, Toronto  High Mast Lighting CNR MacMillan Yard W.P. 139-87-00(B) Hwy. 407, District 6, Toronto

Note: For purposes of the contract, this report supersedes all other Foundation Reports prepared by, or for the Ministry in connection with the above mentioned project.

# EXPLANATION OF TERMS USED IN REPORT

2

**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.

**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

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$r_u$	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
$\sigma'_{vo}$	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
$S_f$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL

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

FOUNDATION INVESTIGATION REPORT  
For  
C.N.R. MacMillan Yard Overpass  
W.P. 139-87-01/04      Site No. 37-1317  
Highway 407, District 6, Toronto

### INTRODUCTION

This report summarizes the results of a foundation investigation conducted for the proposed Highway 407 overhead at the C.N.R. MacMillan Yard. The investigation was carried out at the request of the Central Region Structural Section. The report applies to two bridge structures, their approaches between Sta. 21 + 235 and 21 + 900, Highway 407 Chainage.

### SITE DESCRIPTION

The proposed C.N.R. MacMillan Yard Overhead is located about 1 km south of Highway 7 and about 1 km west of Keele Street, in the Town of Vaughan, Regional Municipality of York.

The immediate area is a yard for the Canadian National Railway and consists of 20 sets of railway tracks.

The ground surface elevation at the site changes rapidly due to the grade of the existing CNR tracks. The CNR tracks are constructed in deep cuts which are up to 6 m deep and slope at approximately 2H:1V. The ground surface elevations at the site varies from 204 m to 211 m.

The site lies within the physiographical region known as the Peel Plain (Reference: Chapman and Putnam, 'The Physiography of Southern Ontario; 3rd Edition, 1984) and it consists largely of glacial till deposits.

### INVESTIGATION PROCEDURES

The field investigation for the MacMillan Yard Overhead was conducted between 90 06 04 to 90 06 20. A total of twenty-seven boreholes (BH 1 through BH 27) were advanced for the proposed structures, all of which were

accompanied by dynamic cone penetration tests. Due to constraints with the drilling operation some of the boreholes were moved away from the proposed pier locations to a higher and flatter surface as two of the four proposed pier locations are on existing slopes. The boreholes were advanced using two track-mounted auger machines equipped with 83 mm ID hollow stem augers and solid stem augers.

Samples were recovered by means of a 50 mm OD split spoon sampler driven into the soil according to the specifications of the Standard Penetration Test (ASTM D 1586). Samples were retrieved at 0.75 m intervals for the first 6.0 m of the boring, then every 1.5 m.

Standpipe piezometers were installed in BH's 3, 4, 9, 10, 16 and 24 to facilitate periodic monitoring of the groundwater elevations.

The boreholes were staked out by the Central Region Surveys and Plans Section of the MTO. Locations and elevations were also provided by the Survey and Plan Section. Coordinates of each boreholes were determined from an E-Plan provided by DS-Lea Associates Ltd.

The laboratory testing program for representative samples consisted of:

- Grain Size Analyses
- Natural Moisture Content Determinations
- Atterberg Limit Determinations, and
- Unit Weight Determinations

The results of the laboratory testing are plotted on the Record of Borehole sheets (Appendix).

## SUBSURFACE CONDITIONS

### General

The record of Borehole sheets in the Appendix illustrate the subsurface conditions at the borehole locations. The locations and elevations of the

boreholes, along with stratigraphical profiles based on the borehole data are shown on Drawing No. 1398701/04-A\*\* and 1398701/04-B.\*\*

The ground level at the site is quite variable due to the grade of the existing CNR tracks. The ground level varies from elevations 204 m to 211 m. The sudden variations in ground surface elevations are due to existing cuts for the CNR tracks, which are up to 6 m deep and sloped at approximately 2H:1V.

The site is predominantly underlain by clayey silt till as a surficial layer which ranges in thickness from 6.2 m to 24.7 m. This layer is underlain by a silt to sandy silt till. All deep boreholes (boreholes for bridges) were terminated in the lower layer of silt to sandy silt till.

Within the limits of the structures, the overburden consists of the following generalized layers, in sequence, from the surface down.

Proposed Structure	CLAYEY SILT TILL		SILT TO SANDY SILT TILL	
	Top Elevation (m)	Thickness Range (m)	Top Elevation (m)	Penetration in Stratum* (m)
West Abutment	206.8 to 208.2	9.9 to 11.4	196.8 to 197.5	2.7 to 11.4
Pier 1	208.5 to 208.7	up to 16.0	192.5 to 192.6	5.2 to 7.2
Pier 2	209.4 to 209.6	12.6 to 15.7	195.0	3.9
Pier 3	209.2 to 210.0	9.9 to >15.4	198.6 to 200.1	2.6 13.3
Pier 4	209.1 to 209.4	14.5 to >24.7	187.3 to 194.6	7.3
East Abutment	209.7 to 210.7	11.4 to 23.6	187.1 to 199.2	8.5
Northeast Retaining Wall	209.7 to 210.7	>9.6		
Northwest Retaining Wall	202.5 to 204.1	6.2 to >8.2		
Southeast Retaining Wall	198.9 to 210.6	>7.7		

\*Note: Boreholes were terminated within this layer. Figures shown are the borehole penetration within the stratum. Actual thickness of this layer could be more than shown here.

\*\* Drawings No 4 & 5 of the Contract Drawings.

Following are detailed descriptions of the soil strata encountered.

### Clayey Silt Till

This cohesive material is a glacial till. This stratum was encountered in all boreholes usually as the surficial layer at the site. At some locations (BH's 2, 19, 26 and 27) this layer was found to be overlain by fill material varied in thickness from 1.4 m (BH 2) to 3.7 m (BH 26). The top elevation of this stratum varied from 198.9 m to 210.7 m. The thickness ranged from 6.2 m (BH 26) to more than 24 m (BH 14). Occasional non-cohesive zones of sand and silty sands from 1.5 m to 3 m thick were encountered within this layer.

The Standard Penetration test 'N' value ranged from 0 to 223 blows/0.3 m. The low 'N' values were occasional and may have been caused by disturbed silt layers. 'N' values between 15 and 40 blows/0.3 m were more frequent which indicates that the stratum is generally very stiff to hard. However, higher 'N' values between 50 and more than 100 blows/0.3 m were achieved at lower depths.

Typical properties of the material, as determined by laboratory tests of representative samples, are summarized as follows:

	<u>Range %</u>	<u>Average %</u>
Natural Moisture Content (w)	7-24	11
Liquid Limit (W <sub>p</sub> )	12-44	19
Plastic Limit (W <sub>L</sub> )	9-19	12
Plasticity Index (I <sub>p</sub> )	1-30	7

Figure 1 illustrates a typical plasticity envelope for this material.

Figure 2 illustrates a typical grain size distribution envelope for this material.

### Silty to Sandy Silt Till

This non-cohesive stratum is a glacial till and is underlying the surficial layer of clayey silt till. The top elevation of this stratum varied from 187.1 m to 200.1 m. All deep boreholes (i.e. borehole for bridge structures) were terminated in this layer. Therefore, the exact thickness of this stratum is undetermined. However, the deep boreholes were advanced from 1.2 m to 13.3 m in this layer. Occasional cohesive zones (BH 4, BH 10 and BH 12) were also encountered within this stratum.

The Standard Penetration test 'N' value ranged from 27 to 175 blows/0.3 m. Occasionally lower 'N' values were recorded, but they were due to disturbed soil caused by unbalanced hydrostatic condition.

### GROUNDWATER

The groundwater was recorded in six piezometers after the completion of the field work (1990 06 21) and several days after the piezometers were installed. The water levels are shown on individual log sheets and also in the Table given below. The groundwater stabilized at depths varying from 1.3 m to 6.9 m below the ground surface. The groundwater elevation therefore, ranged from 201.7 m to 207.7 m.

#### RECORD OF GROUNDWATER LEVEL

Borehole No.	Water Level Elevation (m)	Depth Below Surface (m)
3	205.5	1.3
4	201.7	6.9
9	203.6	6.0
10	202.7	6.5
16	206.6	3.1
24	207.7	2.5

It should be noted that the groundwater elevations are variable across the site. It is anticipated that the groundwater is present in water bearing non-cohesive deposits interbedded in the generally cohesive glacial till. Also, it should be noted that groundwater levels are subject to seasonal fluctuations and may therefore, change from what shown here. Normally, the permanent water table situates where the soil changes its colour from brown to grey.

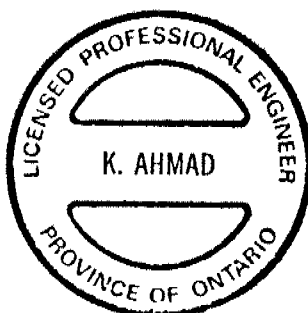


MISCELLANEOUS

The field work for this project was carried out under the supervision of K. Ahmad, Foundation Engineer and B. Lane, Engineering Student.

The equipment used was owned and operated by Master Soil Investigation Ltd.

The report was written by K. Ahmad and B. Bennett, Foundation Engineers, reviewed by D. Dundas, Senior Foundation Engineer and approved by M. Devata, Chief Foundation Engineer.



K. Ahmad, P.Eng.  
Foundation Engineer



D. Dundas, P. Eng.  
Chief Foundation Engineer  
(Acting)

APPENDIX



WITH SAND, TRACE GRAVEL, OCC SANDY SILT SEAMS

W P 139-87-01,03,04



## GRAIN SIZE DISTRIBUTION CLAYEY SILT TILL

FIG No 2

W P 139-87-01,03,04

# RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 139-87-01,03,04 LOCATION N 4 849 729.0, E 303 953.0 ORIGINATED BY KA  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY MJR,BB  
DATUM GEODETIC DATE 90 06 13 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W <sub>P</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub>	WATER CONTENT (%) 10 20 30	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							
208.2	Ground Surface											
0.0						*	208					
	Trace Organics		1	SS	22							
			2	SS	26							
			3	SS	37							
			4	SS	44							
	Brown		5	SS	40							
	Grey		6	SS	11							2 32 58 8
			7	SS	14							
	CLAYEY SILT TILL		8	SS	11							
	With Sand											
	Trace Gravel											
	Occ. Sandy Silt seams		9	SS	19							
	Stiff to Hard											
			10	SS	36							16 29 (55)
196.8			11	SS	116							4 29 49 18
11.4	SILT to SANDY SILT TILL											
	Trace Gravel		12	SS	143	/23cm	196					0 25 68 7
	Trace Clay											
	Occ. Clayey Silt zones											
194.1	Very Dense		13	SS	116	/26cm						
14.1	End of Borehole											
	• Not established											

# RECORD OF BOREHOLE No 2

1 OF 1 METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 702.5, E 303 962.0 ORIGINATED BY BL  
 DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY MJR,BB  
 DATUM GEODETIC DATE 90 06 13-14 CHECKED BY DD

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			20 40 60 80 100	20 40 60 80 100					
208.9	Ground Surface													
0.0	GRAVELLY SAND Trace Silt Trace Clay Very Dense (Fill Material)		1	SS	74	*	208							
207.5			2	SS	12									
1.4			3	SS	22									
	Trace Organics		4	SS	22									
			5	SS	27									
			6	SS	27									
	Brown		7	SS	20									
	Grey		8	SS	7									
	CLAYEY SILT TILL With Sand Trace Gravel Occ. Sandy Silt seams Stiff to Hard		9	SS	12									
			10	SS	12									
197.5			11	SS	43									
11.4	SILT to SANDY SILT TILL Trace Gravel Trace Clay Occ. Clayey Silt zones Very Dense		12	SS	85									
194.7			13	SS	88									
14.2	End of Borehole													
	* Not established													

# RECORD OF BOREHOLE No 3

1 OF 1 METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 675.3, E 303 971.5 ORIGINATED BY KA  
DIST 5 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BLBB  
DATUM GEODETIC DATE 90 06 12-13 CHECKED BY DO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 20 40 60 80 100	PLASTIC LIMIT W <sub>P</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub>	WATER CONTENT (%) 10 20 30	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											
206.8	Ground Surface															
0.0	CLAYEY SILT TILL With Sand Trace Gravel Occ. Sandy Silt seams Stiff to Hard  Brown Grey		1	SS	14		206									
			2	SS	18											
			3	SS	16											
			4	SS	18											
			5	SS	20											
			6	SS	16											
			7	SS	22											
			8	SS	23											
			9	SS	18											
			10	SS	53											
196.9	9.9  SILT to SANDY SILT TILL Trace Gravel Trace Clay Occ. Clayey Silt zones Occ. Sand Zones  Dense to Very Dense		11	SS	71		196									
			12	SS	40											
			13	SS	88											
			14	SS	71											
			15	SS	86											
			16	SS	42											
			17													
185.5	End of Borehole															
21.3	<p>• GROUND WATER CONDITIONS</p> <table border="1"> <tr> <td>PIEZO. NO.</td> <td>GROUND WATER ELEVATION (Metres)</td> </tr> <tr> <td>1</td> <td>205.5</td> </tr> </table>												PIEZO. NO.	GROUND WATER ELEVATION (Metres)	1	205.5
PIEZO. NO.	GROUND WATER ELEVATION (Metres)															
1	205.5															

# RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 139-87-01,03,04

LOCATION N 4 849 752.0, E 304 020.0

ORIGINATED BY BL

DIST 6 HWY 407

BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER

COMPILED BY BL

DATUM GEODETIC

DATE 90 06 15-18

**CHECKED BY** DD

[illegible]

+3, x5: Numbers refer to Sensitivity



# RECORD OF BOREHOLE No 5

1 OF 1 METRIC

W.P. 139-87-01,03,04 LOCATION N 4 849 723.0, E 304 024.5 ORIGINATED BY BL  
DIST 5 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY MJR, BB  
DATUM GEODETIC DATE 90 06 19 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			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			20 40 60 80 100	20 40 60 80 100	w <sub>p</sub>	w	w <sub>L</sub>		
208.7	Ground Surface													
0.0	Trace Organics		1	SS	21	*	208							
			2	SS	22		206							
			3	SS	22		204							
			4	SS	31		202							
	Brown		5	SS	25		200							
	Grey		6	SS	9		198							
			7	SS	8		196							
	CLAYEY SILT TILL		8	SS	13									
	With Sand		9	SS	19									
	Trace Gravel		10	SS	100									
	Occ. Sandy Silt seams		11	SS	94									
	Stiff to Hard		12	SS	74									
198.8			13	SS	223									
9.9	SILT to SANDY SILT TILL													
	Trace Gravel Trace Clay													
	Very Dense													
	Occ. Clayey Silt Zones													
194.7														
14.0	End of Borehole													
	• Not Established													

# RECORD OF BOREHOLE No 6

1 OF 1- METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 695.0, E 304 029.0 ORIGINATED BY KA  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BLBB  
DATUM GEODETIC DATE 90 06 18 CHECKED BY DD

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 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
208.5	Ground Surface													
0.0														
	CLAYEY SILT		1	SS	20									
			2	SS	10									
			3	SS	36									
			4	SS	39									
			5	SS	43									
			6	SS	32									
			7	SS	16									
			8	SS	18									
	CLAYEY SILT TILL with Sand Trace Gravel Occ. Sandy Silt Seams Stiff to Hard		9	SS	26									6 34 45 15
			10	SS	27									
			11	SS	50									6 29 55 10
			12	SS	70									
			13	SS	137	/23cm								
			14	SS	48									
192.3			15	SS	3	**								0 88 (12)
16.2			16	SS	59	**								
	SILT TO SANDY SILT Occ. Sand Zones Trace Gravel V. Dense		17	SS	127									
			18	SS	127	/23cm								
185.3			19	SS	147									
23.2	End of Borehole * Not Established ** Disturbed													

## RECORD OF BOREHOLE No 7

1 OF 1-

METRIC

W.P. 139-87-01,03,04

LOCATION N 4 849 767.5, E 304 066.0

ORIGINATED BY KA

DIST 6 HWY 407BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER

COMPILED BY BLBB

DATUM GEODETIC

DATE 90 06 20

CHECKED BY DD

[illegible]

+3, x5: Numbers refer to Sensitivity

## METRIC

+3, x5: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 9

1 OF 1 METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 713.0, E 304 084.5 ORIGINATED BY KA  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BLBB  
DATUM GEODETIC DATE 90 06 19 CHECKED BY DD

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		
209.6	Ground Surface														
0.0			1	SS	12										
			2	SS	8										
			3	SS	6										
			4	SS	23										
			5	SS	25										
	Brown		6	SS	22										
	Grey		7	SS	14										
			8	SS	12										
	CLAYEY SILT TILL														
	With Sand		9	SS	20										
	Trace Gravel														
	Occ. Sandy Silt seems		10	SS	20										
	Firm to Hard														
			11	SS	41										
	Sand Zone														
	Trace Silt		12	SS	139										
	Dense														
			13	SS	136										
193.9			14	SS	124										
15.7	End of Borehole														
<p>* GROUND WATER CONDITIONS</p> <table border="1"> <tr> <th>PIEZO NO.</th> <th>GROUND WATER ELEVATION (Metres)</th> </tr> <tr> <td>1</td> <td>203.6</td> </tr> </table>												PIEZO NO.	GROUND WATER ELEVATION (Metres)	1	203.6
PIEZO NO.	GROUND WATER ELEVATION (Metres)														
1	203.6														

# RECORD OF BOREHOLE No 10

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 792.0, E 304 138.5 ORIGINATED BY KA  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BLBB  
DATUM GEODETIC DATE 90 06 14 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL * LAB VANE 20 40 60 80 100	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								
209.2	Ground Surface												
0.0			1	SS	21		208						
			2	SS	25								
			3	SS	21								
			4	SS	38		206						
	Brown		5	SS	38								
	Grey		6	SS	37							22.9	50 27 13 10
			7	SS	22		204	120/25cm					
			8	SS	25								
	CLAYEY SILT TILL With Sand Trace Gravel Occ. Sandy Silt seams Very Stiff to Hard		9	SS	27		202						
			10	SS	17		200						7 34 41 18
			11	SS	55	/5cm	198						
186.9			12	SS	116								0 56 32 12
12.3	SILT to SANDY SILT TILL Trace Gravel Trace Clay Very Dense		13	SS	201	/23cm	196						
			14	SS	120	/13cm	194						
193.8													
15.4	End of Borehole												

\* GROUND WATER CONDITIONS

PIEZO NO.	GROUND WATER ELEVATION (Metres)
1	202.7

RECORD OF BOREHOLE No 11

1 OF 1

METRIC

W.P. 139-87-01,03,04 LOCATION N 4 849 761.5, E 304 138.5 ORIGINATED BY KA  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BB  
DATUM GEODETIC DATE 90.06.15 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIMIT MOISTURE CONTENT		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			20 40 60 80 100	20 40 60 80 100	w <sub>p</sub> w w <sub>L</sub>	10 20 30		
210.0	Ground Surface												
0.0						*							
	Trace Organics		1	SS	21								
			2	SS	17								
			3	SS	27								
			4	SS	29								
	Brown		5	SS	35								
	Grey		6	SS	18								
			7	SS	14								
	CLAYEY SILT TILL		8	SS	15								
	With Sand												
	Trace Gravel												
	Occ. Sandy Silt seems		9	SS	16								
	Stiff to Hard												
198.6			10	SS	13								
11.4			11	SS	29								
	SILT to SANDY SILT TILL												
	Trace Gravel		12	SS	130								
	Trace Clay												
	Very Dense												
196.0			13	SS	175								
14.0	End of Borehole												
	* Not Established												

# RECORD OF BOREHOLE No 12

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 731.5, E 304 139.0 ORIGINATED BY KA  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BLBB  
DATUM GEODETIC DATE 90 06 14 CHECKED BY DD

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			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100					
210.0	Ground Surface														
0.0						*									
	Trace Organics		1	SS	12										
			2	SS	25										
			3	SS	20										
			4	SS	28										
			5	SS	38										
	Brown		6	SS	26										
	Grey		7	SS	16										
	CLAYEY SILT TILL		8	SS	18										
	With Sand		9	SS	19										
	Trace Gravel														
	Stiff to Hard														
200.1			10	SS	22								22.9	9 33 43 15	
9.9			11	SS	48									0 69 (31)	
			12	SS	116	/28cm									
			13	SS	104	/15cm									
	Clayey Silt Zone		14	SS	74									0 1 66 33	
			15	SS	70										
	SILT to SANDY SILT TILL		16	SS	55									0 48 42 10	
	Trace Gravel		17	SS	125	/21cm									
	Trace Clay		18	SS	109										
	Occ. Clayey Silt zones														
	Very Dense														
186.8			19	SS	131	/21cm									
23.2	End of Borehole														
	* Not Established														



# RECORD OF BOREHOLE No 13

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 818.5, E 304 216.0 ORIGINATED BY KA  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BL/BB  
DATUM GEODETIC DATE 90 06 04 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 20 40 60 80 100	PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
209.4	Ground Surface												
0.0			1	SS	20								
			2	SS	36								
			3	SS	43								
	Brown		4	SS	41								
	Grey		5	SS	37								
			6	SS	21								
			7	SS	28								
	CLAYEY SILT TILL		8	SS	24								
	With Sand												
	Trace Gravel												
	Occ. Sandy Silt seams		9	SS	23								
	Very Stiff to Hard		10	SS	25								
			11	SS	16								
			12	SS	81								
	Silt to Sandy Silt Zone		13	SS	26								
			14	SS	16								
			15	SS	33								
			16	SS	81								
			17	SS	118								
187.3			18	SS	23								
22.1			19	SS	156								
	SILT to SANDY SILT TILL		20	SS	103								
	Trace Gravel												
	Trace Clay												
	Occ. Clayey Silt zones												
	Very Dense		21	SS	105								
183.0													
26.4	End of Borehole												

