



PRELIMINARY FOUNDATION INVESTIGATION AND DESIGN REPORT
for
CNR OVERHEADS NBL AND SBL STRUCTURE WIDENINGS
HIGHWAY 404 HOV LANE EXPANSION
FROM HIGHWAY 407 TO GREEN LANE (26 KM)
WO 03-20024
REGIONAL MUNICIPALITY OF YORK, ONTARIO

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

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PML Ref.: 14TF003A-CNR
Index No.: 043FIDR
Geocres No.: 30M14-419
June 1, 2015



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 (for the original NBL and SBL bridges)
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 WP 160-74-33, Structural Site 37-700
 GEOCREST # 30M14-160
- Reference 1b - Contract Drawings (Excerpt)
 (for the original NBL and SBL bridges)
 CNR Overheads, Hwy 404, 3.7 Miles North of Regional Road 14
 Contract 82-74, WP 160-74-33, Structural Site 37-700
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 South Approach Embankment Instabilities
 CNR Overheads, Hwy 404, 3.7 Miles North of Regional Road 14
 WO-86-11006, Structural Site 37-700
- Reference 3 - Contract Drawings (Excerpt)
 (for the initial median widening of NBL and SBL bridges)
 CNR Overheads, Hwy 404, 3.7 Miles North of Regional Road 14
 Contract 2000-0106, WP 433-98-01, Structural Site 37-700

PART A
PRELIMINARY FOUNDATION INVESTIGATION REPORT

for
CNR Overheads NBL and SBL Structure Widening
Highway 404 HOV Lane Expansion
From Highway 407 to Green Lane (26 km)
GWP 03-20024,
Regional Municipality of York, Ontario

1. INTRODUCTION

The Foundation Engineering Services required for this project include preparation of a preliminary design level Foundation Investigation and Design Report for the proposed High Occupancy Vehicle (HOV) lanes, which will require widening into the median of both the Highway 404 NBL and SBL Overpasses over the CNR tracks. The report was prepared for the MMM Group Limited on behalf of the Ontario Ministry of Transportation.

This Preliminary Foundation Investigation Report summarizes the subsurface conditions based on review and compilation of information from available relevant reports for this site. This report is intended for preliminary design and planning purposes. Detail design level foundation engineering services will be required for the detail design phase of the project.

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

2. SOURCES OF INFORMATION

The following reports, including drawings, were available for the CNR Overhead Structures.

- Reference 1a - Foundation Investigation and Design Report
(for the original NBL and SBL bridges)
CNR Overheads, Hwy 404, 3.7 Miles North of Regional Road 14
WP 160-74-33, Structural Site 37-700
GEOCREC # 30M14-160
- Reference 1b - Contract Drawings
(for the original NBL and SBL bridges)
CNR Overheads, Hwy 404, 3.7 Miles North of Regional Road 14
Contract 82-74, WP 160-74-33, Structural Site 37-700



- Reference 2 - Foundation Investigation and Design Report
South Approach Embankment Instabilities
CNR Overheads, Hwy 404, 3.7 Miles North of Regional Road 14
WO-86-11006, Structural Site 37-700
- Reference 3 - Contract Drawings
(for the initial median widening of NBL and SBL bridges)
CNR Overheads, Hwy 404, 3.7 Miles North of Regional Road 14
Contract 2000-0106, WP 433-98-01, Structural Site 37-700

3. SITE DESCRIPTION AND GEOLOGY

The site is located at the crossing of Highway 404 over the CNR alignment, approximately 1.5 km north of Bloomington Road in the Regional Municipality of York.

The topography to the north of the site is rolling with some low-lying and swampy areas with the elevation of the natural ground in the order of 3 m higher than at the CNR crossing. The topography to the south of the site is hilly with the elevation of the natural ground in the order of 10 m higher than at the CNR crossing. The site topography may have been changed since the existing investigations were carried out.

The site is located within the Oak Ridges Interlobate Moraine physiographic region with the ground typified by glacial till deposits with extensive sand and gravel cover in the hills and terraces. Layers of fine sand, silt and clay are common within the glacial till deposit.

4. SUBSURFACE CONDITIONS

The subsurface conditions presented in this report were determined through review of the Foundation Investigation and Design Report prepared for design of the original NBL and SBL CNR Overpasses (Reference 1a in Section 2).

The site investigation for that project included advancing 30 boreholes at locations illustrated in the Borehole Locations and Soil Strata Drawing in Appendix A (Reference 1a). Refer to Appendix A (Reference 1a) for copies of these Borehole Logs illustrating ground conditions and for associated Figures illustrating laboratory test results on selected soil samples.



Subsurface conditions are quite variable across the site. The surficial deposits adjacent to the CNR tracks and roughly bounded by the topographic contour at elevation 304.0 m consisted of very soft to soft organic silt and/or organic clay with a thickness up to 5.0 m prior to construction of the original CNR Overpasses. During the construction of the original CNR Overpasses, extensive subexcavation of these organic silt/clay deposits and replacement with suitable fill was carried out at the location of both forward embankments of the SBL Overpass. Refer to Appendix A (Reference 1b), Sheet 74, General Layout, for illustration of the planned location of the subexcavation area. The actual plan and depth limits of the subexcavation are not known as they may have changed from the planned limits especially at the south approach as a result of a slope instability that occurred during construction and subsequent measures for slope stabilization and reconstruction of portions of the bridge.

Elsewhere, beneath a thin veneer of organic silt up to 0.6 m thick or extending from the ground surface are deposits of loose to compact sand or silt with some sand up to approximately 5.0 m thick. Underlying these surficial deposits is an extensive deposit of clayey silt to silt of slight plasticity up to approximately 23.0 m thick. This cohesive deposit is not continuous and is interrupted in an apparently random fashion by seams or pockets of loose to dense sands or silts with some sand up to approximately 3.0 m thick. One large continuous pocket of silt, approximately 15.0 m thick, was encountered about 75.0 m south of the CNR tracks. Underlying the clayey silt to silt deposit or the extensive pocket of silt is a stratum of hard glacial till composed of a heterogeneous mixture of clayey silt, sand and gravel, which was encountered at depths ranging from approximately 14.0 to 26.0 m below the ground surface. The full thickness of the glacial till was not explored but was proven to a thickness of at least 6.0 m.

Refer to the Record of Borehole Sheets in Appendix A (Reference 1a) for details on the subsurface conditions at borehole locations. The locations of the boreholes and a stratigraphical profile based on the borehole data are shown on Drawing No. 1607433-A in Appendix A (Reference 1a). In addition, 5 stratigraphical sections based on the borehole data are shown on Drawing No. 1607433-B in Appendix A (Reference 1a).

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



4.1 **Organic Silt**

The organic silt was encountered surficially at approximate elevation 303.1 to 305.8 and penetrated at 0.6 to 3.0 m (approximate elevation 300.6 to 305.2). Prior to construction of the original CNR Overheads, this surficial deposit was encountered across most of the site where it was generally only a thin veneer up to 0.6 m thick. However, in the vicinity of the CNR tracks the deposit was up to 3.0 m thick.

Due to ground subexcavation and replacement operations during construction of the original overpasses, the horizontal and vertical extent of the remaining deposit is not known. Refer to Section 4 SUBSURFACE CONDITIONS, for further explanation of the changes to the extent of this deposit that were part of previous construction activities.

Where it does exist, the deposit is composed of black organic silt with some decomposed vegetation and in certain locations, some sand. Results of previous laboratory testing performed on representative samples from this deposit are provided in Table 4.1(a).

Table 4.1(a) - Organic Silt

PARAMETER	RANGE	AVERAGE
Organic Content (% of weight)	1 – 76	18
Natural Moisture Content (w) %	26 – 355	113
Liquid Limit (w_L) %	18 - 40	32
Plastic Limit (w_P) %	13 - 29	22
Plasticity Index (I_p) %	5 - 20	10

The results of the Atterberg Limit Testing are shown on the Plasticity Chart, Figure 1 in Appendix A (Reference 1a), and indicate that the material is organic and of intermediate plasticity (OI zone).

The shear strength, as determined by in-situ vane testing, ranges from 3.8 kPa to 15.6 kPa. Based on the field vane test results and the SPT 'N' values ranging from 1 to 6 blows per 0.3 m, this deposit is estimated to have very soft to soft consistency.



4.2 Organic Clay

The organic clay deposit was encountered at 0.6 to 1.6 m (approximate elevation 301.7 to 302.7) and penetrated at 2.1 to 4.8 m (approximate elevation 298.6 to 301.2). Prior to construction of the original CNR Overheads, this stratum was encountered immediately below the organic silt deposit in the area roughly bounded by the topographic contour at elevation 304.0. Prior to the previous construction, the thickness of this cohesive organic deposit ranges ranged from approximately 0.9 to 3.2 m.

Due to ground subexcavation and replacement operations during construction of the original overpasses, the horizontal and vertical extent of the deposit is currently not known. Refer to Section 4 SUBSURFACE CONDITIONS, for further explanation of the changes to this deposit that were part of previous construction activities. Refer to Appendix A, (Reference 1b) for a figure (cross section) illustrating the recommended depth and geometry of excavation.

Where it does exist, this deposit is composed of grey to white organic clay or marl. Results of previous laboratory testing performed on representative samples from this deposit are provided in Table 4.2(a).

Table 4.2(a) - Organic Clay

PARAMETER	RANGE	AVERAGE
Organic Content (% of weight)	2, 13	(two tests)
Natural Moisture Content (w) %	47 - 147	108
Liquid Limit (w_L) %	56, 58	(two tests)
Plastic Limit (w_P) %	46, 46	(two tests)
Plasticity Index (I_p) %	10, 12	(two tests)
Bulk Density (γ) kN/m ³	13.3 – 17.1	15.2
PARAMETER	RANGE	SENSITIVITY
Shear Strength (s_u) field vane kPa	3.8 – 11.5	2 - 12
Shear Strength(s_u) unconfined compression test kPa	3.0 – 6.1	-



The Atterberg Limit testing results shown on Figure 1, Appendix A (Reference 1a), indicate that the deposit is organic material of high plasticity (OH zone).

The results of shear strength testing indicate that the consistency of the deposit is very soft.

4.3 Clayey Silt to Silt of Slight Plasticity

The clayey silt to silt of slight plasticity was encountered surficially to a depth of 13.9 m (approximate elevation 289.5 to 305.2) and penetrated at 2.5 to 25.9 m (approximate elevation 277.8 to 303.3). This cohesive stratum was encountered surficially and immediately below the surficial organic strata or the surficial sand some silt deposits. The thickness of this stratum varies from 12.8 to 22.8 m at borehole locations. The deposit is composed of clayey silt to silt of slight plasticity and in certain locations contains some sand. In addition, at the southeast area of the site, the upper 3.0 to 7.0 m of the stratum contains random seams or pockets of silt and fine sand about 6 mm thick every 76 mm. Furthermore this deposit is not continuous, but is interrupted in a random fashion by seams or pockets of silt, some sand or sand up to 5.8 m thick.

The results of Atterberg Limit testing on samples from the clayey silt to silt of slight plasticity and samples from the clayey silt to silt of slight plasticity with some sand are shown on the Plasticity Chart, Figure 2, in Appendix A (Reference 1a). The Atterberg Limits indicate that the deposit is inorganic and of low plasticity (CL-ML to CL zone for clayey silt to silt of slight plasticity and ML to CL-ML for clayey silt to silt of slight plasticity with some sand).

Generally, the 'N' values as determined by the SPT range from 8 to 71 blows per 0.3 m, generally increasing with depth except for a 2.4 to 7.0 m thick zone immediately below the deep organic deposit (i.e. adjacent to the CNR tracks and bounded by contour 304.0 m) where 'N' values as low as 1 blow for 0.45 m were observed. The shear strength, as measured by in-situ vane testing in the zone immediately below the deep organic stratum, increases with depth from 57.5 kPa to 76.6 kPa and elsewhere was greater than 96.8 kPa. Based on the SPT and field vane tests, the



consistency of the deposit is estimated to be very stiff to hard, except in the upper portion of the deposit immediately below the deep organic stratum where the consistency is very soft to stiff.

4.4 Sand

This deposit was encountered in some boreholes adjacent to the CNR tracks as distinct pockets within the stratum of clayey silt to silt of slight plasticity at a depth ranging from 2.4 to 11.6 m below the ground surface. In addition, outside the limits of the deep organic deposit, this noncohesive stratum was encountered in some locations either beneath a thin veneer of organic silt or extending from the ground surface. The thickness of this deposit is estimated to range from 0.6 to 4.6 m thick, being generally in the order of 3.0 m thick. In general, the sand deposit was encountered between approximate elevation 286.8 to 304.1 and penetrated at approximate elevation 283.0 to 302.0.

Grain size distribution testing performed on representative samples from this stratum are shown in envelope form on Figure 4 in Appendix A (Reference 1a). The composition of this deposit ranges from a sand with some silt to a sand with some gravel.

The results of Standard Penetration Test (SPT) 'N' values range generally from 6 to 37 blows per 0.3 m except for some tests performed in the surficial deposit where 'N' values as low as 2 and 3 were observed. Based on these values the relative density of the deposit ranges from very loose to dense, being generally in the loose to compact range.

4.5 Silt some Sand

This deposit was encountered in some boreholes adjacent to the tracks within the stratum of clayey silt to silt of slight plasticity at depths ranging from 3.7 to 14.6 m below the ground surface. Furthermore, this stratum was encountered in some locations immediately below a thin veneer of organic silt or extending from the ground surface. The thickness of this deposit ranged from 1.8 to 5.8 m at the borehole locations. In general, the silt some sand deposit was encountered between approximate elevation 295.8 to 302.8 and penetrated at approximate elevation 291.8 to 301.0.



Grain size distribution testing performed on representative samples from this deposit are shown on envelope form on Figure 4, Appendix A (Reference 1a).

Based on SPT 'N' values ranging generally from 4 to 19 blows per 0.3 m, the relative density of the deposit is described as loose to compact.

4.6 Silt

This deposit was encountered approximately 76.2 m south of the tracks immediately below the stratum of clayey silt to silt of slight plasticity at a depth of 3.4 to 11.6 m (approximate elevation 289.0 and 302.0) below the existing ground surface and penetrated at 9.6 to 24.3 m (approximate elevation 279.3 to 295.8). This noncohesive stratum appears to form a continuous pocket or trench up to 15.8 m thick and about 45.7 m wide and is approximately parallel to the CNR tracks at this location.

The deposit is composed almost entirely of silt with negligible amounts of clay and sand. The results of grain size distribution testing are shown in envelope form in Figure 5 in Appendix A (Reference 1a).

The relative density of the deposit is described as compact to dense increasing with depth as inferred from the SPT 'N' value range of 19 to 46 blows per 0.3 m.

4.7 Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)

This cohesive deposit was encountered in 15 of the boreholes at a depth ranging from 16.2 to 25.9 m below the existing ground surface (approximate elevations 277.8 to 287.4) and penetrated at 21.8 to 32.4 m (approximate elevation 272.7 to 281.8). The upper boundary of the deposit is gently rising to the north and south from a low basin located some 30.5 to 91.4 m south of the railway tracks. This deposit was not fully penetrated but proven to extend to a thickness of over 11.6 m.



Grain size distribution testing performed on representative samples from this deposit are shown in envelope form on Figure 5, Appendix A (Reference 1a). The deposit is a glacial till composed of a heterogeneous mixture of clayey silt, sand and gravel. In some locations, a 0.3 to 0.6 m zone of cobbles was encountered about 3.0 m below the upper surface of this stratum.

Based on SPT 'N' values being generally over 100 blows per 0.3 m, the consistency of this stratum is estimated to be hard.

4.8 Groundwater Conditions

The groundwater level was observed during the progress of the fieldwork by measuring in the open boreholes approximately 24 hours after completion of the boring. In the low lying swampy areas adjacent to the CNR tracks, groundwater was at the surface and elsewhere the groundwater was found to vary from 0.3 to 2.1 m below the existing ground surface which corresponds to elevation 302.1 to 307.7. These observations indicate that the groundwater level generally reflects the topography.

In addition, temporary sub-artesian conditions were observed in Boreholes 22 and 24 immediately above the glacial till deposit. Piezometers were installed in Borehole 24 at depths of 8.5 m (approximate elevation 294.8) and 19.8 m (approximate elevation 283.5) to monitor the artesian pressure. The piezometer readings indicate that the artesian pressure is approximately at the groundwater level.

Groundwater levels are subjected to fluctuations due to seasonal and rainfall patterns.



5. MISCELLANEOUS

The Preliminary Foundation Investigation portion of this report was prepared by Mr. N. Rahman, P.Eng., and reviewed by Mr. D. Dundas, P.Eng. The report was independently reviewed by Mr. Carlos M.P. Nascimento, P.Eng., MTO Designated Principal Contact.

Yours very truly,

Peto MacCallum Ltd.



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



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



Carlos M.P. Nascimento, P.Eng.
MTO Designated Principal Contact



APPENDIX A

Reference 1a

Excerpt from Foundation Investigation and Design Report
(for the original NBL and SBL bridges)
CNR Overheads, Hwy 404, 3.7 Miles North of Regional Road 14
WP 160-74-33, Structural Site 37-700
GEOCREC # 30M14-160



RECORD OF BOREHOLE No 1

W P 160-74-33 LOCATION Coords. N 15,958,028, E 1,027,374 ORIGINATED BY M.M.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY M.M.
DATUM Geodetic DATE March 9, 1978 CHECKED BY *el.j.*

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
996.2	Ground Surface																
0.0	Organic Silt, Some Sand Loose																
990.2			1	TW	PM												
6.0			2	SS	4		990										9 27 48 16
	Sand		3	SS	5		980										2 36 44 18
			4	SS	8												3 24 57 16
	Firm to Stiff		5	SS	8		970										
	Clayey Silt to Silt of Slight Plasticity		6	SS	20												
	Some Sand		7	SS	27		960										0 1 79 20
	Very Stiff to Hard		8	SS	26												
			9	SS	45		950										
			10	SS	37												
			11	SS	55		940										0 10 74 16
			12	SS	47												
			13	SS	50		930										11 10 73 6
			14	SS	56												
919.2							920										
77.0	Heterogeneous Mixture, Clayey Silt, Sand and Gravel (Glacial Till) Hard		15	SS	60/ 4"		910										4 37 43 16
			16	SS	138		900										
894.7			17	SS	150/ 2"												
101.5	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15
10

5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 2

W P 160-74-33 LOCATION Coords. N 15,985,085; E 1,027,412 ORIGINATED BY M.M.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY M.M.
DATUM Geodetic DATE March 9, 1978 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100							
								SHEAR STRENGTH							
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE			WATER CONTENT (%)			PCF			
996.6	Ground Surface														
0.0	Organic Silt Very Soft														
991.6															
5.0	Clayey Silt to Silt of Slight Plasticity With Random Seams or Pockets of Silt and Fine Sand Stiff		1	TW	PM		990							135	
			2	SS	4										2 20 64 14
			3	SS	3		980								2 26 67 5
			4	SS	9										11 28 40 21
			5	SS	13		970								
			6	SS	29										
			7	SS	27		960								0 1 74 25
			8	SS	21										
			9	SS	35		950								
945.1			10	SS	41										
51.5	End of Borehole														

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 3

W P 160-74-33 LOCATION Coords. N 15,985,146 E 1,027,455 ORIGINATED BY M.M.
 DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY M.M.
 DATUM Geodetic DATE March 7 & 8, 1978 CHECKED BY P.J.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
998.6	Ground Surface																
0.0	Silt, Some Sand Loose to Compact					No Water Level Established											
992.6			1	SS	11												0 26 68 6
6.0	Clayey Silt to Silt of Slight Plasticity Soft		2	SS	1												0 2 69 29
			3	TW	PM												
			4	TW	PH												
974.6																	
24.0	Sand, Some Silt Some Gravel Loose to Compact		5	SS	8												27 44 24 5
			6	SS	6												7 69 (24)
			7	SS	30												20 75 (5)
959.6																	
39.0	Clayey Silt to Silt of Slight Plasticity Silt Very Stiff to Hard		8	SS	18												0 7 81 12
			9	SS	41												
			10	SS	18												
			11	SS	22												
			12	SS	67												
			13	SS	41												
			14	SS	60/5"												
925.6																	
73.0	Heterogeneous Mixture Clayey Silt, Sand and Gravel Hard Glacial Till		15	SS	145												
907.1																	
91.5	End of Borehole Note: Water Level Not Established		16	SS	100/3"												

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 4

W P 160-74-33 LOCATION Coords. N 15,985,250; E 1,027,475 ORIGINATED BY B.L.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY M.M.
DATUM Geodetic DATE March 8, 1978 CHECKED BY J.J.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
995.3	Ground Surface																
0.0	Clayey Silt to Silt of Slight Plasticity With Random Seams of Silt and Fine Sand		1	TW	PM		990										
			2	TW	PH												
	Very Soft		3	TW	PM		980										
	Soft to Stiff		4	TW	PH												
972.3			5	SS	9		970										
23.0	Silt, Some Sand Trace Clay Loose to Compact		6	SS	11												
			7	SS	16		960										
957.3			8	SS	17												
38.0	Sand, Some Silt Some Gravel Compact		9	SS	18		950										
949.8			10	SS	50												
45.5	Clayey Silt to Silt of Slight Plasticity Some Sand Hard		11	SS	38		940										
			12	SS	70												
933.8																	
61.5	End of Borehole																

+3, x5 : Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 5

W P 160-74-33 LOCATION Coords. N 15,985,150; E 1,027,355 ORIGINATED BY O.J.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY
DATUM Geodetic DATE March 8, 1978 CHECKED BY SPJ

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
995.2	Ground Surface																
0.0	Organic Silt, v. Soft																
988.2	Organic Clay Very Soft		1	PS	PM		990									109	
7.0	Clayey Silt to Silt of Slight Plasticity With Random Seams of Silt and Fine Sand Very Soft to Firm		2	SS	Own Weight												2 26 54 18
			3	SS	2		980										2 28 54 16
972.2			4	TW	PH											139	
23.0	Silt, Some Sand		5	SS	11		970										2 30 62 6
966.2	Compact		6	SS	0/18"												
29.0	Clayey Silt to Silt of Slight Plasticity		7	SS	21		960										
	Hard		8	SS	28												0 1 79 20
			9	SS	72		950										
942.2			10	SS	31												1 8 81 10
53.0	Sand, Some Silt and Gravel		11	SS	37		940										20 49 28 3
933.7	Dense		12	SS	33												
61.5	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 6

W P 160-74-33 LOCATION Coords. N 15,985,216; E 1,027,395 ORIGINATED BY B.L.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.
DATUM Geodetic DATE March 15, 1978 CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
994.8	Ground Surface																
0.0	Organic Silt																
989.8	Very Soft																
5.0	Clayey Silt to Silt of Slight Plasticity With Random Seams of Sand and Silt		1	SS	PM		990									127	E _o =0.71 P _o =0.47 tsf C _c =0.21 E _c =0.47 C _o =0.06
			2	TW	PM												
			3	SS	3												
			4	TW	PM		980										
			5	TW	PM												
973.3																	
21.5	End of Borehole																
	Note: Groundwater Level Not Established																

+3, x5: Numbers refer to
Sensitivity

20
15
10
5
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
(%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 7

W P 160-74-33 LOCATION Coords. N 15,985,276; E 1,027,435 ORIGINATED BY O.J.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY O.J.
DATUM Geodetic DATE March 9, 1978 CHECKED BY *[Signature]*

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
994.6	Ground Surface																
992.6	Organic Silt, V. Soft		1	TV	PM												
2.0																	
	Soft to Firm		2	SS	7												
	Some Sand Stiff		3	SS	8												
			4	SS	10												
	Sandy Silt Loose		5	SS	9												
	Clayey Silt to Silt of Slight Plasticity Very Stiff to Hard		6	SS	26												
			7	SS	67												
			8	SS	26												
	Silt Compact		9	SS	19												
			10	SS	34												
940.6	Hard																
54.0	Sand, Some Silt and Gravel Compact to Very Dense		11	SS	67												
			12	SS	83												
928.1			13	SS	26												
66.5	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 8

W P 160-74-33 LOCATION Coords. N 15,985,148; E 1,027,313 ORIGINATED BY O.J.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY
DATUM Geodetic DATE March 7, 1978 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
994.7	Ground Surface															
0.0	Organic Silt Very Soft to Soft															
	Organic Clay		1	SS	PM		990									Om 17% W 148%
984.0	Very Soft															
10.0	Clayey Silt to Silt of Slight Plasticity		2	SS	0/18"		980									
	Very Soft		3	SS	1/18"											
	Stiff to Hard		4	SS	10											14 23 50 13
	Some Sand		5	SS	9		970									
			6	SS	9											
			7	SS	18		960									
			8	SS	25											2 23 61 14
			9	SS	55		950									0 1 80 19
	Sand, Some Silt, Compact		10	SS	28											10 42 34 14
936.7			11	SS	55		940									
58.0	Heterogeneous Mixture, Clayey Silt Cobbles Sand and Gravel Hard (Glacial Till)		12	SS	145		930									9 50 31 10
			13	SS	100/2"											
			14	SS	100/3"		920									
			15	SS	100/4"		910									14 44 32 10
898.2			16	SS	100/3"		900									
96.5	End of Borehole															

