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DIST. 6 REGION

W.P. No. 145-87-00

CONT. No.

W. O. No.

STR. SITE No. 37-1394

HWY. No. 407

LOCATION FLOW SPLITTER NEAR
WEST DON RIVER BRIDGE

No. of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 145-87-02/03

DIST 6

HWY 407

STR SITE 37-1394

Highway 407 West Don River WB and EB Bridges

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FOUNDATION INVESTIGATION REPORT

For

Highway 407 West Don River WB and EB Bridges

W.P. 145-87-02/03 (WB/EB), Site No. 37-1394

Highway 407, District 6, Toronto

INTRODUCTION

This report summarizes the foundation investigation conducted for the above-noted new bridges for Highway 407. The report is applicable to the proposed structure and the approaches within 20 m of the abutments. The investigation was carried out at the request of Central Region Structural Section.

SITE DESCRIPTION

The site is located at the West Don River Valley, about 400 m south of Highway 7 N in the Township of Vaughan, District of Toronto. At present, the valley consists of a generally straight-flowing river and adjacent flood plains. In the vicinity of Highway 407, the valley floor of the West Don River is about 6 m wide.

The West Don River flows in a north-south direction through the site. The slope gradient of the valley varies from 5H:1V to 4H:1V. The flood plain of the river in the vicinity of the structure extends out 90± m to the east and 20± m to the west where it abuts a 3H:1V natural slope. The area is generally grassed with sparsely spaced trees. The river bed is composed largely of gravel and sand, but also contains cobbles and occasional boulders.

The site lies within the physiographic region known as South Slope (Chapman and Putnam, 1984) and it consists largely of glacial till deposits.

INVESTIGATION PROCEDURES

Field

The field investigation was conducted between 91 04 29 and 91 05 06 and consisted of eight (8) sampled boreholes taken down to 12.5-30.9 m depths. A continuous flight track mounted auger machine equipped with 82 mm I.D. hollow stem augers and 'N' size casings was used to advance the boreholes.

The sampling program consisted of split spoon samples collected at regular intervals. They provided Standard Penetration Test (N) values for assessment of the compaction of the non-cohesive materials. These samples also provide material for identification and laboratory testing purposes. Dynamic Cone Penetration test was also carried out on all the boreholes to determine the strength of the material.

Groundwater level was measured in the open boreholes and in the two (2) piezometers installed in BH 2 and BH 3.

The elevations and co-ordinates of the boreholes were provided by MTO Central Region Surveys and Plans Office.

Laboratory

The laboratory testing program for representative samples consisted of:

- Natural Moisture Content
- Atterberg Limits
- Grain Size Distribution

The results of the laboratory testing are plotted on the Record of Borehole sheets and are also summarized in Figures 1 through 5.

SUBSURFACE CONDITION

General

The Record of Borehole sheets in the Appendix illustrates the subsurface conditions at the borehole locations. The locations and elevations of the boreholes, along with stratigraphical profiles based on the borehole data are shown on Drawing No. 145870203-A.

The subsurface conditions across the flood plain are composed of a combination of water-laid and glacial deposits. The overburden extends below elevation 155.4 m and was not penetrated in the boreholes augered.

A surficial layer of silty sand was contacted in all boreholes except BH 6 which was located at the top of a slope. The thickness of the material is 1.5 to 3.0 m and it extends to elevation $184\pm$ m. Underlying this non-cohesive layer is a cohesive glacial till deposit (Clayey Silt). The thickness of this stratum is about 7 to 12 m and it typically extends to elevation $175\pm$ m. Below the glacial till stratum is a layer of silty clay. This layer was penetrated in BH 2 and BH 3 at $159\pm$ m, and extends 16 to 18 m in thickness. Underlying the silty clay stratum is a layer of silt. The material was not penetrated at the terminal depths of the two deep boreholes BH 2 and BH 3 at $155\pm$ m.

Silty Sand

This non-cohesive material is encountered in all boreholes except BH 6. The material has been described as a silty fine to coarse sand with trace of gravel and clay, and occasional inclusions of organics and woodchips. The 'N' values obtained from field testing range 3 to 22 indicating that the material is in a loose to compact state.