# RECORD OF BOREHOLE No 14

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 790.0, E 304 220.5 ORIGINATED BY KA  
DIST 5 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BLBB  
DATUM GEODETIC DATE 90 06 05 CHECKED BY DD

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 7 KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
209.2	Ground Surface													
0.0						*								
			1	SS	28		208							
			2	SS	40		206							
			3	SS	19		204							
	Brown		4	SS	17		202						22.7	7 31 44 18
	Grey		5	SS	26		200							
			6	SS	22		198							
			7	SS	21		196							
	Sandy Silt Zone		8	SS	36		194						4	41 44 11
			9	SS	15		192							
			10	SS	12		190						3	35 49 13
	CLAYEY SILT TILL		11	SS	34		188							
	With Sand		12	SS	56		186							
	Trace Gravel		13	SS	74									
	Occ. Sandy Silt seams		14	SS	51									
	Stiff to Hard		15	SS	49									
184.5			16	SS	127	/18cm								
24.7	End of Borehole													
	• Not Established													

# RECORD OF BOREHOLE No 15

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 762.0, E 304 227.0 ORIGINATED BY KA  
 DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BLBB  
 DATUM GEODETIC DATE 90 06 06 CHECKED BY DD

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			20	40						60	80
209.1	Ground Surface															
0.0																
			1	SS	40											
			2	SS	44											
			3	SS	18											
			4	SS	17											
			5	SS	11											
			6	SS	11											
			7	SS	16											
			8	SS	17											
			9	SS	52											
			10	SS	108											
194.6			11	SS	69											
14.5			12	SS	27											
			13	SS	102	/26cm										
			14	SS	119	/28cm										
			15	SS	126	/21cm										
187.3			16	SS	134											
21.8	End of Borehole															
	* Not established															

RECORD OF BOREHOLE No 16

1 OF 1 METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 834.0, E 304 262.0 ORIGINATED BY KA  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BLBB  
DATUM GEODETIC DATE 90 06 11 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH $kPa$ ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC UNIT $w_p$	NATURAL MOISTURE CONTENT $w$	LIQUID UNIT $w_L$	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								
209.7	Ground Surface												
0.0	Trace Organics		1	SS	9								
			2	SS	17								1 7 37 55
			3	SS	25								1 34 40 25
			4	SS	24								
			5	SS	40								
	Brown		6	SS	51								
	Grey		7	SS	60								
			8	SS	41								
	CLAYEY SILT TILL With Sand Trace Gravel Occ. Sandy Silt seams Stiff to Hard		9	SS	33								
			10	SS	70								
			11	SS	24								4 32 44 20
			12	SS	102								4 36 47 13
			13	SS	67								
193.7			14	SS	64								
16.0	SILT to SANDY SILT TILL Trace Gravel Trace Clay Occ. CL seams Very Dense		15	SS	52								
192.5													
17.2	End of Borehole												
• GROUND WATER CONDITIONS PIEZO. NO. 1 GROUND WATER ELEVATION (Metres) 206.6													

RECORD OF BOREHOLE No 17

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 807.0, E 304 271.0 ORIGINATED BY KA  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BLB  
DATUM GEODETIC DATE 90 06 11 CHECKED BY DD

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			20 40 60 80 100	20 40 60 80 100					
210.6	Ground Surface													
0.0						*								
	Trace Organics		1	SS	15		210							
			2	SS	12									
	CLAYEY SILT TILL		3	SS	40		208							
	With Sand		4	SS	28									
	Trace Gravel		5	SS	28		206							
	Occ. Sandy Silt seams		6	SS	32									
	Stiff to Hard		7	SS	44									
	Brown		8	SS	20		204							
	Grey		9	SS	19									
			10	SS	24		202							
			11	SS	19		200							
199.2														
11.4	SILT to SANDY SILT TILL													
	Trace Gravel Trace Clay													
198.0	Occ. Clayey Silt Seams Dense		12	SS	44		198							
12.6	End of Borehole													
	* Not Established													

RECORD OF BOREHOLE No 18

1 OF 2

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 780.0, E 304 280.0 ORIGINATED BY KA  
DIST 5 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BLBB  
DATUM GEODETIC DATE 90 06 07-11 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT		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			20 40 60 80 100	20 40 60 80 100	W <sub>P</sub> W W <sub>L</sub>	10 20 30		
210.7	Ground Surface												
0.0													
	Trace Organics		1	SS	9		210						
	Sandy Silt zone		2	SS	12		208						8 34 42 16
			3	SS	30								
			4	SS	25								
			5	SS	31								
			6	SS	39								
			7	SS	31								
			8	SS	17								
	CLAYEY SILT TILL												
	With Sand												
	Trace Gravel												
	Occ. Sandy Silt seams												
	Stiff to Hard												
			9	SS	22		202						8 33 44 15
			10	SS	17		200						
			11	SS	20								
			12	SS	40		198						
	Sandy Silt zone												
			13	SS	85		196						3 38 45 14
			14	SS	28		194						
			15	SS	30								
			16	SS	30		192						
			17	SS	23		190						4 34 47 15
			18	SS	47								
			19	SS	26		188						
187.1													
23.6			20	SS	8 *		186						
	SILT to SANDY SILT TILL												
	Trace Gravel												
	Trace Clay												
	Occ. Clayey Silt zones												
	Loose to very Dense												
			21	SS	20		184						3 50 43 4
			22	SS	30								
			23	SS	128		182						
180.2													

30.5

Continued

+3, x5: Numbers refer to  
Sensitivity

20  
15-5 (%) STRAIN AT FAILURE  
10

Continued

RECORD OF BOREHOLE No 18

2 OF 2

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 780.0, E 304 280.0 ORIGINATED BY KA  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BL, BB  
DATUM GEODETIC DATE 90 06 07-11 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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			20	40	60	80	100	w <sub>p</sub>	w	w <sub>L</sub>		
180.2	Continued																
30.5	SILT to SANDY SILT TILL Trace Gravel Trace Clay Occ. Clayey Silt zones Loose to Very Dense	24	SS	148	7/26cm	180											
178.6		25	SS	130	7/11cm												
32.1	End of Borehole • Disturbed •• Not Established																

# RECORD OF BOREHOLE No 19

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 789.0, E 304 319.5 ORIGINATED BY BL  
 DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BB  
 DATUM GEODETIC DATE 90 06 12 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES								
210.8	Ground Surface												
0.0	CLAYEY SILT (FILL) Brown Trace Organics Firm to Stiff		1	SS	10		210						
208.9			2	SS	7		208						
1.9			3	SS	12								
			4	SS	22								
			5	SS	32								
			6	SS	32								
	Brown Grey		7	SS	16								
			8	SS	18								
	CLAYEY SILT TILL With Sand Trace Gravel Occ. Sandy Silt seams Firm to Hard		9	SS	17								
201.2			10	SS	17								
9.6	End of Borehole												



# RECORD OF BOREHOLE No 20

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 800.7, E 304 362.0 ORIGINATED BY BL  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, SOLID STEM AUGER COMPILED BY BB  
DATUM GEODETIC DATE 90 06 12 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
210.6	Ground Surface												
0.0													
			1	SS	7		210						
			2	SS	18								
			3	SS	51		208						
			4	SS	70								
			5	SS	43								
			6	SS	26		206						
			7	SS	20								
			8	SS	25		204						
			9	SS	24								
			10	SS	20		202						
201.0													
9.6	End of Borehole * Not Established												

# RECORD OF BOREHOLE No 21

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 815.3, E 304 407.5 ORIGINATED BY BL  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, SOLID STEM AUGER COMPILED BY BB  
DATUM GEODETIC DATE 90 06 12 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
210.0	Ground Surface											
0.0												
			1	SS	11							
			2	SS	26							
			3	SS	26							
			4	SS	34							
			5	SS	48							
			6	SS	27							
			7	SS	25							
			8	SS	26							
			9	SS	33							
200.4			10	SS	17							
9.6	End of Borehole											
	• Not Established											

# RECORD OF BOREHOLE No 22

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 860.5, E 304 275.0 ORIGINATED BY BL  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, SOLID STEM AUGER COMPILED BY BB  
DATUM GEODETIC DATE 90 06 04 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL * LAB VANE 20 40 60 80 100	PLASTIC LIMIT W <sub>P</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub>	WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA S <sub>1</sub> CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES							
209.7	Ground Surface											
0.0	Topsoil		1	SS	5	*						
			2	SS	22							
			3	SS	42							
			4	SS	43							
	Brown		5	SS	56							2 34 45 19
	Grey		6	SS	36							10 32 39 19
			7	SS	32							
			8	SS	42							
			9	SS	32							
	CLAYEY SILT TILL											
	Some Sand											
	Trace Gravel											
	Occ. Sandy Silt zones		10	SS	24							
	Very Stiff to Hard											
			11	SS	31							
198.6			12	SS	41							
11.1	End of Borehole											
	* Not Established											

# RECORD OF BOREHOLE No 23

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 872.7, E 304 318.0 ORIGINATED BY BL  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, SOLID STEM AUGER COMPILED BY BB  
DATUM GEODETIC DATE 90 06 12 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	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								
208.7	Ground Surface												
0.0													
			1	SS	7								
			2	SS	5								
			3	SS	20								
			4	SS	28								
			5	SS	15								
			6	SS	16								
			7	SS	31								
			8	SS	20								
			9	SS	21								
			10	SS	21								
200.1													
9.6	End of Borehole												

## METRIC

CHECKED BY DD

+3, x5: Numbers refer to Sensitivity

# RECORD OF BOREHOLE No 25

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 733.5, E 303 900.0 ORIGINATED BY BL  
 DIST 5 HWY 407 BOREHOLE TYPE CONE TEST, SOLID STEM AUGER COMPILED BY BB  
 DATUM GEODETIC DATE 90 06 19 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID UNIT MOISTURE CONTENT UNIT		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			20 40 60 80 100	20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>	WATER CONTENT (%)		
205.5	Ground Surface												
0.0	SAND Trace Gravel Very Dense (Fill Material)		1	SS	143								
204.1			2	SS	20								
1.4	CLAYEY SILT TILL With Sand Trace Gravel		3	SS	9								
			4	SS	34								
			5	SS	42								
			6	SS	47								
	Brown		7	SS	25								
	Grey		8	SS	27								
	Occ. Sandy Silt seams Stiff to Hard		9	SS	45								
195.9			10	SS	53								
9.6	End of Borehole												

RECORD OF BOREHOLE No 26

1 OF 1

METRIC

W.P. 139-87-01,03,04 LOCATION N 4 849 712.6, E 303 833.5 ORIGINATED BY BL  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, SOLID STEM AUGER COMPILED BY BB  
DATUM GEODETIC DATE 90 06 20 CHECKED BY DD

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						
206.2	Ground Surface							20 40 60 80 100	20 40 60 80 100	10 20 30				
0.0	SAND AND GRAVEL Some Silt Trace Asphalt Dense (Fill Material)		1	SS	36	*	206	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
204.8								20 40 60 80 100						
1.4	ORGANIC SILT to CLAYEY SILT Some Sand Trace Gravel Trace Organics/Wood Chips Trace Asphalt Very Soft to Stiff (Fill Material)		2	SS	49		204							0 17 71 12
202.5			3	SS	1									
3.7			4	SS	10									
			5	SS	8		202							0 13 62 25
			6	SS	6									
			7	SS	7		200							
			8	SS	13									
			9	SS	18		198							
196.3			10	SS	25									
9.9	SILT to SANDY SILT Trace Gravel Trace Clay Occ. CL zones Dense						196							
195.1			11	SS	39									3 39 46 12
11.1	End of Borehole													
	• Not Established													
	** Bouncing on piece of wood													

RECORD OF BOREHOLE No 27

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 684.5, E 303 742.5 ORIGINATED BY BL  
DIST 5 HWY 407 BOREHOLE TYPE CONE TEST, SOLID STEM AUGER COMPILED BY BB  
DATUM GEODETIC DATE 90 06 20 CHECKED BY DD

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 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
205.1	Ground Surface													
0.0	SAND Some Gravel Some/With Silt Trace Clay Very Stiff (Fill Material)		1	SS	21									
203.7			2	SS	27									
1.4	CLAYEY SILT TILL With Sand Trace Gravel Occ. Sandy Silt seams Very Stiff to Hard		3	SS	30									
			4	SS	34									
			5	SS	31									
			6	SS	32									
			7	SS	25									
			8	SS	33									
			9	SS	116									
195.7			10	SS	161	31cm								
9.4	End of Borehole													
	* Not Established													



Foundation Investigation Report  
for High Mast Lighting  
CNR MacMillan Yard Overhead  
W.P. 139-87-00 (B)  
Highway 407, District 6

Soil information was obtained from previous foundation investigations at this site (WP 139-87-01, 03, 04, Site No. 37-1317, dated November 30, 1990), which was carried out for the construction of Highway 407 bridge structure over MacMillan Yard. Relevant borehole logs are attached.

It may be assumed that subsurface conditions at High Mast Light locations will be similar to those encountered in the closest boreholes.

*P. Payor*  
for Ken Ahmad, P. Eng.  
Foundation Engineer



*D. Dundas*  
Dave Dundas, P. Eng.  
Chief Foundation Engineer  
(Acting)

# RECORD OF BOREHOLE No 2

1 of 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 702.5, E 303 962.0 ORIGINATED BY BL  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY MJB,BB  
DATUM GEODETIC DATE 90 06 13-14 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT		UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>	
208.9	Ground Surface												
0.0	GRAVELLY SAND Trace Silt Trace Clay Very Dense (Fill Material)		1	SS	74	*	208						
207.5			2	SS	12								0 24 (76)
1.4	Trace Organics		3	SS	22								
			4	SS	22								
			5	SS	27								
			6	SS	27								
	Brown		7	SS	20								
	Grey		8	SS	7								
	CLAYEY SILT TILL With Sand Trace Gravel Occ. Sandy Silt seams Stiff to Hard		9	SS	12							22.0	4 30 42 24
			10	SS	12								
197.5			11	SS	43							24.0	7 32 41 20
11.4	SILT to SANDY SILT TILL Trace Gravel Trace Clay Occ. Clayey Silt zones		12	SS	85								0 15 75 10
194.7	Very Dense		13	SS	88								
14.2	End of Borehole												
	* Not established												

RECORD OF BOREHOLE No 16

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 834.0, E 304 262.0 ORIGINATED BY KA  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER COMPILED BY BLBB  
DATUM GEODETIC DATE 90 06 11 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT W <sub>p</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub>	WATER CONTENT (%) 10 20 30	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							
209.7	Ground Surface											
0.0	Trace Organics		1	SS	9							
			2	SS	17							
			3	SS	25							
			4	SS	24							
			5	SS	40							
	Brown		6	SS	51							
	Grey		7	SS	60							
			8	SS	41							
	CLAYEY SILT TILL		9	SS	33							
	With Sand											
	Trace Gravel		10	SS	70							
	Occ. Sandy Silt seams											
	Stiff to Hard		11	SS	24							
			12	SS	102							
			13	SS	67							
193.7			14	SS	64							
16.0	SILT to SANDY SILT TILL											
192.5	Trace Gravel Trace Clay		15	SS	52							
	Occ. CL seams Very Dense											
17.2	End of Borehole											
• GROUND WATER CONDITIONS PIEZO. NO. GROUND WATER ELEVATION (Metres) 1 206.6												

RECORD OF BOREHOLE No 20

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 800.7, E 304 362.0 ORIGINATED BY BL  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, SOLID STEM AUGER COMPILED BY BB  
DATUM GEODETIC DATE 90 06 12 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT		UNIT WEIGHT 7 KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100	20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>		
210.6	Ground Surface											
0.0			1	SS	7							
			2	SS	18							
			3	SS	51							
			4	SS	70							
			5	SS	43							
	Brown		6	SS	26							
	Grey		7	SS	20							
			8	SS	25							
	CLAYEY SILT TILL With Sand Trace Gravel Occ. Sandy Silt seams Firm to Hard		9	SS	24							
201.0			10	SS	20							
9.6	End of Borehole • Not Established											

RECORD OF BOREHOLE No 21

1 OF 1

METRIC

W.P. 139-87-01,03,04 LOCATION N 4 849 815.3, E 304 407.5 ORIGINATED BY BL  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, SOLID STEM AUGER COMPILED BY BB  
DATUM GEODETIC DATE 90 05 12 CHECKED BY DD

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			20 40 60 80 100	20 40 60 80 100						10 20 30
SHEAR STRENGTH kPa								UNCONFINED + FIELD VANE QUICK TRIAXIAL * LAB VANE							WATER CONTENT (%)
210.0	Ground Surface														
0.0	CLAYEY SILT TILL Some Sand Trace Gravel Occ. Sandy Silt seams Stiff to Hard		1	SS	11	*					1 28 (71)				
			2	SS	26										
			3	SS	26										
			4	SS	34										
			5	SS	48										
			6	SS	27										
			7	SS	25										
			8	SS	26										
			9	SS	33										
200.4			10	SS	17							7 22 47 24			
9.6	End of Borehole														
	* Not Established														

RECORD OF BOREHOLE No 25

1 OF 1

METRIC

W.P. 139-87-01,03,04 LOCATION N 4 849 733.5, E 303 900.0 ORIGINATED BY BL  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, SOLID STEM AUGER COMPILED BY BB  
DATUM GEODETIC DATE 90 06 19 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
205.5	Ground Surface															
0.0	SAND Trace Gravel Very Dense (Fill Material)		1	SS	143						502					
204.1			2	SS	20						359					
1.4	CLAYEY SILT TILL  With Sand Trace Gravel  Brown Grey  Occ. Sandy Silt seams Stiff to Hard		3	SS	9											6 40 36 18
			4	SS	34											
			5	SS	42											
			6	SS	47											
			7	SS	25											8 34 (58)
			8	SS	27											
			9	SS	45											
195.9			10	SS	53											
9.6	End of Borehole															

RECORD OF BOREHOLE No 26

1 OF 1

METRIC

W.P. 139-87-01.03.04 LOCATION N 4 849 712.6, E 303 833.5 ORIGINATED BY BL  
DIST 6 HWY 407 BOREHOLE TYPE CONE TEST, SOLID STEM AUGER COMPILED BY BB  
DATUM GEODETIC DATE 90 06 20 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT		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			20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W		
206.2	Ground Surface						206						
0.0	SAND AND GRAVEL Some Silt Trace Asphalt Dense (Fill Material)		1	SS	36		206						
204.8													
1.4	ORGANIC SILT to CLAYEY SILT Some Sand Trace Gravel Trace Organics/Wood Chips Trace Asphalt Very Soft to Stiff (Fill Material)		2	SS	48*		204						0 17 71 12
			3	SS	1								
202.5			4	SS	10		202						0 13 62 25
3.7	Brown Grey  CLAYEY SILT TILL  With Sand Trace Gravel  Occ. Sandy Silt seams  Firm to Very Stiff		5	SS	8		200						
			6	SS	6								
			7	SS	7								
			8	SS	13		198						
			9	SS	18								
196.3			10	SS	25		196						
9.8	SILT to SANDY SILT Trace Gravel Trace Clay Occ. CL zones Dense		11	SS	39								3 39 46 12
195.1													
11.1	End of Borehole  • Not Established  ** Bouncing on piece of wood												

**NOTATIONS**  
 T/A - TOP OF FINISHED PAVEMENT  
 B.M. - BENCH MARK  
 W.P. - WORKING POINT  
 E.B.L. - EAST BOUND LANES  
 W.B.L. - WEST BOUND LANES  
 H.M.L.P. - HIGH MAST LIGHTING POLE