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 9

W P 160-74-33 LOCATION Coords. N 15,985,385; E 1,027,464 ORIGINATED BY O.J.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY O.J.
DATUM Geodetic DATE March 10 & 13, 1978 CHECKED BY *W.J.*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
995.4	Ground Surface																GR SA SI CL
0.0	Organic Silt Very Soft		1	TW	PM		990										W 116% Om
	Organic Clay Very Soft		2	SS	1			+5									13%
								+2									W 147%
								+6									Om 10%
								+12									
979.4			3	SS	2		980										
16.0	Sand, Some Silt Some Gravel Compact		4	SS	14												17 74 (9)
968.4			5	SS	20		970										1 54 35 10
27.0	Clayey Silt to Silt of Slight Plasticity Very Stiff		6	SS	19												
961.4			7	SS	20		960										50 31 17 2
34.0	Sandy Gravel		8	SS	43		950										8 17 50 25
956.4	Compact		9	SS	43												
39.0	Clayey Silt to Silt of Slight Plasticity Some Sand Hard		10	SS	17		940										11 18 61 10
			11	SS	55												
935.4			12	SS	150		930										18 40 28 14
60.0	Heterogeneous Mixture Clayey Silt Sand and Gravel (Glacial Till) Hard		13	SS	72												
			14	SS	100/4"		920										13 46 30 11
							910										
903.9			15	SS	100/2"												
91.5	End of Borehole																

+3, x^S: Numbers refer to
Sensitivity

20
15
10
S (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 10

W P 160-74-33 LOCATION Coords. N 15,984,984; E 1,027,348 ORIGINATED BY B.L.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY M.M.
DATUM Geodetic DATE March 13, 1978 CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	100	W _p	W	W _L		
996.4	Ground Surface							SHEAR STRENGTH		WATER CONTENT (%)			PCF	GR SA SI CL
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL x LAB VANE						
								400 800 1200 1600 2000		20 40 60				
0.0	Organic Silt Very Soft to Soft		1	SS	1		990	+2						Om 4%
986.4			2	PS	PH									
10.0	Clayey Silt to Silt of Slight Plasticity With Random Seams or Pockets of Silt and Fine Sand Very Soft to Soft		3	SS	1		980	+2					127	
			4	TW	PH									
			5	SS	3									
			6	TW	PH									
			7	SS	1		970	+2						
			8	TW	PH									
	Clayey Silt to Silt of Slight Plasticity Some Sand		9	TW	PH									
			10	TW	PH		960							4 28 57 11
	Stiff Very Stiff to Hard		11	SS	17									
			12	SS	18									
			13	SS	33		950							17 16 52 15
			14	SS	29									3 14 69 14
							940							
							930							
							920							
911.4							910							
85.0	Heterogeneous Mixture, Clayey Silt Sand and Gravel Glacial Till Hard													
899.9			15	SS	100/5"		900							
96.5	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

20
15
10
5
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 11

W P 160-74-33 LOCATION Coorde. N 15,984,932; E 1,027,512 ORIGINATED BY D.C.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.
DATUM Geodetic DATE May 23, 1978 CHECKED BY R.J.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH						
								○ UNCONFINED	+ FIELD VANE	WATER CONTENT (%)				
						● QUICK TRIAXIAL	x LAB VANE	20	40	60				
1001.9	Ground Surface		1	SS	2									
0.0	Organics Sand, Some Silt, Some		2	SS	8									
2.0	Clayey Silt to Silt of Slight Plasticity Some Sand Very Stiff		3	SS	10									
990.9			4	SS	16								0 13 75 12	
11.0	Silt Compact to Dense		5	SS	19								1 1 92 6	
			6	SS	27									
			7	SS	25									
			8	SS	31								0 3 90 7	
970.4			9	SS	29									
31.5	End of Borehole													



RECORD OF BOREHOLE No 12

W P 160-74-33 LOCATION Coords. N 15,984,855; E 1,027,403 ORIGINATED BY D.C.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.
DATUM Geodetic DATE May 23, 1978 CHECKED BY *al.f.*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100													
								SHEAR STRENGTH					WATER CONTENT (%)								
								○ UNCONFINED	+ FIELD VANE				20 40 60								
								● QUICK TRIAXIAL	x LAB VANE												
1001.6	Ground Surface																				
0.0	Organic Silt		1	SS	2		1000														
997.6	Very Soft		2	SS	16																
4.0	Sand, Some Gravel		3	SS	28																
990.6	Compact		4	SS	26																
11.0	Clayey Silt to Silt of Slight Plasticity Some Sand		5	SS	21		990														
			6	SS	14																
	Silt Compact		7	SS	19		980														
	Very Stiff		8	SS	29																
			9	SS	23		970														
963.6			10	SS	22																
38.0	Silt		11	SS	15		960														
	Compact		12	SS	22																
950.1			13	SS	20																
51.5	End of Borehole																				

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 13

W P 160-74-33 LOCATION Coords. N 15,984,745; E 1,027,280 ORIGINATED BY D.C.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.
DATUM Geodetic DATE May 23-24, 1978 CHECKED BY W.J.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100										SHEAR STRENGTH			WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 400 800 1200 1600 2000													20 40 60		
999.4	Ground Surface																						
0.0	Clayey Silt to Silt of Slight Plasticity Some Sand Very Stiff		1	SS	6		990									1 38 43 18							
			2	SS	12																		
			3	SS	15																		
			4	SS	13																		
			5	SS	7																		
			6	SS	16																		
			7	SS	15																		
			8	SS	24																		
			9	SS	31																		
966.4	With Gravel Silt Compact to Very Dense		10	SS	19		960									9 32 41 18							
33.0			11	SS	66																		
			12	SS	44																		
947.9			13	SS	46		950									0 0 96 4							
51.5	End of Borehole																						

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 14

W P 160-74-33 LOCATION Coords. N 15,984,940; E 1,027,378 ORIGINATED BY D.C.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.
DATUM Geodetic DATE May 24, 1978 CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH						
								○ UNCONFINED	+ FIELD VANE					
								● QUICK TRIAXIAL	x LAB VANE					
996.4	Ground Surface							20 40 60 80 100						
0.0	Sand With Silt		1	SS	2									
	Loose		2	SS	11					○			2 50 40 8	
			3	SS	4									
	Soft Clayey Silt		4	SS	5									
			5	SS	4		+ 2			○			1 59 39 1	
			6	SS	5									
977.4									+ 2					
19.0	Clayey Silt to Silt of Slight Plasticity Some Sand Very Stiff		7	SS	7								10 17 50 23	
968.4			8	SS	8									
28.0	Silt Compact to Dense		9	TW	PH									
			10	SS	14									
			11	SS	25									
			12	SS	18					○				
			13	SS	36									
			14	SS	38									
919.4														
77.0	Heterogeneous Mixture Clayey Silt, Sand and Gravel Hard Glacial Till		15	SS	150/5"									
			16	SS	150/4"					○			18 45 26 11	
904.9			17	SS	117/6"									
91.5	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 15

W P 160-74-33 LOCATION Coords. N 15,984,836; E 1,027,350 ORIGINATED BY D.C.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY D.C.
DATUM Geodetic DATE May 29-31, 1978 CHECKED BY W.J.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT Wp	NATURAL MOISTURE CONTENT W	LIQUID LIMIT Wl	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80						100
							SHEAR STRENGTH										
						○ UNCONFINED + FIELD VANE											
						■ QUICK TRIAXIAL x LAB VANE											
996.1	Ground Surface															GR SA SI CL	
0.0	Sand, Some Silt		1	SS	12											2 55 36 7	
	Loose to Compact		2	SS	11												
			3	SS	7		990									2 74 18 6	
			4	SS	10												
983.1			5	SS	29												
13.0	Clayey Silt to Silt of Slight Plasticity Some Sand		6	SS	23		980										
	Uniform Fine Sand		7	SS	15												
	Very Stiff		8	SS	19		970									2 10 48 40	
968.1			9	SS	17												
28.0	Silt						960										
	Compact to Dense		10	SS	11												
							950										
			11	SS	46											0 1 87 12	
							940										
							930										
							920										
916.1																	
80.0	Heterogeneous Mixture Clayey Silt, Sand and Gravel (Glacial Till)		12	SS	110/5"		910										
			13	SS	110/4"												
	Hard		14	SS	100/4"												
899.6			15	SS	120/1"		900										
96.5	End of Borehole																

RECORD OF BOREHOLE No 16

W P 160-74-33 LOCATION Coords. N 15,985,063; E 1,027,455 ORIGINATED BY D.C.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.
DATUM Geodetic DATE May 31 & June 1, 1978 CHECKED BY *h.j.*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
998.0	Ground Surface																
0.0	Organic Silt With Sand		1	SS	3												GR SA SI CL
993.0	Soft		2	SS	10												0m 4%
5.0	Clayey Silt to Silt of Slight Plasticity With Random Seams of Silt and Fine Sand		3	SS	9		990										2 26 57 15
			4	SS	5												0 18 66 16
			5	SS	9												
983.0	Firm to Stiff		6	SS	10												
15.0	Silt, Some Sand		7	SS	11		980										
	Compact		8	SS	11												
			9	SS	11		970										2 29 63 6
963.0																	
35.0	Clayey Silt to Silt of Slight Plasticity		10	SS	23		960										2 10 54 34
	Very Stiff						950										
			11	TW	PH		940										
							930										
921.0			12	SS	92		920										
77.0	Heterogeneous Mixture Clayey Silt Sand and Gravel Hard Glacial Till		13	SS	140												8 49 32 11
	Cobbles		14	SS	100/6"		910										
			15	SS	110/5"												
901.5			16	SS	120/5"												
96.5	End of Borehole																

+3, +5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 17

W P 160-74-33 LOCATION Coords. N 15,985,024; E 1,027,490 ORIGINATED BY DC.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers 0-55, Washboring With Casing COMPILED BY J.J.
55-80, Wash Ahead 80-95
DATUM Geodetic DATE June 1, 1978 and June 2, 1978 CHECKED BY *W.J.*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH							WATER CONTENT (%) 20 40 60
								UNCONFINED ○		FIELD VANE +		QUICK TRIAXIAL ●			
												PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
1000.3	Ground Surface														
0.0	Organic Silt With Sand		1	SS	5		1000								
998.3	Very Soft		2	SS	13										
2.6	Sand, Some Silt		3	SS	17										
	Compact		4	SS	26										
990.3			5	SS	43		990								
10.0	Clayey Silt to Silt of Slight Plasticity Some Sand With Pockets of Sand and Gravel up to 1 Ft. Thick Every 4 Feet		6	SS	21										
			7	SS	17										
			8	SS	23		980							22 15 38 25	
	Very Stiff		9	SS	34										
971.9			10	SS	14		970								
29.0	Silt														
	Compact to Dense														
			11	SS	18		960								
							950								
							940								
							930								
923.3															
77.0	Heterogeneous Mixture, Clayey Silt Sand and Gravel (Glacial Till)		12	SS	100/ 1"		920								
	Hard		13	SS	93/ 6"									29 37 24 10	
			14	SS	110/ 2"		910								
903.8			15	SS	110/ 4"										
96.5	End of Borehole														



RECORD OF BOREHOLE No 19

W P 160-74-33 LOCATION Coords. N 15,984,750; E 1,027,362 ORIGINATED BY D.C.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers 0-60, Washboring With COMPILED BY J.J.
DATUM Geodetic DATE June 6, 1978 CHECKED BY P.J.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION-SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
1009.4	Ground Surface																
0.0	Sand, Some Gravel		1	SS	4												
	Dense		2	SS	39												30 56 (14)
998.4			3	SS	37		1000										
11.0	Clayey Silt to Silt of Slight Plasticity Some Sand		4	SS	34												1 32 51 16
987.4	Hard		5	SS	34		990										
22.0	Silt, Some Sand Compact		6	SS	PH												
981.4			7	SS	10												
28.0	Clayey Silt to Silt of Slight Plasticity Some Sand Hard		8	SS	40		980										0 37 59 4
			9	SS	PM		970										
							960										
							950										
							940										
932.4																	
77.0	Heterogeneous Mixture, Clayey Silt, Sand and Gravel		10	SS	149		930										
	Silt		12	SS	182												
	Hard						920										
	Glacial Till		13	SS	94/6												8 47 34 11
			14	SS	100/ 5"		910										
902.9			15	SS	100/ 4"												
106.5	End of Borehole																

+³, x⁵: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 20

W P 160-74-33 LOCATION Coords. N 15,984,878; E 1,027,458 ORIGINATED BY D.C.
 DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers 0-50, Washboring With Casing COMPILED BY J.J.
 50-80, Wash Ahead 80-91.5
 DATUM Geodetic DATE June 8, 1978 CHECKED BY *ef*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
1003.3	Ground Surface													
1001.3	Organic Silt		1	SS	6		1000							
2.0	Clayey Silt to Silt of Slight Plasticity		2	SS	22									5 40 41 14
995.3	Some Sand, Very Stiff													
8.0	Sand, Some Silt		3	SS	20		990							
990.3	Compact													
13.0	Some Sand and Gravel		4	SS	39									
	Silt Dense		5	SS	45		980							0 1 95 4
	Clayey Silt to Silt of Slight Plasticity		6	SS	51									
	Hard Some Sand and Gravel		7	SS	47		970							
							960							
							950							
							940							
							930							
925.3														
78.0	Heterogeneous Mixture, Clayey Silt Sand and Gravel		8	SS	147/	10"	920							
	Hard Glacial Till		9	SS	114/	6"								
911.8			10	SS	112/	6"								
91.5	End of Borehole													

RECORD OF BOREHOLE No 21

W P 160-74-33 LOCATION Coords. N 15,985,514; E 1,027,440 ORIGINATED BY D.C.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY J.J.
DATUM Geodetic DATE June 9, 1978 CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH								WATER CONTENT (%)		
								20 40 60 80 100										
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					20 40 60			GR SA SI CL			
1003.3	Ground Surface																	
0.0	Trace Organics		1	SS	5		1000								0m 4%			
	Sand, Some Silt		2	SS	5										2 67 25 6			
996.3	Loose		3	SS	27										0 19 66 15			
7.0			4	SS	18													
			5	SW	PH		990											
			6	SS	24													
			7	SS	24													
	Some Sand		8	SS	38		980											
	Clayey Silt		9	SS	36													
	to Silt of Slight Plasticity						970											
	Very Stiff to Hard		10	SS	24													
							960											
			11	SS	30													
							950								0 2 80 18			
							940											
928.3							930											
75.0	Heterogeneous Mixture, Clayey Silt Sand and Gravel Hard		12	SS	126/	6"									7 43 38 12			
			13	SS	100/	5"												
916.8			14	SS	100/	4"												
86.5	End of Borehole																	



RECORD OF BOREHOLE No 22

W P 160-74-33 LOCATION Coords. N 15,985,386; E 1,027,415 ORIGINATED BY D.C.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers (0-65 ft.) and Washboring COMPILED BY M.M.
DATUM Geodetic DATE June 12-14, 1978 (65 ft.) CHECKED BY *al.j.*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH										WATER CONTENT (%)		
								○ UNCONFINED	● QUICK TRIAXIAL	+ FIELD VANE	× LAB VANE									
996.0	Ground Surface							20	40	60	80	100								
0.0	Organic Silt		1	SS	5															
994.0	Soft																			
2.0	Sand, Some Silt		2	SS	15															
	Some Gravel		3	SS	6															
	Loose to Compact		4	SS	17															
			5	SS	17															
979.0			6	SS	9															
17.0	Clayey Silt to																			
	Silt of Slight		7	SS	11															
	Plasticity		8	SS	10															
	Very Stiff		9	SS	15															
			10	SS	24															
			11	SS	113															
943.0																				
53.0	Heterogeneous		12	SS	88															
	Mixture, Clayey		13	SS	120/	5"														
	Silt		14	SS	100/	3 1/2"														
	Sand and Gravel		15	SS	100/	6"														
	Glacial Till																			
	Hard																			
	Cobbles																			
919.5			16	SS	114/	6"														
76.5	End of Borehole																			



RECORD OF BOREHOLE No 23

W P 160-74-33 LOCATION Coords. N 15,985,302; E 1,027,300 ORIGINATED BY D.C.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.
DATUM Geodetic DATE June 14-15, 1978 CHECKED BY R.J.

SOIL PROFILE.			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH										WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	x LAB VANE	20						40	60	
996.2	Ground Surface															GR SA SI CL				
994.2	Organic Silt		1	SS	6											0m 2%				
2.0	Sand, Some Silt		2	SS	16															
990.2	Compact		3	SS	20		990													
6.0	Clayey Silt to Silt of Slight Plasticity Very Stiff to Hard		4	SS	24											2 21 41 36				
			5	SS	27															
			6	SS	31															
			7	SS	28															
			8	SS	37															
			9	SS	22															
			10	SS	71															
			11	SS	104															
			948.2						950											
			48.0	Silt Very Dense		12	SS	100/ 5"											10 43 32 15	
941.2																				
55.0	Heterogeneous Mixture of Clayey Silt, Sand and Gravel Hard Glacial Till	 	13	SS	106/ 6"															
			14	SS	100/ 5"		930													
924.7																				
71.5	End of Borehole																			



RECORD OF BOREHOLE No 24

W P 160-74-33 LOCATION Coords. N 15,985,255; E 1,027,336 ORIGINATED BY D.C.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Auger COMPILED BY D.C.
DATUM Geodetic DATE June 15-19, 1978 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
995.2	Ground Elevation		1	SS	3		990							
0.0	Sand, Some Gravel Trace Organics		2	SS	16									
990.2	Loose to Compact		3	SS	13									
5.0	Clayey Silt to Silt of Slight Plasticity		4	SS	16									
	Stiff to Hard		5	TW	PH									
			6	SS	30									
			7	SS	20									
			8	SS	39									
			9	SS	39									
			10	SS	25									
			11	SS	145									
941.2			12	SS	100/ 4"									
54.0	Heterogeneous Mixture Clayey Silt, Sand and Gravel		13	SS	100/ 5"									
923.7			14	SS	150/ 6"									
71.5	End of Borehole													

+3, x5 : Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 25

W P 160-74-33 LOCATION Coords. N 15.985,208; E 1,027,256 ORIGINATED BY D.C.
 DIST 6 HWY 404 @ CNR BOREHOLE TYPE Hollow Stem Augers COMPILED BY D.C.
 DATUM Geodetic DATE June 20, 1978 CHECKED BY dlj

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
994.7	Ground Surface																
0.0	Organic Silt		1	SS	15												Om 77% W=355%
	Very Soft		2	SS	15												
986.7	Organic Clay, White to Grey, Very Soft		3	SS	1/18		990										Om 2%
8.0	Clayey Silt to Silt of Slight Plasticity		4	SS	0 W N WT												
	Very Soft		5	SS	2												
			6	SS	3		980										
975.7																	
19.0	Silt, Some Sand		7	SS	7												
	Loose to Compact																
			8	SS	12		970										
965.7																	
29.0	Clayey Silt to Silt of Slight Plasticity		9	SS	40												
	Hard																
958.2			10	SS	63		960										
36.5	End of Borehole																0 2 78 20

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 26

W P 160-74-33 LOCATION Coords. N 15,985,178; E 1,027,280 ORIGINATED BY D.C.
DIST 6 HWY 404 @ CNR BOREHOLE TYPE Hollow Stem Augers COMPILED BY D.C.
DATUM Geodetic DATE June 21, 1978 CHECKED BY D.J.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100										
								SHEAR STRENGTH										
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					WATER CONTENT (%)					
								400 800 1200 1600 2000					20 40 60					
994.5	Ground Surface																	
0.0	Organic Silt Black		1	SS	2	18"	990									1 30 63 6		
	Organic Clay Very Soft		2	SS	27			+ 8										
986.5	White to Grey, Very Soft		3	TW	PH			+ 4										
8.0	Clayey Silt to Silt of Slight Plasticity Some Sand Very Soft to Firm	4	SS	0	+ 3													
		5	SS	0	+ 3													
		6	SS	3														
		7	SS	3														
970.5																		
24.0	Silt, Some Sand Loose		8	SS	6													
963.5			9	SS	67													
31.0	Clayey Silt to Silt of Slight Plasticity					960												
958.0	Hard		10	SS	50													
36.5	End of Borehole																	

+3, x5: Numbers refer to
Sensitivity

20
15
10
S (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 27

W P 160-74-33 LOCATION Coords. N 15,985,485; E 1,027,495 ORIGINATED BY D.C.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY D.C.
DATUM Geodetic DATE June 21, 1978 CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100										WATER CONTENT (%)		
								SHEAR STRENGTH												
995.3	Ground Elevation																			
993.3	Organic Silt Some Sand		1	SS	4															
2.0	Silt, Some Sand		2	SS	15															
987.3	Compact		3	SS	21															
8.0	Clayey Silt to Silt of Slight Plasticity		4	SS	22															
	Some Sand		5	SS	23															
	Silt, Compact		6	SS	25															
	Very Stiff to Hard		7	SS	33															
			8	SS	30															
964.8			9	SS	21															
31.5	End of Borehole																			

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 28

W P 160-74-33 LOCATION Coords. N 15,985,298; E 1,027,392 ORIGINATED BY D.C.
 DIST 6 HWY 404 & CNR BOREHOLE TYPE Hollow Stem Augers COMPILED BY D.C.
 DATUM Geodetic DATE June 22, 1978 CHECKED BY *D.J.*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES			20	40	60	80	100					
995.3	Ground Surface		1	SS	13												
0.0	Sand, Some Silt		2	SS	15												
	Loose to Compact		3	SS	9												
985.3			4	SS	9												
10.0	Clayey Silt to Silt of Slight Plasticity		5	SS	12												
	Some Sand		6	SS	17												
	Very Stiff to Hard		7	SS	21												
			8	SS	32												
963.8			9	SS	28												
31.5	End of Borehole																



RECORD OF BOREHOLE No 29

W P 160-74-33 LOCATION Coords. N 15,985,268; E 1,027,273 ORIGINATED BY D.C.
DIST 6 HWY 404 @ CNR BOREHOLE TYPE Hollow Stem Augers COMPILED BY D.C.
DATUM Geodetic DATE June 22, 1978 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
994.3														
0.0	Organic Silt Very Soft		1	SS	1		990							
	Organic Clay		2	SS	1/18"									
985.3	Very Soft		3	TW	PH			+4						
9.0	Clayey Silt to Silt of Slight Plasticity		4	TW	PH			+4						
982.0	Very Soft		5	SS	13		980	+2						
12.0	Clayey Silt to Silt of Slight Plasticity		6	SS	15									0 28 62 10
	Very Stiff to Hard		7	SS	19									
966.3			8	SS	17		970							
28.0	Clayey Silt to Silt of Slight Plasticity													
962.8	Hard		9	SS	48									
31.5	End of Borehole													

*3, x5: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10



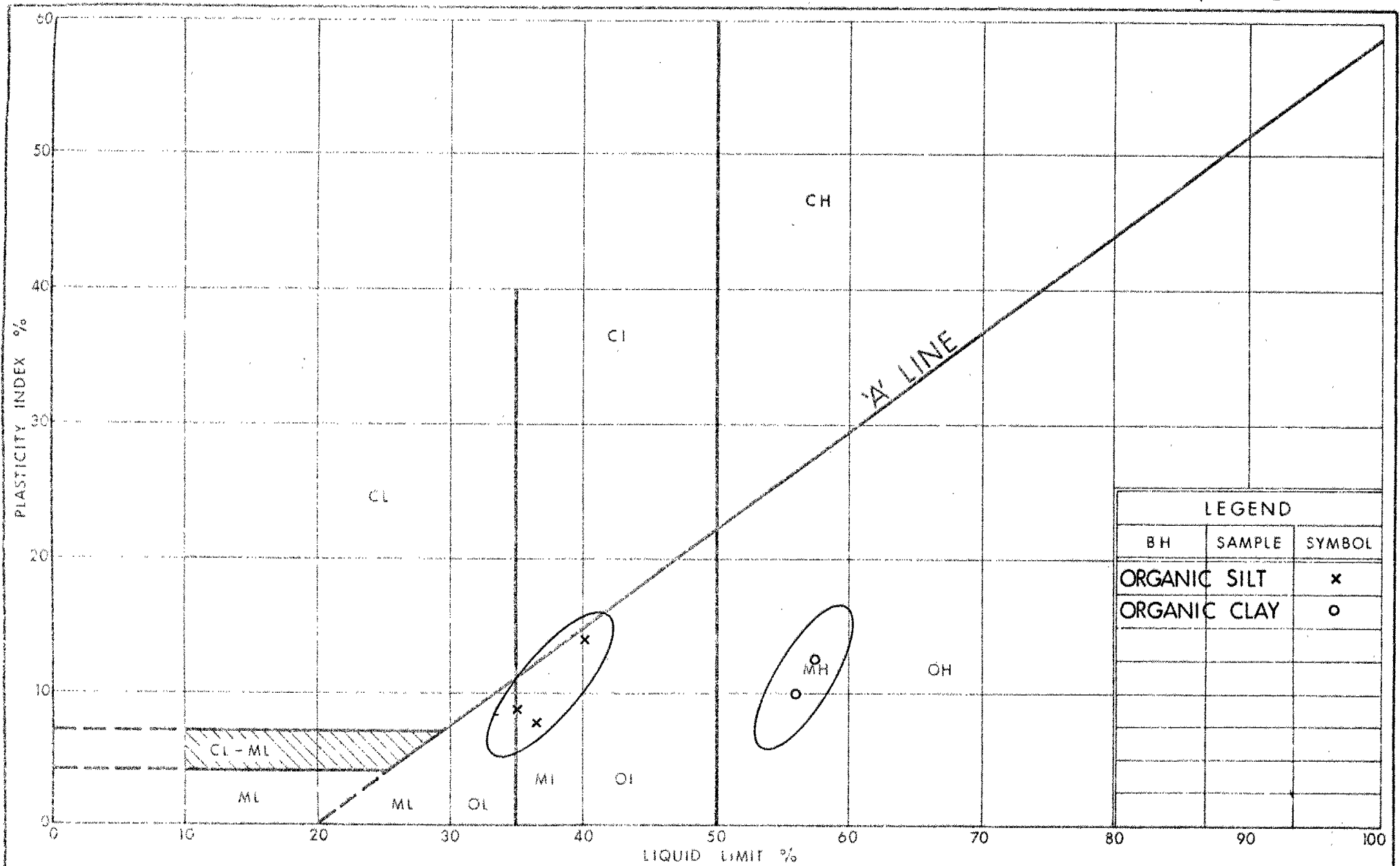
RECORD OF BOREHOLE No 30

W P 160-74-33 LOCATION Coords. N 15,985,320; E 1,027,212 ORIGINATED BY D.C.
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.
DATUM Geodetic DATE June 23, 1978 CHECKED BY d.j.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT Σ					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N ^o VALUES		20	40	60	80	100					
996.3	Ground Surface		1	SS	15											
0.0	Organic Silt		2	SS	14											
991.3			3	SS	13											
5.0	Silt, Some Sand Loose to Compact		4	SS	4											
985.3			5	SS	13											
11.0	Clayey Silt to Silt of Slight Plasticity		6	SS	24											
	Very Stiff to Hard		7	SS	20											0 3 44 53
			8	SS	24											
			9	SS	39											
964.8																
31.5	End of Borehole															