Figure 1 illustrates a typical grain size distribution for this material.

Clayey Silt (Glacial Till)

This cohesive material has been described as clayey silt, some sand, trace gravel. It contains some silt zones and occasional cobbles and boulders.

Based on the results of Standard Penetration Tests ($N=6$ to over 100), the material is in a firm to hard state, but typically hard below elevation $182\pm$ m.

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

	<u>Range</u>	<u>Average</u>
Water Content (%)	8.5-26.5	15.7
Liquid Limit (%)	15.0-44.0	24.8
Plastic Limit (%)	11.0-18.0	14.4

Figure 2 illustrates a typical plasticity envelope for this material, based on representative samples from the entire site.

Figure 3 illustrates a typical grain size distribution for this material based on representative samples from the entire site.

Silty Clay

The silty clay deposit has been described as silty clay, trace sand, with occasional silt zones. The thickness of this deposit was fully explored in BH 2 and BH 3 and was found to be 15.8 to 17.7 m.

Based on 'N' values ranging from 21 to over 100, the consistency of this deposit ranges from very stiff to hard, but is generally hard.

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

	<u>Range</u>	<u>Average</u>
Water Content (%)	15.5-27.5	21.2
Liquid Limit (%)	23.0-46.0	32.9
Plastic Limit (%)	15.0-20.0	17.3

Figure 4 illustrates a typical plasticity envelope for this material based on representative samples from the entire site.

Silt

This non-cohesive material has been described as silt, trace sand, trace clay. It was contacted in the two deep boreholes BH 2 and BH 3 at 159± m. Its thickness was not determined. The material is in a very dense state with 'N' values in excess of 100.

Figure 5 illustrates a typical grain size distribution for this material, based on representative samples from the entire site.

GROUNDWATER

The groundwater level was measured in open boreholes and also in piezometers installed at BH 2 and BH 3. The perched groundwater table was found to be close to the existing ground surface, typically between 184 and 185 m. The groundwater level at BH 6 was measured to be at $187.5 \pm$ m. The base groundwater table determined by the piezometers installed at BH 2 and BH 3 was at elevation $177 \pm$ m. The elevation of the creek was at $183.4 \pm$ m during the time of the investigation. Seasonal variations are expected.

DISCUSSION AND RECOMMENDATIONS

DISCUSSION

The recommendations in this report apply to the structure and the approaches within 20 m of the abutments.

The project comprises construction of two bridge structures across the West Don River to support the westbound and eastbound lanes of the proposed Highway 407. The elevation of the Highway will be at about 192 m, some 9 m above the river bed. The abutments on both sides of the river will be constructed as closed end structures with both ends extended longitudinally to the road to retain backfill materials.

RECOMMENDATION

Foundation

Due to the existence of competent materials at relatively shallow depths as revealed by the site investigation, it is recommended to support the proposed bridge structure on shallow foundations such as conventional footings. Recommendation on deep foundation is also given below as an alternative in the event that Reinforced Earth false abutments are designed.

Shallow Foundation:

For footings founded on competent clayey silt, the bearing capacities as per the O.H.B.D.C., are as follows:

Factored Bearing Capacity at U.L.S. = 600 kPa

Bearing Capacity at S.L.S. Type II = 400 kPa

For design purpose, the estimated founding elevations are given in Table 1 assuming foundation elevations must be below elevation 184 m for structure geometry purposes.

Table 1

	<u>Estimated Founding Elevation (m)</u>
<u>WB Structure</u>	
West Abutment	182.0
East Abutment	183.0
<u>EB Structure</u>	
West Abutment	182.0
East Abutment	182.5
<u>Median Retaining Structure</u>	
West Side	182.0
East Side	183.0

The depth of excavation will be up to 4 m. Temporary slopes should be maintained at 1.5H:1V or flatter.

Sliding resistance between concrete and foundation soil should be calculated in accordance with the O.H.B.D.C. assuming an unfactored ϕ value of 28 degrees.