ASPHALT, WATERPROOFING, APPROACH SLABS  
 AND RETAINING WALLS.  
 NOT PART OF THIS CONTRACT

**METRIC**  
 DIMENSIONS ARE IN METRES  
 AND/OR MILLIMETRES  
 UNLESS OTHERWISE SHOWN

DIST No 6  
**CONT No**  
**WP No 139-87-01 & 04**

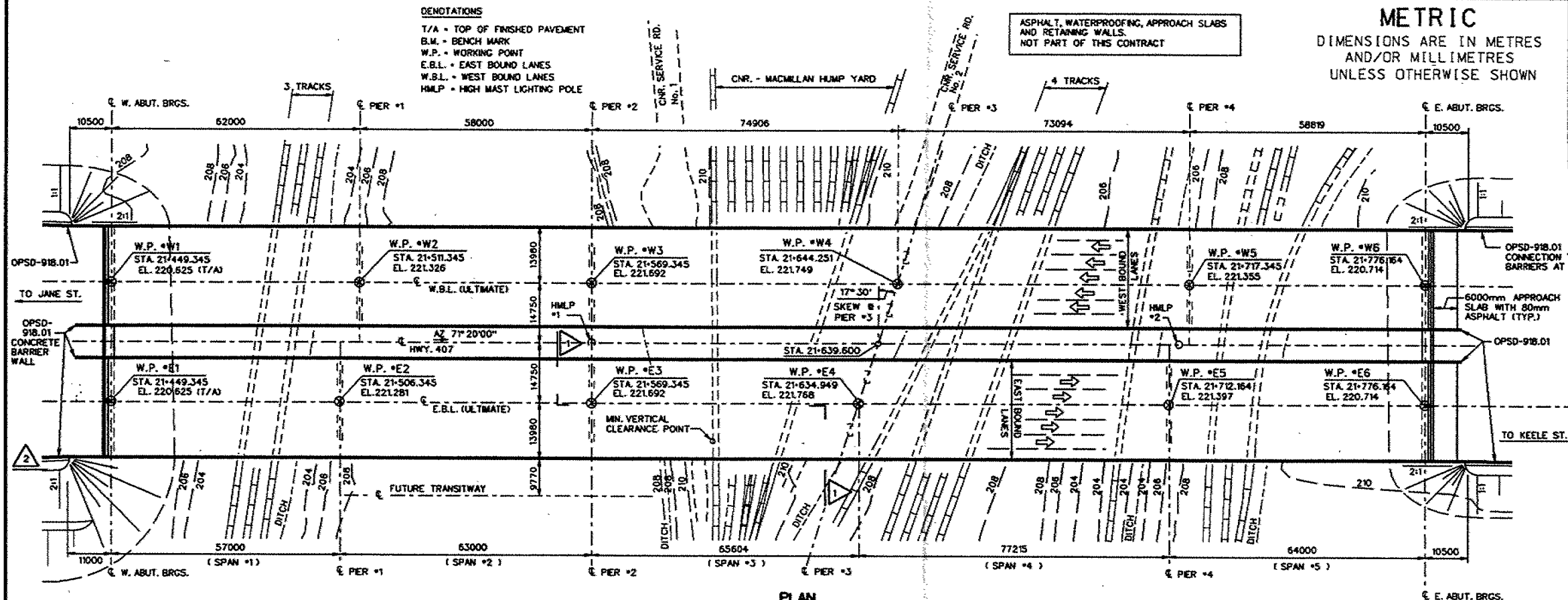


**HWY.407 / C.N.R. OVERHEAD  
 AT MACMILLAN YARD  
 W.B.L. & E.B.L. STRUCTURES  
 GENERAL ARRANGEMENT**

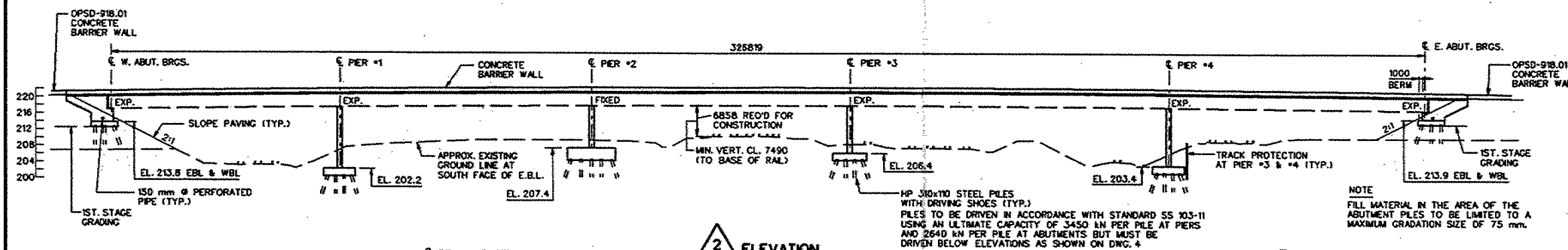
**SHEET**

**PRESTRESSED CONCRETE SCHEME**

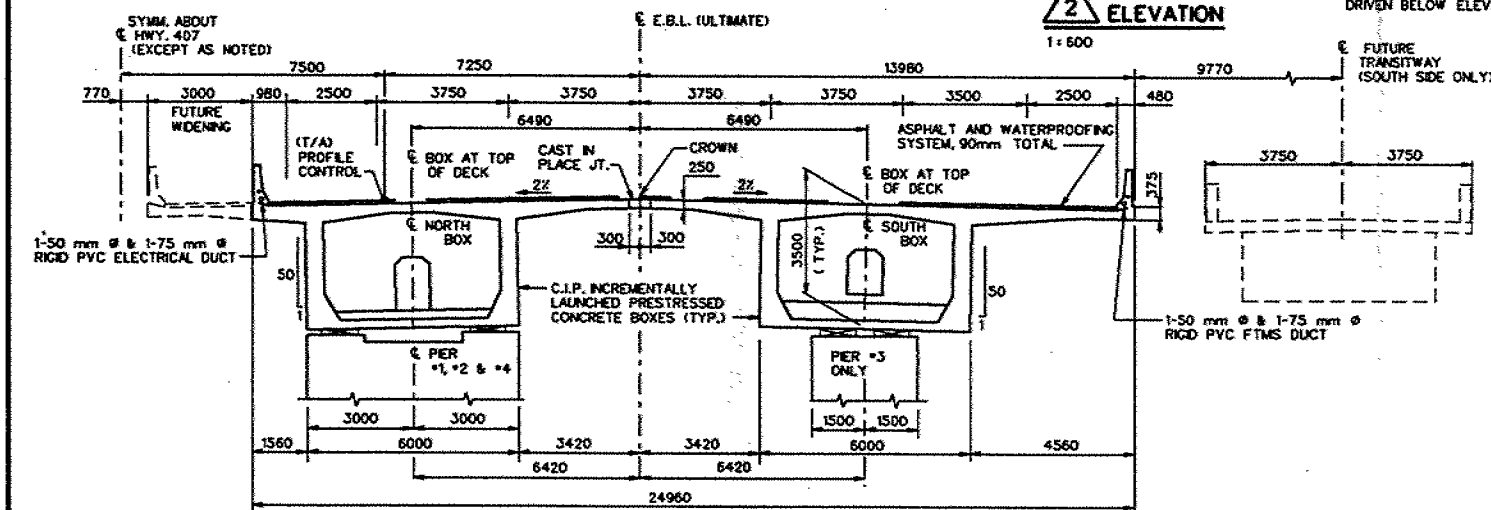
**NOTE**  
 FOR GENERAL NOTES AND LIST OF DRAWINGS SEE DWG. 2



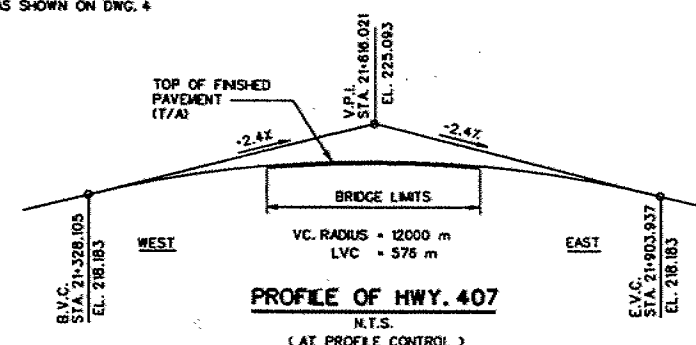
**PLAN**  
 1:500



**2 ELEVATION**  
 1:500



**1 HALF SECTION**  
 SCALE 1:100



**PROFILE OF HWY. 407**  
 N.T.S.  
 (AT PROFILE CONTROL)

**APPLICABLE STANDARD DRAWINGS**  
 OPSD-918.01 CONCRETE BARRIER CONNECTION  
 DD-3503 MIN. GRANULAR BACKFILL REQUIREMENT

BM 209.086  
 CUT CROSS ON NE CORNER OF CONCRETE DOOR  
 SLL, 57.1 RT 21-792.9 GEODETIC DATUM

DRAWING NOT TO BE SCALED  
 100 mm ON ORIGINAL DRAWING

DESIGN	CHK	CODE	DATE
DRWING/VC	CHK	37-1317	1991



WORKING POINT	W.P.#W1	W.P.#W2	W.P.#W3	W.P.#W4	W.P.#W5	W.P.#W6
STATION	21+449.345	21+511.345	21+569.345	21+644.251	21+717.345	21+776.164

**METRIC**  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

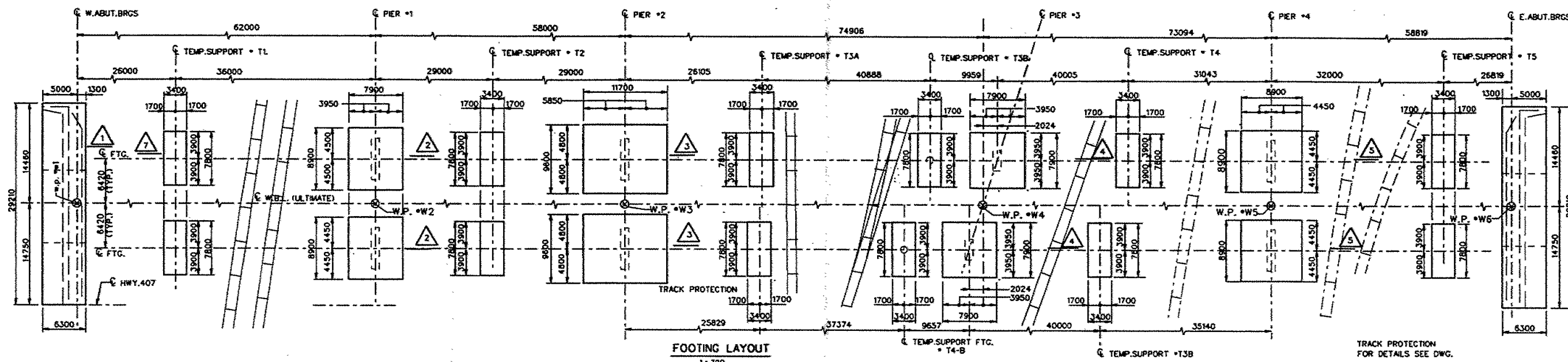
CONT No  
WP No 139 - 87 - 01

HWY.407 / C.N.R. OVERHEAD  
AT MACILLAN YARD  
W.B.L. STRUCTURE  
FOOTING LAYOUT

PRESTRESSED CONCRETE SCHEME



SHEET



FOOTING LAYOUT  
1:300

TRACK PROTECTION  
FOR DETAILS SEE DWG.

#### PILE DATA

LOCATION	NO.	BATTER	LENGTH (mm)	MINIMUM PILE PENETRATION ELEV. (M)
WEST ABUT.	42	1:3	21820	EL195.000
	21	1:3.5	21530	
	21	1:4	21340	
PIER #1 N. & S.	10	1:4	14230	EL195.000
	6	1:5	14070	
	14	1:6	13990	
	10	1:7	13940	
	5	VERT.	13800	
PIER #2 N. & S.	10	1:3	10120	EL197.000
	10	1:4	9900	
	10	1:5	9790	
	10	1:6	9730	
	18	1:8	9680	
PIER #3 N. & S.	24	1:6	10140	EL197.000
	16	1:7	10100	
	9	VERT.	10000	
	10	1:4	19280	
	6	1:5	19070	
PIER #4 N. & S.	2	1:6	18960	EL185.000
	16	1:7	18890	
	12	1:8	18850	
	6	VERT.	18700	
	11	VERT.	26900	
EAST ABUT.	21	1:3	28360	EL190.000
	21	1:3.5	27980	
	21	1:4	27730	

#### NOTES

- PILES ARE HP310 X 110
- PILES SPACING TO BE MEASURED AT THE UNDERSIDE OF FOOTINGS
- PILE LENGTH SHOWN ON THE DRAWING IS THE THEORETICAL LENGTH BELOW CUT-OFF
- AFTER PILES ARE DRIVEN TO THE MINIMUM PILE PENETRATION ELEVATION (SEE PILE DATA TABLE) PILE DRIVING SHOULD BE CONTROLLED BY THE HILEY FORMULA AS PER STD SS103-10 OR SS103-11
- DRIVING SHOES TO BE PROVIDED ON ALL PILES

#### PILE DESIGN DATA

##### FOR PILE AT ABUTMENT

- CAPACITY AT SLS.II : 880 KN/PILE
- FACTORED CAPACITY AT ULS : 1230 KN/PILE

##### FOR PILE AT PIERS

- CAPACITY AT SLS.II : 1150 KN/PILE
- FACTORED CAPACITY AT ULS : 1600 KN/PILE

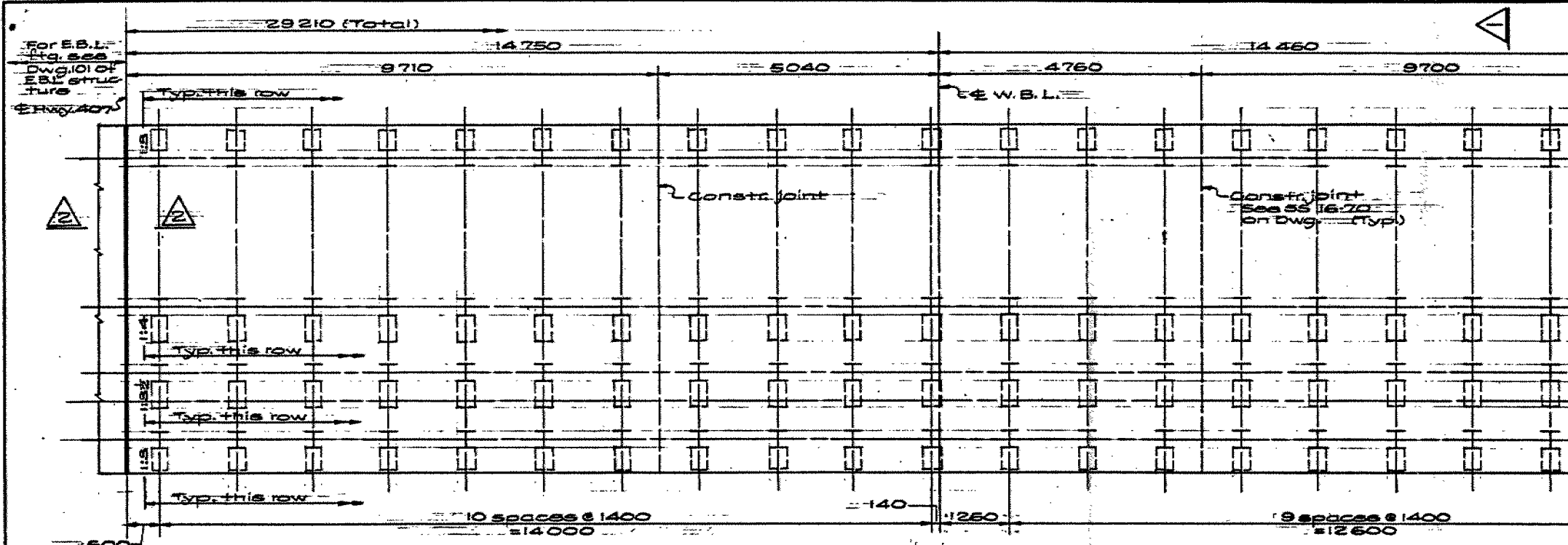
#### APPLICABLE STANDARD DRAWINGS

DD-3301-SPLICE AND DRIVING SHOE DETAILS  
FOR STEEL "H" PILES.

NOTE  
FOR PILE LAYOUT AND FOOTING DETAILS SEE DWGS.

DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

REVISIONS	DESCRIPTION
DESIGN KYC	CODE OMBDC-83
DRAWN WP	SITE 37-1317
	STRUCT
	SCHEME A
	PAGE 21

**METRIC**

**DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN**

CONT No  
WP No 139-87-01

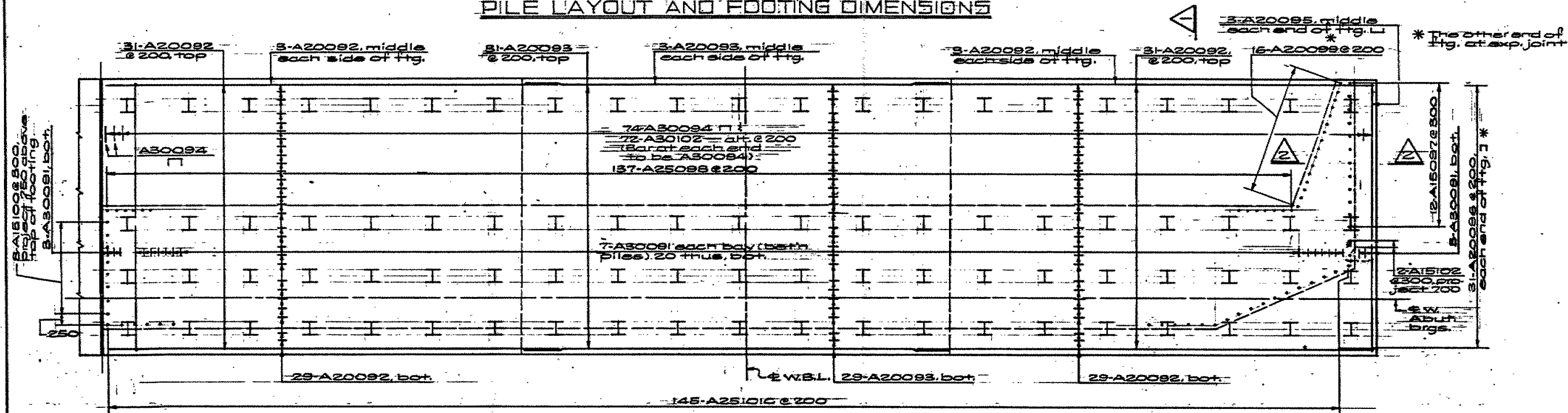


**SHEET**

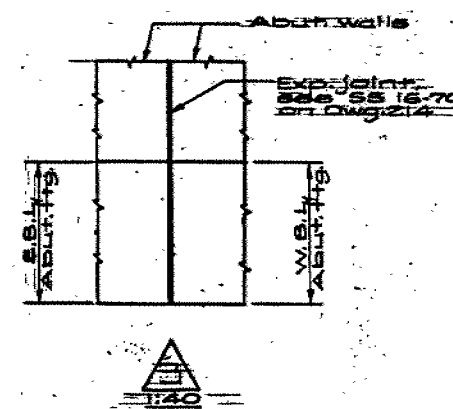
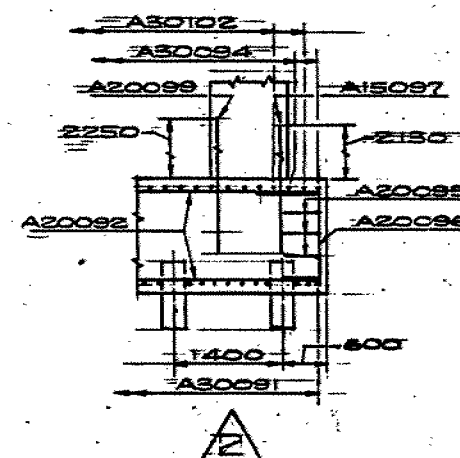
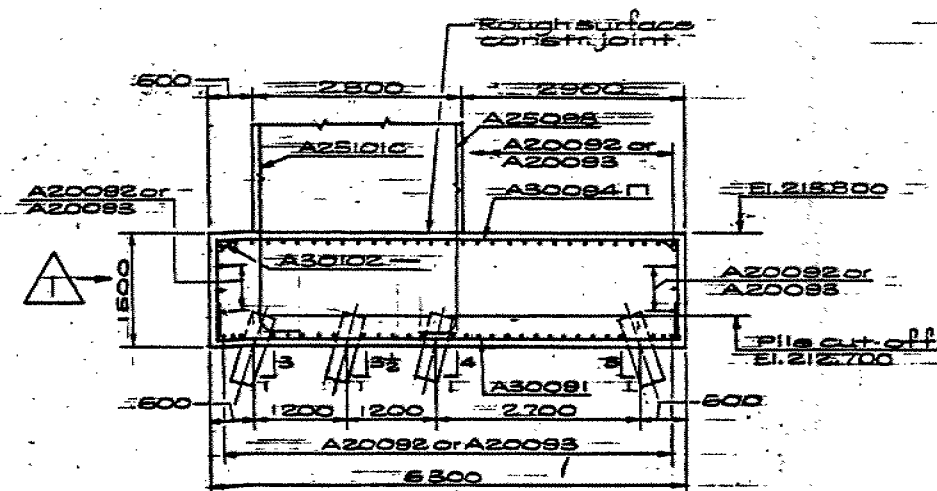
HWY. 407/C.N.R. OVERHEAD  
AT MACMILLAN YARD  
W.B.L. STRUCTURE  
WEST ABUTMENT FOOTING