+3, x⁵: Numbers refer to
Sensitivity

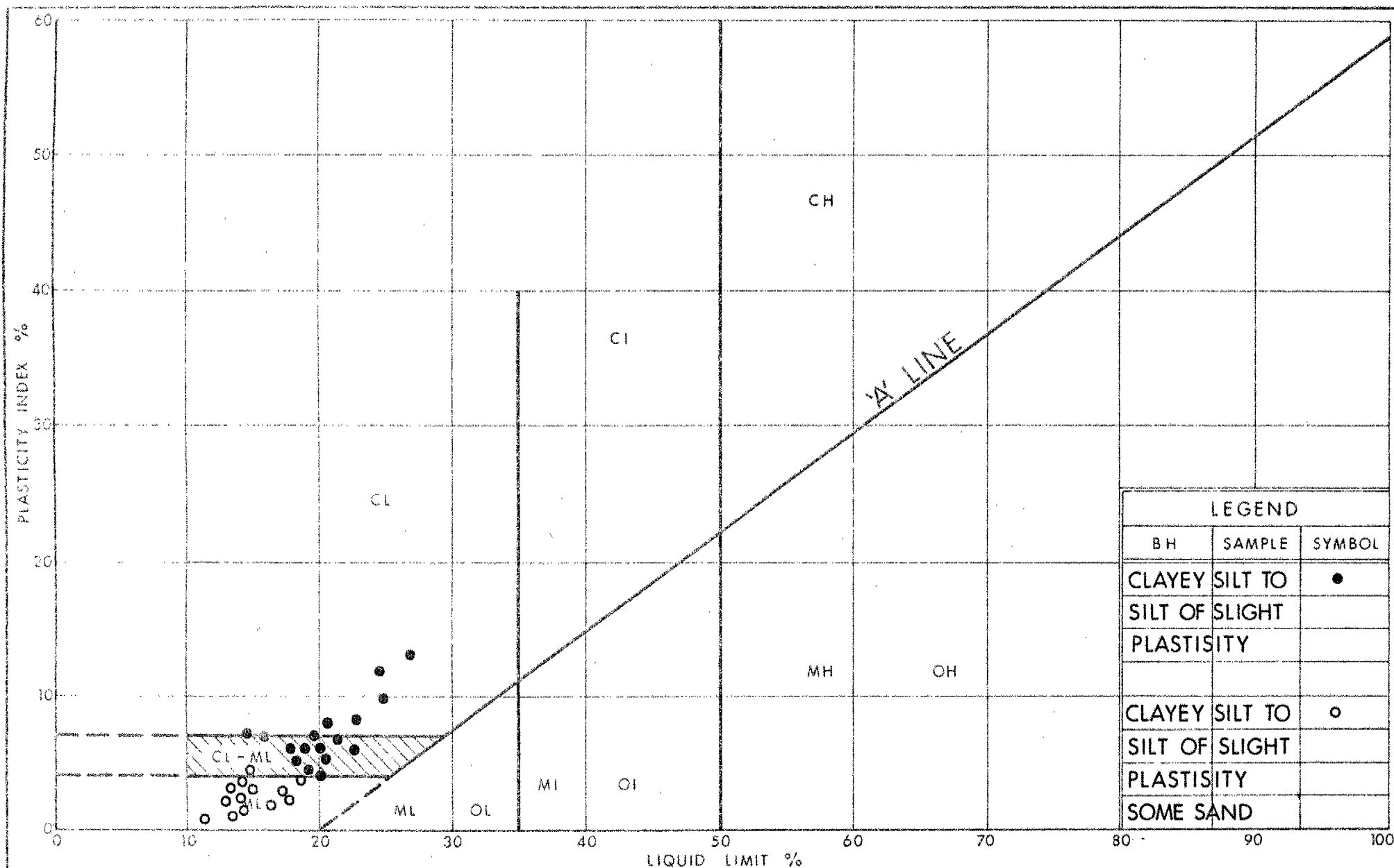
20
15 ϕ 5 (%) STRAIN AT FAILURE
10

Ministry of
Transportation and
Communications

PLASTICITY CHART ORGANIC SILT & ORGANIC CLAY

FIG No 1

W P 160-74-33



Ministry of
Transportation and
Communications

PLASTICITY CHART CLAYEY SILT TO SILT OF SLIGHT PLASTICITY

FIG No 2

W P 160-74-33



GRAIN SIZE DISTRIBUTION CLAYEY SILT TO SILT OF SLIGHT PLASTICITY

W P 160-74-33



**Ministry of
Transportation and
Communications**

GRAIN SIZE DISTRIBUTION

W P 160-74-33

UNDRAINED SHEAR STRENGTH VS DEPTH

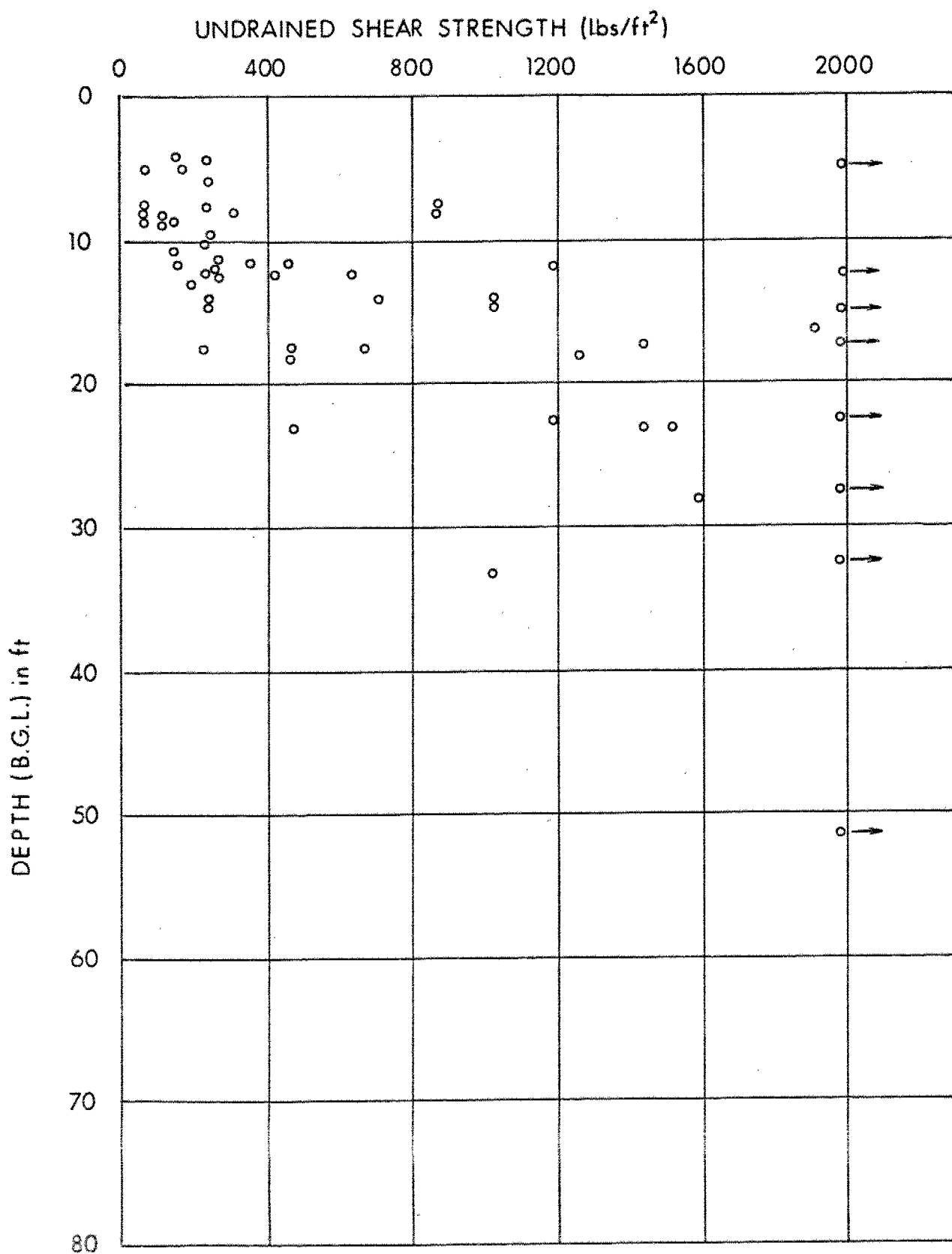
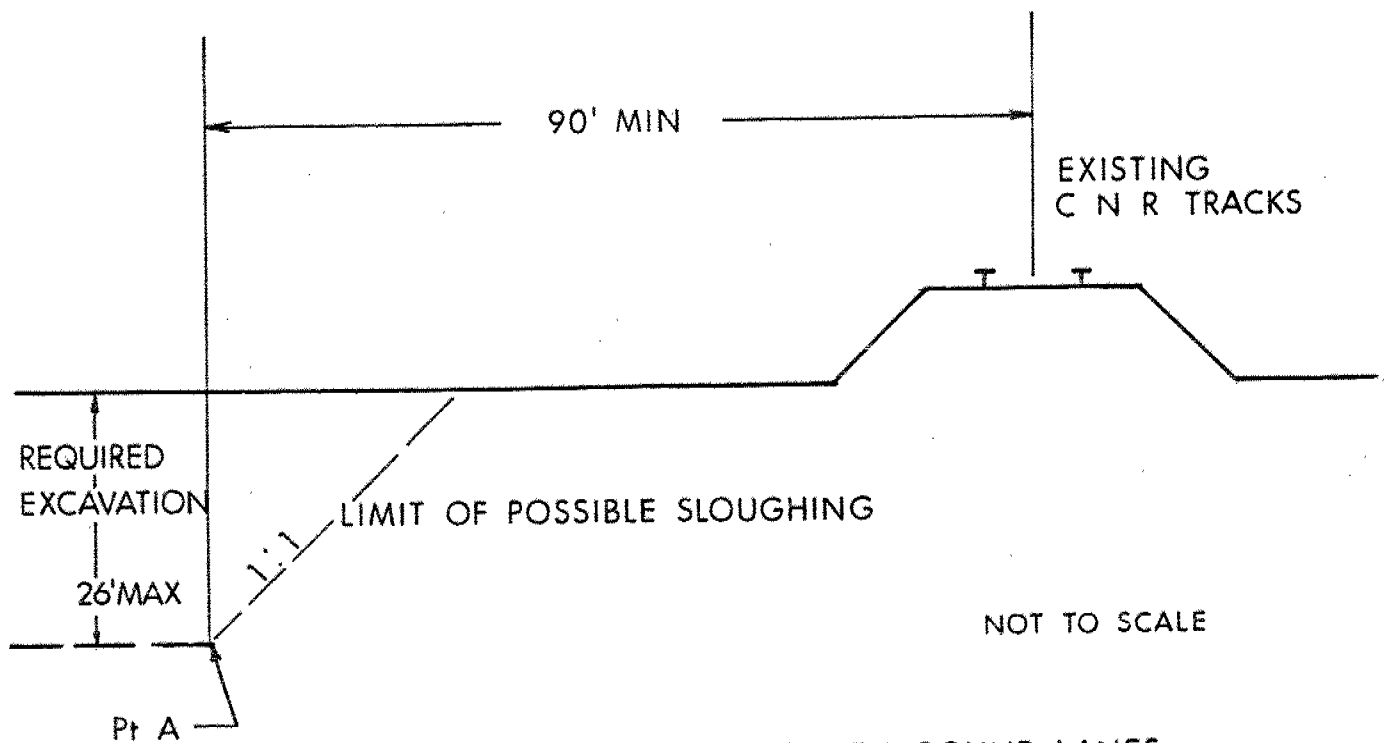


FIG 6

WP 160-74-33

REQUIRMENTS FOR C N R TRACKS SLOPE STABILITY DURING SUBEXCAVATION



- NOTE: 1 SOUTH BOUND LANES
TRACK PROTECTION IN THE
FORM OF SHEET PILING &
TIE BACKS MAY BE REQUIRED
IF THE BASE OF THE EXCAVATION
Pt A, IS CLOSER THAN 90 FEET
TO THE C N R TRACKS
- 2 NORTH BOUND LANES
THE REQUIREMENT FOR TRACK
PROTECTION WILL BE EVALUATED
BASED ON THE LOCATION OF
THE TOE OF THE SLOPE AND THE
QUANTITY AND DEPTH OF
SUBEXCAVATION

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS N_c .

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH AS FOLLOWS:

S_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF SPT 'N' VALUES AS FOLLOWS:

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCK QUALITY: 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 DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" 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	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAXIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG. $\bar{C}IU$ = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

S S SPLIT SPOON
W S WASH SAMPLE
S T SLOTTED TUBE SAMPLE
B S BLOCK SAMPLE
C S CHUNK SAMPLE
T W THINWALL OPEN
T P THINWALL PISTON
O S OSTERBERG SAMPLE
F S POIL SAMPLE
R C ROCK CORE
P H T.W. ADVANCED HYDRAULICALLY
P M T.W. ADVANCED MANUALLY

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
 δ ANGLE OF WALL FRICTION
 k_o COEFFICIENT OF EARTH PRESSURE AT REST
 k_A COEFFICIENT OF ACTIVE EARTH PRESSURE
 k_P COEFFICIENT OF PASSIVE EARTH PRESSURE
 i ANGLE OF INCLINATION OF SURCHARGE
 w SLOPE ANGLE-BACKFACE OF WALL
 β ANGLE OF SLOPE
 N_q, N_c, N_{γ} BEARING CAPACITY FACTORS
 D_f DEPTH OF FOOTING
 B, L FOOTING DIMENSIONS

INDEX PROPERTIES

γ UNIT WEIGHT OF SOIL (BULK DENSITY)
 γ_w UNIT WEIGHT OF WATER
 γ_d UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
 γ' UNIT WEIGHT OF SUBMERGED SOIL
 G_s SPECIFIC GRAVITY OF SOLIDS
 e VOIDS RATIO
 e_o INITIAL VOIDS RATIO
 e_{max} e IN LOOSEST STATE
 e_{min} e IN DENSEST STATE
 D_r RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
 n POROSITY
 w WATER CONTENT
 w_L LIQUID LIMIT
 w_P PLASTIC LIMIT
 w_S SHRINKAGE LIMIT
 I_P PLASTICITY INDEX = $w_L - w_P$
 I_L LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
 I_C CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
 A_c ACTIVITY = $\frac{I_P \text{ of soil}}{w_L - w_{2\mu m \text{ Soil Fraction}}}$
 Om ORGANIC MATTER CONTENT
 S_r DEGREE OF SATURATION
 S SENSITIVITY = $\frac{S_u(\text{undisturbed})}{S_u(\text{remoulded})}$

STRENGTH PARAMETERS

ϕ ANGLE OF SHEARING RESISTANCE
 τ_f PEAK SHEAR STRENGTH
 τ_R RESIDUAL SHEAR STRENGTH
 c COHESION INTERCEPT
 $\sigma_1, \sigma_2, \sigma_3$ NORMAL PRINCIPAL STRESSES
 u PORE WATER PRESSURE
 u_e EXCESS u
 r_u PORE PRESSURE RATIO
 q_u UNCONFINED COMPRESSIVE STRENGTH
 s_u UNDRAINED SHEAR STRENGTH
 ϵ LINEAR STRAIN
 γ SHEAR STRAIN
 ν POISSON'S RATIO
 E MODULUS OF ELASTICITY
 G MODULUS OF SHEAR DEFORMATION
 k_s MODULUS OF SUBGRADE REACTION
 m, n STABILITY COEFFICIENTS
 A, B PORE PRESSURE COEFFICIENTS

HYDRAULIC TERMS

h HYDRAULIC HEAD OR POTENTIAL
 q RATE OF DISCHARGE
 v VELOCITY OF FLOW
 i HYDRAULIC GRADIENT
 j SEEPAGE FORCE PER UNIT VOLUME
 η COEFFICIENT OF VISCOSITY
 k COEFFICIENT OF HYDRAULIC CONDUCTIVITY
 k_h k IN HORIZONTAL DIRECTION
 k_v k IN VERTICAL DIRECTION
 m_v COEFFICIENT OF VOLUME CHANGE
 c_v COEFFICIENT OF CONSOLIDATION
 C_c COMPRESSION INDEX
 C_r RECOMPRESSION INDEX
 d DRAINAGE PATH DISTANCE
 T_v TIME FACTOR
 U DEGREE OF CONSOLIDATION
 O_r OVERCONSOLIDATION RATIO (OCR)

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
 ϕ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
 σ' = EFFECTIVE NORMAL STRESS

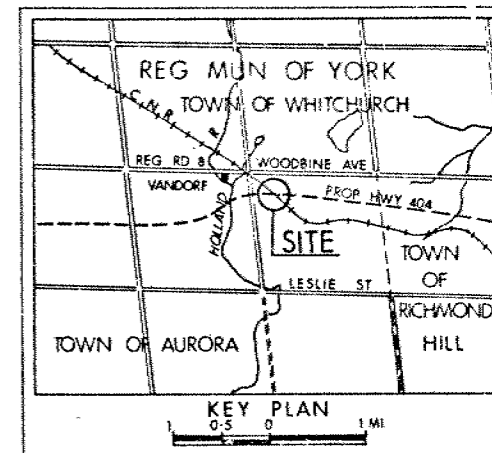
CONT No
WP No 160-74-33

CNR OVERHEAD AT HWY 404

BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊙ Bore Hole & Cone
- 'N' Blows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- W.L. at time of investigation
MAR, MAY & JUNE 1978

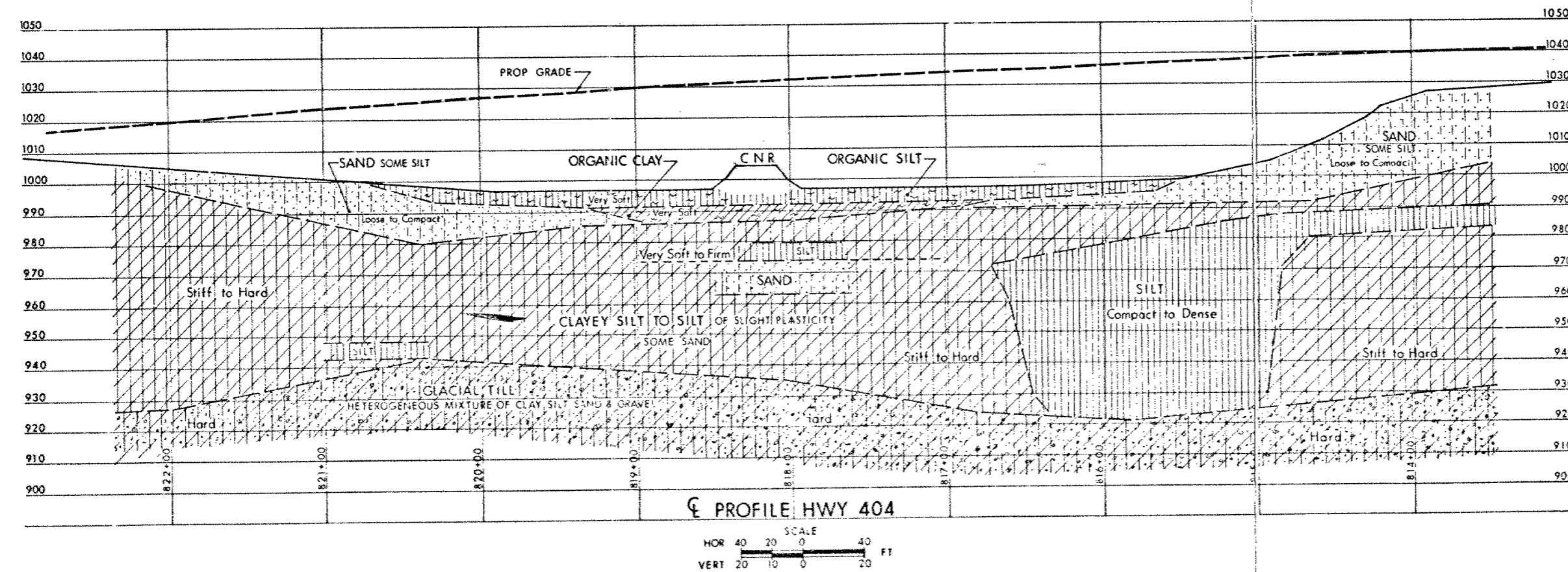
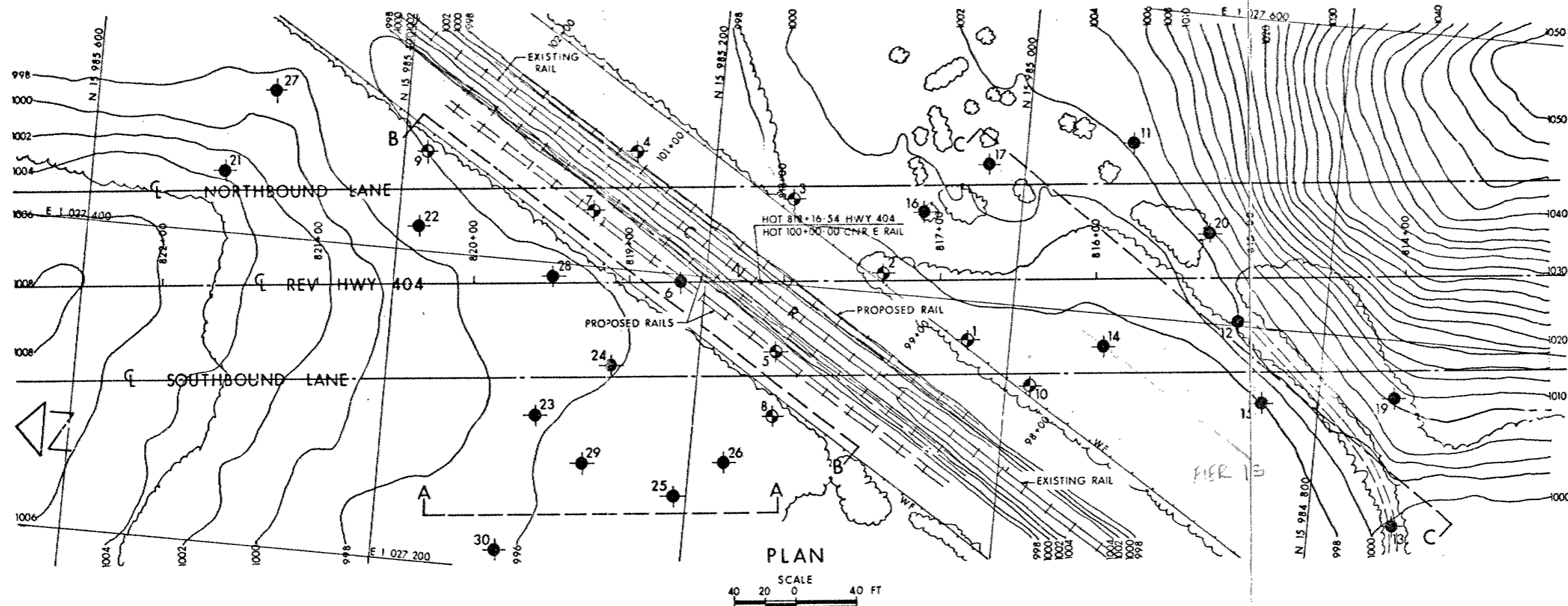
NO	ELEVATION	COORDINATES	
		NORTH	EAST
1	996-2	15 988 028	1 027 374
2	996-6	15 985 035	1 027 412
3	998-6	15 985 146	1 027 455
4	995-3	15 985 250	1 027 475
5	995-2	15 985 150	1 027 355
6	994-8	15 985 216	1 027 395
7	994-6	15 985 276	1 027 435
8	994-7	15 985 148	1 027 313
9	995-4	15 985 385	1 027 464
10	996-4	15 984 984	1 027 348
11	1001-9	15 984 932	1 027 512
12	1001-6	15 984 855	1 027 403
13	999-4	15 984 745	1 027 280
14	996-4	15 984 910	1 027 378
15	996-1	15 984 836	1 027 350
16	998-0	15 985 063	1 027 455
17	1000-3	15 985 024	1 027 490
19	1009-4	15 984 750	1 027 362
20	1003-3	15 984 878	1 027 458
21	1003-3	15 985 514	1 027 440
22	996-0	15 985 386	1 027 415
23	996-2	15 985 302	1 027 300
24	995-2	15 985 255	1 027 336
25	994-7	15 985 208	1 027 256
26	994-5	15 985 178	1 027 280
27	995-3	15 985 485	1 027 495
28	995-3	15 985 298	1 027 392
29	994-3	15 985 268	1 027 273
30	996-3	15 985 320	1 027 212