Deep Foundation

If Reinforced Earth false abutments are considered, the Foundation Design Section should be contacted for recommendations pertaining to the design. Deep foundations in the form of H-piles can be used to support the structures. Piles driven to the very dense silt layer at about 159 m elevation, and then controlled by the Hiley Formula, would be capable of supporting the structures with minimal settlements. For preliminary planning purposes, it may be estimated that the piles would penetrate to elevation 156 m.

For design purposes, the following values according to the O.H.B.D.C. are recommended.

Table 2

<u>Pile Type</u>	<u>Factored Capacity</u>	<u>Capacity at S.L.S.</u>	<u>Lateral Resistance</u>	
	<u>at U.L.S.</u>	<u>Type II</u>	<u>U.L.S.</u>	<u>S.L.S. Type II</u>
HP310x79	1150 kN/pile	825 kN/pile	60 kN/pile	40 kN/pile
HP310x110	1600 kN/pile	1150 kN/pile	80 kN/pile	60 kN/pile

Pile driving should be controlled by the Hiley Formula as per MTO Standards SS103-10 or SS103-11, assuming ultimate capacities as indicated below.

Ultimate Capacities for Hiley Formula

<u>HP310x79</u>	<u>HP310x110</u>
2460 kN/pile	3450 kN/pile

Due to the existence of a competent intermediate layer across the site, there is a possibility that piles could develop the required capacity at higher elevations (approximately 174 m). This hard layer may also serve as an end bearing stratum for caisson foundations. Specific recommendations on this will be addressed if required. This office should be contacted for details.

The field investigation has revealed layers of boulders and cobbles in the glacial till stratum. Provisions should be made in the contract document to take into account possible obstructions during pile driving. Piles should be equipped with reinforced pile tips. If piles are driven through new fill, the grain size of the fill should be less than 75 mm under the pile locations.

Temporary slopes for the construction of pile caps should be maintained at a gradient of 1.5H:1V or flatter.

Dewatering

Since the perched groundwater table is close to the existing ground surface, dewatering is required to allow backfilling and placement of concrete footings or pile caps to be carried out in the dry. Construction has to be carried out

in stages with the river temporarily diverted prior to excavation. This can be done by a detour alignment or by pumping water through pipes in conjunction with an impermeable dyke to block of the river. Dewatering for footing or pile cap construction can be achieved by carrying out oversized excavation with perimeter drains as shown in Figure 6.

Frost Protection

The footings and pile caps should have a minimum earth cover of 1.2 m for frost protection.

Backfill

Backfill to abutments and retaining walls should consist of granular material in accordance with MTO Standard Special Provision No. 121 (83 10). Computation of earth pressures should be in accordance with Section 6.6.1.2 of the O.H.B.D.C. For design purposes, the following properties for backfill are recommended.

<u>Material</u>	<u>ϕ</u>	<u>γ</u>	<u>K_o</u>	<u>K_a</u>
Granular 'A'	35°	22.8 kN/m ³	0.43	0.27
Granular 'B'	30°	21.2 kN/m ³	0.50	0.33

Abutment Slopes

Maximum height of the slopes is about 6.5 m. The slopes may be safely constructed with compacted granular fill to a gradient of 2H:1V. The slope toe should be provided with 0.6 m thick rock protection extending up to the high water mark, and down to cover at least 2 m of the river bed. Since the abutment is situated in a causeway, it is necessary to extend the rock armouring all around it to protect the bridge. It is recommended that any additional requirements of the MTO Hydrology Section should be incorporated into the design.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of D. Kwok, Project Foundation Engineer using the drilling equipment owned and operated by Master Soil Investigation Ltd. The report was prepared by D. Kwok under the general supervision of Mr. D. Dundas, Senior Foundation Engineer. The report was reviewed by Mr. D. Dundas and approved by Mr. M. Devata, Chief Foundation Engineer.



A handwritten signature in black ink, appearing to read 'D. Kwok', written over a horizontal line.