## PRESTRESSED CONCRETE SCHEME

### PILE LAYOUT AND FOOTING DIMENSIONS



~~PLAN OF FOOTING REINF.~~

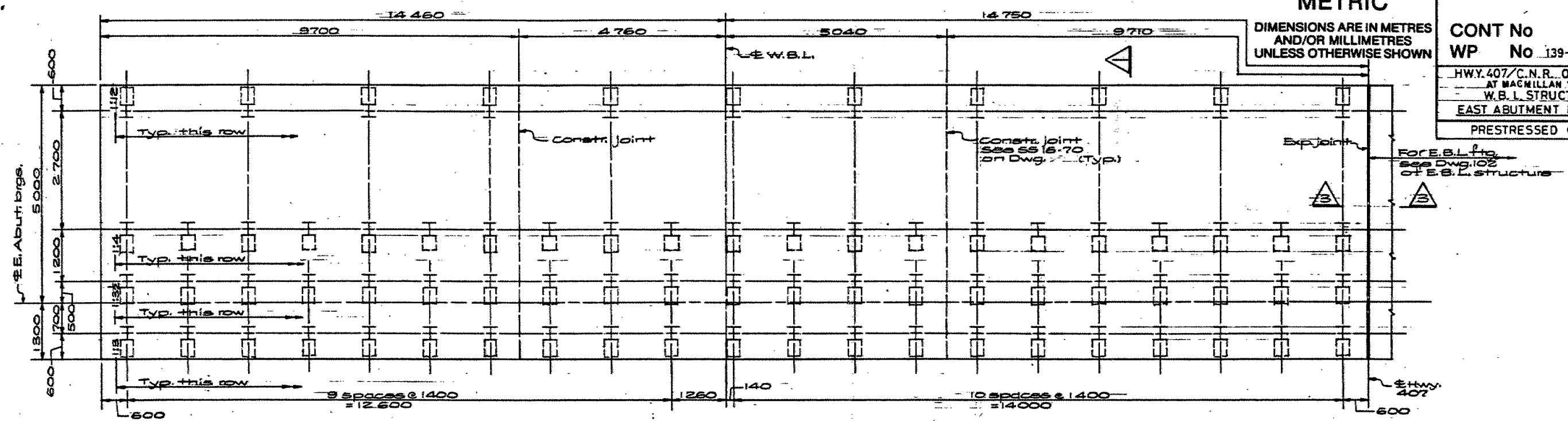


SCALE: 1:750 except  
as noted

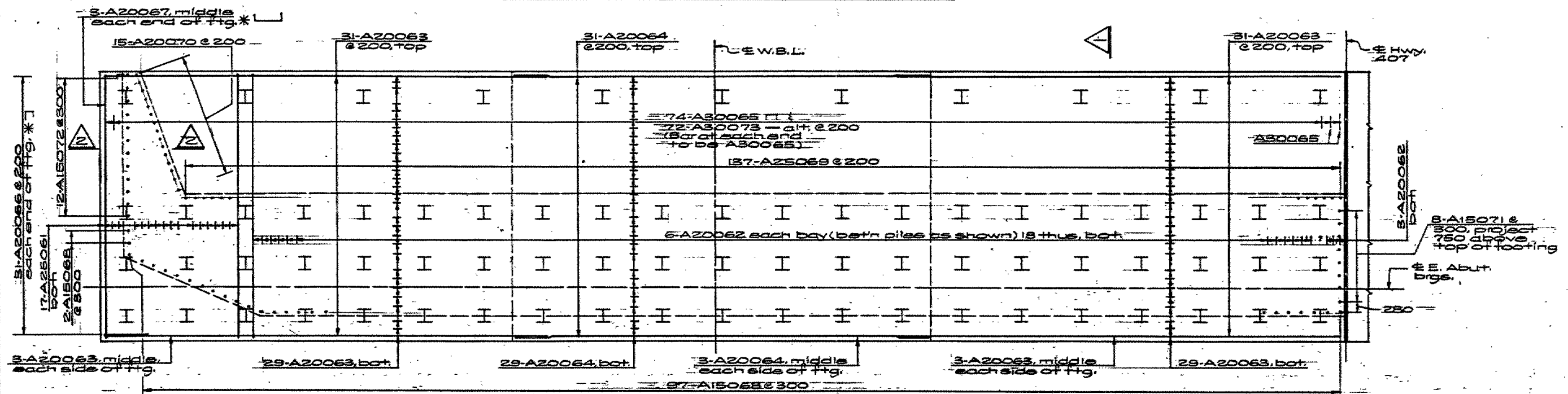
**DRAWING NOT TO BE SCALED**  
**100 mm ON ORIGINAL DRAWING**

~~For pile data & notes,~~  
~~see Dwa.21~~

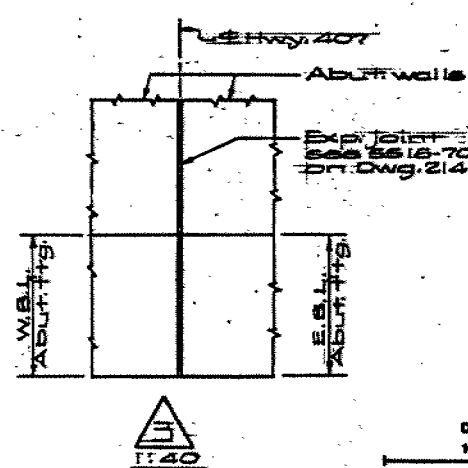
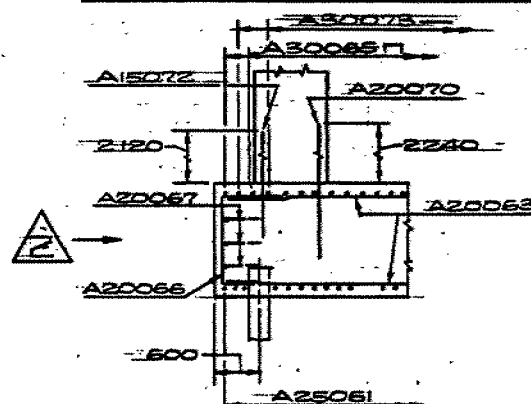
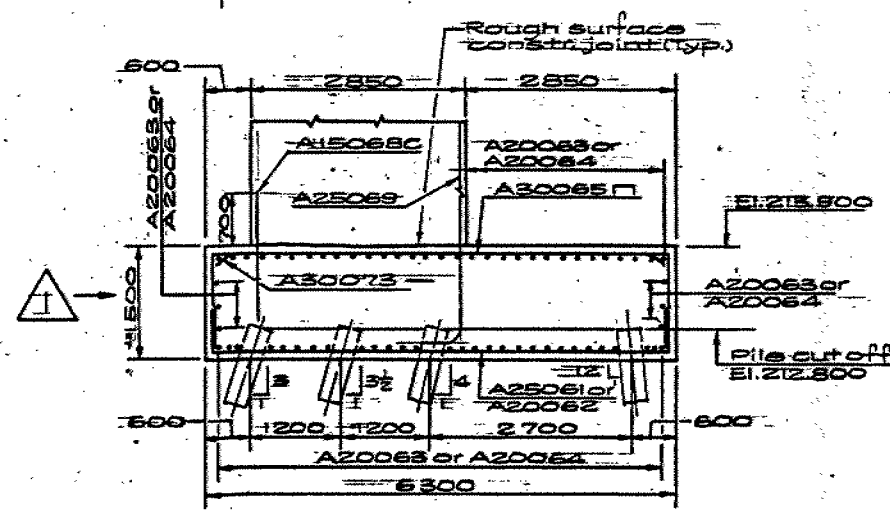
REVISIONS			DESCRIPTION	
DATE	BY			
DESIGN K.V.C.	CHK		CODE CHBDC-83 (LOAD CL 'A')	DATE MAY '92
DRAWN D.C.	CHK		SITE 37-1B17 (STRUCT	SCHEME (DWG 22



### PILE LAYOUT AND FOOTING DIMENSIONS



PLAN OF FOOTING REINF.

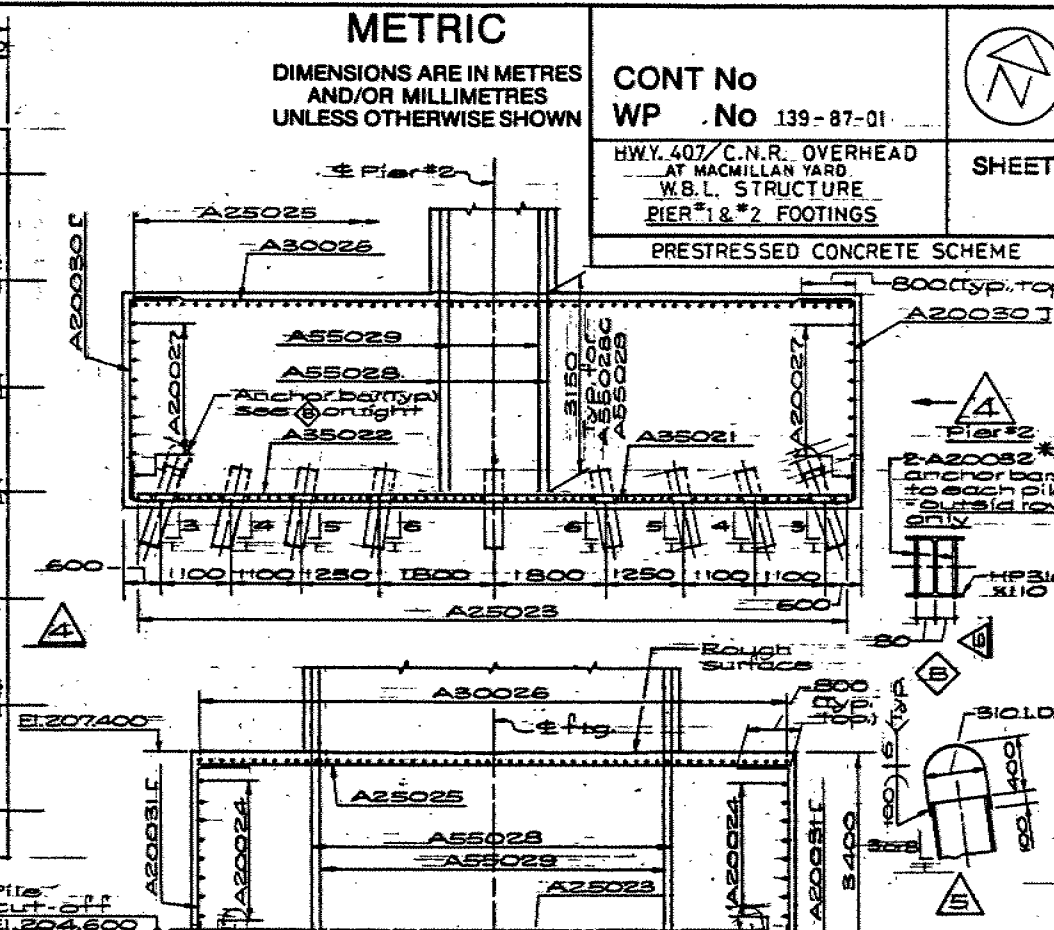


Scale:  
1:50 except  
as noted.

For pile data & notes  
see Dwg. 21

[illegible]

## PRESTRESSED CONCRETE SCHEME



PLAN OF FOOTING REIN

REVISIONS			DESCRIPTION			
	DATE	BY				
			DESIGN	KYC	CHK	CODE 04-BDC-85 LOAD CL. 'A' DATE MAY 92
			DRAWN	CC	CHK	SITE 57-1317 STRUCT SCHEME DWG 24



10-110 27-24

# METRIC

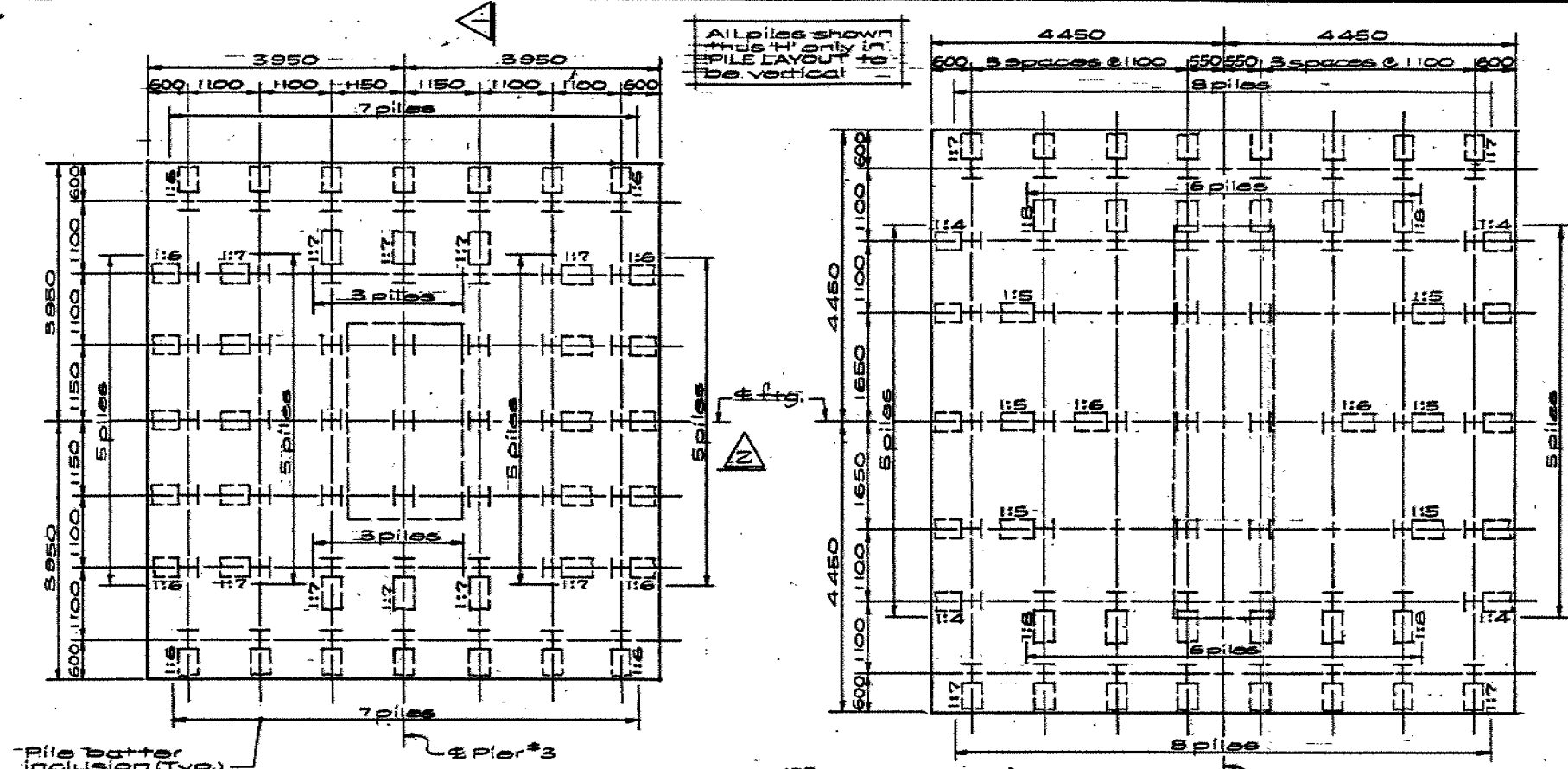
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

CONT No  
WP No 139-87-01

HWY. 407/C.N.R. OVERHEAD  
AT MACMILLAN YARD  
W.B.L. STRUCTURE  
PIER 3 & 4 FOOTINGS

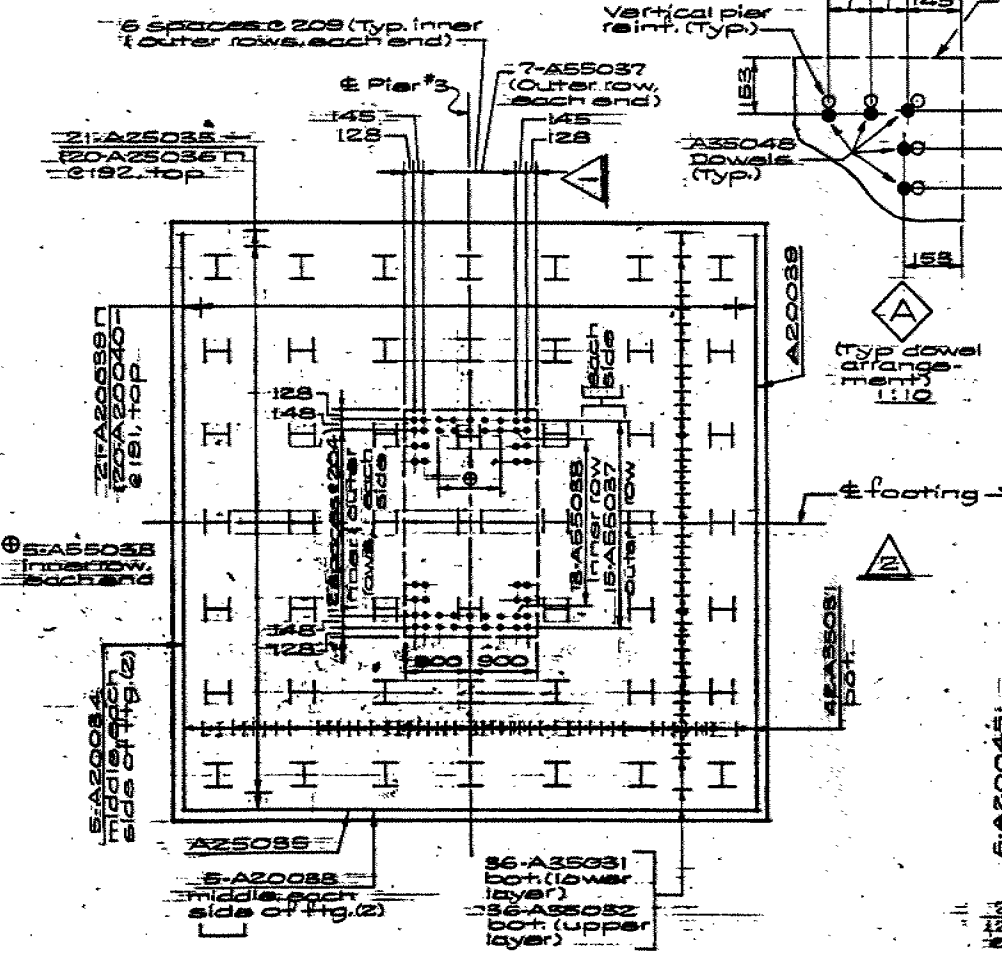
PRESTRESSED CONCRETE SCHEME

SHEET

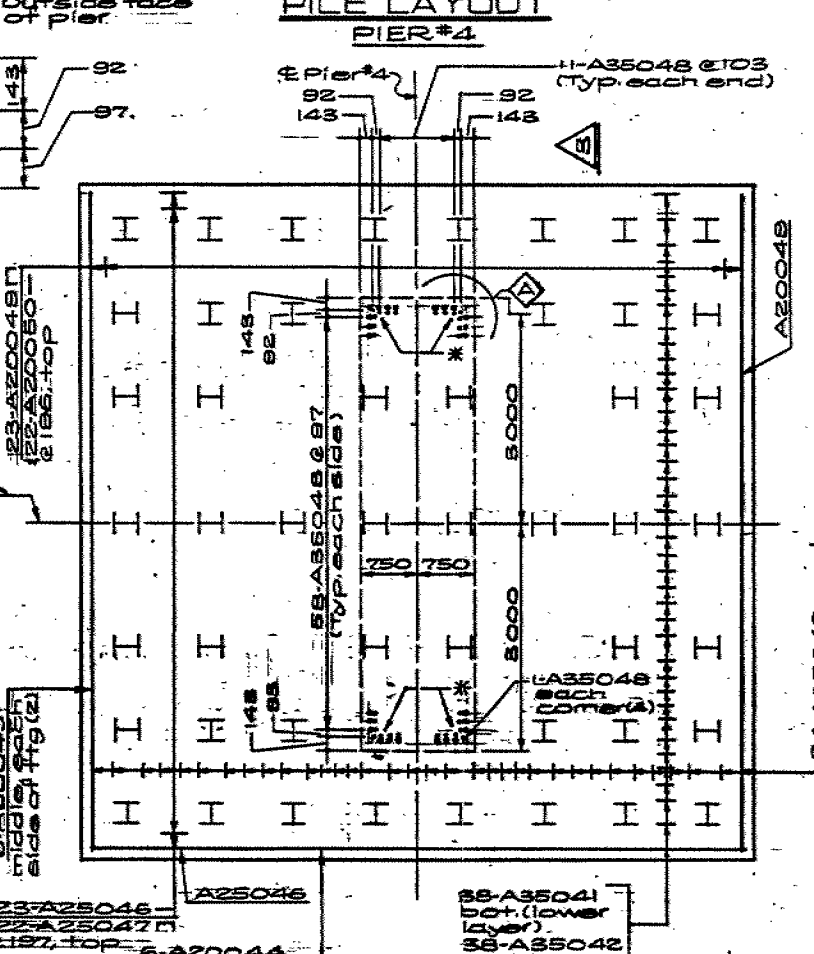


PILE LAYOUT  
PIER #3

PILE LAYOUT  
PIER #4



PLAN OF FOOTING REINFORCING  
PIER #3



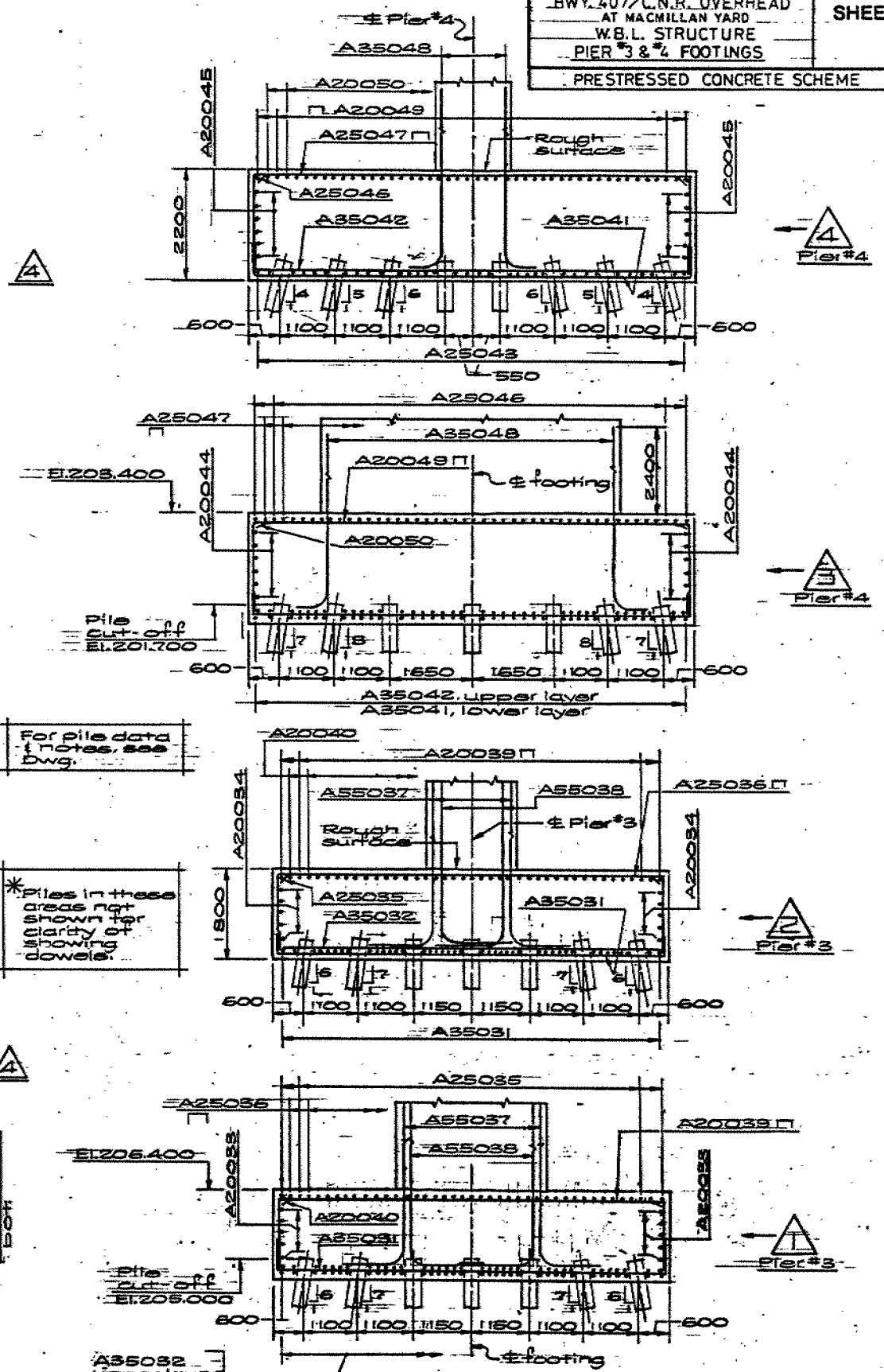
PLAN OF FOOTING REINFORCING  
PIER #4

For pile data  
(notes, see  
Dwg.