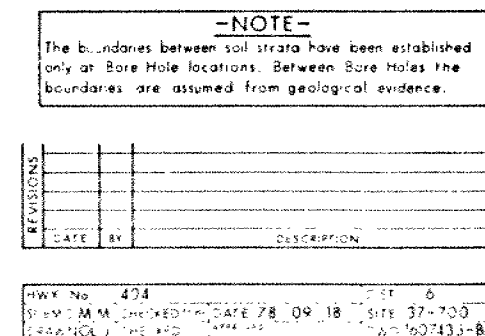
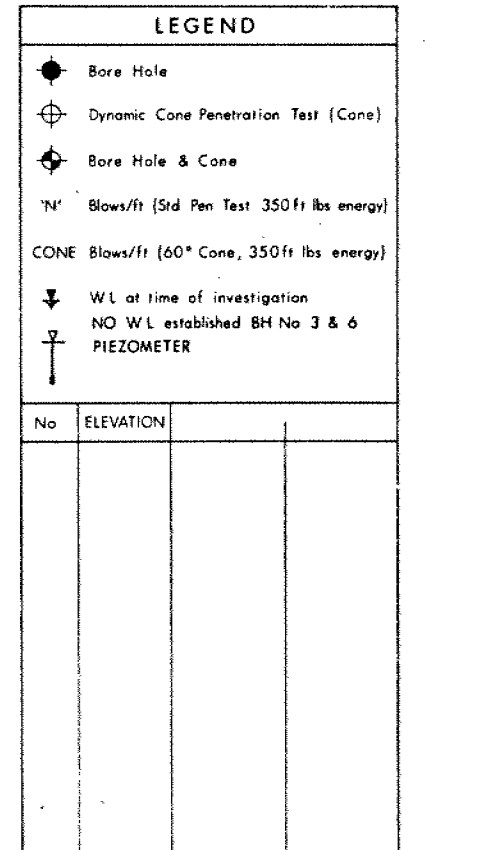
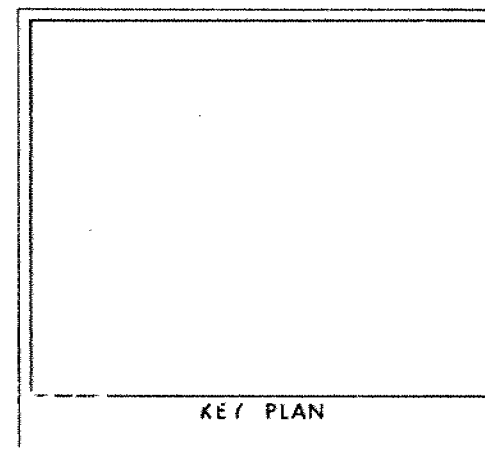
NOTE

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

REVISIONS	DATE	BY	DESCRIPTION

HWY NO 404
SUBMITTAL CHECKED DATE 78 09 18 SITE 37-700
DRAWN BY J. M. KED DATE 78 09 18 SHEET 160-74-33-A





CONT No
WP No 160-74-33

REQUIREMENTS FOR SLOPE
STABILITY & SUBEXCAVATION
FOR SCHEME 'A' & 'B'

SHEET

NOTE: TOE OF SLOPE BASED
ON 20' WING WALL

NO SUBEXCAVATION IS
REQUIRED ON SECTIONS
A₁-A₂, B₁-B₂, & E₁-E₂

KEY PLAN

LEGEND

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

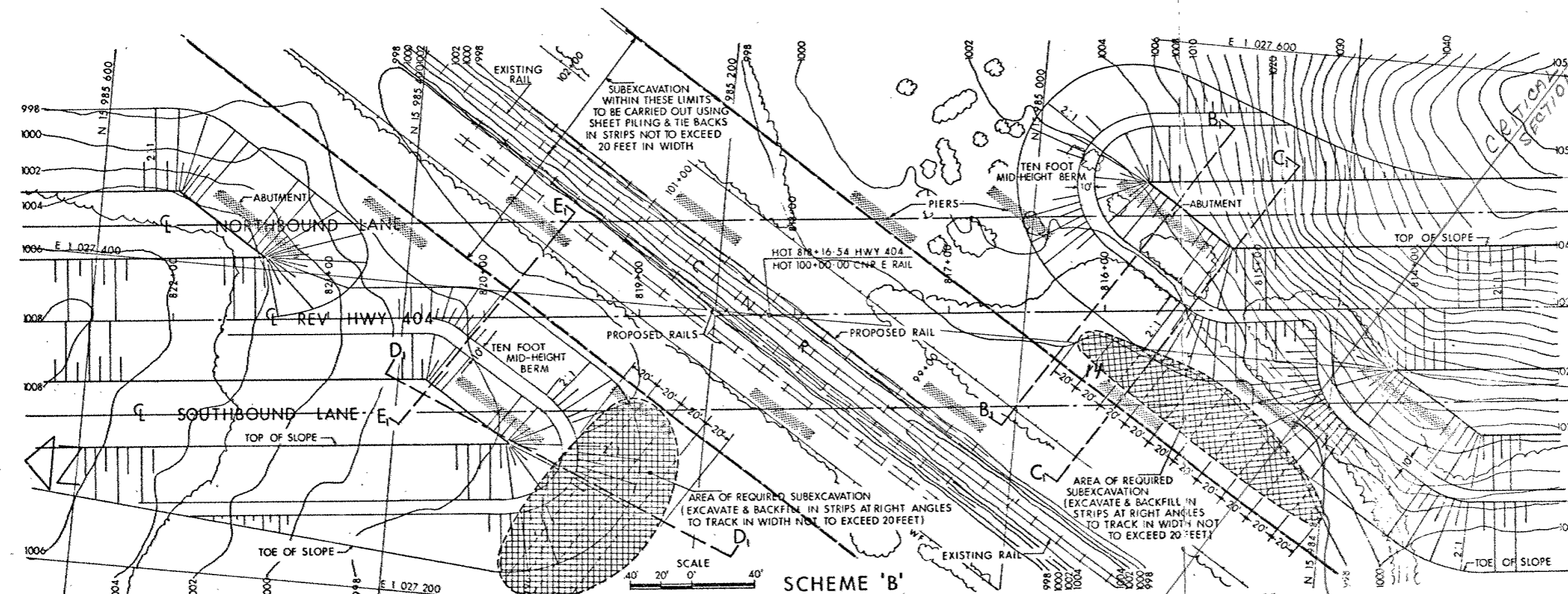
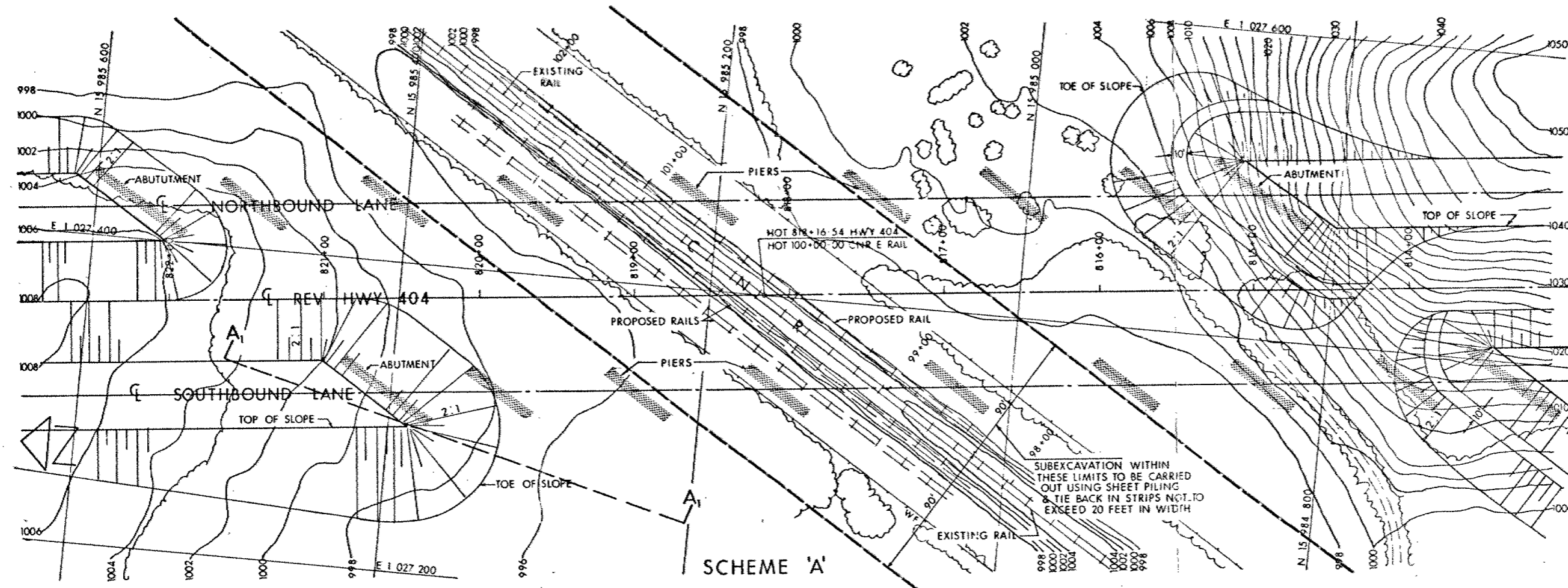
No	ELEVATION

-NOTE-

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

REVISIONS	DATE	BY	DESCRIPTION

HWY No 404
SLOPE M CHECKED DATE 78 09 18
DRAWN BY J CHECKED APPROVED
DIST 6
SITE 37-700
DWG 1607433-C



DOES NOT
EXIST

CONT No 82-74
WP No 160-74-33

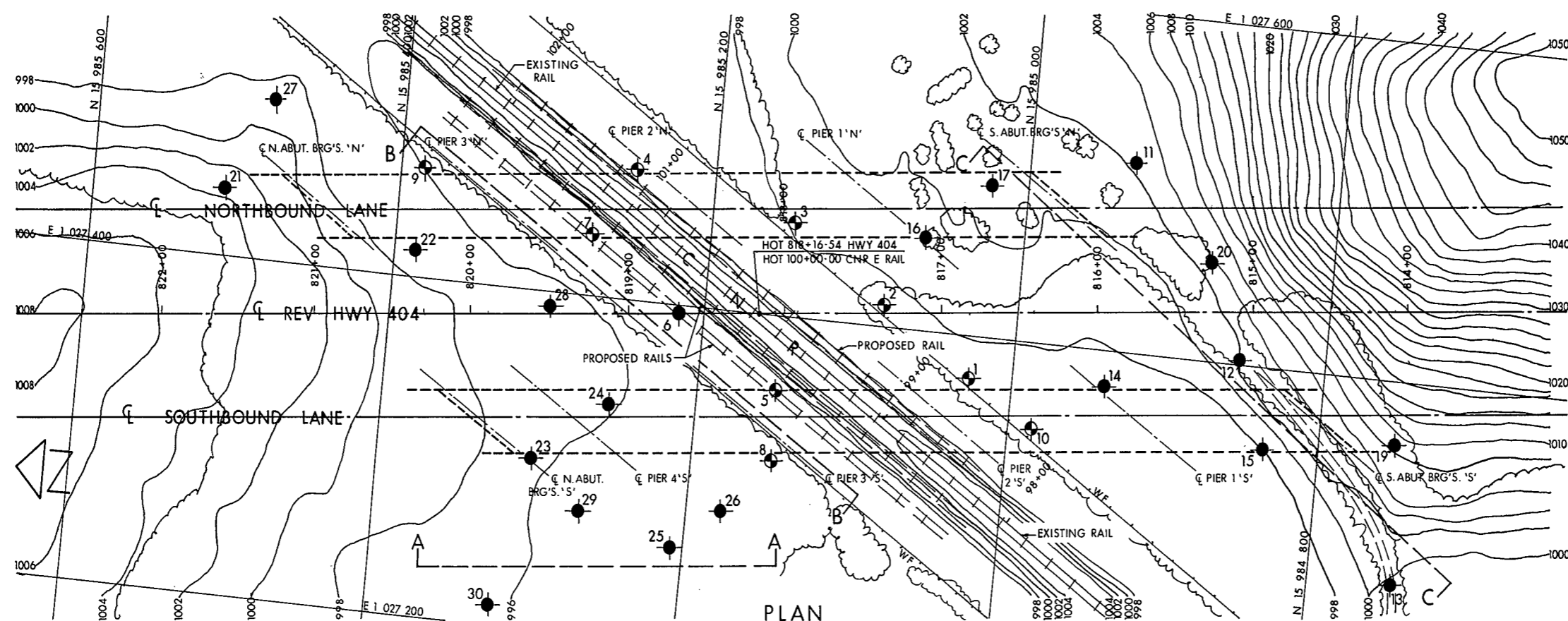


CNR OVERHEAD AT HWY 404

SHEET

BORE HOLE LOCATIONS & SOIL STRATA

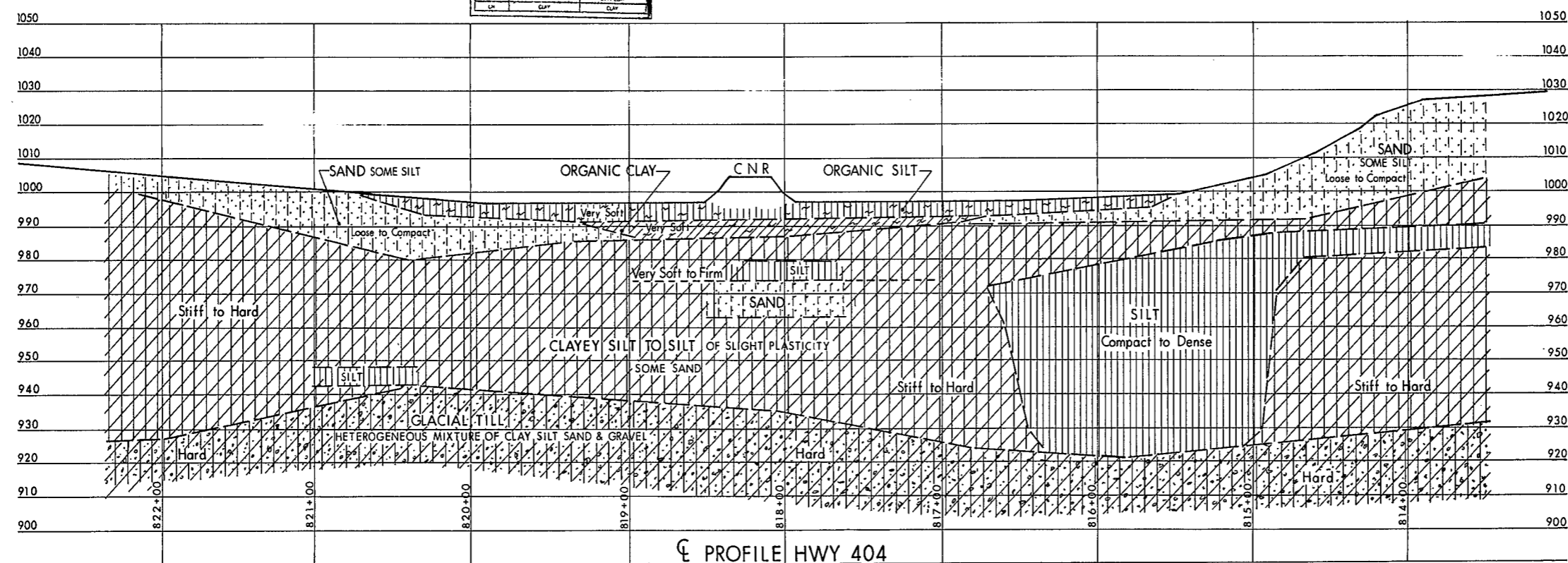
75



ATTENTION IS DRAWN TO THE FOLLOWING:
THE NEW M.T. FOR CLASSIFICATION SYSTEM IS NOT USED ON THIS DRAWING. THE OLD SYSTEM USED TO DETERMINE THE STRATUM REPORTING THE MOST PRESENT DIFFERENCES BETWEEN THE OLD AND NEW SYSTEM CLASSIFICATION SYSTEMS IS SHOWN IN THE FIELD OF VIEW.

STRATUM	OLD SYSTEM	NEW SYSTEM
1	CLAYEY SILT	CLAYEY SILT
2	CLAYEY SILT	CLAYEY SILT
3	CLAYEY SILT	CLAYEY SILT
4	CLAYEY SILT	CLAYEY SILT
5	CLAYEY SILT	CLAYEY SILT
6	CLAYEY SILT	CLAYEY SILT
7	CLAYEY SILT	CLAYEY SILT
8	CLAYEY SILT	CLAYEY SILT
9	CLAYEY SILT	CLAYEY SILT
10	CLAYEY SILT	CLAYEY SILT
11	CLAYEY SILT	CLAYEY SILT
12	CLAYEY SILT	CLAYEY SILT
13	CLAYEY SILT	CLAYEY SILT
14	CLAYEY SILT	CLAYEY SILT
15	CLAYEY SILT	CLAYEY SILT
16	CLAYEY SILT	CLAYEY SILT
17	CLAYEY SILT	CLAYEY SILT
18	CLAYEY SILT	CLAYEY SILT
19	CLAYEY SILT	CLAYEY SILT
20	CLAYEY SILT	CLAYEY SILT
21	CLAYEY SILT	CLAYEY SILT
22	CLAYEY SILT	CLAYEY SILT
23	CLAYEY SILT	CLAYEY SILT
24	CLAYEY SILT	CLAYEY SILT
25	CLAYEY SILT	CLAYEY SILT
26	CLAYEY SILT	CLAYEY SILT
27	CLAYEY SILT	CLAYEY SILT
28	CLAYEY SILT	CLAYEY SILT
29	CLAYEY SILT	CLAYEY SILT
30	CLAYEY SILT	CLAYEY SILT

NOTE: GROUND CONDITIONS AS OF TIME
OF FIELD INVESTIGATION - MAR., MAY & JUNE 1978



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- 'N' Blows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- W.L. at time of investigation
MAR, MAY & JUNE 1978

NO	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	996-2	15 958 028	1 027 374
2	996-6	15 985 085	1 027 412
3	998-6	15 985 146	1 027 455
4	995-3	15 985 250	1 027 475
5	995-2	15 985 150	1 027 355
6	994-8	15 985 216	1 027 395
7	994-6	15 985 276	1 027 435
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9	995-4	15 985 385	1 027 464
10	996-4	15 984 984	1 027 348
11	1001-9	15 984 932	1 027 512
12	1001-6	15 984 855	1 027 403
13	999-4	15 984 745	1 027 280
14	996-4	15 984 940	1 027 378
15	996-1	15 984 836	1 027 350
16	998-0	15 985 063	1 027 455
17	1000-3	15 985 024	1 027 490
19	1009-4	15 984 750	1 027 362
20	1003-3	15 984 878	1 027 458
21	1003-3	15 985 514	1 027 440
22	996-0	15 985 386	1 027 415
23	996-2	15 985 302	1 027 300
24	995-2	15 985 255	1 027 336
25	994-7	15 985 208	1 027 256
26	994-5	15 985 178	1 027 280
27	995-3	15 985 485	1 027 495
28	995-3	15 985 298	1 027 392
29	994-3	15 985 268	1 027 273
30	996-3	15 985 320	1 027 212

-NOTE-

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

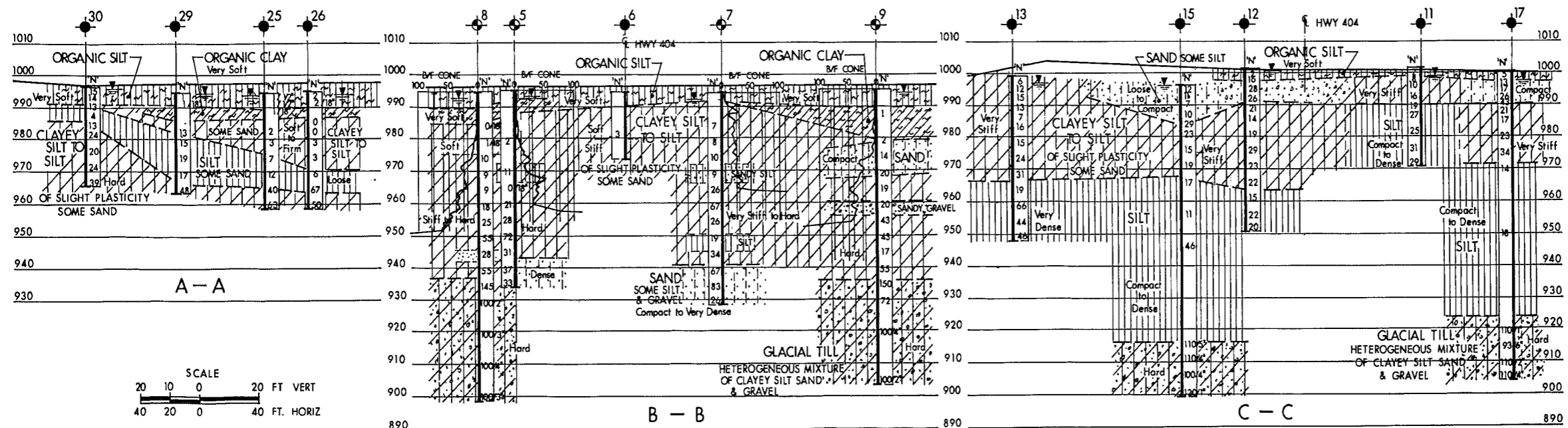
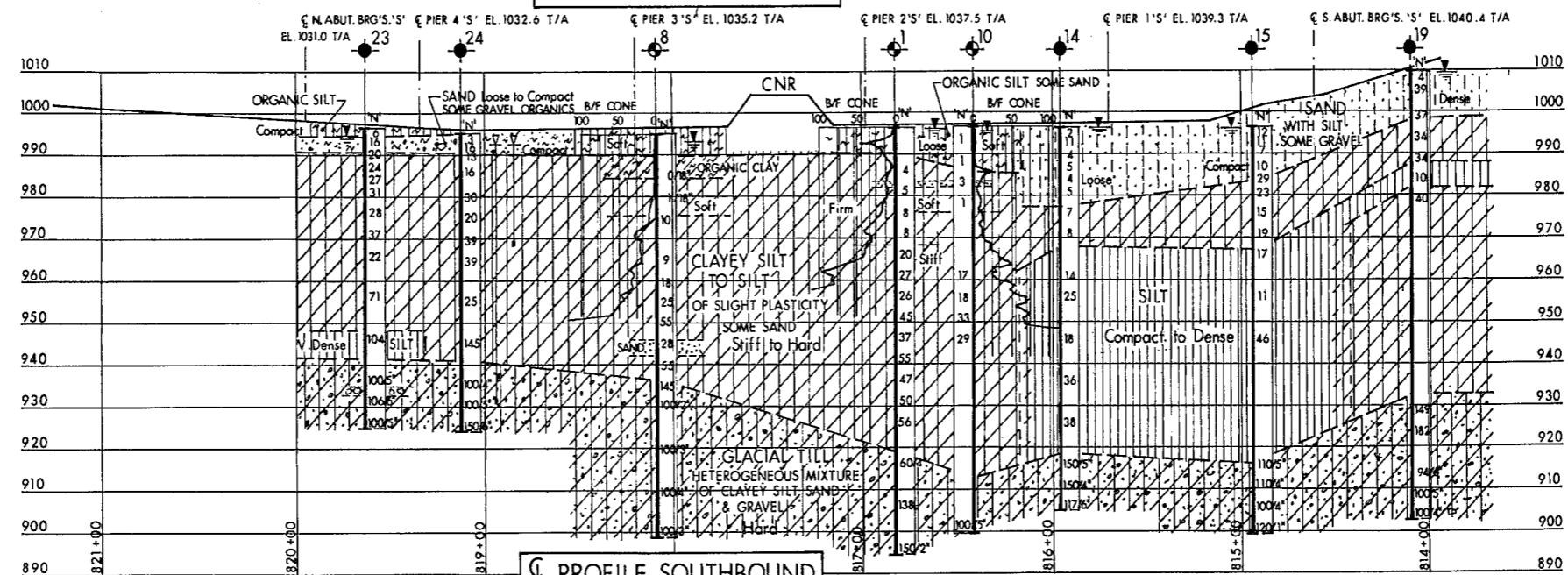
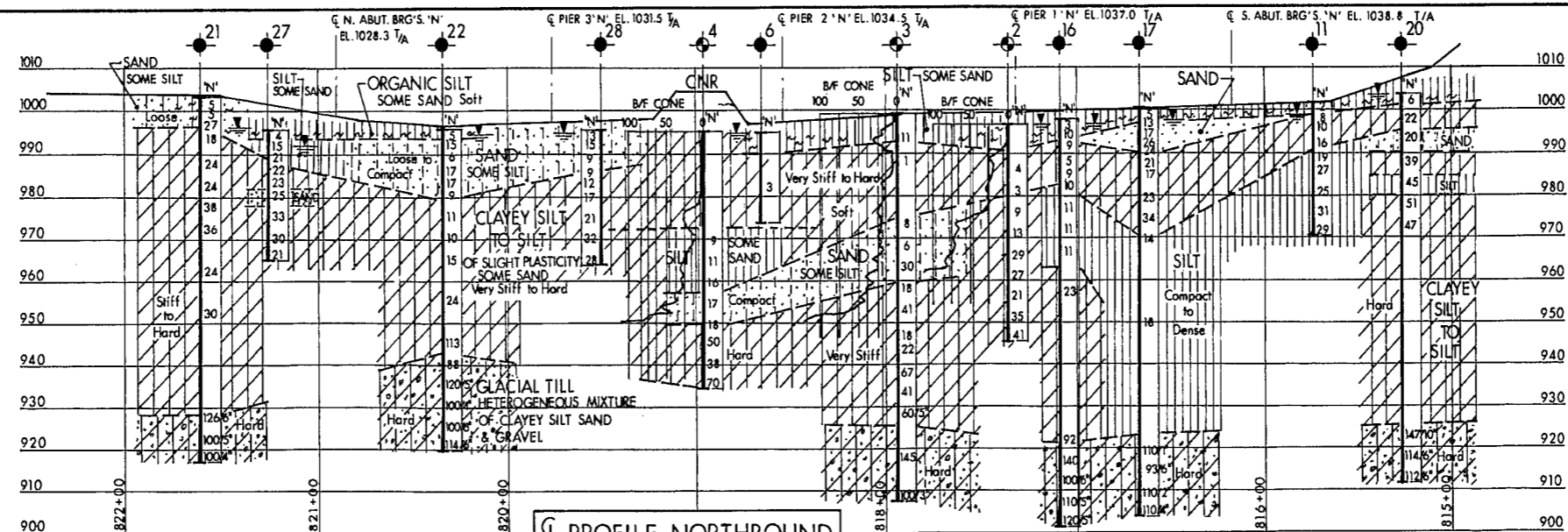
REVISIONS	DATE	BY	DESCRIPTION

NOTE:

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

HWY No 404	CHECKED 11M	DATE 78 09 18	DIST 6
SUBM'D M.M.	CHECKED	APPROVED	SITE 37-700
DRAWN O.L.J.	CHECKED	APPROVED	DWG 2








NOTE:
The complete foundation investigation file for this project may be examined at the Engineering Materials Office, Downsview. Information contained in this file and any supplementary files is specifically excluded in accordance with the conditions of Section 107.2 of Form 101.