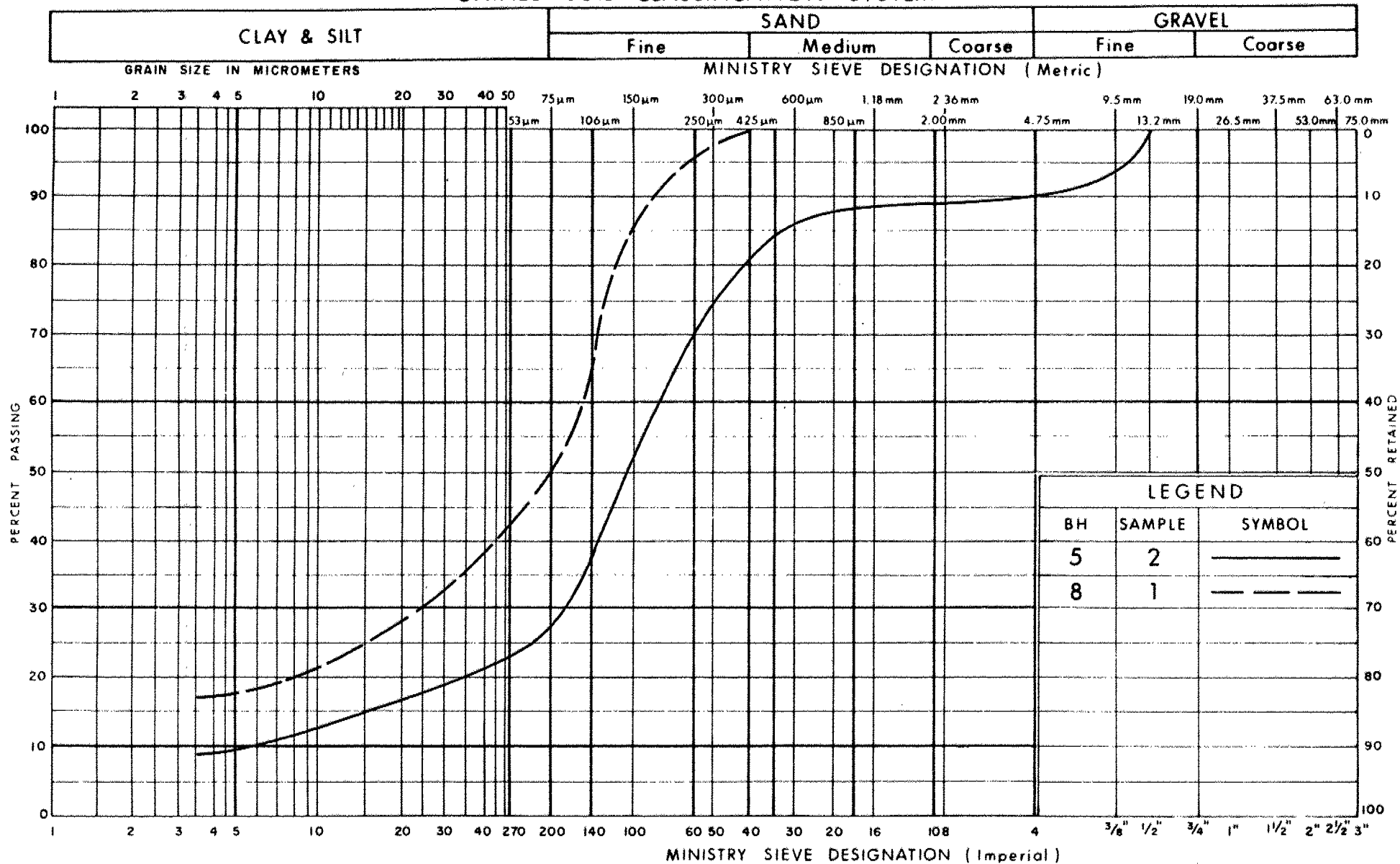
D. Kwok, P.Eng.
Project Foundation Engineer

A handwritten signature in black ink, appearing to read 'M. Devata', written over a horizontal line.