\*Piles in these  
areas not  
shown for  
clarity of  
showing  
dowels.

Scale:  
Plans - 1:50  
Sections - 1:60

DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING



REVISIONS	DATE	BY	DESCRIPTION

DESIGNED BY: CHK CODE ON BOC 23 LOAD CL 'A' DATUM 92  
DRAWN BY: CHK SITE 37-317 STRUCT SCHEME DWG 225

# memorandum



To: B. Farago, P. Eng.  
Design Engineer  
Design Section  
Structural Office

From: Foundation Design Section  
Room 315, Central Bldg.

Re: Final Design Review  
CNR Overhead at MacMillan Yard  
WP 139-87-01/04, Site 37-1317N/S  
Hwy. 407, District 6, Toronto

Date: 1992 10 26

As requested in your memo dated June 1/92, we have reviewed the Final Design documents for the above-noted structure. Our comments are as follows;

1) Dewatering

From our assessment, it would appear that the bases of excavations for Piers #1 and #4 are below groundwater level. Please refer to the attached memo of Jan. 29/92 for our recommendations regarding dewatering.

2) Soil Anchors

The notes on the drawing for soil anchors are inconsistent with the NSSP due to unnecessary references to the Can. Fdn. Manual and testing requirements. We recommend that these notes should be removed. Also it would be preferable to permit Dywidag anchors as an alternative to BBR.

3) Lagging

Regarding your specific queries about sizing of lagging, in the past this has usually been left to the responsibility of the designer. As you are aware, the contractor usually resubmits his own shoring design and from my experience the thickness of lagging seldom exceeds 4". The specification of lagging of excessive thickness may lead to problems for the contractor to obtain this material.

4) Piles

In our opinion, it is unlikely that piles will drive to elevation 185 m at the south half of EB Pier #4. Elevation 190 m would be more appropriate. Please refer to the attached memo of April 28/92 for specifics.

If there are any questions, please call.

  
D. Dundas, P. Eng.  
Sr. Foundation Engineer

for

M. Devata, P. Eng.  
Chief Foundation Engineer

# MEMORANDUM

(416) 235-3731

To: B. Farago  
Design Engineer  
Structural Office  
7th Floor, Atrium Tower  
1201 Wilson Avenue, Downsview

1992 01 29

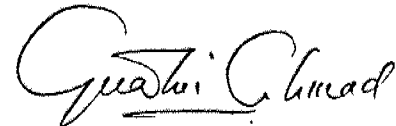
From: Foundation Design Section  
Room 315, Central Building  
Downsview, Ontario

Re: C.N.R. MacMillan Yard Overpass  
W.P. 139-87-01,02,03, Site 37-1317  
Highway 407, District 6, Toronto

This memo is in response to your enquiry about dewatering requirement at the above mentioned site. Please note that any excavation for footings or pile caps below elevation 202m may require dewatering.

Our review of the recent proposed foundation layout indicates that pile caps for Pier 1 and Pier 4 would be constructed at elevations 200m and 201m respectively. These elevations are below water table encountered at the time of foundation investigation. Although it is expected that at most of the locations groundwater could be controlled by sump pump, in our opinion a special provision should be included in the contract to lower the groundwater below the base of any excavation prior to excavation. The contractor should be advised that cohesionless material may be encountered at the excavation depth and it would be susceptible to disturbance under conditions of unbalanced hydrostatic head. Therefore, the construction should be carried out without disturbance to the underlying foundation soil. The contractor should submit his dewatering proposal for review a minimum of 10 working days prior to the construction.

Should you have any further questions, please advise.



K. Ahmad, P. Eng.  
Foundation Engineer

For

D.H. Dundas, P. Eng.  
Sr. Foundation Engineer

# MEMORANDUM

(416) 235-3731

To: B. Farago  
Design Engineer  
Structural Office  
7th Floor, Atrium Tower  
1201 Wilson Avenue  
Downsview, Ontario

1992 04 28

From: Foundation Design Section  
Room 315, Central Building  
Downsview, Ontario

Re: C.N.R. MacMillan Yard Overpass  
W.P. 139-87-01,02,03, Site 37-1317  
Highway 407, District 6, Toronto

Further to the Foundation Investigation Report for the above captioned project, please find detailed pile tip elevations for the foundations of two individual bridge structures. It is understood that the bridge foundations would be supported on piles.

## Westbound Structure

Foundation Location	Minimum Pile Penetration Elevation (m)		Estimated Tip Elevation (m)	
W. Abutment	<u>North Half</u>	<u>South Half</u>	<u>North Half</u>	<u>South Half</u>
	197.0	195.0	195.0	192.0
Pier No. 1 Pier No. 2 Pier No. 3 Pier No. 4	<u>N. Footing</u>	<u>S. Footing</u>	<u>N. Footing</u>	<u>S. Footing</u>
	195.0	199.0	187.0	193.0
	197.0	197.0	195.0	195.0
	198.0	197.0	196.0	195.0
	186.0	185.0	184.0	183.0
E. Abutment	<u>North Half</u>	<u>South Half</u>	<u>North Half</u>	<u>South Half</u>
	197.0	190.0	194.0	187.0



### Eastbound Structure

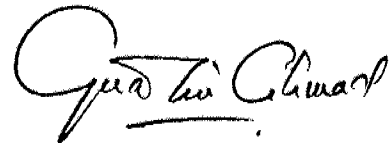
<u>Foundation Location</u>	<u>Minimum Pile Penetration Elevation (m)</u>		<u>Estimated Tip Elevation (m)</u>	
	<u>North Half</u>	<u>South Half</u>	<u>North Half</u>	<u>South Half</u>
W. Abutment	195.0	196.0	192.0	193.0
	<u>N. Footing</u>	<u>S. Footing</u>	<u>N. Footing</u>	<u>S. Footing</u>
Pier No. 1	199.0	195.0	193.0	187.0
Pier No. 2	197.0	197.0	195.0	195.0
Pier No. 3	197.0	197.0	195.0	190.0
Pier No. 4	185.0	192.0	183.0	190.0
	<u>North Half</u>	<u>South Half</u>	<u>North Half</u>	<u>South Half</u>
E. Abutment	190.0	182.0	187.0	179.0

After the piles are advanced to the minimum pile penetration elevations, pile driving should be controlled by the Hiley Formula as per MTO Standards SS 103-10 or SS 103-11, assuming ultimate capacities as indicated below.

### Ultimate Pile Capacities for Hiley Formula:

HP 310X110 = 3450 kN/pile  
HP 310X79 = 2475 kN/pile

The recommendations given in this memo supersedes the recommendations in the Foundation Report. If you have any questions please advise.



K. Ahmad, P. Eng.  
Foundation Engineer

For

D.H. Dundas, P. Eng.  
Sr. Foundations Engineer



Ministry  
of  
Transportation

Ministère  
des  
Transports

Foundation Design Section  
Room 315, Central Building  
1201 Wilson Avenue  
Downsview, Ontario  
M3M 1J8

Telephone: (416) 235-3731

Sept 25/92

D.S. Lea Assoc.  
~~1240 Ellesmere Road~~  
~~Scarborough, Ontario~~  
~~M1P 2X4~~

Attention: Mr. J. Lyle

Re: Contract Package  
CNR Overhead at MacMillan Yard  
WP 139-87-01,03,04; Site 37-1317  
Hwy. 407, District 6, Toronto

As discussed, we have reviewed the Contract Package and have no comments. Terrafix has agreed that HL-8 can be used instead of 19 mm clear stone for the Genesis Wall.

If there are any questions, please call.

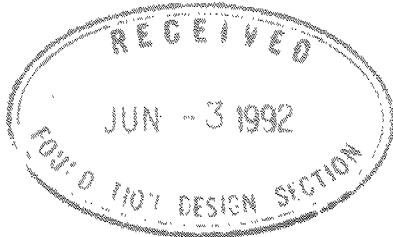
D. Dundas, P.Eng.  
Sr. Foundation Engineer

# memorandum



To: Mr D Smith  
Sr. Project Manager  
Planning & Design  
Central Region

Date: May 27/1992



From: Document Review Unit  
6th Floor  
Atrium Tower

Tel: 235-5615

Re: Genesis Retaining Wall and Reinforced Slopes

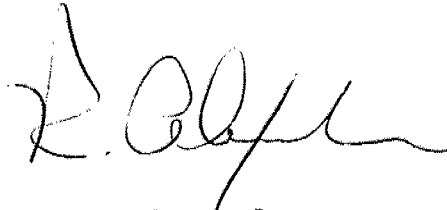
As requested, Document Review has given the submitted special provision a general review and provides the following comments. Please note these comments are of a general nature only and should not be considered final. Comments have not been provided for the drawings as they were only used as a guide to determine the work involved and as you pointed out, are being revised.

- ok 1) The Genesis Retaining Wall and the Reinforced Slopes should be paid as separate items.
- vertical projection 2) The Genesis Wall should be paid by square metres of the face of the wall. (agree).
- add RIS  
RIS to same 3) The Reinforced Slopes should be paid by the plan area of each layer of geogrid in square metres. (disagree).
- agree 4) Any material and construction specification references should be to OPSS when possible.
- agree 5) Materials such as granulars should be specified in M.T.O. terms when possible (i.e. granular 'A' or 'B').
- ? 6) Detailed specifications for the construction of materials and their specification sheets are not required. As the materials are proprietary products, it is only necessary to specify the specific material name and model number and the supplier's name, address and phone number.
- agree 7) The Construction section of the special provisions should only indicate specific required information. Options, superfluous information and "...or as directed by the Engineer" should not be included.

...../P.2

CC. D. Dundas

- ✓ 8) Measurement for Payment and Basis of Payment clauses in M.T.O. format are required for both special provisions.
- ✓ 9) It is suggested the O.P.S. specification format be used for the special provisions.

A handwritten signature in dark ink, appearing to read 'R. Alexander', with a long horizontal flourish extending to the right.

Roy Alexander  
Head, Document Review Unit

/tc

# memorandum



Dave Dindas

To: David Smith  
Sr. Project Manager  
Planning and Design  
Central Region

Date: 1992 05 12

From: Maintenance Office  
Room 230, Central Bldg.  
Downsview, Ontario  
(416) 235-3662



Our File No: 6-90-13

Re: WP 139-87-00, Hwy. 407, Structure at CNR MacMillan Yard

I have reviewed the latest set of plans for the embankment design on the above project. The surface slope treatment now incorporates the Tensar TM3000 blanket, 75mm of topsoil to be seeded and a biodegradable erosion control blanket as a top protective layer.

I have written to the University of Guelph concerning design of this project and I attach my letter and the response for your perusal. Basically the U of G Horticultural Science and Turfgrass Institute experts agree that vegetation will germinate and establish on a 1:1 slope provided that the slope can be stabilized during germination, suitable fertility is available and irrigation or precipitation is available. Stabilization during germination should be provided by the TM3000 blanket (according to Tensar) and the top biodegradable blanket. We can modify the fertilizer requirements based on an analysis of available nutrients in the topsoil and parent (embankment) fill material. The last point, the availability of moisture, has been improved by removing the granular blanket. I would assume that surface moisture from precipitation or ground moisture from the embankment will be available for the plant's use.

The type of vegetation is still in question, the Guelph professors acknowledge that Crown Vetch has a vigorous tap root and the restricted size of the TM3000 may inhibit older plant's development 2 to 3 years after establishment. They do say, however, that there should be no problem establishing Crown Vetch initially on a shallow (100mm) depth of topsoil. Our Crown Vetch seeding, in accordance with OPSS 572, contains a mix of Creeping Red Fescue Turfgrass and Crown Vetch in a 2:1 ratio. If the vetch fails we should still have a turf cover.

In light of the Tensar design and the above comments I am prepared to agree with the design. I would have liked to try the design on the Hwy. 410 slope rehabilitation first, but it doesn't look like that is going to happen in time. I also would have liked to see the Pennsylvania project firsthand, this too didn't materialize.

For your consideration.

A handwritten signature in cursive script, reading "N. R. Close".

N. R. Close  
Supervisor  
Landscape Architecture Unit

cc: J. Lyle  
H. McNeely (G. Ivanoff)  
W. Peck (S. Lo)  
A. Stripnieks (A. Ilnyckyj)  
D. Dundas



*file 407 MacMillan*

Maintenance Office,  
Room 230, Central Bldg.,  
1201 Wilson Ave.,  
Downsview, Ontario  
M3M 1J8  
Tel. (416) 235-3662

February 19, 1992

University of Guelph  
Dep't of Horticultural Science  
University of Guelph  
Guelph, Ontario  
N1G 2W1

Attn: Dr. Ken Carey

Dear Dr. Carey:

Re: Highway 407, Earth Embankment Fill Slope Over CNR MacMillan  
Yards, District 6, Toronto

On the advice of Anna Ilnyckyj, I am soliciting your advice on a project that has implications for vegetative growth, establishment and maintenance. I hope you can shed some light on the practicality of the proposal based on your expertise.

The Ministry of Transportation is constructing Highway 407 across the top of Toronto. One of the projects involves building the freeway over existing railroad yards at the CNR MacMillan Yard between Jane Street and Keele Street. Due to property limitations and cost, the decision was made to use 1:1 reinforced slopes to construct the fill. The design engineers want a low maintenance vegetative cover over the fill. The consultant, Tensar Earth Technologies Inc. is proposing a Tensar Erosion Mat as a layer between the granular blanket core (see my sketch) and the earth/topsoil layer. I have enclosed a sample of their mat and have attempted to illustrate their proposal with a typical cross-section sketch. The granular blanket may be deleted and replaced with a "common" (glacial till) fill material.

We have argued that to sustain healthy, competitive growth we need a minimum depth of 200 to 250 mm of organic topsoil that would retain moisture and provide a medium for root development. The consultant thinks the blanket may be able to hold 100 mm of soil before slippage becomes a reality. Bear in mind that these slopes are up to 15 metres in height. The construction technique is also questionable as there is some concern over how we can

place and spread the topsoil and how we can hold it until germination and establishment of the legume. Our initial thoughts are a top layer of a wood excelsior blanket.

I would appreciate it if you could comment on:

1. The ability of crown vetch to germinate and establish itself on a 1:1 slope with 100 mm of topsoil over the Tensar TM3000 Mat. In particular, the effect of the mat on the growth habit of the plants if the mat was beneath the topsoil or conversely if the mat was on the surface of the soil.
2. The effect of the mat on the perennial habit of crown vetch again if the mat were on the surface or beneath the topsoil layer.
3. The practicality of trying to establish vegetation on a 1:1 slope, blanketed with reinforced granular to improve drainage and topped with a minimum (either 100 or 250 mm) layer of earth (the difference between an engineer's definition of topsoil and horticultural topsoil is substantial). I have included copies of our topsoil and seeding and mulching specifications for your interest.

I apologize for the manner of this request, normally we would put out a research request to the universities, however in this case the design must be finalized by summer 1992 and the project is a multi-million dollar venture of which this is one small component.

Any comments you can provide on the subject will be of interest and used solely as "technical advice" from the Department of Horticultural Science, U. of G.

Thank you in advance for any assistance and if you would like to discuss this in detail or require clarification please call.



N. R. Close  
Supervisor  
Landscape Architecture Unit

cc: A. Ilnyckyj

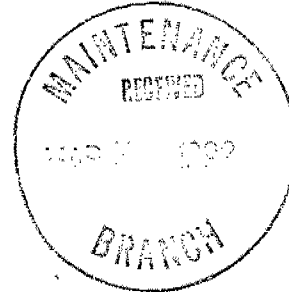


# UNIVERSITY of GUELPH

File 407 M3C-118  
6-90-13

ONTARIO AGRICULTURAL COLLEGE  
The Guelph Turfgrass Institute

Mr. N. R. Close  
Supervisor, Landscape Architecture Unit  
Maintenance Office  
Room 230, Central Bldg.  
1201 Wilson Ave.  
Downsview, Ontario  
M3M 1J8



March 20, 1992

Dear Mr. Close;

I'm sorry to have taken so long responding to your request for comments on the Hwy 407 Fill Slope Project. I've talked to Dr. Jack Eggens and Norm McCollum about some aspects of it, so the comments below are sort of an amalgam.

Since you haven't asked about the engineering aspects of the project, and it is somewhat outside our area of expertise, I will only briefly mention a concern about the physical stability of a 1:1 slope with topsoil on top of a mat of material like the TM3000. 250 mm of topsoil at the top of a 15 m 1:1 slope, when saturated with water, is going to put a lot of shear stress at the interface between subsoil/erosion mat/topsoil. Unless you're confident of the behaviour of the erosion mat when compressed between topsoil and subsoil I would suggest either putting the mat on top of the topsoil, or reducing the topsoil layer as outlined below.

There are three phases to the vegetation management aspects of this type of project. The first is germination and (early) establishment of the vegetation. During this phase, the substrate and management regime are controlling the vegetation. The second is later establishment, root growth, and slope stabilization by the vegetation, during which the vegetation begins to control the environment. The last is the long term development of the vegetation, where the level of management (fertility, pesticides, mowing, irrigation, etc.) affect the persistence of the vegetation, competitiveness against weed invasion, etc. Some compromises will be necessary to allow vegetation to function successfully in all three phases, because the preparation and management to optimize one phase will not necessarily do the same for the others. It may even reduce the success of other phases. For example, using deep topsoil *may* increase the chances for successful long term persistence of vegetation under low maintenance, but if it reduces the success of the slope stabilization by preventing root growth into the subsoil, the net effect may be negative.

To deal with the three specific questions you asked:

1. Crown vetch should be able to germinate and establish on a 1:1 slope with 100 mm of topsoil. The TM3000 erosion control mat would not affect germination and establishment if placed under the topsoil. If placed on top of the topsoil it would not affect germination provided the seed is underneath the mat (topsoil:seed:mat). If the sequence were topsoil:mat:seed, it is likely that the seed/soil contact, and subsequent germination, would be adversely affected.

2. Mature crown vetch is a large plant, which has a fairly large taproot. The combination of small gaps, strength, and stability of the TM3000 mat may cause problems with growth in older crown vetch plants. If the mat is laid below 100 mm of topsoil, it may eventually (2 or 3 years after establishment?) cause problems by restricting root growth in thickness. If laid at the surface, the mat may interfere with growth of the aboveground plant. These problems would not affect turfgrasses the same way, as individual plants (roots and shoots) are much smaller.

3. *Germination and early establishment* There is no problem getting vegetation to germinate and establish on a 1:1 slope, provided

- the slope can be stabilized during germination (preventing washouts)
- suitable fertility is available. 100 mm of topsoil is more than adequate, provided the NPK levels are appropriate. In fact, subsoil may be adequate, with appropriate fertility amendment, depending on the structure and chemistry.
- irrigation or precipitation is available to balance evapotranspirative losses. This requirement is very sensitive to timing of the seeding (season), weather, and the drainage pattern of the rootzone. Topsoil may provide improved water holding capacity during germination and establishment, so that water stress is less of a problem. Too much water-holding topsoil will create a slippage problem.

*Root growth and slope stabilization* If the vegetation is an important structural element in the slope stabilization, that is if the rooting of the vegetation is required to hold the topsoil/erosion mat/subsoil profile together, then the depth of topsoil is critical. Turfgrass seeded into 250 mm of topsoil, especially if the topsoil is high in fertility and with good moisture holding capacity, will develop most of its roots in the topsoil rather than penetrating through [mat and] subsoil. Crown vetch has a deeper root system, but the same principle applies in that deeper topsoil will delay the binding together of the substrate layers by the roots. Even 100 mm of topsoil may be thick enough to prevent adequate and speedy root growth into the subsoil. From the structural point of view, the best system might involve the vegetation being established [under and through the erosion mat?] directly on the subsoil, amended with fertilizer and irrigated in the early stages.