SHEET
75 -1

KEY PLAN

LEGEND

- | | |
|---|---|
|  | Bore Hole |
|  | Dynamic Cone Penetration Test (Cone) |
|  | Bore Hole & Cone |
|  | Blows/ft (Std Pen Test 350 ft lbs energy) |
|  | Cone Blows/ft (60° Cone, 350 ft lbs energy) |
|  | WL at time of investigation |
|  | No WL established BH No 3 & 6 |
| PIEZOMETER | |

No	ELEVATION		

-NOTE-

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

REVISIONS			
	DATE	BY	DESCRIPTION

HWY No	404	DIST	6
SUBM'D M M	CHECKED M J	DATE 78 09 18	SITE 37-700
DRAWN Q J	CHECKED	APPROVED	DWG 3



APPENDIX A

Reference 1b

Excerpt from Contract Drawings
(for the original NBL and SBL bridges)
CNR Overheads, Hwy 404, 3.7 Miles North of Regional Road 14
Contract 82-74, WP 160-74-33, Structural Site 37-700

DIST. No. 6
 CONT No 82-74
 WP No 160-74-33

HWY. 404 C.N.R. OVERHEAD
 Mileage 29-98 Bala Subdivision
 GENERAL LAYOUT

SHEET
 74

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NOTE:
 CONTOURS SHOWN ARE PRIOR
 TO PLACEMENT OF FILL.
 FOR NEW CONTOURS SEE
 GRADING DRAWINGS.

NOTES

CLASS OF CONCRETE
 PIER COLUMNS, PIER CAPS, DECK, ABUTMENTS,
 WINGWALLS AND BARRIER WALLS. 30 MPa
 REMAINDER 20 MPa

CLEAR COVER TO REINFORCING STEEL
 TOP OF DECK SLAB 2"
 BOTTOM OF DECK SLAB 1 1/2"
 FOOTINGS, PIER COLUMNS, ABUTMENTS AND
 WINGWALLS 3"
 PIER CAPS 2"
 (OR AS NOTED ON THE DRAWING)
REINFORCING STEEL
 REINFORCING STEEL TO BE GRADE 400.
 REINF. BARS WITH THE DESIGNATION 'C' AT THE
 END OF BAR MARKS SHALL BE EPOXY COATED BARS.

CONSTRUCTION NOTES

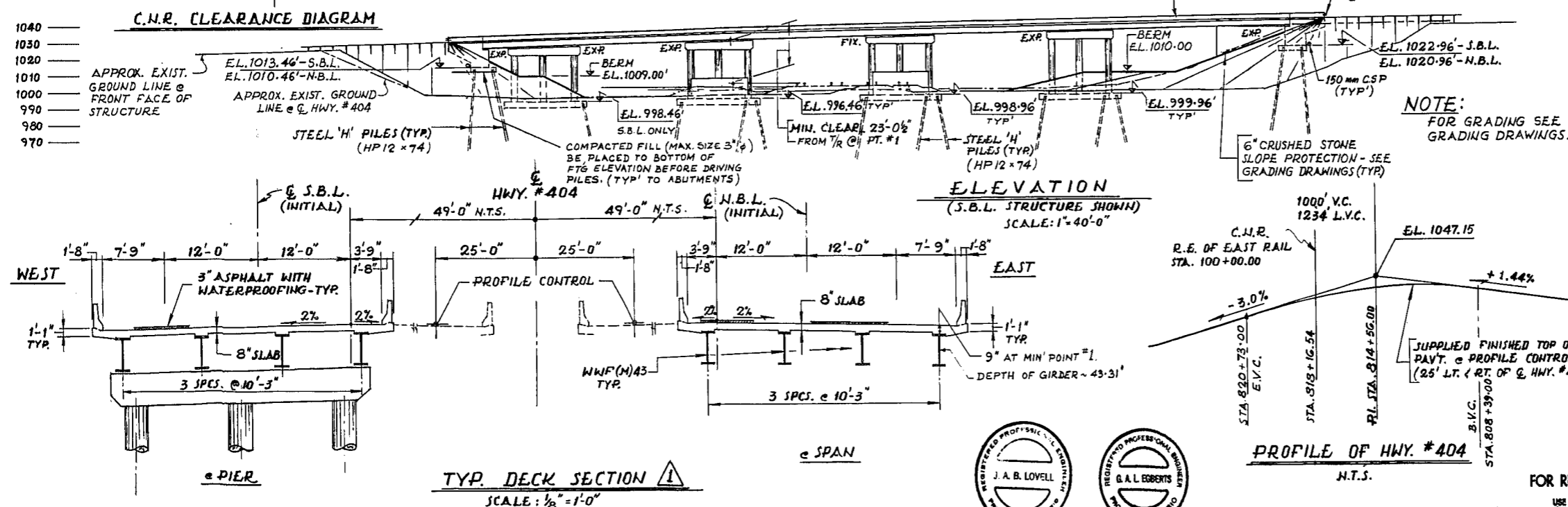
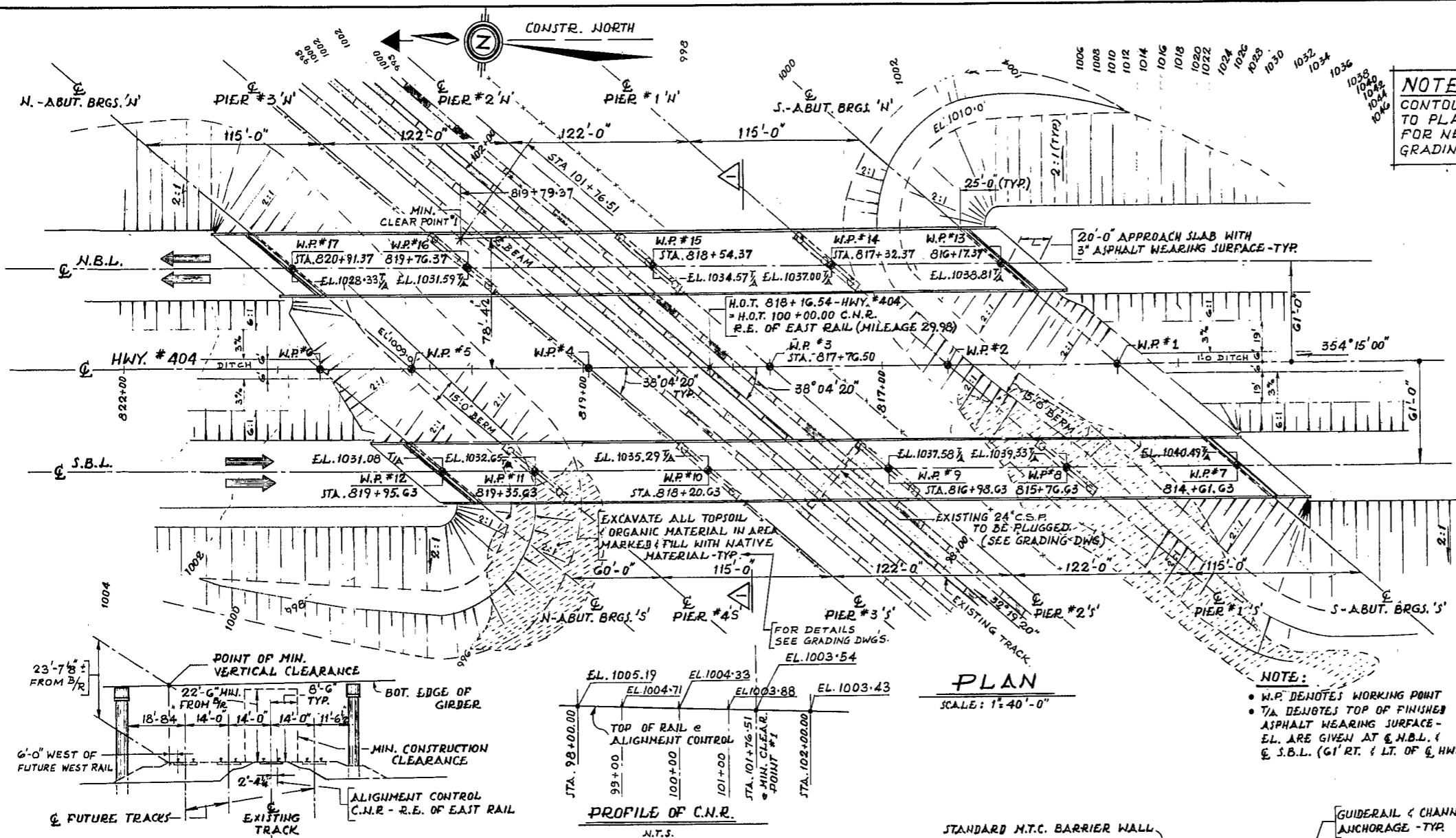
- THE CONTRACTOR IS RESPONSIBLE FOR FINISHING
 THE BEARING SEATS DEAD LEVEL TO THE SPECI-
 FIED ELEVATIONS WITH A TOLERANCE OF $\pm 1/8"$
- NO CONCRETE SHALL BE PLACED ABOVE THE
 ABUTMENT BEARING SEATS UNTIL THE CONCRETE
 IN DECK HAS BEEN PLACED.
- TO ACHIEVE THE MINIMUM CLEAR COVER OF 2"
 SPECIFIED, THE TOP LAYER OF DECK REINF. BARS
 SHALL BE PLACED, PRIOR TO CONCRETING, WITH
 A CLEAR COVER OF $2 1/2" \pm 1/2"$ TOLERANCE.
- ONLY THE NORTHBOUND STRUCTURE MAY BE USED BY HEAVY
 EQUIPMENT TO TRANSPORT FILL OVER THE TRACKS-SEE
 DETAIL 552-1 ON DRAWING #26.

CONCRETE QUANTITIES		C.U.Y.D.
CONCRETE IN DECK	NORTHBOUND	490
	SOUTHBOUND	565
CONCRETE IN BARRIER WALLS	NORTHBOUND	132
	SOUTHBOUND	147
CONCRETE IN APPROACH SLABS	NORTHBOUND	44
	SOUTHBOUND	44
CONCRETE IN PIERS, ABUTMENTS & WINGWALLS	NORTHBOUND	528
	SOUTHBOUND	579

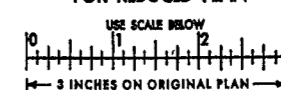
QUANTITY OF STRUCTURAL STEEL		C.U.Y.D.
	NORTHBOUND	295 TONS
	SOUTHBOUND	325 TONS

LIST OF DRAWINGS

- GENERAL LAYOUT.
- BOREHOLE LOCATIONS & SOIL STRATA.
- NORTHBOUND STRUCTURE - FOOTING LAYOUT.
- SOUTHBOUND STRUCTURE - FOOTING LAYOUT.
- NORTHBOUND STRUCTURE - SOUTH ABUTMENT - LAYOUT.
- NORTHBOUND STRUCTURE - NORTH ABUTMENT - LAYOUT.
- SOUTHBOUND STRUCTURE - SOUTH ABUTMENT - LAYOUT.
- SOUTHBOUND STRUCTURE - NORTH ABUTMENT - LAYOUT.
- ABUTMENT AND PIER FOOTINGS - REINFORCEMENT.
- NORTHBOUND STRUCTURE - SOUTH ABUTMENT - REINFORCEMENT.
- NORTHBOUND STRUCTURE - NORTH ABUTMENT - REINFORCEMENT.
- SOUTHBOUND STRUCTURE - SOUTH ABUTMENT - REINFORCEMENT.
- SOUTHBOUND STRUCTURE - NORTH ABUTMENT - REINFORCEMENT.
- PIER LAYOUT & REINFORCEMENT.
- NORTHBOUND STRUCTURE - GIRDER LAYOUT.
- SOUTHBOUND STRUCTURE - GIRDER LAYOUT.
- STRUCTURAL STEEL DETAILS.
- NORTHBOUND STRUCTURE - DECK.
- SOUTHBOUND STRUCTURE - DECK.
- DECK DRAIN LAYOUT.
- NORTHBOUND STRUCTURE - SCREED ELEV'S & BEARING SCHEDULE.
- SOUTHBOUND STRUCTURE - SCREED ELEV'S & BEARING SCHEDULE.
- BARRIER WALL.
- 20 FT APPROACH SLAB.
- (NOT USED)
- STANDARD DETAILS - SHEET 1.
- STANDARD DETAILS - SHEET 2.
- STANDARD DETAILS - SHEET 3.
- STANDARD DETAILS - SHEET 4.
- AS CONSTRUCTED ELEV & DIM.



FOR REDUCED PLAN



REVISION	DATE	BY	DESCRIPTION
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

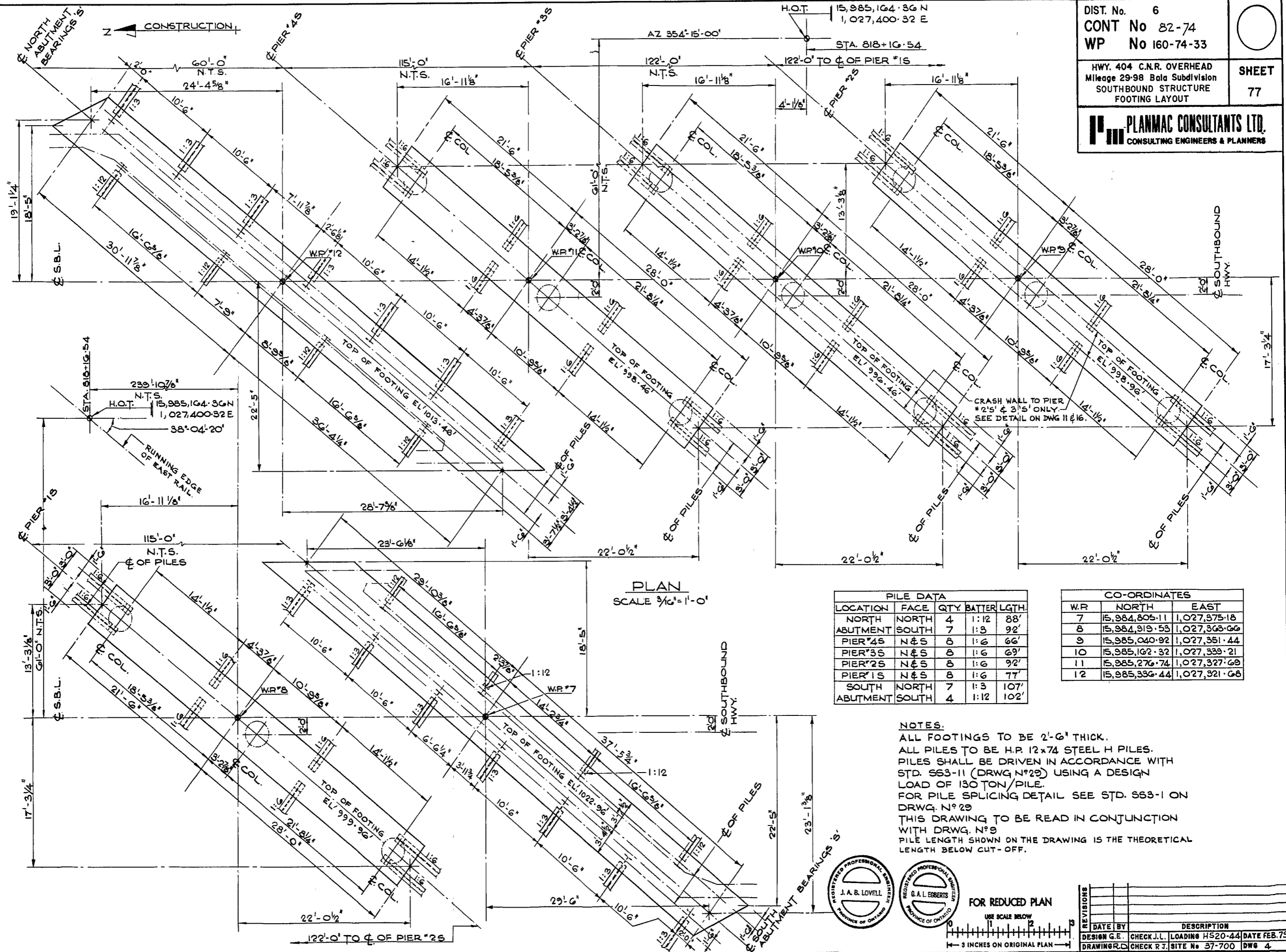


DIST. No. 6
CONT No 82-74
WP No 160-74-33

HWY. 404 C.N.R. OVERHEAD
Mileage 29-98 Bala Subdivision
SOUTHBOUND STRUCTURE
FOOTING LAYOUT

SHEET
77

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PLAN
SCALE 3/16" = 1'-0"

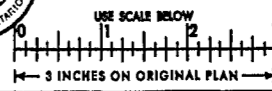
PILE DATA				
LOCATION	FACE	QTY	BATTER	LGTH.
NORTH ABUTMENT	NORTH	4	1:12	88'
PIER #4S	N&S	8	1:6	66'
PIER #3S	N&S	8	1:6	69'
PIER #2S	N&S	8	1:6	92'
PIER #1S	N&S	8	1:6	77'
SOUTH ABUTMENT	SOUTH	4	1:12	102'

CO-ORDINATES		
W.P.	NORTH	EAST
7	15,984,805.11	1,027,375.18
8	15,984,919.53	1,027,368.66
9	15,985,040.92	1,027,351.44
10	15,985,162.32	1,027,339.21
11	15,985,276.74	1,027,327.69
12	15,985,336.44	1,027,321.68

NOTES.
ALL FOOTINGS TO BE 2'-6" THICK.
ALL PILES TO BE H.P. 12x74 STEEL H PILES.
PILES SHALL BE DRIVEN IN ACCORDANCE WITH STD. S63-11 (DRWG. N°29) USING A DESIGN LOAD OF 130 TON/PILE.
FOR PILE SPlicing DETAIL SEE STD. S63-1 ON DRWG. N°29
THIS DRAWING TO BE READ IN CONJUNCTION WITH DRWG. N°9
PILE LENGTH SHOWN ON THE DRAWING IS THE THEORETICAL LENGTH BELOW CUT-OFF.



FOR REDUCED PLAN



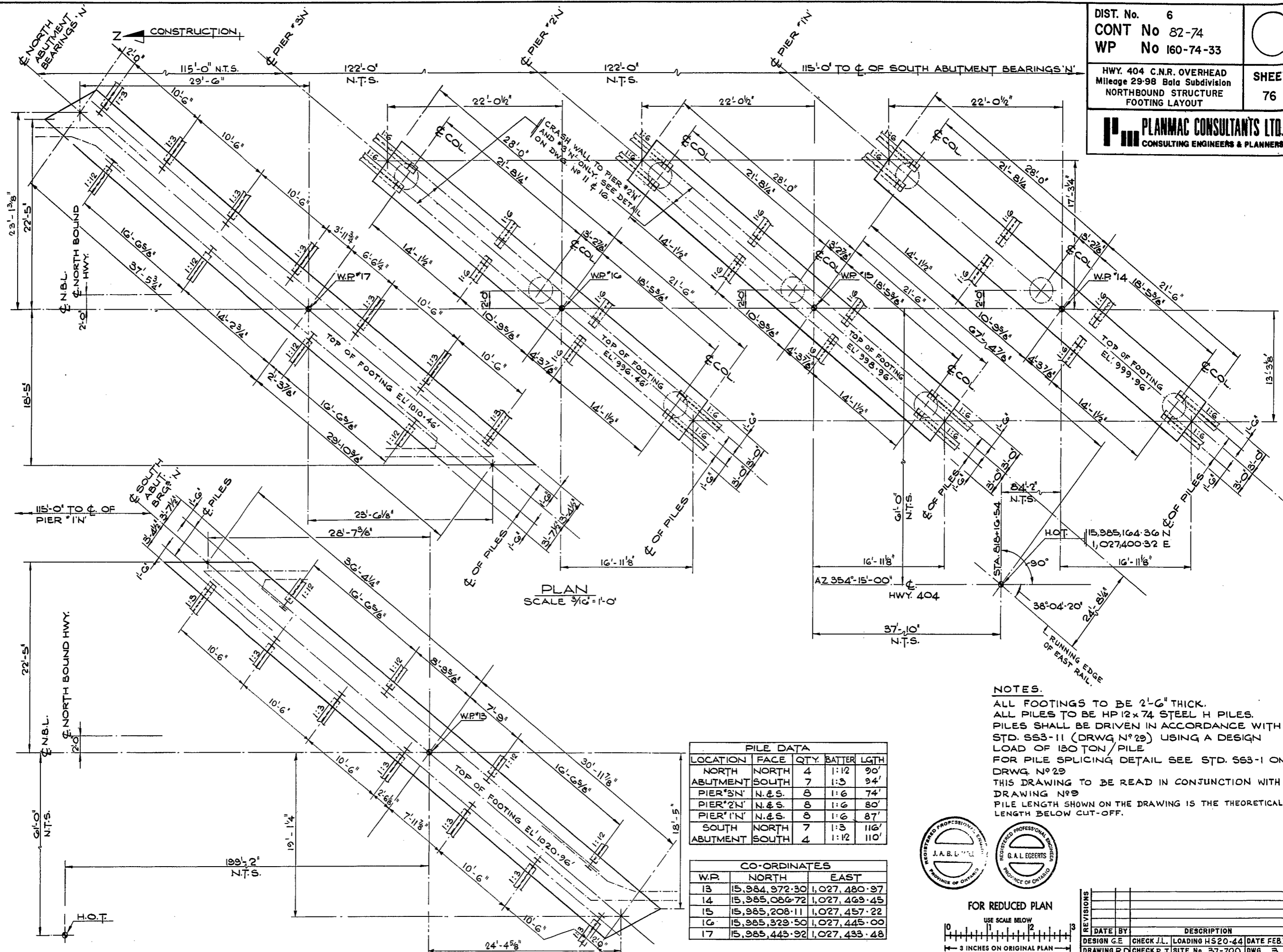
REVISIONS	DATE	BY	DESCRIPTION
DESIGN	G.E.	CHECK	J.L. LOADING HS20-44 DATE FEB. 79
DRAWING	G.D.	CHECK	R.J. SITE No 37-700 DWG 4

DIST. No. 6
CONT No 82-74
WP No 160-74-33

HWY. 404 C.N.R. OVERHEAD
Mileage 29.98 Bala Subdivision
NORTHBOUND STRUCTURE
FOOTING LAYOUT

SHEET
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APPENDIX A

Reference 2

Excerpt from Foundation Investigation and Design Report
South Approach Embankment Instabilities
CNR Overheads, Hwy 404, 3.7 Miles North of Regional Road 14
WO86-11006, Structural Site 37-700
Contract 2000-0106, WP 433-98-01, Structural Site 37-700
GEOCRETS # 30M14-183

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{\min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	KN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	KN/m^3	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	KN/m^3	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	KN/m^3	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{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
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	e_{\max}	1, %	VOID RATIO IN LOOSEST STATE	j	KN/m^2	SEEPAGE FORCE
γ'	KN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						



RECORD OF BOREHOLE No 1

METRIC

WO 86-11006 LOCATION Sta. 31 + 702.6; O/S 24.2 m Lt of C/L Hwy. 404 ORIGINATED BY JD
DIST 6 HWY 404 BOREHOLE TYPE Cone Test, Hollow Stem Auger COMPILED BY DD
DATUM Geodetic DATE 86 08 18 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
317.3	Ground Surface																
0.0	Silt (CL-ML) Hard		1	SS	34		316										1 32 56 11
315.2	Silty Sand ** (Fill)		2	SS	30												3 48 43 6
2.1	Silt (ML to CL-ML) some sand trace/some clay trace gravel Occasional silty clay (CL) zones Firm to Hard (Fill)		3	SS	8		314										3 15 67 15
			4	SS	18												
			5	SS	14												
			6	SS	13		312										0 18 60 22
			7	SS	18												
			8	SS	63		310										0 30 63 7
			9	SS	47												
308.5	Silt (ML) to Sandy Silt with organics		10	SS	26		308										
8.8	Silt (ML to CL-ML) some sand trace/some clay trace gravel Occasional silty clay (CL) zones Very Stiff (lacustrine)		11	SS	21		306										
304.7	End of Borehole		12	SS	35												
12.6	* not a stabilized groundwater elevation ** trace gravel trace clay dense																



RECORD OF BOREHOLE No 2

METRIC

WO 86-11006 LOCATION Sta. 31 + 704.0; O/S 56.8 m Lt of C/L Hwy. 404 ORIGINATED BY JD
DIST 6 HWY 404 BOREHOLE TYPE Cone Test, Hollow Stem Auger COMPILED BY DD
DATUM Geodetic DATE 86 08 18 to 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 x LAB VANE 20 40 60 80 100	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
305.2	Ground Surface										
0.0	Silt (ML) to Sandy Silt with Organics		1	SS	60	13 cm					
			2	SS	15						8 40 42 10
			3	SS	26						
			4	SS	29						22 22 46 10
			5	SS	17						
	trace/some gravel some/with sand		6	SS	9						
	Silt (ML to CL-ML) some sand		7	SS	10						
	trace/some clay		8	SS	21						
	trace gravel										
297.6	Occasional silty clay (CL) zones		9	SS	14						
7.6			10	TW	PM					19.6	0 0 95 5
	slightly cohesive		11	SS	15						
			12	SS	11						
	Silt (ML) trace sand trace clay		13	TW	PH						
	Compact to Very Dense (Lacustrine)		14	SS	27						
			15	SS	31						
			16	SS	35						
	slightly cohesive		17	SS	97						
			18	SS	41						
287.2			19	SS	58						
18.0	End of Borehole										
	* groundwater elevation measured on 86 08 20										
	** stiff to very stiff Lacustrine										



RECORD OF BOREHOLE No 3

METRIC

WO 86-11006 LOCATION Sta. 31 + 825.0, O/S 27.7 m Rt of C/L Hwy. 404 ORIGINATED BY JD
DIST 6 HWY 404 BOREHOLE TYPE Cone Test, Hollow Stem Auger COMPILED BY DD
DATUM Geodetic DATE 86 08 20 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
316.1	Ground Surface														
0.0	Silty Sand *						316								
315.3	(Fill)						314								
0.8	Cobbles and Gravel (Lighweight Fill)		1	SS	30		314								89 10 (1)
313.4	Compact to Dense						312								
2.7	Silt (ML to CL-ML) some sand trace/some clay trace gravel Occasional silty clay (CL) zones Very Stiff to Hard (Fill)		2	SS	50		312								1 22 72 5
			3	SS	23		310								
			4	SS	28		310								1 24 60 15
			5	SS	27		308								
			6	SS	23		306								5 12 55 28
			7	SS	36		304								
304.8	Silt (ML) to Sandy Silt with organics		8	SS	44		304								
11.3	Silt (ML to CL-ML) ** (Lacustrine)		9	SS	24		302								
301.9															
14.2	End of Borehole														
	* trace gravel trace clay compact														
	** some sand trace/some clay trace gravel Occasional silty clay (CL) zones Very Stiff to Hard														

+3, x5: Numbers refer to
Sensitivity


20
15 5 (%) STRAIN AT FAILURE



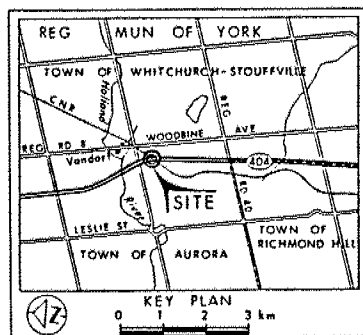
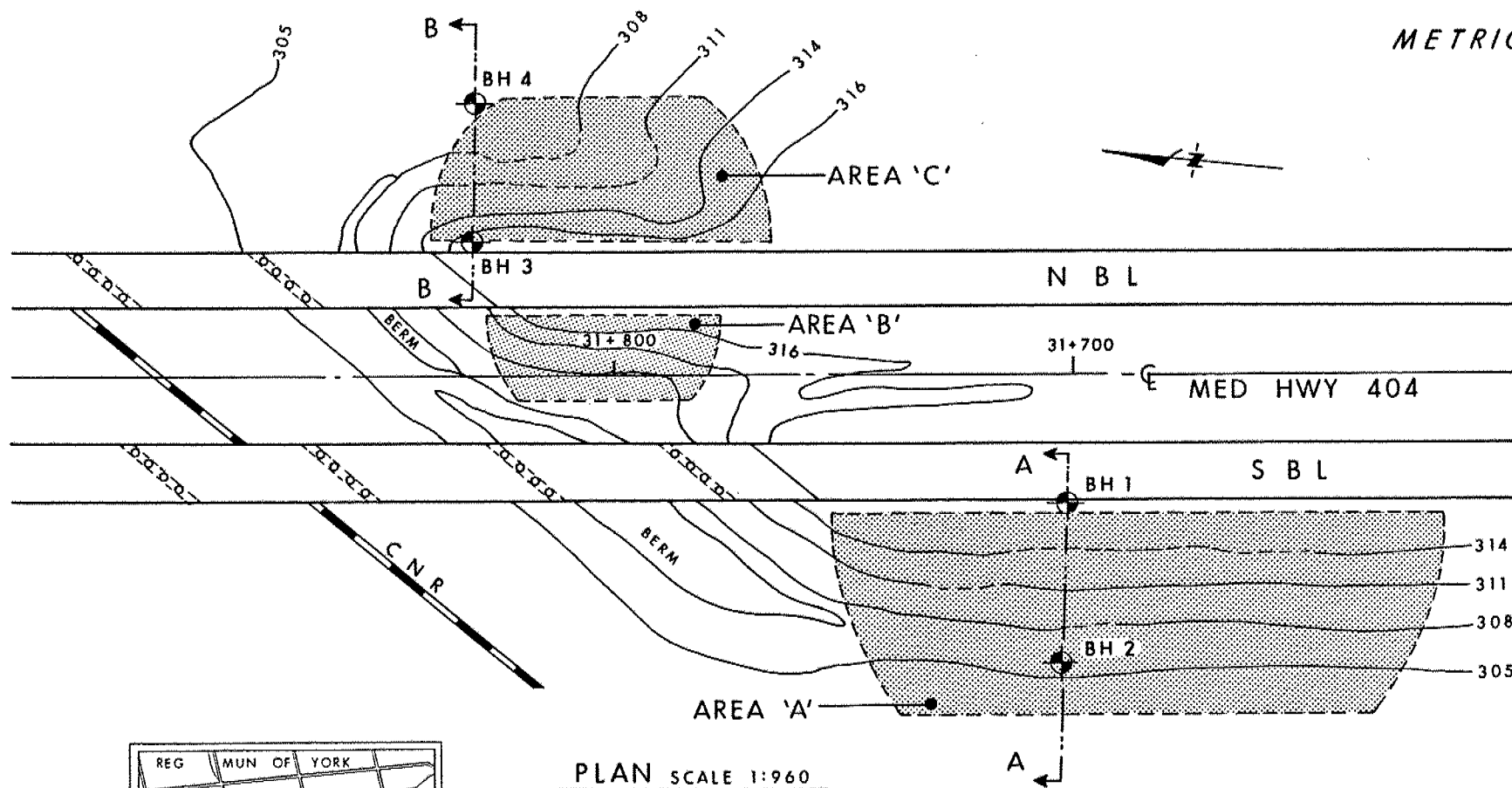
RECORD OF BOREHOLE No 4

METRIC



WO 86-11006 LOCATION Sta. 31 + 825.0, O/S 55.9 m Rt. of C/L Hwy. 404 ORIGINATED BY JD
DIST 6 HWY 404 BOREHOLE TYPE Cone Test, Hollow Stem Auger COMPILED BY DD
DATUM Geodetic DATE 86 08 19 to 20 CHECKED BY DD

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
306.8	Ground Surface							20 40 60 80 100	20 40 60 80 100	10 20 30			GR SA SI CL					
0.0	Sandy Silt to Silty Sand trace/with gravel trace clay Compact to Dense (Lacustrine)	[Strat Plot]	1	SS	42		86 08 20							0 30 61 9				
			2	SS	18										34 28 28 10			
			3	SS	20											34 56 8 2		
			4	SS	48												20.8	
			5	SS	18													0 1 72 27
301.6			6	SS	18													
5.2	Silt (ML to CL-ML) some sand trace/some clay trace gravel Occasional silty clay (CL) zones	[Strat Plot]	7	SS	35													
			8	SS	24													
			9	TW	PH													
293.7	*	[Strat Plot]	10	SS	27													
8.1	End of Borehole						298											
296.7																		
10.1	End of Cone Test																	
	* Very Stiff to Hard (Lacustrine)																	

METRIC



LEGEND

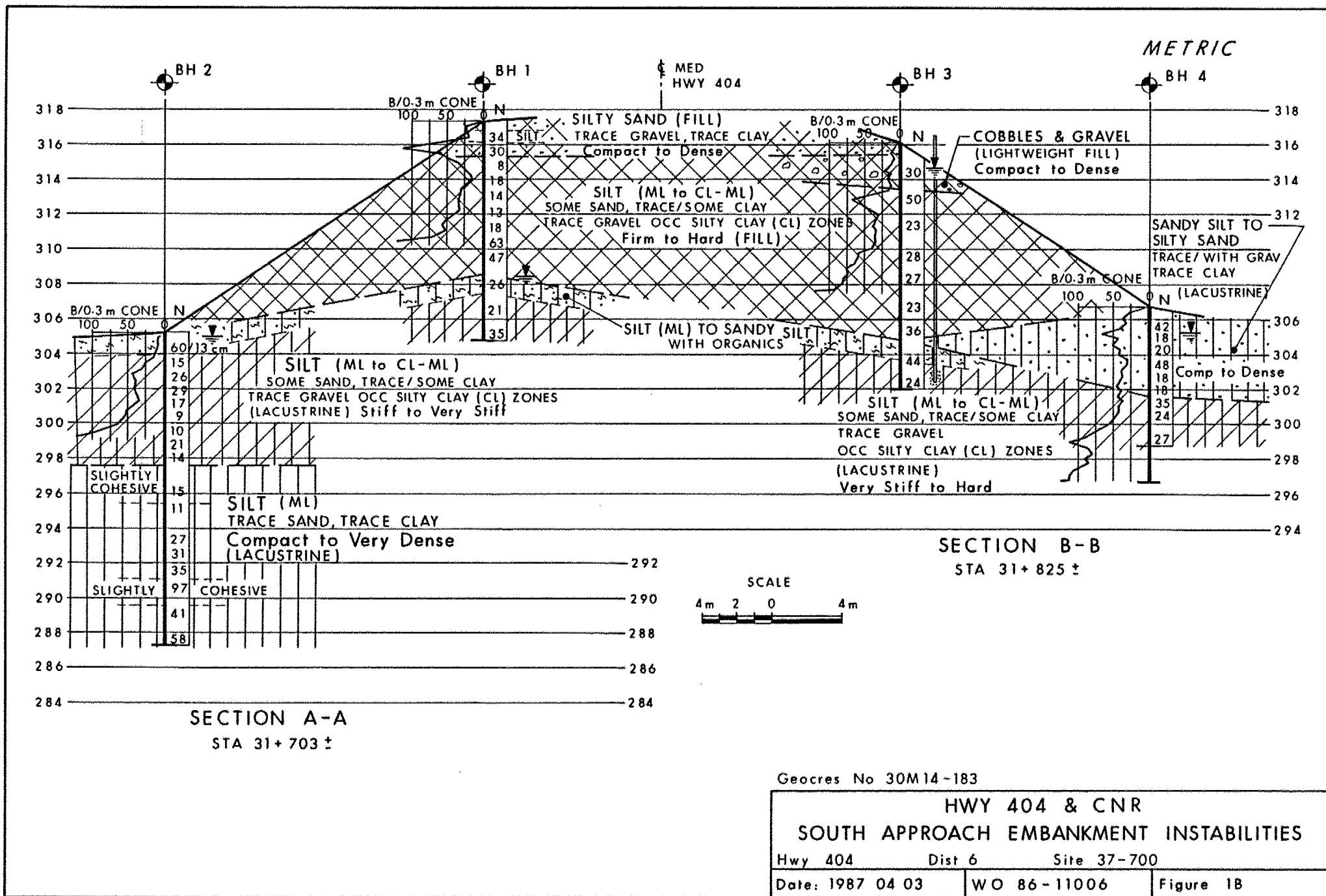
-  Bore Hole and Cone
-  Instability Area

Geocres No 30M14-183

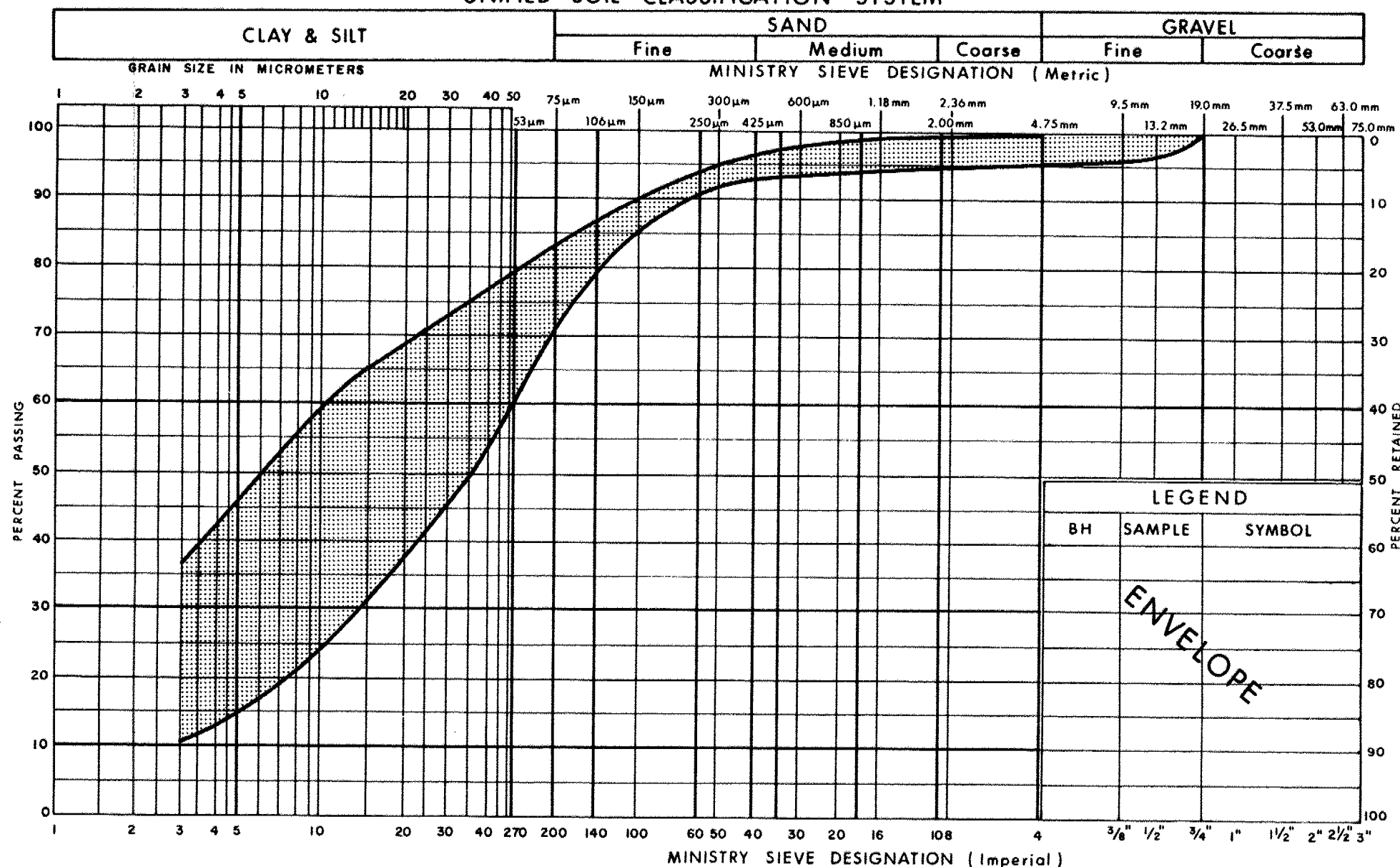
HWY 404 & CNR SOUTH APPROACH EMBANKMENT INSTABILITIES

Hwy 404 Dist 6 Site 37-700

Date: 1987 03 12 WO 86-11006 Figure 1A



UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

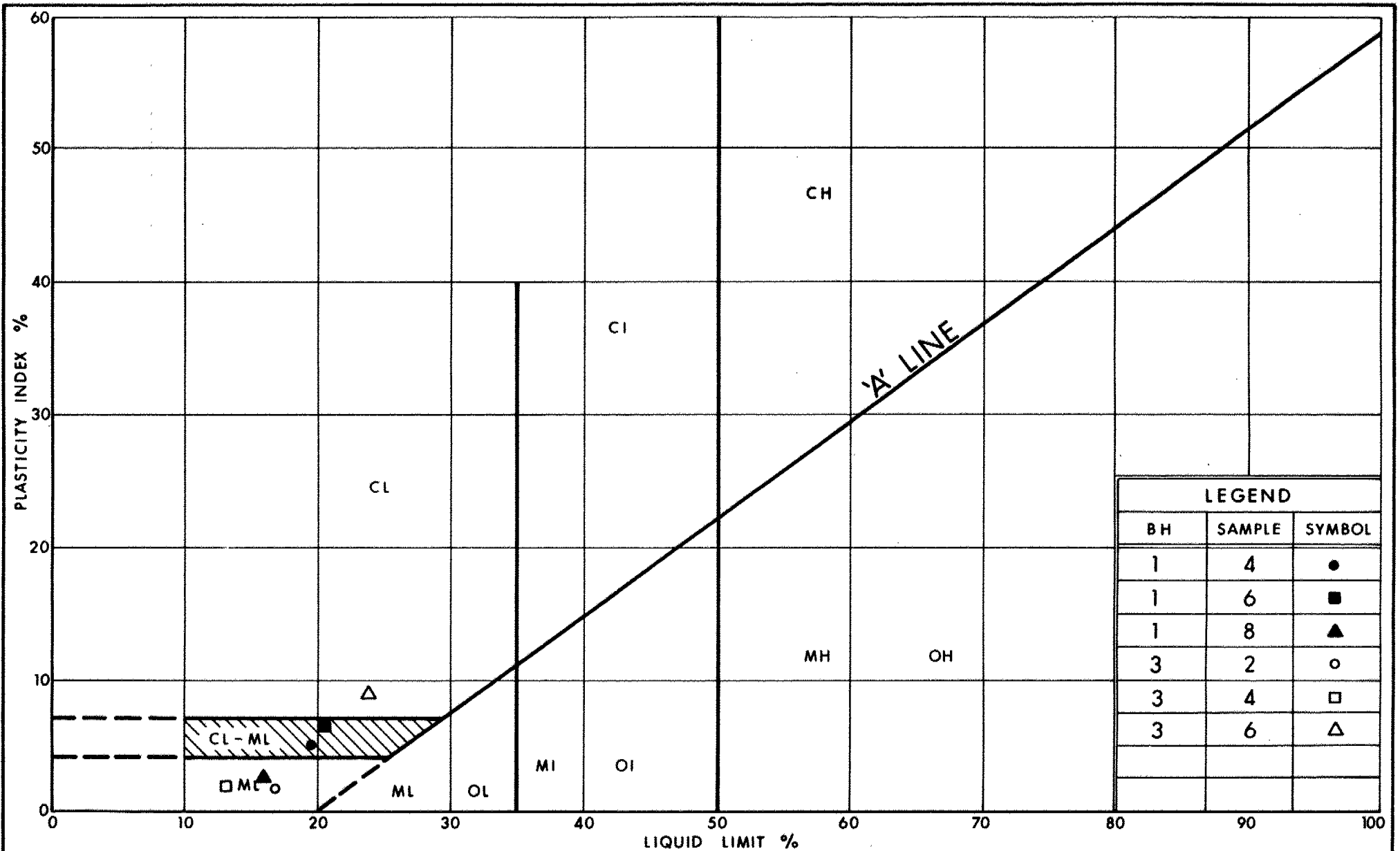
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION

SILT (ML to CL-ML) SOME SAND,
TRACE/SOME CLAY, TRACE GRAVEL, OCC SILTY CLAY (CL) ZONES (Fill)

FIG No 2

WO 86-11006



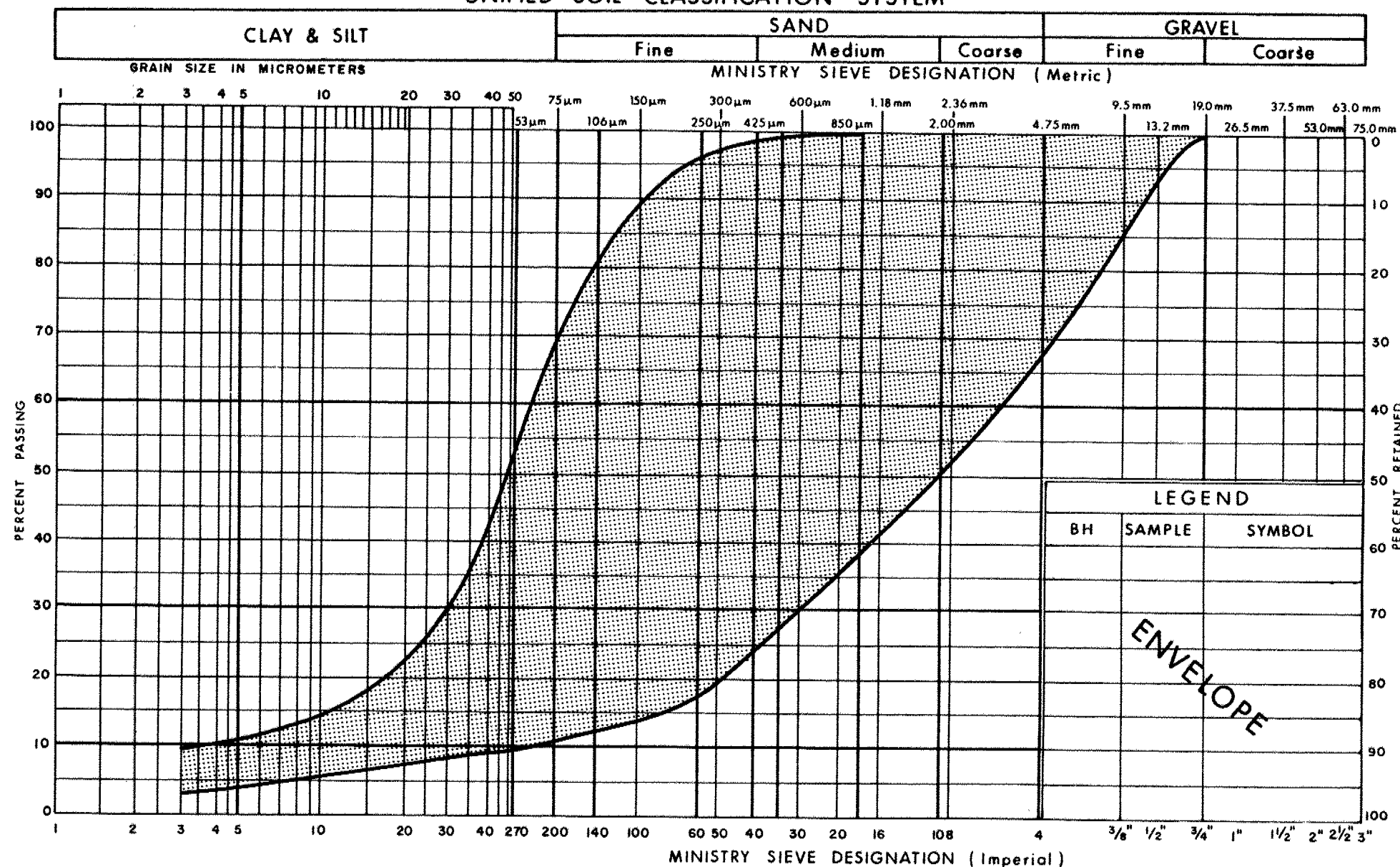
Ministry of
Transportation and
Communications
Ontario

PLASTICITY CHART
SILT (ML to CL-ML) SOME SAND,
TRACE/SOME CLAY, TRACE GRAVEL, OCC SILTY CLAY (CL) ZONES (Fill)

FIG No 3

WO 86-11006

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

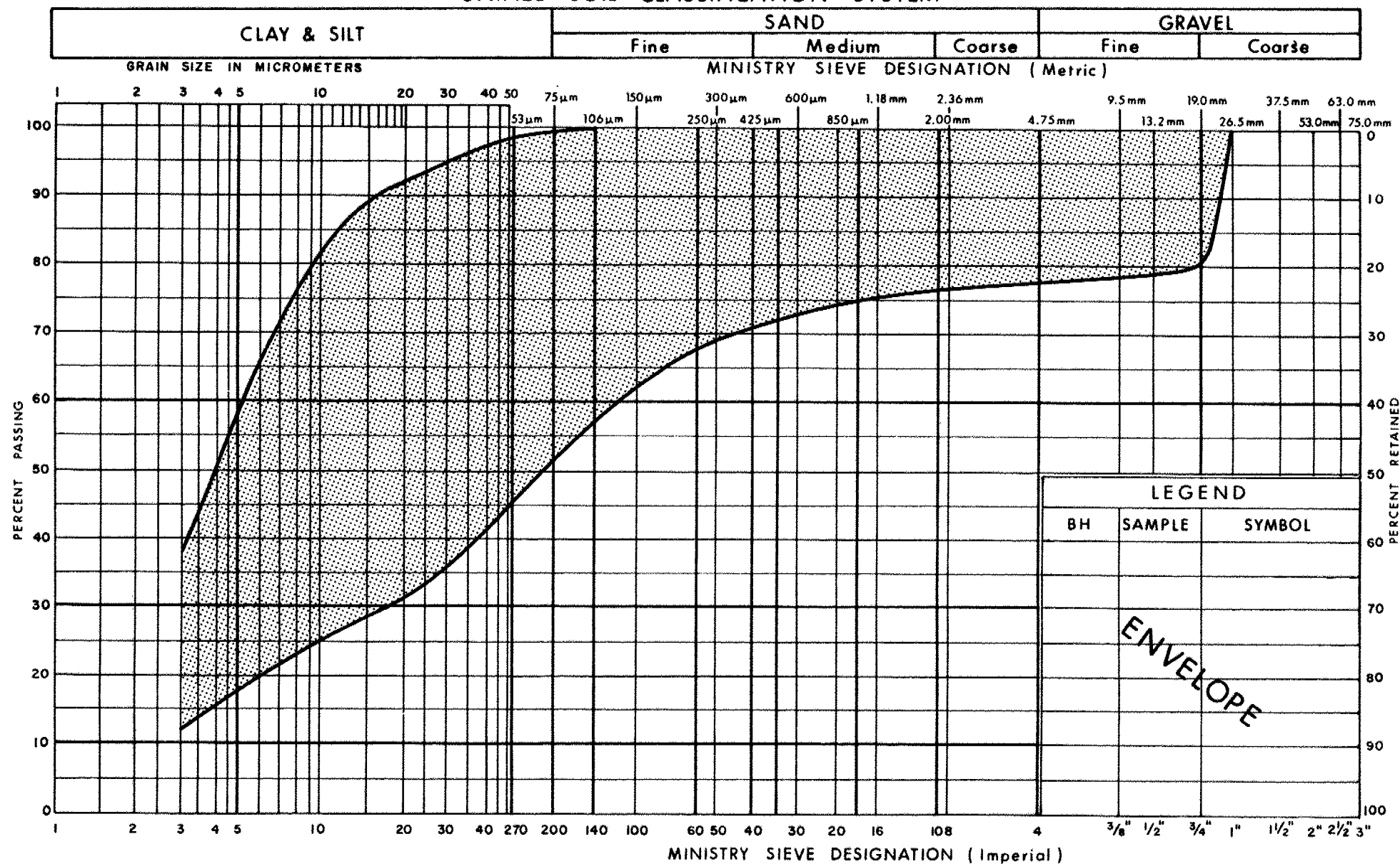
 Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
 SANDY SILT TO SILTY SAND
 TRACE / WITH GRAVEL, TRACE CLAY, (LACUSTRINE)