*Long term behaviour of vegetation under low maintenance* The positive value of deeper topsoil in low maintenance vegetation may be overestimated. If no fertility,

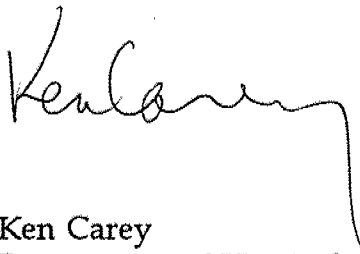
irrigation, or pest/weed control is applied, the extra topsoil will enhance the growth of unwanted weed species as much as the desirable vegetation, and probably more so if the desired vegetation is specifically low maintenance and chosen to survive with reduced fertility and water inputs. The water holding capacity of organic topsoil may be useful in establishment, but if the subsoil is granular and well-drained, even 250 mm of topsoil may not prevent drought stress problems at the top of a 15 m slope if irrigation is not provided. This is particularly true if the topsoil has prevented the development of a deep root system in the early stages of the vegetation.

To summarize: The main concern, if crown vetch/red fescue is going onto a 15 m 1:1 slope, is to maintain the substrate and get the root system [through the erosion mat] into the subsoil as fast as possible. Keeping the topsoil addition as thin as possible will probably improve rooting and reduce the engineering stresses. Nevertheless, the success of the stabilization will depend heavily on providing adequate fertility and moisture during the early establishment of the vegetation. Extra topsoil (above 100 mm) would probably add more problems in the early phases than it would solve in the long term. [The long term success of real low (no) maintenance vegetation on this kind of slope may be more dependent on the species choice than on anything else - since you only have three seed mixes to choose from, they may not include the plants that are most likely to be successful. This is an ongoing problem in low maintenance vegetation management, which is not going to be solved soon or easily, but needs to be addressed.]

I hope these comments may be of some value to you. Please don't take this as a criticism of your unit (I know your hands are often tied by policy), but it is sometimes difficult to reconcile the "high value" aspects of vegetation that is supposed to be aesthetically pleasing and function in erosion control and slope stabilization with the "low value" that is implicit in low maintenance and a choice of three all-purpose seed mixes.

is this a shot?

Sincerely,



Ken Carey  
Department of Horticultural Science and the Guelph Turfgrass Institute



Foundation Design Section  
Room 315, Central Building  
1201 Wilson Avenue  
Downsview, Ontario  
M3M 1J8

Telephone: (416) 235-3731

May 5/92

D.S. Lea Assoc.  
1240 Ellesmere Road  
Scarborough, Ontario  
M1P 2X4

Attention: Mr. J. Lyle

Re: Steep Slopes and Retaining Wall  
CNR Overhead at MacMillan Yard  
WP 139-87-01,03,04; Site 37-1317  
Hwy. 407, District 6, Toronto

Two copies of the design drawings for the steep slopes at the NW, NE and SE quadrants and the retaining wall at the NE quadrant are enclosed along with two copies of Tensar's proposed specification. We understand that you will arrange distribution of this drawing and coordinate comments.

Details requiring clarification before finalization of the design are discussed below:

#### 1) Embankment Material

The embankment should be constructed of suitable earth fill material. The maximum size of particles beneath the pile foundations should be restricted to 75 mm to facilitate pile driving.

An exception will be at the launch pad founding elevation, where a 1 m thick pad of Granular A should be placed across the full width of the embankment from the abutments to 5 m beyond the end of the launch pad.

The final embankment should be reconstructed (with benching as per MTO procedures) with suitable earth fill material, so that the thickness of earth fill is a minimum of 1 m along the the entire outer shell of the embankment.

#### 2) Slope Treatment

Pending a site visit to inspect and verify the performance of a similarly constructed Tensar slope in Pennsylvania, it can be assumed that

- the slope treatment will consist of Tensar erosion mat, 100 mm of topsoil, then a biodegradable erosion control blanket.

**3) Interference With Abutment and Launch Pad Foundations**

Tensar reinforcement will simply be truncated where it intersects foundation units.

**4) Contract Administration**

We recommend that, if feasible, a lump sum bid should be prearranged with Terrafix, and reviewed to ensure that the advertised cost advantages over other alternatives are realized.

The Tensar document may be considered as a draft of an NSSP.

**5) Jersey Barrier Foundations**

Further to discussions with B. Farago and A. Liu, the wing wall details will be modified to support the end of the Jersey Barrier at the abutment.

**6) Underground Utilities**


Based on the preliminary information provided, no continuous (parallel to the alignment) underground utilities will encroach on the reinforcing grids. This requires confirmation.

**7) Grading for Surface Drainage**

As agreed in our meeting normal grading and drainage provisions will be followed. The embankment will be overbuilt to protect from erosion, and trimmed to meet final geometry.

For final grading, it is assumed that only that portion of the embankment outside the Jersey barrier will not be drained through storm sewer.

If there are any questions, please call.

  
D. Dundas, P.Eng.  
Sr. Foundation Engineer

# MEMORANDUM

(416) 235-3731

To: B. Farago  
Design Engineer  
Structural Office  
7th Floor, Atrium Tower  
1201 Wilson Avenue  
Downsview, Ontario

1992 04 28

From: Foundation Design Section  
Room 315, Central Building  
Downsview, Ontario

Re: C.N.R. MacMillan Yard Overpass  
W.P. 139-87-01,02,03, Site 37-1317  
Highway 407, District 6, Toronto

Further to the Foundation Investigation Report for the above captioned project, please find detailed pile tip elevations for the foundations of two individual bridge structures. It is understood that the bridge foundations would be supported on piles.

## Westbound Structure

Foundation Location	Minimum Pile Penetration Elevation (m)		Estimated Tip Elevation (m)	
	North Half	South Half	North Half	South Half
W. Abutment	197.0	195.0	195.0	192.0
	<u>N. Footing</u>	<u>S. Footing</u>	<u>N. Footing</u>	<u>S. Footing</u>
Pier No. 1	195.0	199.0	187.0	193.0
Pier No. 2	197.0	197.0	195.0	195.0
Pier No. 3	198.0	197.0	196.0	195.0
Pier No. 4	186.0	185.0	184.0	183.0
	<u>North Half</u>	<u>South Half</u>	<u>North Half</u>	<u>South Half</u>
E. Abutment	197.0	190.0	194.0	187.0

### Eastbound Structure

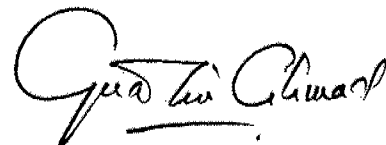
Foundation Location	Minimum Pile Penetration Elevation (m)		Estimated Tip Elevation (m)	
	North Half	South Half	North Half	South Half
W. Abutment	195.0	196.0	192.0	193.0
	<u>N. Footing</u>	<u>S. Footing</u>	<u>N. Footing</u>	<u>S. Footing</u>
Pier No. 1	199.0	195.0	193.0	187.0
Pier No. 2	197.0	197.0	195.0	195.0
Pier No. 3	197.0	197.0	195.0	190.0
Pier No. 4	185.0	192.0	183.0	190.0
	<u>North Half</u>	<u>South Half</u>	<u>North Half</u>	<u>South Half</u>
E. Abutment	190.0	182.0	187.0	179.0

After the piles are advanced to the minimum pile penetration elevations, pile driving should be controlled by the Hiley Formula as per MTO Standards SS 103-10 or SS 103-11, assuming ultimate capacities as indicated below.

### Ultimate Pile Capacities for Hiley Formula:

HP 310X110 = 3450 kN/pile  
HP 310X79 = 2475 kN/pile

The recommendations given in this memo supersedes the recommendations in the Foundation Report. If you have any questions please advise.



K. Ahmad, P. Eng.  
Foundation Engineer

For

D.H. Dundas, P. Eng.  
Sr. Foundations Engineer

# memorandum

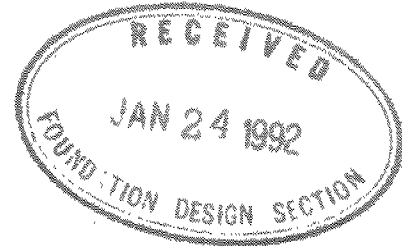


*Dave Dundas*

To: David Smith  
Planning and Design  
Central Region  
4th Floor, Atrium Tower

Date: 1992 01 22

From: Maintenance Office  
Room 230, Central Bldg.  
Downsview, Ontario  
(416) 235-3662



Our File No: 6-90-13

Re: WP 139-87-00, Hwy. 407/CNR MacMillan Yard

I have reviewed the preliminary drawings for the reinforced earth embankment slopes at the above site. While I do not have any concern (or knowledge) of the basic core embankment I do have several concerns with the exterior finished slope surface.

My concerns are:

1. The memo from Dave Dundas mentions a blanket of 1.2 m of Granular A. I assume this will apply across the entire cross-sectional area. While Dave has mentioned my concern for topsoil depth it appears that there will not be a 250 mm cover to sustain plant growth. He indicates we will discuss the details later.
2. The technical requirements indicate fill placement in 25 cm increments with only hand-operated equipment within 1 metre of the slope face. How and when will the final surface layer be built up, in sequence with the fill layers or as a final one-shot application? I don't see how the topsoil can be applied and retained on the slope face.
3. The exterior surface Tensar mesh TM 3000 if it is the same as that demonstrated by the company is a very fine mesh. I am not sure how the topsoil will be caught by the mesh and what the application sequence is (ie topsoil, seed and mesh or mesh, topsoil and seed). This sequence will have a big impact on germination and control of the surface material.
4. The choice of a vegetative cover will be affected by the design of the earth cover and mesh. I still believe that the construction of the fine mesh will prohibit all but



the fine-bladed grasses, this will eliminate Crown Vetch as an option. Crown Vetch is the best material we have for low maintenance cover.

5. My desire to retain an earth medium (and associated moisture) to sustain plant growth seems to be diametrically opposed to the engineering need to drain the embankment of all moisture. As I indicated earlier if this is the selected cheapest option then perhaps an engineered finish is appropriate and we should not be "trying to grow grass on concrete".

For your consideration.

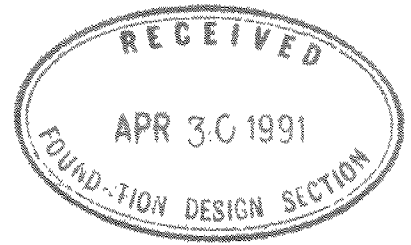


N. R. Close  
Supervisor  
Landscape Architecture Unit

cc: D. Dundas  
J. Kernaghan (S. Lo)  
G. Ivanoff  
J. Lyle

see notes

MINUTES OF MEETING  
HWY 407 OVER MACMILLAN YARD  
WEDNESDAY, APRIL 24, 1991



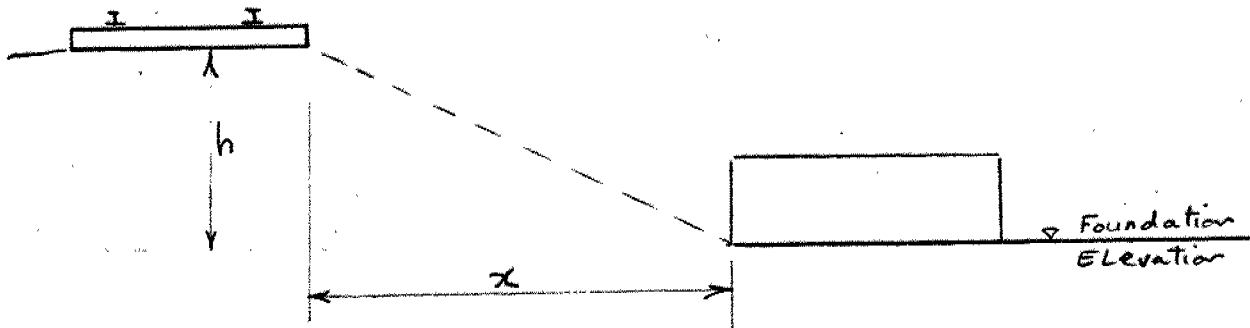
Present: B. Farago  
A. Aly  
K.Y. Chu  
D. Dundas ✓

\* Track protection design parameters were discussed. The following was recommended

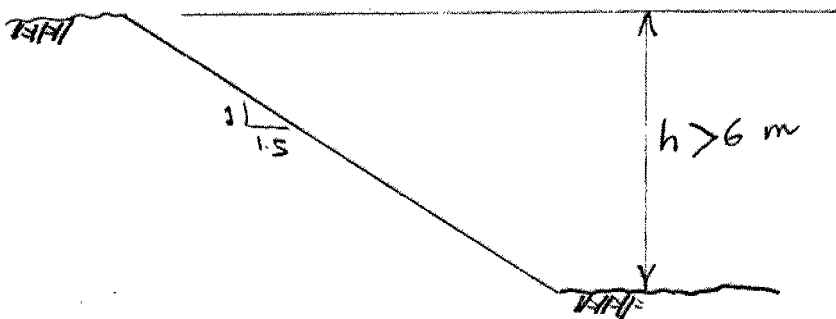
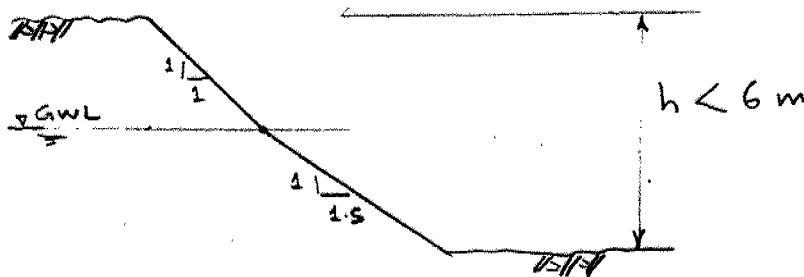
- ✓ - Although the soil is cohesive, an equivalent granular soil properties and design method were recommended:

$$\phi = 30^\circ$$
$$\gamma = 21.5 \text{ kN/m}^3$$

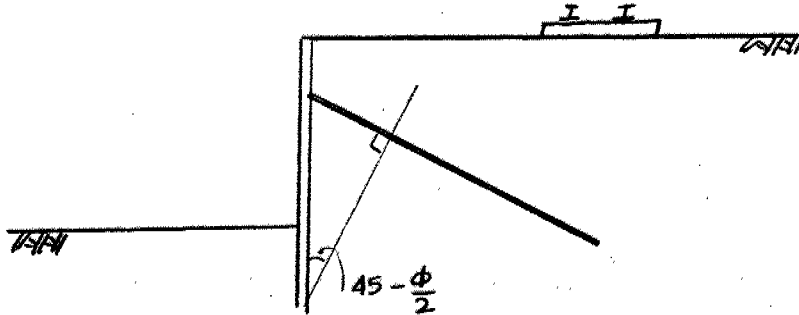
- ✓ - Track protection is needed if the horizontal distance from the tip of the tie to the foundation elevation 'x' is less than two times their elevation difference 'h'.



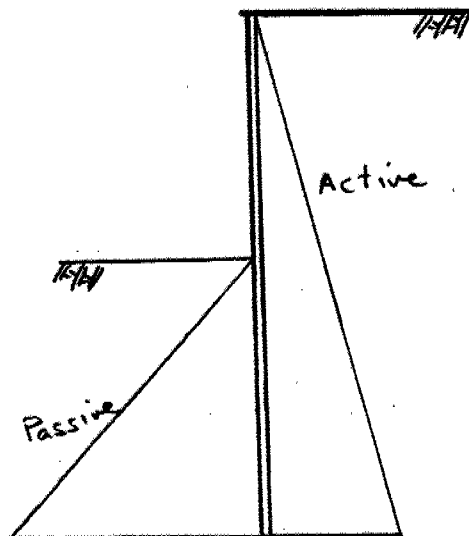
- ✓ - Recommended excavation slopes are illustrated below



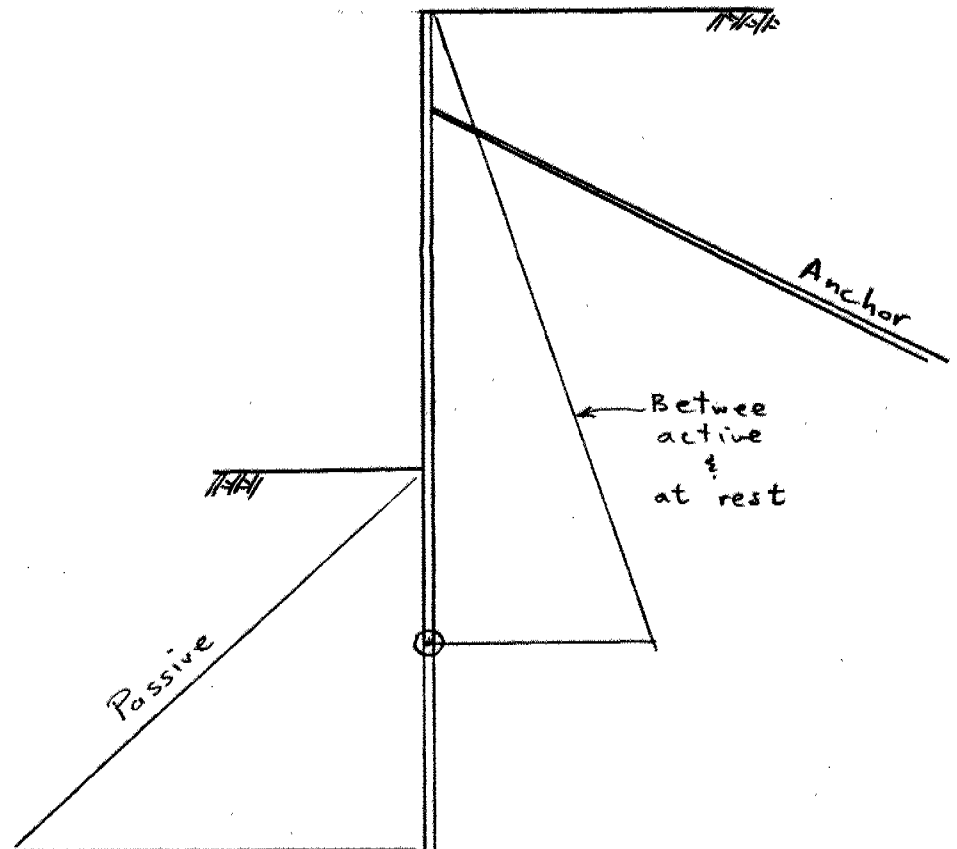
- A special provision will be needed to caution contractor about Ground Water Level.
- Soil Anchors  
Use a bond stress of 75 KPa (SLS)  
Recommended anchor orientation is shown below



- Recommended earth pressure distribution on track protection schemes is illustrated below



NO ANCHORS USED



- 2 -

ANCHORS USED

- Below the foundation level where there is no logging, it is recommended to use an effective width of 3 times the pile diameter for both passive and active earth pressure.

\* **Pile Capacity for temporary supports**

It was confirmed that the same recommendation for the nearest structure footing element can be used for the temporary supports without any reduction in pile capacities.

c.c. K.G. Bassi

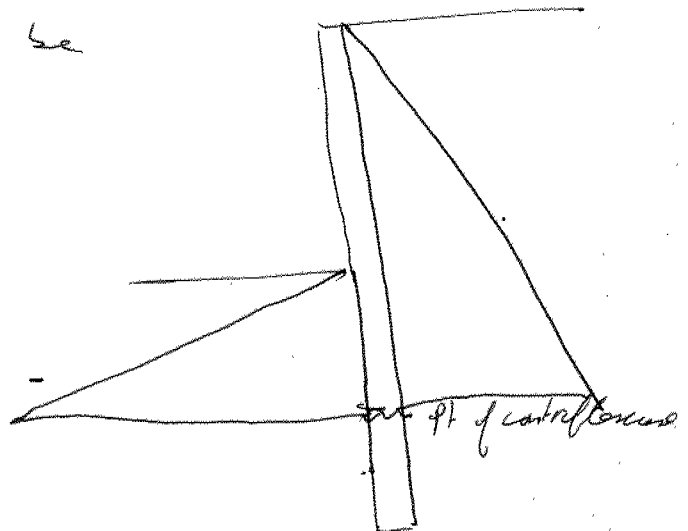
memo to file

re: April 24/91 meeting

note the following inaccuracies in minutes.

- ① soldier piles recommended due to driving difficulties with sheet piles & drilled soldier piles preferred due to ease of alignment over driven soldier pile
- ② gw should be assumed to be at base of excavation
- ③ earth pressure will be more than active but may be less than at-rest
- ④ Pressure diagram should be

- 3 -



⑤ SP also needed for boulders

⑥ SP needed for soil anchors

⑦ safety has to be checked for all stages of construction.

WP 139-87

CNR / Mac Miller Yd.

Apr 1 24/91

Meeting re: track protection

with B. Farago

A. Ali

K.Y. Chiu

D. Dundas

- I cautioned that CNR had restrictions re: restricted zone near track for equipment
- I recommended that base of any excavation should be 2:1 from tracks  
1:1 above G.W. & 1.5:1 below G.W. up to 6m  
or 1.5:1 if > 6 m slope

- re: shoring.

I suggested drilled soldier piles for ease of alignment

Bob agreed that a typical design was OK

regarding earth pressure I suggested  $45^\circ - \frac{\phi}{2}$  for plane behind wall  
 $\phi = 30^\circ$   $\gamma = 21.5$  go at base of excavation

I suggested something between active and at rest for earth pressure assumption, regarding earth pressure distribution. We agreed that for this temporary situation that passive resistance could be assumed from surface of excavation down.

re soil anchors

- they should be  $\perp$  to plane defined by  $45^\circ - \phi/2$
- assume 75 kPa bond stress is allowable for 4.5" to 6"  $\phi$  cased post grouted soil anchors with no full scale testing
- use pt of contact between end of active pressure
- assume same assumption with active pressure as with passive re: zone of action (eg. 3x flange width) for zone below excavation
- SP required for determining and builders
- safety has to be checked at each phase of construction. eg. top cantilever above soil anchors.