FIG No 4

W O 86-11006

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

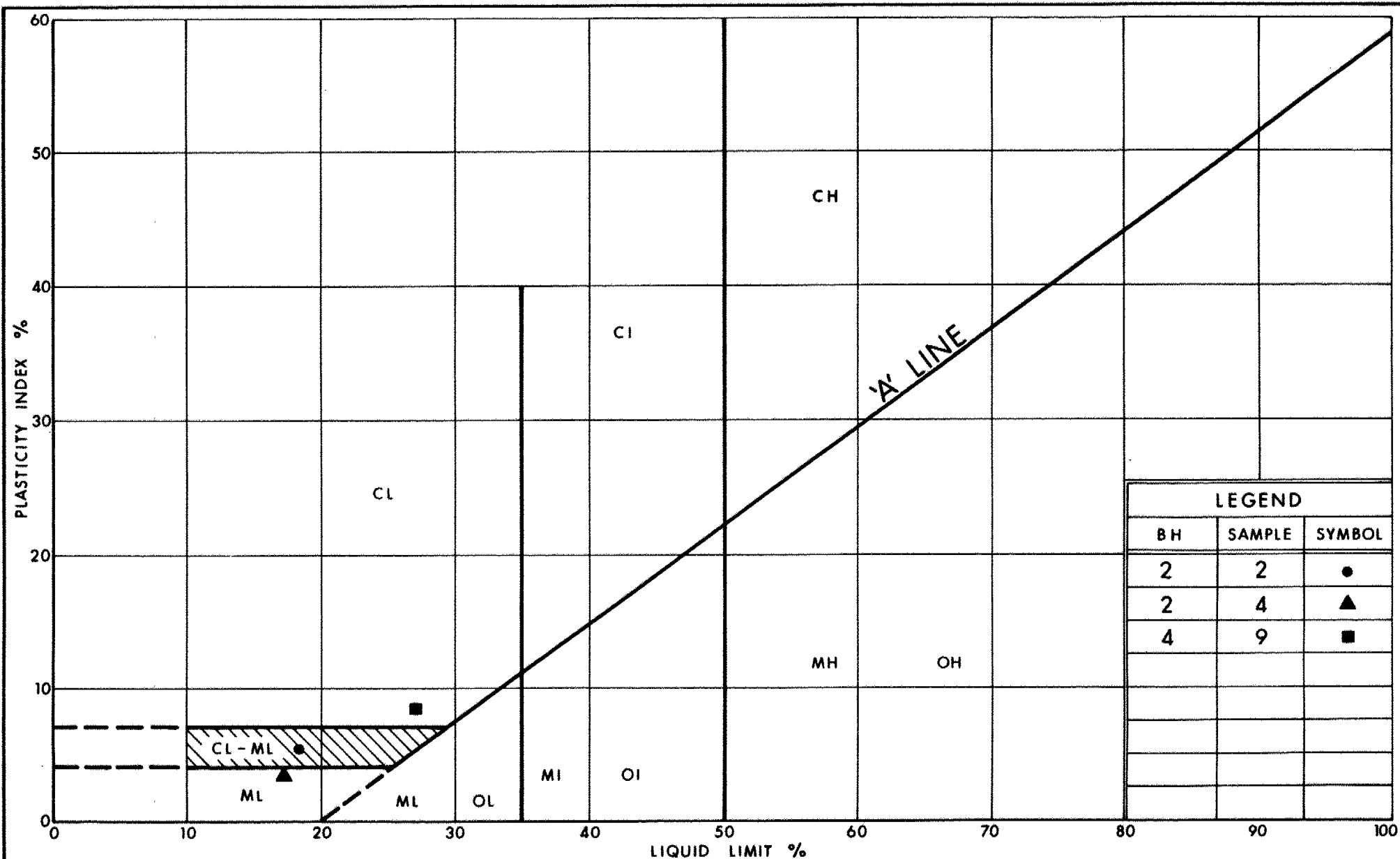
 Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION

 SILT (ML to CL - ML) SOME/WITH SAND,
TRACE/SOME CLAY/GRAVEL, OCC SILTY CLAY (CL) ZONES (LACUSTRINE)

FIG No 5

W O 86-11006



Ministry of
Transportation and
Communications
Ontario

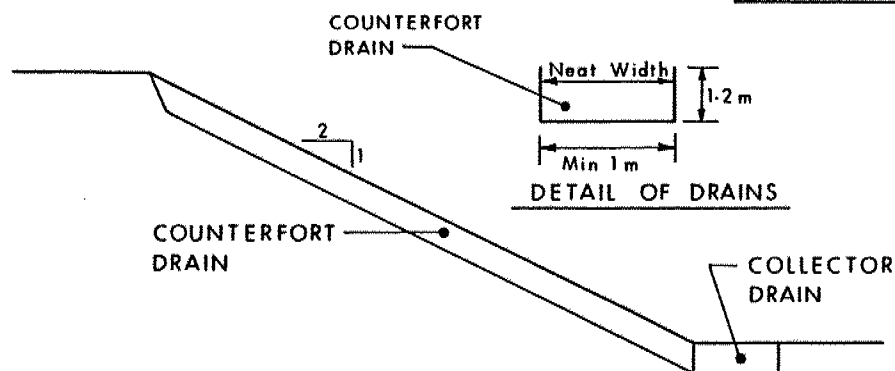
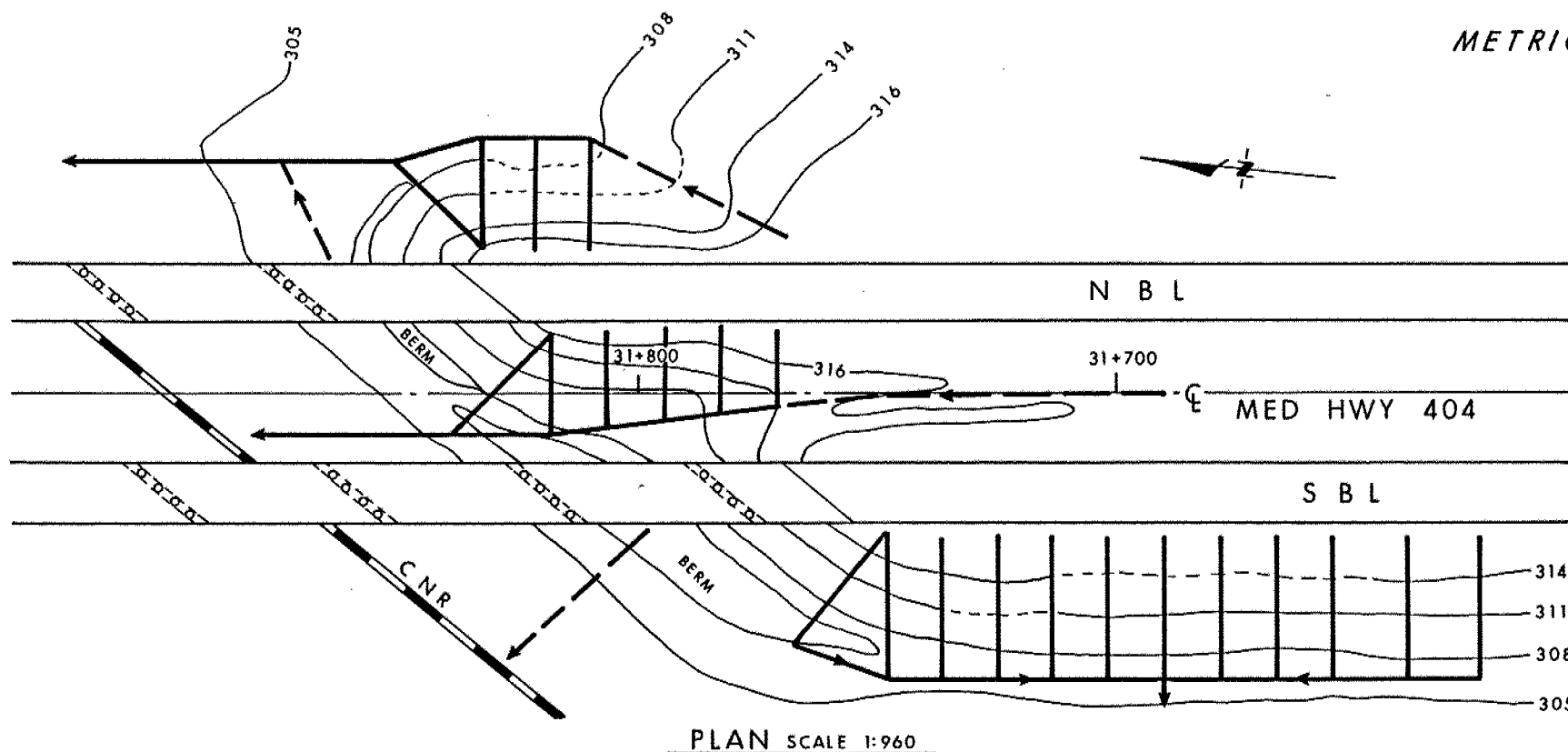
PLASTICITY CHART

SILT (ML to CL-ML) SOME/WITH SAND, TRACE/SOME CLAY,
TRACE/SOME GRAVEL, OCC SILTY CLAY (CL) ZONES (LACUSTRINE)

FIG No 6

WO 86-11006

METRIC



LEGEND

- DRAIN
- - - DITCH
- DIRECTION OF FLOW

Geocres No 30M14-183

HWY 404 & CNR SOUTH APPROACH EMBANKMENT INSTABILITIES

Hwy 404 Dist 6 Site 37-700

Date: 1987 03 13 WO 86-11006 Figure 15



APPENDIX A

Reference 3

Excerpt from Contract Drawings
(for the initial median widening of NBL and SBL bridges)
CNR Overheads, Hwy 404, 3.7 Miles North of Regional Road 14
Contract 2000-0106, WP 433-98-01, Structural Site 37-700

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

CONT No 2000-0106
WP No 433-98-01



HWY. 404 C.N.R. OVERHEAD NBL WIDENING
MILEAGE 30.01 BALA SUBDIVISION

SHEET

FOOTING AND PILE LAYOUT

342

DELCAN ENGINEERS
PLANNERS
ARCHITECTS

NOTES:

1. ALL PILES ARE HP 310x110 STEEL 'H' PILES WITH DRIVING SHOES.
2. SPACING OF PILES TO BE MEASURED AT UNDERSIDE OF FOOTING.
3. PILE LENGTH SHOWN IS THEORETICAL LENGTH BELOW CUT-OFF ELEVATION AND SHALL BE DETERMINED ON SITE FROM PILE DRIVING RECORDS.
4. PILE SPLICES SHALL BE IN ACCORDANCE WITH OPSD 3301.00.
5. WELDING SHALL CONFORM TO CSA STANDARD W59 AND SHALL BE DONE BY WELDER QUALIFIED UNDER CSA STANDARD W47.
6. PILES TO BE DRIVEN IN ACCORDANCE WITH STANDARD SS103-11 USING AN ULTIMATE CAPACITY OF 4000 kN PER PILE.
7. PILES SHALL BE RETAPPED IN ACCORDANCE WITH THE PILING SPECIAL PROVISION 903501.
8. THE ESTIMATED APPROXIMATE PILE TIP ELEVATIONS ARE LISTED IN THE TABLE BELOW:

LIST OF PILES				
LOCATION	BATTER	NUMBER REQUIRED	LENGTH (mm)	ESTIMATED PILE TIP ELEV. (m)
NORTH ABUT.	1:5	6	26 100	281.0±
	1:12	3	25 700	
	VERTICAL	3	25 600	
PIER 1N	1:10	6	24 300	279.0±
PIER 2N	1:6	8	22 600	280.0±
PIER 3N	1:10	6	19 300	283.0±
SOUTH ABUT.	1:4	10	31 800	279.0±
	1:12	3	30 900	

9. PILE DRIVING AT THE SOUTH ABUTMENT OF THE N.B.L. SHOULD ONLY TAKE PLACE AFTER THE CONSTRUCTION OF THE BERM.

PILE DESIGN DATA:

CAPACITY @ ULS : 2000 kN/PILE
CAPACITY @ SLS : N/A

NOTES TO CONTRACTOR:

- LOCATIONS OF EXISTING CN TRACKS AND CABLES SHOWN ON THE DRAWINGS ARE APPROXIMATE AND SHALL BE VERIFIED IN THE FIELD BY CONTRACTOR.
- THE CONTRACTOR IS FULLY RESPONSIBLE FOR ADEQUATE PROTECTION OF CN CABLES, TRACK ETC. DURING CONSTRUCTION OPERATION.

LOCATION OF WORKING POINTS

W.P.	STATION	CO-ORDINATE	
		NORTHING	EASTING
1N	15+678.000	4 872 217.425	313 176.476
2N	15+713.050	4 872 252.298	313 172.963
3N	15+750.240	4 872 289.301	313 169.235
4N	15+787.420	4 872 326.294	313 165.508
5N	15+822.480	4 872 361.177	313 161.994

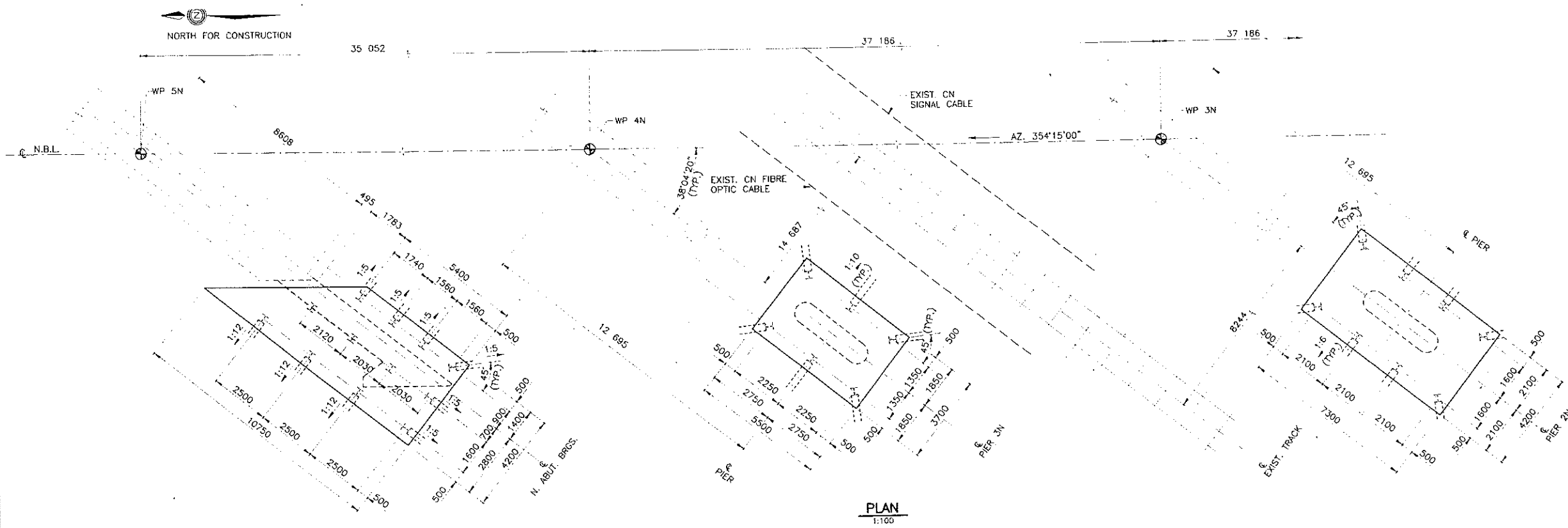
APPLICABLE STANDARD DRAWINGS:

OPSD-3301.00 SPLICE AND DRIVING SHOES
DETAILS FOR STEEL H-PILES

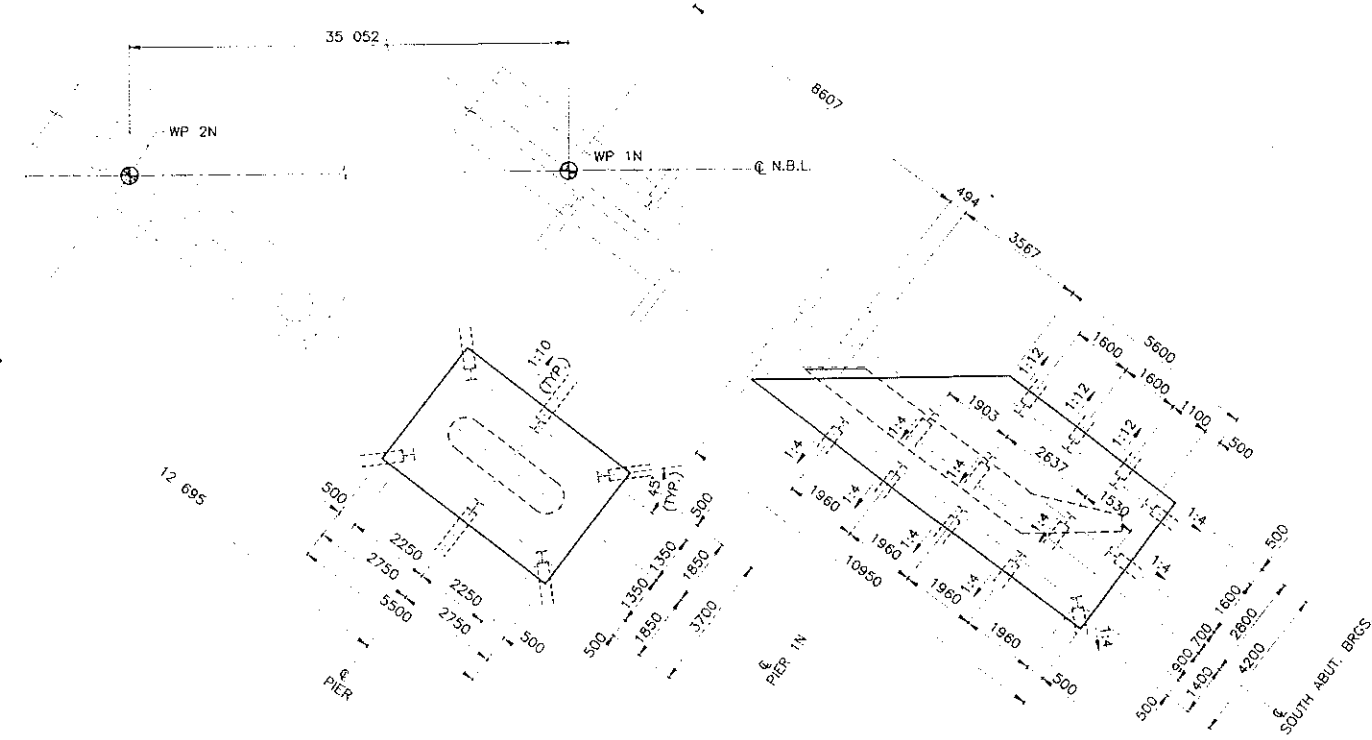


DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS		DATE	BY	CHK	T.W.	CODE	OHBC-91	LOAD	100%
DESIGN H.L.									
DRAWN T.L.									



PLAN
1:100



PLAN
1:100

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DIST. 6 HWY. 404

CONT No 2000-0106

WP No 433-98-01

HWY. 404 C.N.R. OVERHEAD SBL WIDENING
MILEAGE 29.98 BALA SUBDIVISION

GENERAL ARRANGEMENT

SHEET

360

DELCAN

ENGINEERS
PLANNERS
ARCHITECTS

GENERAL NOTES:

CLASS OF CONCRETE:

30 MPa UNLESS NOTED OTHERWISE

CLEAR COVER TO REINFORCING STEEL:

FOOTINGS 100 ± 25
DECK TOP 70 ± 20
BOTTOM 40 ± 10
REMAINDER, UNLESS OTHERWISE NOTED. 70 ± 20

REINFORCING STEEL:

- REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BAR MARKED WITH PREFIX 'C' DENOTES COATED BARS.
- UNLESS SHOWN OTHERWISE, TENSION LAP LENGTHS NOT INDICATED ON THE CONTRACT DRAWINGS SHALL BE CLASS 'C'.
- HOOKS AND BENDS FOR REINFORCING STEEL SHALL BE DETAILED ACCORDING TO OHBDC-91 UNLESS SHOWN OTHERWISE, THE FOLLOWING SHALL APPLY:
 - (a) STANDARD HOOKS WITH MINIMUM BEND DIAMETERS SHALL BE USED FOR STIRRUPS AND TIES ACCORDING TO CLAUSES 8-14.1
 - (b) OTHER BARS SHALL HAVE STANDARD HOOKS WITH DIAMETERS ACCORDING TO CLAUSE C8-14.1

CONSTRUCTION NOTES:

- THE CONTRACTOR SHALL VERIFY ALL RELEVANT ELEVATIONS & DIMENSIONS OF THE PROPOSED WORK AND ALL DETAILS ON SITE AND REPORT ANY DISCREPANCIES TO THE CONTRACT ADMINISTRATOR BEFORE PROCEEDING WITH THE REPAIR WORK.
- LOCATIONS OF EXISTING UTILITY DUCTS SHOWN ON THE DRAWINGS ARE APPROXIMATE AND SHALL BE VERIFIED IN THE FIELD BY THE CONTRACTOR.
- WHERE INDICATED ON DRAWING THAT A SAWCUT IS REQUIRED TO DELINEATE AREAS OF CONCRETE REMOVAL, THE SAWCUT SHALL BE 25mm DEEP OR TO FIRST LAYER OF REINFORCING STEEL, WHICHEVER IS LESS.
- FOR TRAFFIC AND CONSTRUCTION STAGING LAYOUTS SEE DRAWING 5 AND GRADING DRAWINGS.
- FOR CONSTRUCTION NOTES FOR CLOSURE POUR STRIP SEE DWG. 5
- FOR PROFILE CONTROL INFORMATION SEE GRADING DRAWINGS.
- ELEVATIONS AND DIMENSIONS SHOWN ON THE DRAWINGS ARE APPROXIMATE AND SHALL BE VERIFIED IN THE FIELD BY THE CONTRACTOR.
- THE CONTRACTOR SHALL VERIFY RELEVANT EXISTING ELEVATIONS, DIMENSIONS AND DETAILS, AND ESTABLISH THE FINAL BEARING SEAT ELEVATIONS FOR THE NEW PIERS AND WIDENED ABUTMENTS. THE FINAL BEARING SEAT ELEVATIONS SHOULD BE ADJUSTED FOR THE ACTUAL BEARING THICKNESS. IF THE ACTUAL BEARING THICKNESS ARE DIFFERENT FROM THOSE GIVEN WITH THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE REINFORCING STEEL TO SUIT.
- THE CONTRACTOR SHALL CHECK ALL RELEVANT ELEVATIONS AND DIMENSIONS OF EXISTING WORK PRIOR TO FABRICATION OF THE EXPANSION JOINT ASSEMBLIES.
- THE BALLAST WALLS AND WINGWALLS SHALL NOT BE PLACED UNTIL THE GIRDERS ARE ERECTED.

APPLICABLE STANDARD DRAWINGS:

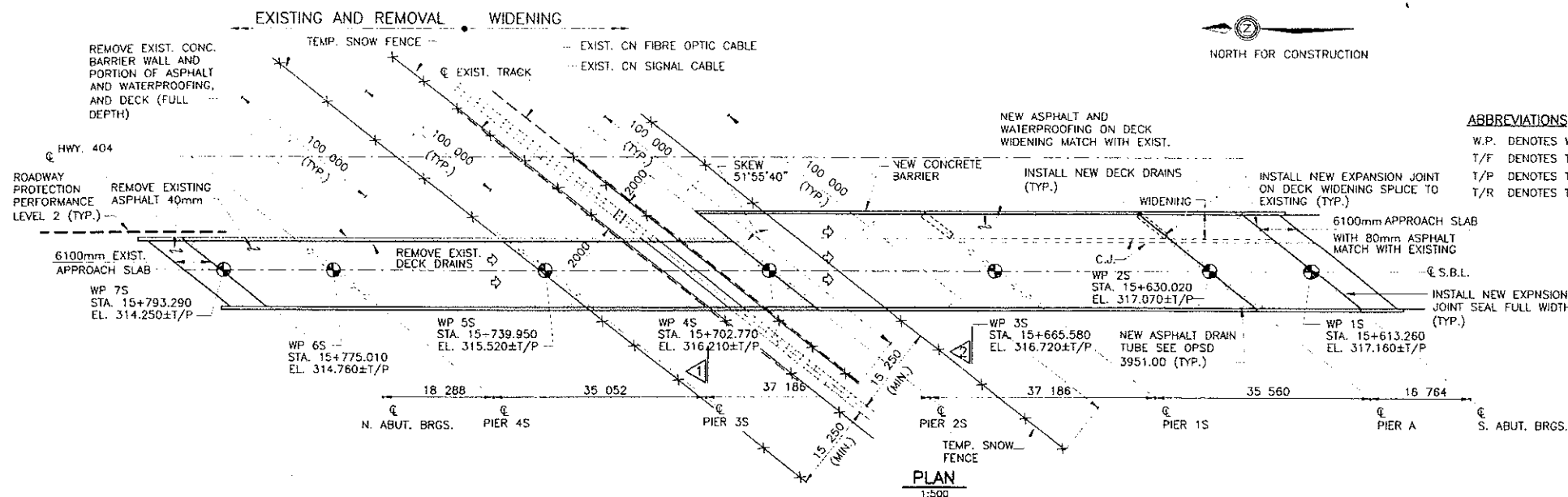
- OPSD-3301.00 SPLICE AND DRIVING SHOE DETAILS FOR H-PILES
- OPSD-3501.00 GRANULAR BACKFILL REQUIREMENTS.
- OPSD-3515.00 WINGWALL SLEEVE DETAIL FOR PERFORATED DRAIN
- OPSD-3904.04 DRIP DETAILS
- OPSD-3906.02 BRIDGE DECK WATERPROOFING.
- OPSD-3906.03 BRIDGE DECK WATERPROOFING DETAILS.
- OPSD-3923.00 SUPPORTS FOR REINFORCING STEEL
- OPSD-3930.00 METHOD OF OBTAINING SCREED ELEVATIONS
- OPSD-3950.00 DRAINAGE OF ASPHALT WEARING SURFACE ON NEW DECKS
- OPSD-3951.00 DRAINAGE OF ASPHALT WEARING SURFACE OF EXISTING DECKS
- OPSD-4010.00 GUIDERAIL AND CHANNEL ANCHORAGE.
- OPSD-4601.00 LOCATION OF SITE NUMBER & DATE FIGURES.
- OPSD-4670.00 TYPICAL JOINT DETAIL.

LIST OF DRAWINGS

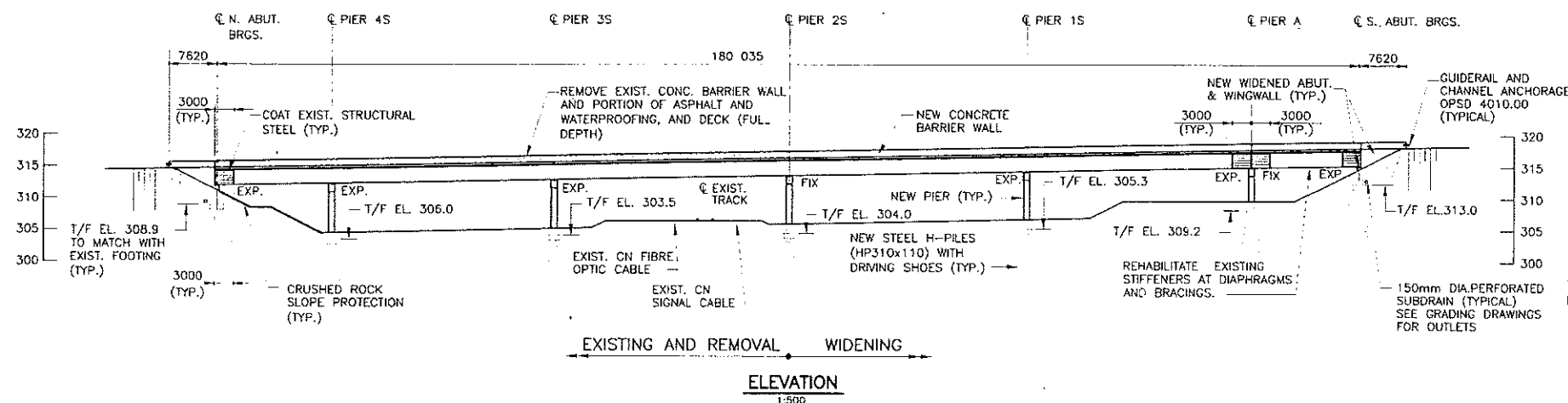
- GENERAL ARRANGEMENT
- BOREHOLE LOCATIONS AND SOIL STRATA I
- BOREHOLE LOCATIONS AND SOIL STRATA II
- BOREHOLE LOCATIONS AND SOIL STRATA III
- CONSTRUCTION STAGING
- REMOVALS
- FOOTING AND PILE LAYOUT
- FOOTING REINFORCEMENT
- ABUTMENTS
- WINGWALLS
- PIERS
- STRUCTURAL STEEL - I
- STRUCTURAL STEEL - II
- BEARINGS
- REHABILITATION OF EXISTING STIFFENERS
- DECK DETAILS AND REINFORCING
- 6100mm APPROACH SLABS
- BARRIER WALLS
- JOINT ANCHORAGE AND AMOURING I
- JOINT ANCHORAGE AND AMOURING II
- MISCELLANEOUS DETAILS
- PILE DRIVING - STEAM & DIESEL HAMMERS
- QUANTITIES - STRUCTURE I
- QUANTITIES - STRUCTURE II

ABBREVIATIONS

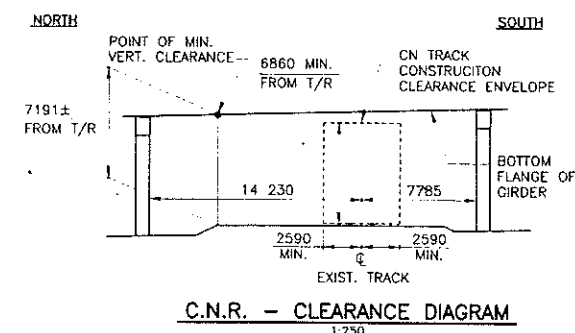
W.P. DENOTES WORKING POINT
T/F DENOTES TOP OF FOOTING
T/P DENOTES TOP OF PAVEMENT
T/R DENOTES TOP OF RAIL



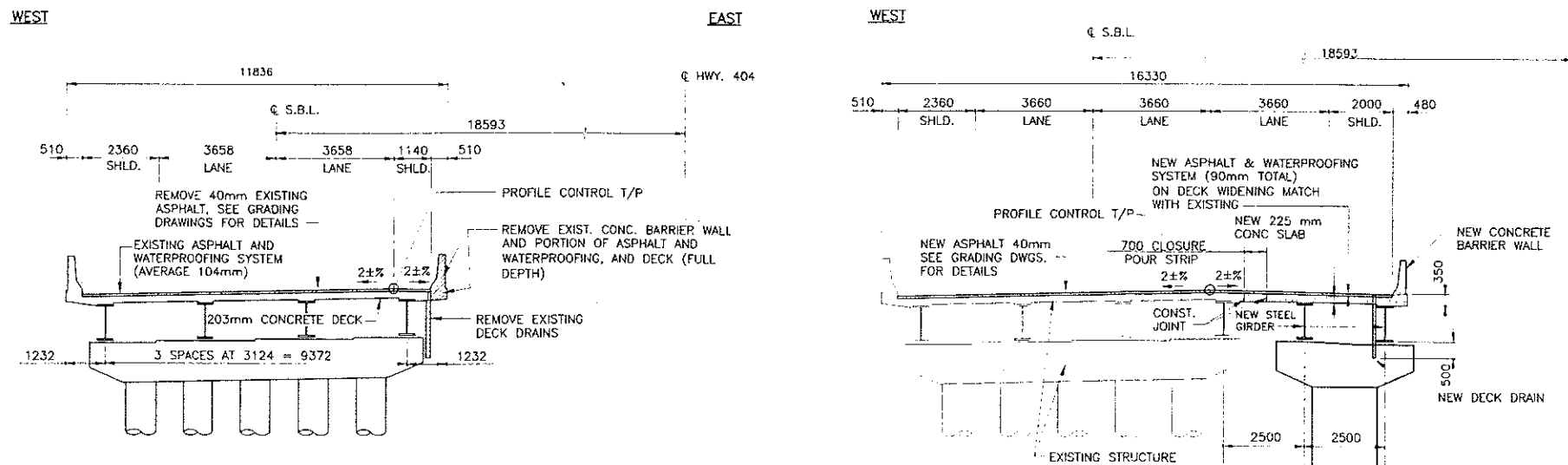
PLAN
1:500



ELEVATION
1:500



C.N.R. - CLEARANCE DIAGRAM
1:250



SHOWING WIDENING
1:100

B.M. 612 EL. 312.970m

TOP OF BOLT SET IN N E
CORNER RAILWAY BRIDGE
STATION 15+840.9 OFFSET
24.9m

SHOWING EXISTING AND REMOVALS
1:100



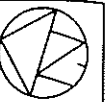
DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	CHK	T.W.	CODE	OHBC-91	LOAD	DATE	JULY 2000
DESIGN	H.L.	CHK	H.L.	SITE	37-7005	STRUCT	SCHEME	DWG.	1

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No 2000-0106
WP No 433-98-01



HWY. 404 C.N.R. OVERHEAD SBL WIDENING
MILEAGE 29.98 BALA SUBDIVISION

SHEET

FOOTING LAYOUT

366

DELCAN

ENGINEERS
PLANNERS
ARCHITECTS

PILE DESIGN DATA:

CAPACITY @ ULS : 2000 kN/PILE
CAPACITY @ SLS : N/A

NOTES TO CONTRACTOR:

- LOCATIONS OF EXISTING CN TRACKS AND CABLES SHOWN ON THE DRAWINGS ARE APPROXIMATE AND SHALL BE VERIFIED IN THE FIELD BY CONTRACTOR.
- THE CONTRACTOR IS FULLY RESPONSIBLE FOR ADEQUATE PROTECTION OF CN CABLES, TRACK ETC. DURING CONSTRUCTION OPERATION.

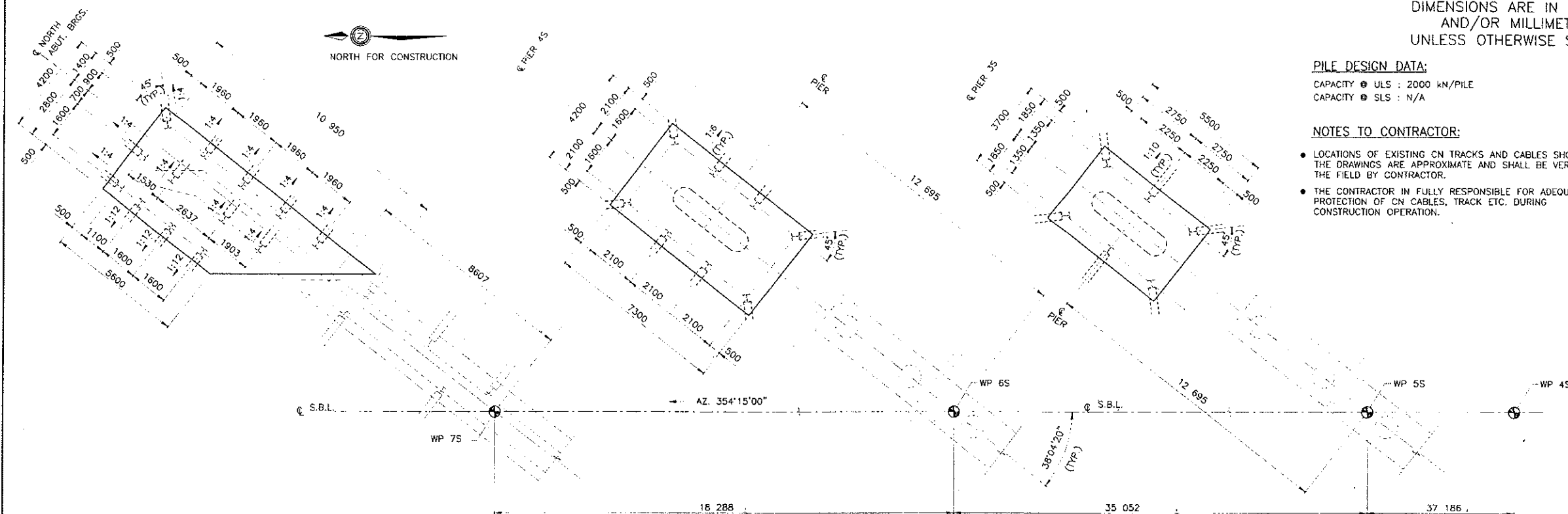
NOTES:

- ALL PILES ARE HP 310x110 STEEL 'H' PILES WITH DRIVING SHOES.
- SPACING OF PILES TO BE MEASURED AT UNDERSIDE OF FOOTING.
- PILE LENGTH SHOWN IS THEORETICAL LENGTH BELOW CUT-OFF ELEVATION AND SHALL BE DETERMINED ON SITE FROM PILE DRIVING RECORDS.
- PILE SPLICES SHALL BE IN ACCORDANCE WITH OPSD 3301.00.
- WELDING SHALL CONFORM TO CSA STANDARD W59 AND SHALL BE DONE BY WELDER QUALIFIED UNDER CSA STANDARD W47.
- PILES TO BE DRIVEN IN ACCORDANCE WITH STANDARD SS103-11 USING AN ULTIMATE CAPACITY OF 4000 kN PER PILE.
- PILES SHALL BE RETAPPED IN ACCORDANCE WITH THE PILING SPECIAL PROVISION 903501.
- THE ESTIMATED APPROXIMATE PILE TIP ELEVATIONS ARE LISTED IN THE TABLE BELOW:

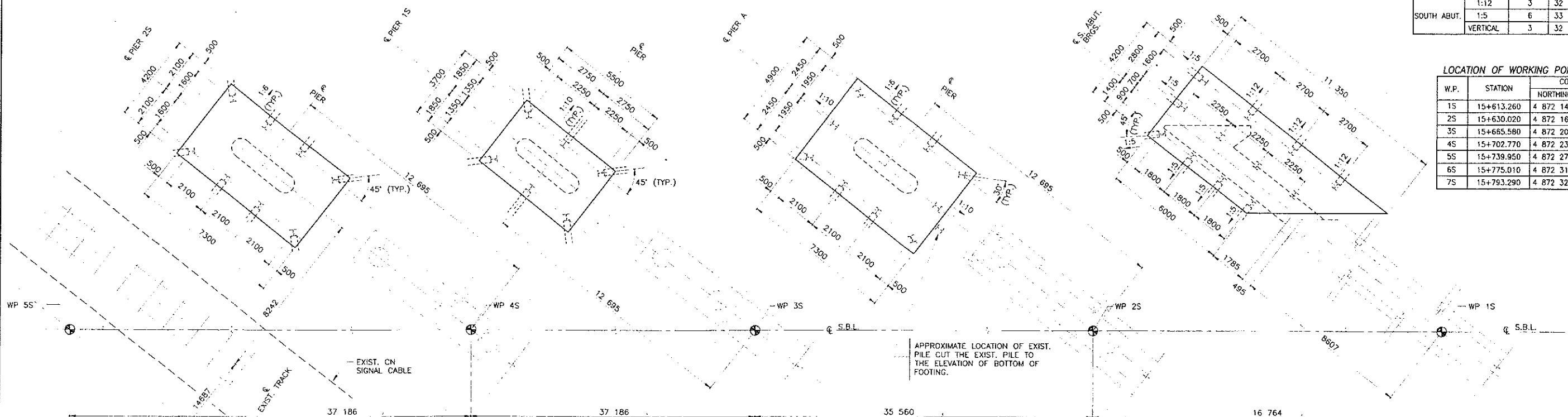
LIST OF PILES				
LOCATION	BATTER	NUMBER REQUIRED	LENGTH (mm)	EST. PILE TIP ELEVATION (m)
NORTH ABUT.	1:4	10	22 200	286.0±
	1:12	3	21 600	
PIER 4S	1:6	8	18 600	286.0±
PIER 3S	1:10	6	19 100	283.0±
PIER 2S	1:6	8	27 200	275.5±
PIER 1S	1:10	6	25 900	278.0±
PIER A	1:6	8	30 400	277.5±
	1:10	2	30 200	
	1:12	3	32 700	
SOUTH ABUT.	1:5	6	33 200	279.0±
	VERTICAL	3	32 600	

LOCATION OF WORKING POINTS

W.P.	STATION	CO-ORDINATE	
		NORTHING	EASTING
1S	15+613.260	4 872 149.284	313 145.966
2S	15+630.020	4 872 165.959	313 144.286
3S	15+665.580	4 872 201.340	313 140.722
4S	15+702.770	4 872 238.343	313 136.994
5S	15+739.950	4 872 275.336	313 133.268
6S	15+775.010	4 872 310.219	313 129.753
7S	15+793.290	4 872 328.407	313 127.921

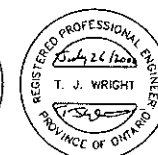


PLAN
1:100



PLAN
1:100

APPROXIMATE LOCATION OF EXIST.
PILE CUT THE EXIST. PILE TO
THE ELEVATION OF BOTTOM OF
FOOTING.



APPLICABLE STANDARD DRAWINGS:

OPSD-3301.00 SPLICE AND DRIVING SHOES
DETAILS FOR STEEL H-PILES

REVISIONS	DATE	BY	CHK	T.W. CODE	OHBC-91	LOAD	DATE	JULY 2000
DESIGN H.L.			CHK	H.L.	SITE	37-7005	STRUCT	SCHEME
DRAWN T.L.			CHK	H.L.	SITE	37-7005	STRUCT	DWG 7

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING



PRELIMINARY FOUNDATION DESIGN REPORT

for

**CNR OVERHEADS NBL AND SBL STRUCTURE WIDENINGS
HIGHWAY 404 HOV LANE EXPANSION
FROM HIGHWAY 407 TO GREEN LANE (26 KM)
WO 03-20024
REGIONAL MUNICIPALITY OF YORK, ONTARIO**

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

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Geocres No.: 30M14-419
June 1, 2015



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PART B
PRELIMINARY FOUNDATION DESIGN REPORT
for
CNR Overheads NBL and SBL Structure Widening
Highway 404 HOV Lane Expansion
From Highway 407 to Green Lane (26 km)
GWP 03-20024,
Regional Municipality of York, Ontario

6. PRELIMINARY ENGINEERING RECOMMENDATIONS

Part B of this report provides preliminary foundation design recommendations for the proposed widening of the existing the CNR NBL and SBL Overheads associated with the proposed widening of Highway 404 in the Regional Municipality of York. The recommendations are intended for preliminary design and planning purposes only and are based on subsurface and groundwater conditions from existing contract documents as outlined in the Part A of this report. Further foundation engineering services will be required to provide detail design level recommendations.

It is expected that the existing highway platform will be widened throughout the project length and will require the widening of the existing CNR Overheads. It is understood that the widening will be achieved by adding one HOV lane in each direction of the Highway 404 NBL and SBL lanes in the existing median.

7. BACKGROUND

The original bridges were constructed under Contract 82-74. Refer to Part A, Appendix A, Reference 1b for the General Arrangement drawing for this contract and additional contract sheets illustrating the design span geometries of the bridges. The NBL structure consists of 4 spans – approximately 35.1 m, 37.2 m, 37.2m, 35.1 m from north to south. The SBL structure originally consisted of 5 spans – approximately 18.3 m, 35.1 m, 37.2 m, 37.2 m, 35.1 m from north to south. During the original construction, a slope failure at the south approach embankment of the SBL bridge resulted in a redesign of the SBL bridge to 6 spans – approximately 18.3m, 35.1 m, 37.2 m, 37.2 m, 35.6 m, 16.8 m from north to south. In addition, surficial slope instabilities resulting from entrapment of water within the core of the embankment fills at the south approaches resulted in the installation of 22 granular embankment drains under WO 86-11006 at the locations illustrated in Appendix A, Reference 2, Figure 15 of the Foundation Investigation Report. Both bridges were



widened towards the median under Contract 2000-016 under Contract 2000-0106 with geometry and foundation details as illustrated in Appendix A, Reference 3.

For illustration purposes only, the level of the CNR tracks is approximately at elevation 305.0, the grade of the road surface at the south abutments is approximately at elevation 315 and the grade of the road surfaces at the north abutments is approximately at elevation 318. Actual elevations for the site, the CNR tracks and the bridges should be determined from appropriate construction drawings or surveys for detail design purposes.

8. FOUNDATION OPTIONS

The following table summarizes the foundation types considered, their advantages and disadvantages as well as relative cost and risks/consequences.

FOUNDATION TYPE	ADVANTAGES	DISADVANTAGES	RELATIVE COST	RISKS/CONSEQUENCES
Spread Footings (placed on granular pads or on existing embankment fill)	Ease of installation. No vibration concerns from pile driving.	Differential settlements between the existing and proposed structures. Increased loading at top of embankment.	Low	Differential settlements would be longitudinal to direction of travelled lanes could pose safety issues. Additional loading at top of embankment could destabilize forward approach slopes.
Driven H-Piles	Driven H-piles cause small soil displacement and less risk to disturbing existing foundations. Same type of foundation used for original bridge and for previous widening.	Vibration induced during pile driving. Potential interference with existing piles. Possible presence of cobbles and boulders in the glacial till soils.	Moderate	Disturbance to existing foundations through physical contact with existing piles during driving of new piles could cause settlement of existing structure. Pile driving induced vibrations could cause disturbance to ground supporting existing piles and subsequent settlement of existing structure.



FOUNDATION TYPE	ADVANTAGES	DISADVANTAGES	RELATIVE COST	RISKS/CONSEQUENCES
Caissons	Larger bearing capacity than other options.	Challenging installation due to the presence of noncohesive soil and high groundwater table, which could require liners, mud drilling techniques and tremie concreting methods. Construction difficulties due to possible presence of cobbles and boulders in the glacial till soils.	High	Loss of ground during installation could cause settlement of existing foundations. Flowing soils under along shaft and base could cause necking of concrete in caisson and subsequent reduction in resistance of caisson foundation.

A foundation system consisting of steel H-piles driven to practical is the recommended foundation type for the widenings. This foundation option is consistent with the foundations for the original bridges and the previous bridge widenings.

9. PILE FOUNDATIONS

Details of pile cap elevations and pile cut-off elevations should be determined from appropriate contract documents. It is anticipated that the base of the new pile caps will match the elevations of the associated existing pile caps at respective widening locations.

Recommendations for pile driving should be determined during detail design. It is anticipated that the steel H-Piles will be driven to practical refusal on typically hard clayey silt glacial till requiring pile lengths in the order of 30 m at abutment widenings and in the order of 20 to 25 m at pier widenings.

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

PILE SECTION	FACTORED AXIAL RESISTANCE AT ULS (KN)	AXIAL REACTION AT SLS (KN)
HP 310 x 79	1300	1000
HP 310 x 110	1800	1400



The values for axial resistance at SLS assume settlements of less than 25 mm for the pile/ground system.

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

Fully braced shoring system and vibration monitoring would be required for excavation near the CNR tracks. These aspects would have to be developed during the detail design.

Construction of the piles should conform to OPSS 903. It is anticipated that the H-piles would have to be equipped with driving shoes and pile installation would be in accordance with OPSS 903.

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

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

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

10. ABUTMENTS AND RETAINING WALLS

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



11. EMBANKMENTS

Due to the history of approach embankment instabilities at this site, the scope of foundations engineering services for detail design should include investigation, analysis and recommendations to provide stable slopes both during and after construction. These recommendations should consider geometries of construction working zones and final embankment slopes as well as embankment and construction loading during and after construction operations.

Recommendations for management of differential settlement between the existing Highway 404 lanes and the new widenings should be provided in detail design. It is anticipated that preloading may be required under the plan limits of the widenings within 20 m of the abutments and that new fills should be benched into the existing embankments per MTO standards.

Consideration should be given to requiring fills for approach embankment widenings as well as for fills placed below grade to deal with unsuitable/compressible soils to be composed of granular material such as Granular A or Granular B Type II in order to optimize time rate of fill settlement and to manage settlement performance in the wet respectively.

12. CONSTRUCTION CONSIDERATIONS

12.1 Excavation

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

12.2 Roadway Protection

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



12.3 Groundwater Control

Based on previous investigations, the water levels measured in the open boreholes were well below the ground surface at the abutment locations and near the ground surface at the pier locations.

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

13. SCOPE OF ADDITIONAL FOUNDATION INVESTIGATION

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

- One shallow borehole between the proposed abutment widenings at each of the north and south approach embankments to provide recommendations for widenings of the abutment foundations
- Two boreholes at each of the north and south approach embankment forward slopes to assess and provide recommendations for slope stability both during and after construction
- One to two shallow boreholes between proposed NBL and SBL pier widenings to assess the extent of compressible material within the extent of the pile cap widenings and to determine shoring and dewatering requirements
- One shallow borehole within the 20 m of abutments at both the north and south approach embankments to determine requirements to manage differential settlements
- Evaluations of the settlement performance and condition of the existing foundations and the stability of the embankments would be required during the detail design phase of the project.



14. CLOSURE

The Preliminary Foundation Design portion of this report was prepared by Mr. N. Rahman, P.Eng., and reviewed by Mr. D. Dundas, P.Eng. The report was independently reviewed by Mr. Carlos M.P. Nascimento, P.Eng., MTO Designated Principal Contact.

Yours very truly,

Peto MacCallum Ltd.



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



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



Carlos M.P. Nascimento, P.Eng.
MTO Designated Principal Contact

NR/DD/CN:j-k-nk