# memorandum

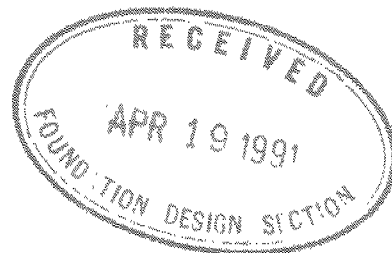


Tel: (416) 235-5649

To: A. Liu  
Sr. Structural Engineer  
Central Region, Downsview

Date: 91 04 18

Re: Hwy 407 - CNR MacMillan Bridges  
W.P. 139-87-01/04, Site 37-1317  
District 6, Toronto



This will record your conversation of April 17, 1991 with D. Chau of the Structural Office. For the bridge approaches the toe of slope for the fill should start 6.0 metres inside the MTO R.O.W. line.

In a previous conversation you had stated that no berms are required at the top of the slopes at the retaining walls (i.e. along the NE, SE and NW sides (ends) of the bridge(s)).

The preliminary drawing has been revised so that only a midheight 2 metre wide berm remains along the SW side (west approach fill).

*J. Brown.*

J. Brown  
Sr. Project Engineer

JB/sl

c.c. File  
B. Bennett  
B. Farago

*Note: This may be irrelevant due to 1:1 slope proposal.*

MEMO

To: T&G  
Re: WP B9-87  
MacMillan 'd.

April 16/91

Regarding reported soft material at NW goodcut.

I cont. met Augustine that the Geotechnical Section recs of 5 m ruber. should be considered with caution since there may be other more economical options such as preloading.

D. Dunder.



# memorandum



To: Mr. V. Boehnke  
Head, Structural Section  
4th floor, Atrium Tower

Date: 1991 04 03

Attn: A. Liu - Sr. Structural Engineer

Re: High Mast Lighting  
CNR MacMillan Yard Overhead  
W.P. 139-87-00, Site 13-1317  
Highway 407, District 6

Your memo dated 91 01 14 requests revised recommendations for highmast lighting following the relocation of the pole bases from Piers #1 and #3 to Piers #2 and #4.

The following parameters are provided for designated HMLP #1 at Pier #2 and HMLP #2 at Pier #4 based on the subsurface conditions encountered at BH's 8 and 14, respectively.

Pole No:	Elevation (m)	Soil Type	Angle of Int. Friction ( $\phi$ )	Unconfined Comp. Strength ( $q_u$ )	Unit Weight
HMLP #1	209.4 - 199.6	Cohesive	0	250 kPa	20.0 kN/m <sup>3</sup>
(BH 8)	199.6 - 198.0	Non-Cohesive	30 <sup>0</sup>	0	20.0 kN/m <sup>3</sup>
HMLP #2	209.2 - 197.8	Cohesive	0	250 kPa	20.0 kN/m <sup>3</sup>
(BH 14)	197.8 - 196.4	Non-Cohesive	28 <sup>0</sup>	0	20.0 kN/m <sup>3</sup>

Groundwater was not encountered in these two boreholes during the investigation, however, it should be assumed that the non-cohesive seams are water-bearing.

Please refer to the memo of preliminary recommendations dated 90 07 20 and the final Foundation Design Report for the dewatering and construction considerations for caisson type foundations.

If there are any questions, please advise.

B. Bennett, P. Eng.  
Foundation Engineer

for

D. Dundas, P. Eng.  
Sr. Foundation Engineer

DD/BB/jb

WP 139-87-00

91 04 05

MacMillan Yd & Hwy 407

## NOTE TO FILE

- D. Dundas spoke to A. Liu regarding request for parameters for two re-located HML poles.
- F.D.S. will respond to the 2 H.M.L. poles only
- ~~the~~ A. Liu. said there would be add'l poles but under a different Contract
- rec's for add'l H.M.L. poles will be provided when design becomes available.
- D. Dundas alerted A. Liu of the ~~soft~~ 'zone of soft' soil in the NW quadrant of the site, as documented in his memo dated 91 03 22.

B. Bennett

# memorandum



To: B. Farago  
Design Section  
Structural Office  
7th Floor, Atrium Tower

Date: 90 03 22

Atten: J. Brown, Sr. Project Engineer

FROM: Foundation Design Section  
Room 315, Central Building

RE: Review of Preliminary Design  
C.N.R. MacMillan Yard Overhead WBL & EBL  
W.P. 139-87-01 & 04, Site 37-1317  
Hwy. 407, District 6, Toronto

Further to your memo of 91 01 29, we have reviewed the foundation design aspects of the preliminary design for the project detailed in Drawing PA1 dated January, 1991.

Our comments follow:

- 1) The details of the pile foundations are not in accordance with the recommendations provided on pages 8 to 10 of the Foundation Report. We recommend that the pile details and notes should be changed to the following for 310 HP 110 piles equipped with driving shoes:

After piles are advanced to the minimum pile penetration elevations indicated in the following table, pile driving should be controlled by the Hiley Formula as per MTO Standards Ss 103-10 or SS 103-11 assuming an ultimate capacity of 2640 kN at the abutments and 3450 kN at the piers.

<u>Foundation Location</u>	<u>Minimum Pile Penetration Elevation</u> (m)		
	N. Side	Centre	S. Side
W. Abutment	197.0	195.0	196.0
Pier No. 1	195.0	199.0	195.0
Pier No. 2	197.0	197.0	197.0
Pier No. 3	198.0	197.0	197.0
Pier No. 4	186.0	185.0	192.0
E. Abutment	197.0	190.0	182.0

- 2) Regarding the west approach and NW retaining structure, our BH #26 encountered a deposit of weak compressible material that requires subexcavation. The horizontal and vertical extent of this deposit should be determined. Please note that the Foundation Design Section has not initiated any investigation to determine the extent of this deposit and will not do so unless requested.

- 3) The maximum size of any fill placed under piling locations should be restricted to 75 mm.
- 4) It is our understanding that the retaining structures at this site will be either reinforced slopes or Reinforced Earth Walls. The location of any High Mast Lights or FTMS foundations will have an impact on the design of these structures. Please advise the Foundation Design Section of proposals for HML and FTMS so that we may coordinate the design of the retaining structures.
- 5) As discussed in our October 25, 1990 meeting with D.S. Lea reinforced slopes or Reinforced Earth Walls should be constructed to their ultimate configuration in width so as not to require extensions in the future.

Regarding your inquiry about track protection, in our opinion, consideration should be given to using a soldier pile/lagging shoring system instead of sheet piling for both cost and pile penetration reasons.

Regarding your inquiry about piles for temporary supports, the pile penetration/capacity characteristics of the site are quite variable. It is recommended that the same recommendations for the nearest structure footing element can be used for the temporary support but with a reduction of 20% in pile capacities for both design and pile driving control (Hiley formula).

If there are any questions, please call.

DD/mmj

for

B. Bennett

D. Dundas, P. Eng.  
Sr. Foundation Engineer

# memorandum



Tel: (416) 235-5649

To: M. Devata  
Chief Foundation Engineer  
Engineering Materials Office  
Foundation Design Section

Date: 91 02 11

Attn: K. Ahmad, P.Eng.  
Project Foundation Engineer

Re: Hwy 407 Bridges over CNR MacMillan Yard  
W.P. 139-87-01 & 04, Site 37-1317, District 6

This memo will record telephone conversations of Feb. 7 & 8, 1991 in respect to the foundation design for the above project.

The deep foundation units are predominately end bearing.

The pile (caisson) capacity listed in the Foundation Report doesn't include a reduction factor for group effect (OHBCD commentary clause C6-8.3.4.1).

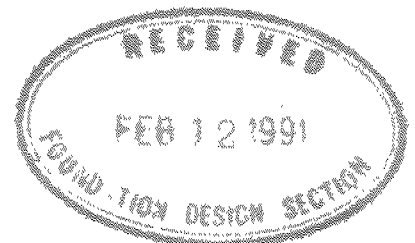
Discussion between Mr. Farago and Mr. Devata concluded that the soil type at this site doesn't warrant the above reduction factor.

A handwritten signature in black ink, appearing to read "J. Brown".

J. Brown  
Sr. Project Engineer

JB/sl

c.c. File  
B. Farago  
K. Price (Delcan)



# memorandum



Tel: (416) 235-5649

To: Engineering Materials Office  
Foundation Design Section

Date: 91 01 29

Attn: Mr. D. Dundas  
Sr. Foundation Engineer

Re: Hwy 407 Bridges over CNR MacMillan Yard  
W.P. 139-87-01 & 04, Site 37-1317, Dist. 6

For the above project and further to our meeting of Nov. 7, 1990 please find attached one copy of proposed preliminary structural drawing 37-1317-PA1 (Prestressed Concrete Scheme) for your review.

Also enclosed are copies of SKETCHES A and B showing the footing elevations at Piers #3 and #4 and a copy of proposed plan of temporary support location during construction.

A. TRACK PROTECTION

It is anticipated that track protection (sheet piling type) will be required at Piers #3 and #4 during footing construction and that a tie back system will be necessary at the Pier #4 location.

Can sheet piling be driven through the material near Boreholes #13, #14 & #15?

What design parameters, recommendations or contract specification criteria will the Foundation Office provide?

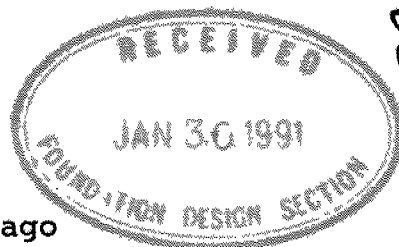
B. FOUNDATIONS FOR TEMPORARY SUPPORTS AND CASTING BED

Are the recommended abutment pile capacities listed on P. 10 of the Foundation Report viable for use with the temporary supports.

Please forward any comments or recommendations.

JB/sl  
Encl:

c.c. B. Farago



*J. Brown*

J. Brown  
Sr. Project Engineer

WEST

EAST



# PIER # 3 (ALTERY 1)

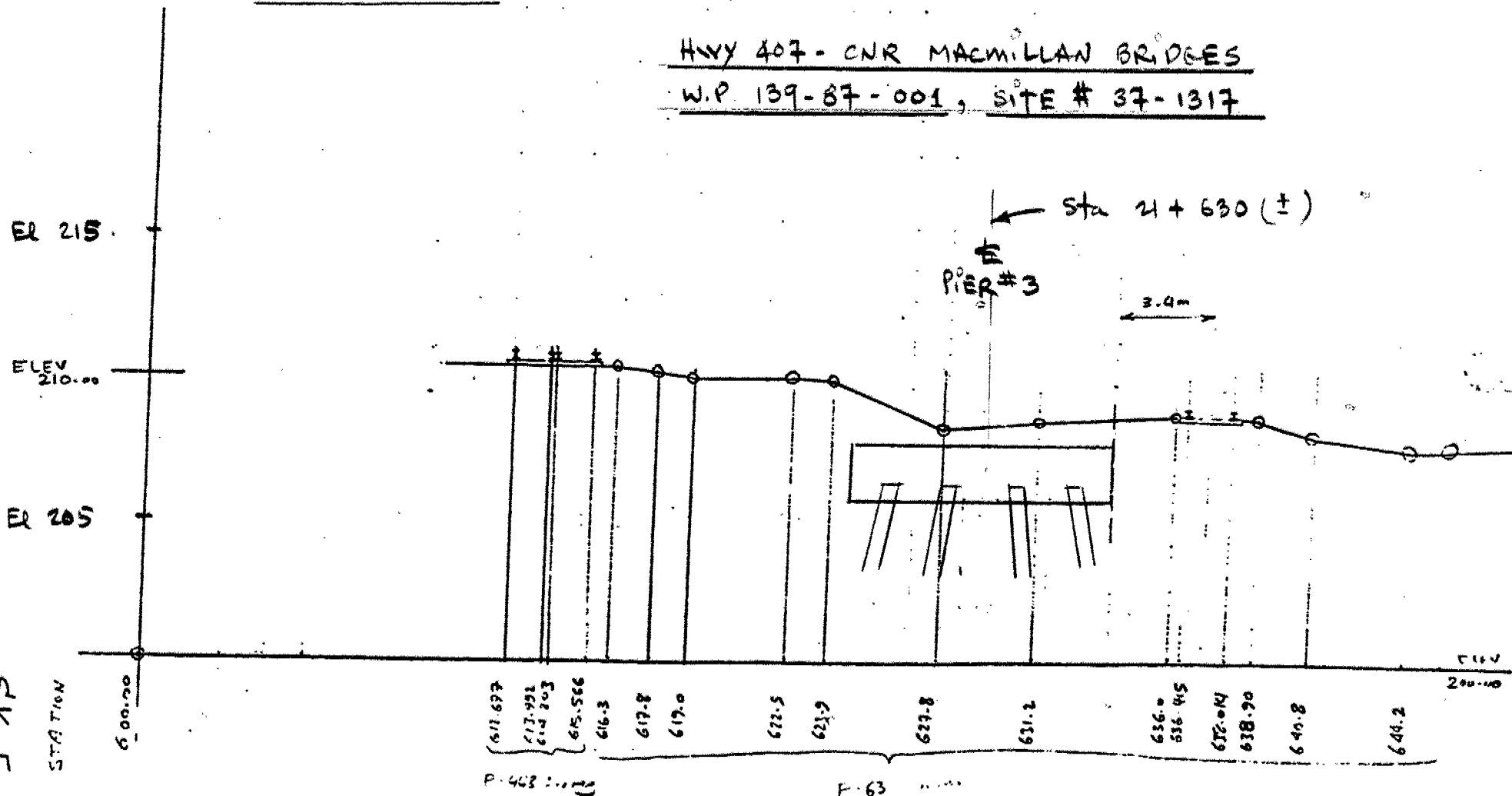
Jan 29, 1991

SEC. A-A (30 meter right of Hwy 407)

Scale 1:200

Hwy 407 - CNR MACMILLAN BRIDGES

W.P. 139-87-001, SITE # 37-1317

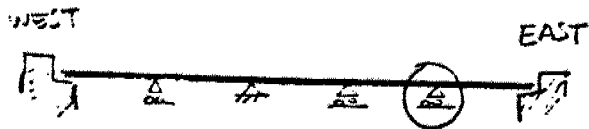


SK-5

SCALE 1:200

30M RT of 407 &

SKETCH A



Hwy 407 - CNR MACMILLAN BRIDGES  
 WP 139-87-001, SITE # 37-1317

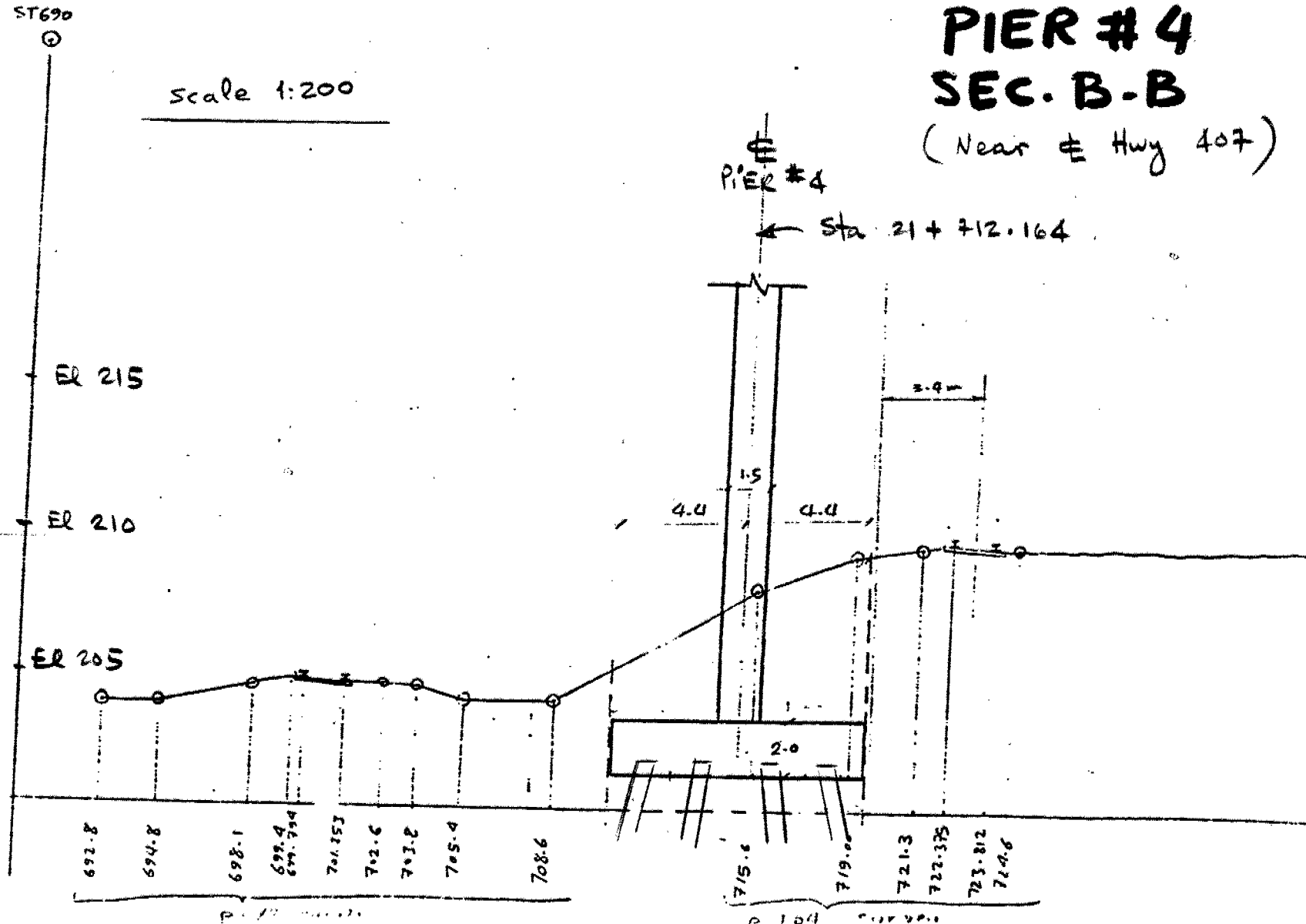
Jan 29  
 1991

# **PIER #4** **SEC. B-B** (Near $\oplus$ Hwy 407)

Scale 1:200

PIER #4

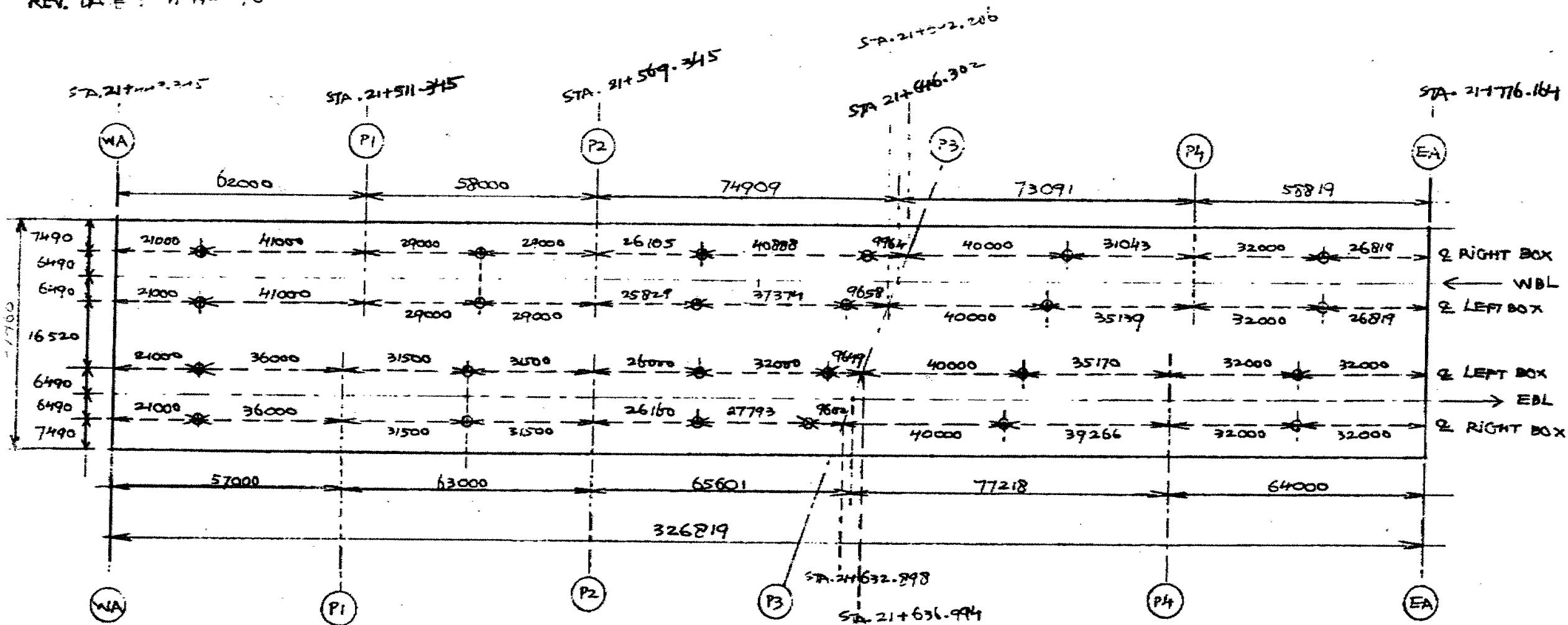
Sta 21 + 712.164



SKETCH B



HWY 487  
REV. DATE: 11-19-190



# PROPOSED TEMPORARY SUPPORTS PLAN

SCALE: 1:1000

## LEGEND:

○ → INDICATE THE TEMPORARY SUPPORT LOCATIONS.

Memorandum

Nov. 7/80

To: File

Re: MacMillan Yard / 407

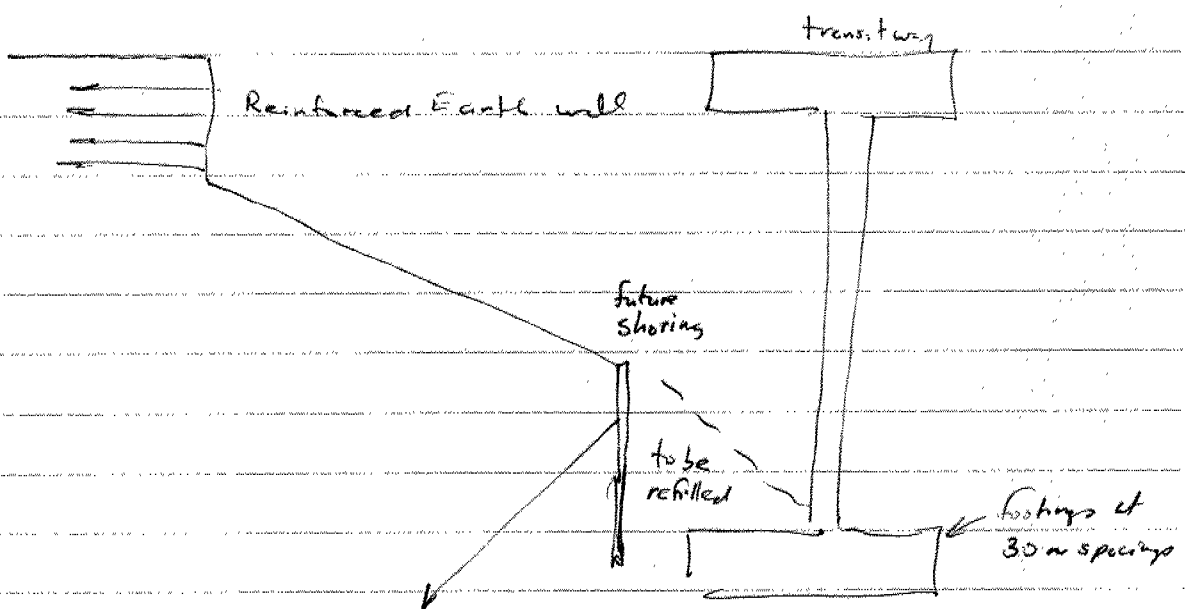
Meeting with Jim Lyke of D.S. Lee  
& E. Lisinski

D. Dundas & M. Dorate

Oct. 25

- 1) Along S side of 407, they are planning  
for future transitory  
they need 12.75 m offset

they propose the following geometry



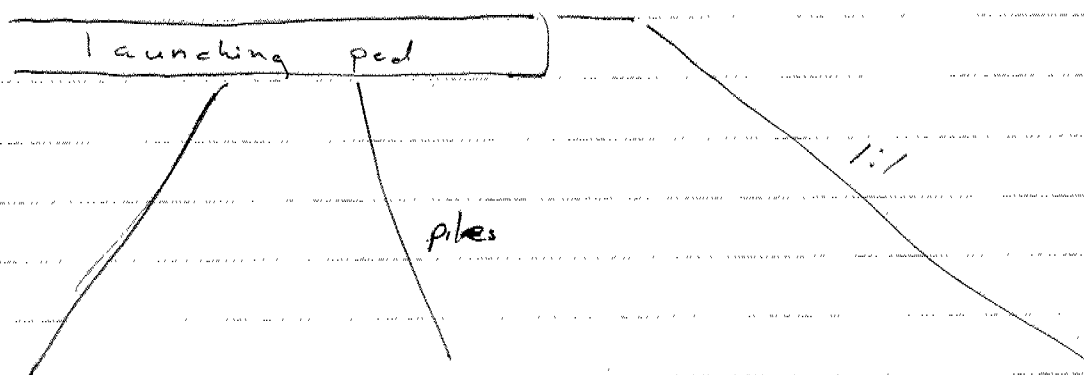
FDS said this is feasible

② NE quad

there is insufficient ROW

- D.S. Lee requested that we consider reinforced slope
- 550 m of the slope would be affected
- they want 1:1 slope
- the embankment will be 3.5 to 10 m high
- the control to property line is 6 m
- the existing ground is flat and the embankment is all in fill
- 1 m of excavation may be required

③ the west abut is the launching pad  
for the segmental bridge



④ Discussion on stepped reinforced wall on E side

⑤ Some discussion of staging at launching  
pad where Foundation Section recommended  
construction to final geometry rather than  
having to reconstruct reinforced slope or  
Reinforced Earth walls.

# memorandum

Tel: (416) 235-5649

Dave Dundas



To: B. Farago  
Design Engineer  
Structural Office

Date: 90 10 05



Re: Proposed Hwy 407 over CNR MacMillan Yard  
W.P. 139-87-01, Site #27-1317, District 6  
(Relative Costs of Deep Foundation Alternatives)

This memo records a telephone conversation on Oct. 4, 1990 with Mr. D. Dundas, Sr. Foundation Engineer and also makes reference to the unit cost estimates of Oct. 2 1990 submitted by Mr. D. Sands (copy attached) of MTO Estimating Office.

For the H-piles (HP 310 x 110) there is consensus that \$125 per metre is a reasonable cost estimate.

In respect to the caissons D. Dundas advises as follows:-

1. In his opinion, an estimated cost of \$550 per metre for the 1200 mm  $\emptyset$  caisson is too low and should be of the order of \$650 to \$750 (min.) per metre and is based on their experience with a \$10,000 to \$20,000 price range for a 15 metre length.
2. High mast lighting (i.e. 1200 mm  $\emptyset$  pole) costs are \$1,000 per metre.
3. The initial foundation proposal for the use of caissons was to exclude the necessity for track protection (if the caissons were extended to the soffit of the deck). This concept (with 1800 mm  $\emptyset$  caissons, founded on bedrock) is presently being employed in the design of the Hwy 401 Bridge over the Rouge River (Site #22-161).
4. The Preliminary Foundation Recommendations of 90 07 20, (P.4, copy attached), includes an estimated caisson length of 13 m to 15 m and is that length below the ground surface (only). Thus the individual lengths of caisson and H-piles are approximately equal. The capacity of a 1.2m  $\emptyset$  caisson is listed as approximately 2.5 times that of a HP310 x 110.

...../2

Page 2

Considering that the (above) estimated cost of a 1200 mm Ø caisson is at least five times that of a HP310 x 110 whereas the increase in capacity is (only) approximately 2.5 times, then the choice of H-pile would appear more cost effective (if the caissons don't extend to the deck soffit).

Additionally and in accordance with the attached calculation (Sheet #1) the OHBDC 6-8.3.10.2 min. spacing criteria would indicate a pier (plan) footing size approximately 15% smaller if H-piles were used instead of caissons.



J. Brown  
Sr. Project Engineer

JB/sl  
Encl

c.c. D. Dundas

SEND TO	MR. J. BROWN		M. T. C. - TORONTO <b>RECEIVED</b> OCT - 3 1990 STRUCTURAL OFFICE TOWER.
	SR. PROJ. <del>ENG.</del> ENG.		
HEAD OFFICE		STR. OFFICE	7 <sup>th</sup> FLOOR
FROM	DAVE SANDS		DEPT. ESTIMATING
SUBJECT	DATE OCT-2/90		
W.P. 139-87-01 - HWY. 407 - BRIDGE OVER C.N.R. YARD.			

IN RESPONSE TO YOUR RECENT MEMO, I HAVE PREPARED  
UNIT PRICES FOR THE ITEMS REQUESTED:

- ① SUP.  $\frac{1}{2}$  DR. 'H' PILES (HP310x110) = \$ 125.00/m.
- ② INSTALL 1200 mm  $\phi$  CAISSONS = \$ 550.00/m
- ③ GRAN. 'A' PADS = \$ 13.00/t

THESE PRICES BASED ON THE ASSUMPTION THAT VERY LARGE  
QUANTITIES WOULD BE INVOLVED.

REPLY

REPLY FROM

REPLY DATE



TO WRITE: HANDWRITE OR TYPE, REMOVE AND RETAIN  
YELLOW COPY, FORWARD BALANCE OF SET.

TO REPLY: WRITE REPLY IN BOTTOM  
AREA, SNAP SET APART

FOLD AT MARKS FOR USE IN #9 OR #10 WINDOW ENVELOPE

RETAIN ORIGINAL AND RETURN PINK COPY

-4-

Below these elevations, pile driving should be controlled by the Hiley Formula as per MTO Standards SS 103-10 or SS 103-11, assuming an ultimate capacity of 2475 kN for a HP310 x 79 and 3450 kN for a HP310 x 110. For design purposes, the following values, according to the O.H.B.D.C., are recommended:

	<u>HP310X110</u>	<u>HP310X79</u>
Factored Axial Capacity at U.L.S.	1600 kN/pile	1150 kN/pile
Axial Capacity at S.L.S. Type II	1150 kN/pile	825 kN/pile

The following pile tip elevations and overburden depths are provided for estimating purposes:

	<u>Pile Tip Elevation</u>	<u>Estimated Overburden Depth</u>
Pier 1	101.4 - 188.0 m = 13.4 m	20.6 m
Pier 2	103.0 - 195.0 m = 12.0	14.5 m
Pier 3	105.4 - 195.0 m = 10.4	15.0 m
Pier 4	101.4 - 185.0 m = 17.4	24.2 m

↑ Length

### Caissons

To minimize shoring in the vicinity of the CN railway tracks, it may be more advantageous to consider founding the piers on reinforced concrete caissons. It is estimated that the caissons will be in the order of 13 m to 15 m in length. The base elevations will be provided in the final Report.

The following O.H.B.D.C. capacities are recommended for 0.9 m, 1.1m, 1.2 m and 1.5 m diameter caissons:

<u>Caisson Diameter</u>	<u>Factored Capacity at U.L.S.</u>	<u>Capacity at S.L.S Type II</u>
0.9 m	2435 kN	1625 kN
1.1 m	3620 kN	2415 kN
1.2 m	4300 kN	2875 kN
1.5 m	6750 kN	4500 kN

HWY 407 BRIDGE OVER CNR MACMILLAN YARD  
W.P. 139-87-01, SITE 27-1317

5 of 5  
 Oct 4, 1990

Comparison of 1.2 m.  $\phi$  caisson vs. HP 310 x 110 pier footing size

(a) Min. spacing requirements of OHBDC clause 6.8.3.10.2

$$S = 2.5b + 0.02 D'$$

(i) 1.2 m.  $\phi$  caisson  $S_1 = 2.5 (1.2m) + 0.02 (15m)$   
 $= 3.3m$  c/c req'd.

(ii) HP 310 x 110  $S_2 = 2.5 (0.3m) + 0.02 (15m)$   
 $= 1.05m$  c/c req'd

Assuming that caissons and HP piles are not battered.

(b) Foundation Capacity (From Foundation Report)

	1.2 m. $\phi$ caisson	HP 310 x 110
ULS	4300 kN	1600 kN
SLS	2875 kN	1150 kN

(c) Ratio of Pier Footing Size: H-Pile / Caisson

(i) ULS  $\left\{ \begin{array}{l} \frac{4300 \text{ kN}}{1600 \text{ kN}} (1.05m \text{ c/c}) = 2.82m \\ < 3.3m \end{array} \right\} 0.85$

(ii) SLS  $\left\{ \begin{array}{l} \frac{2875 \text{ kN}}{1150 \text{ kN}} (1.05m \text{ c/c}) = 2.63m \\ < 3.3m \end{array} \right\} 0.8$

Ignoring the fact that the caisson unit requires more edge (side) cover.



memo

Sept 5/90

To: File

Re: WP 139-87

407 / MacMillan Yd

I returned call to Jim Hyle of DS Lab.

We discussed

1) our requirements for beams in HLE.

I told him an interrupted 2:1 slope

higher than 8 m. Therefore if there was

a RE wall it would not count as 8 m.

2) steeper slope than 2:1.

I told him they are possible

with sampling.

D. Dunder  
Sr. Env. Eng.

## MEMORANDUM

To: Mr. V. Boehnke  
Head, Structural Section  
Central Region

Attn: A. Lui  
Sr. Structural Engineer

From: Foundation Design Section  
Rm. 315, Central Building

Re: Preliminary Foundation Recommendations  
MacMillan Yard Overpass  
W.P. 139-87-01,03,04, Highway 407  
District 6, Toronto

---

90 07 20

The foundation investigation for the above mentioned project has been completed. A total of twenty-seven boreholes were advanced for the overpass structures, proposed retaining walls and high mast lighting poles. The investigation was carried out during the period from 90 06 04 to 90 06 20.

This memo contains a summary of the general subsurface conditions encountered across the site and the preliminary recommendations for the proposed structures.

### GENERAL SUBSURFACE CONDITIONS

The subsurface material encountered across the area consists of a surficial deposit of clayey silt glacial till that extends for depths ranging from 1.4 m to 20.6 m, but is more commonly greater than 5.5 m in thickness. The firm to hard clayey silt contains some sand, trace gravel and occasional seams of sandy silt. The cohesive deposit is underlain by non-cohesive silt to sandy silt strata containing traces of gravel and clay and occasional clayey silt zones. The state of compaction of the non-cohesive strata ranges from very loose to very dense. The full extent of the silt to sandy silt deposit was not explored. The groundwater level measured from installed piezometers varies from 1.3 m to 6.9 m below the ground surface. This variability may be due to the presence of water-bearing seams throughout the clayey silt deposit.

### RECOMMENDATIONS

It is proposed to construct twin 5-span structures to carry Highway 407 across the CN Railway tracks at MacMillan Yard. The structures will be approximately 327.0 m in length with span lengths, from east to west, of 53.0 m - 67.0 m - 65.5 m - 77.4 m - 64.0 m for the eastbound structure and 58.0 m - 62.0 m - 75.2 m - 72.8 m - 58.9 m for the westbound structure. Pier 3 is skewed at 17° 30' to accommodate the alignment of the railway tracks. The profile grade of the proposed Highway 407 has not yet been provided, but is assumed to be 10 m to 12 m above the elevation of the railway tracks.

### STRUCTURE FOUNDATIONS

Both spread footing and deep foundations are feasible at this site. The subsurface material encountered at the abutments will adequately support spread footings on granular 'A' pads. Recommendations for spread footings, pile and caisson type foundations have been provided for the pier locations.

### ABUTMENTS

The abutment footings may be perched within the approaches and founded on compacted Granular 'A' pads. The granular pads should have a minimum thickness of 2.0 m. The recommended bearing capacities for the footings on a granular core, as per the O.H.B.D.C., are as follows:

Factored Bearing Capacity at U.L.S.	900 kPa
Bearing Capacity at S.L.S. Type II	350 kPa

A friction angle of 35° may be assumed to determine sliding resistance between the footing and compacted Granular 'A' pad.

Topsoil and/or soft material should be removed for the entire width of the proposed footings and approach embankments. Soft material was encountered above El 206.8 m at the West Abutment and above El 208.5 m at the East Abutment. The sub-excavated areas should be proof-rolled and any additional soft areas identified by proof-rolling should be removed and replaced with well-compacted granular backfill.

The exposed excavation base should be covered with a 150 mm thick non-cohesive granular working pad as soon as possible to avoid softening and disturbance of the underlying material. Backfill and fill placed to the elevation of the base of the granular pad should be non-cohesive, free draining and well compacted.

A minimum of 1.2 m of earth cover is required for frost protection.

### PIER FOUNDATIONS

Three alternatives are provided for the pier foundations. The recommendations are based on the assumption that the groundwater level is located below the footing bases and that the footing bases will be founded 1.5 m to 2.0 m below the existing ground surface. In addition, it is assumed that there will be no changes to the track alignment and profile.

#### Spread Footings

The piers may be founded on spread footings on original ground, within 1.5 m to 2.0 m of the existing ground surface. The following bearing capacities, as per the O.H.B.D.C, may be achieved:

Factored Bearing Capacity at U.L.S.	375 kPa
Bearing Capacity at S.L.S Type II	250 kPa

A friction angle of  $28^{\circ}$  may be assumed as the shearing resistance between the concrete footing and the clayey silt deposit.

A minimum of 1.2 m of earth cover is required for frost protection.

Upon excavation of the footing base, a 150 mm concrete working slab should be poured within six hours of exposure.

Excavation for placement of footings should be maintained at 1H:1V or flatter.

#### Pile Foundations

Alternatively, the piers may be founded on end-bearing piles equipped with driving shoes. The piles should be driven below the following elevations at each of the pier locations:

Pier 1	El 190.0
Pier 2	El 197.0
Pier 3	El 197.0
Pier 4	El 187.0

Below these elevations, pile driving should be controlled by the Hiley Formula as per MTO Standards SS 103-10 or SS 103-11, assuming an ultimate capacity of 2475 kN for a HP310 x 79 and 3450 kN for a HP310 x 110. For design purposes, the following values, according to the O.H.B.D.C., are recommended:

	<u>HP310X110</u>	<u>HP310X79</u>
Factored Axial Capacity at U.L.S.	1600 kN/pile	1150 kN/pile
Axial Capacity at S.L.S. Type II	1150 kN/pile	825 kN/pile

The following pile tip elevations and overburden depths are provided for estimating purposes:

	<u>Pile Tip Elevation</u>	<u>Estimated Overburden Depth</u>
Pier 1	188.0 m	20.6 m
Pier 2	195.0 m	14.5 m
Pier 3	195.0 m	15.0 m
Pier 4	185.0 m	24.2 m

### Caissons

To minimize shoring in the vicinity of the CN railway tracks, it may be more advantageous to consider founding the piers on reinforced concrete caissons. It is estimated that the caissons will be in the order of 13 m to 15 m in length. The base elevations will be provided in the final Report.

The following O.H.B.D.C. capacities are recommended for 0.9 m, 1.1m, 1.2 m and 1.5 m diameter caissons:

<u>Caisson Diameter</u>	<u>Factored Capacity at U.L.S.</u>	<u>Capacity at S.L.S Type II</u>
0.9 m	2435 kN	1625 kN
1.1 m	3620 kN	2415 kN
1.2 m	4300 kN	2875 kN
1.5 m	6750 kN	4500 kN

### CONSTRUCTION CONSIDERATIONS

The presence of boulders, protection of the railway tracks, and dewatering are items requiring consideration during construction. Because of the proximity of the proposed footings to the existing CN railway tracks, it is essential to minimize their disturbance during construction.

With the spread footing and pile foundation alternatives, railway track protection will be required when excavating and constructing the footings/piles caps. This may be achieved by constructing a temporary wall with either interlocking sheet piling, or soldier piles with timber lagging. It is anticipated that dewatering will not be required within 1.5 m to 2.0 m of the existing ground surface.

With a caisson foundation, a temporary steel liner will be required during installation to support and prevent cave-in of the walls of the excavation. Because of the increasing presence of wet seams of sandy silt with depth, and the possibility of encountering this material at the base of the caisson, precautions should be taken to equalize the conditions of unbalanced hydrostatic head. This may be accomplished by maintaining a sufficient head in the excavation using drilling mud and by placing the concrete by tremie methods. These concerns should be addressed by the contractor to ensure that the stability of caisson installation is maintained.

### SLOPE STABILITY

Comments on slope stability cannot be made until the final profile becomes available.

### LATERAL EARTH PRESSURES

Backfill to the structure should consist of granular material in accordance with MTO Special Provision No. 109F03, for which the following properties apply:

	<u><math>\phi</math></u>	<u><math>\gamma</math></u>
Granular 'A'	35°	22.8 kN/m <sup>3</sup>
Granular 'B'	30°	21.2 kN/m <sup>3</sup>

Lateral earth pressures should be computed as per Section 6.6.1.2 of the O.H.B.D.C.

# HIGH MAST LIGHTING

The foundation investigation included five boreholes for proposed HML pole locations. The design of the high mast lighting foundation (single concrete caisson) should proceed in accordance with the method as outlined in the following papers:

Brohms, B.B.      Lateral Resistance of Piles in Cohesive Soil  
Journal of the Soil Mechanics and Foundation Div.,  
ASCE Vol. 90, No.SM2, Paper 3285, March 1964.

Brohms, B.B.      Lateral Resistance of Piles in Cohesionless Soil  
Journal of the Soil Mechanics and Foundation Div.,  
ASCE Vol. 90, No. SM3, Paper 3909, May 1964.

The following soil parameters are provided for the design of the high mast lighting caissons:

$\phi$  = Apparent angle of internal friction for non-cohesive soils

$q_u$  = Unconfirmed compressive strength in kPa

$\gamma$  = Unit weight in kN/m<sup>3</sup>

The design values for each of the HML locations are provided as follows:

<u>Light Pole</u>	<u>Elev. (m) From-To</u>	<u>Soil Type</u>	<u><math>\phi</math></u>	<u><math>q_u</math></u>	<u><math>\gamma</math> (kN/m<sup>3</sup>)</u>
P1 (BH4)	208.6-200.2 200.2-197.2	Cohesive Non-Cohesive	0 30°	300 0	20.0 20.0
P2 (BH7)	209.5-201.1 201.1-198.1	Cohesive Non-Cohesive	0 30°	250 0	20.0 20.0
P3 (BH10)	209.2-196.9	Cohesive	0	250	20.0
P4 (BH13)	209.4-198.0	Cohesive	0	300	20.0
P5 (BH11)	210.0-196.0	Cohesive	0	250	20.0

The construction considerations for caisson type foundations are applicable to the high mast lighting pole foundations.

Recommendations for the proposed retaining wall structures will be provided when their locations are finalized.

The design values and recommendations provided are preliminary in nature and are subject to change when the final E-Plan and footing locations become available. The final Foundation Design Report, complete with borehole log sheets and stratigraphic sections, will be issued six weeks following the arrival of the E-Plan.



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BB/lh