M. Devata, P.Eng.
Chief Foundation Engineer

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM

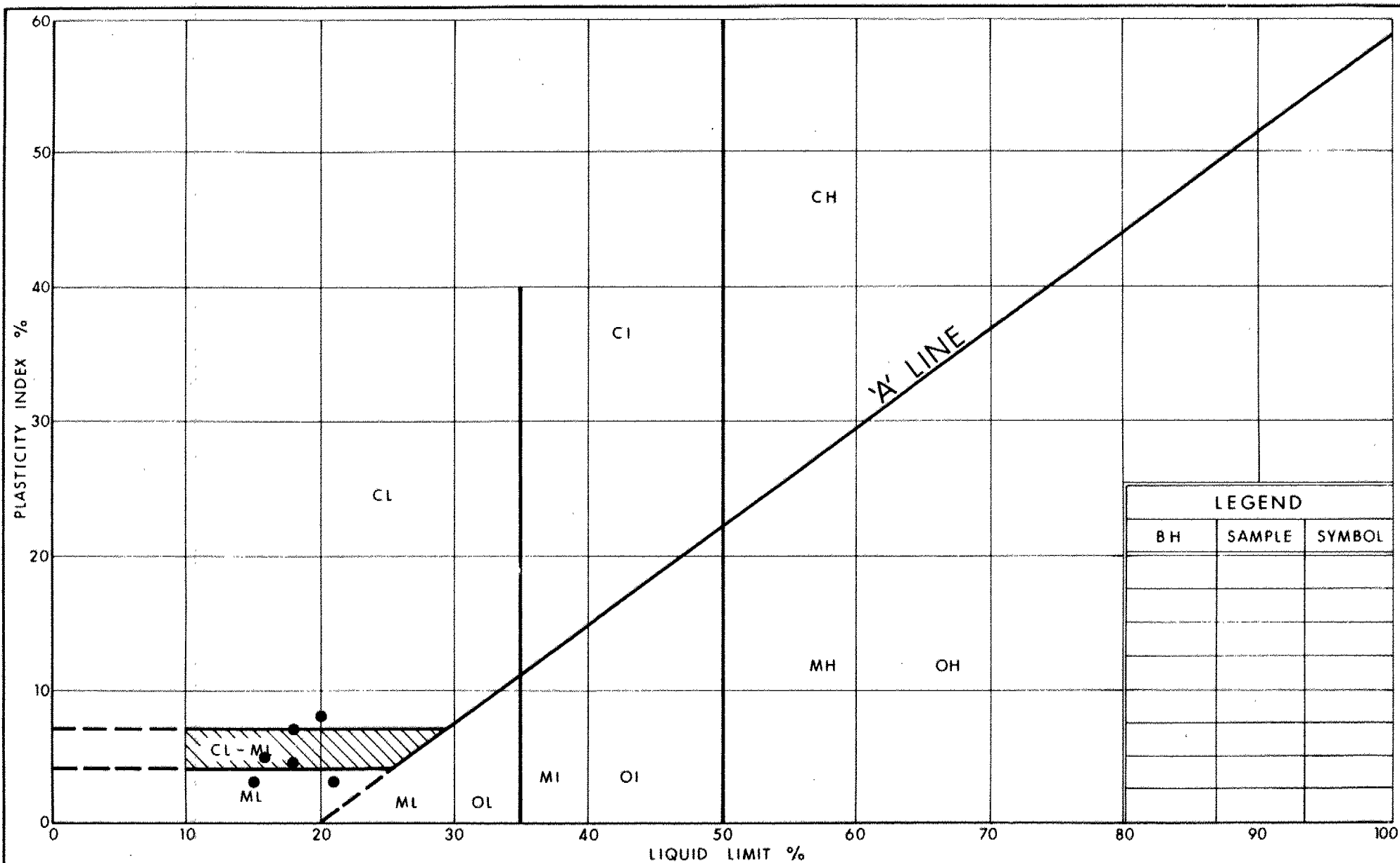


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SILTY SAND
TRACE GRAVEL

FIG No 1

W P 145-87-02/03



Ministry of
Transportation

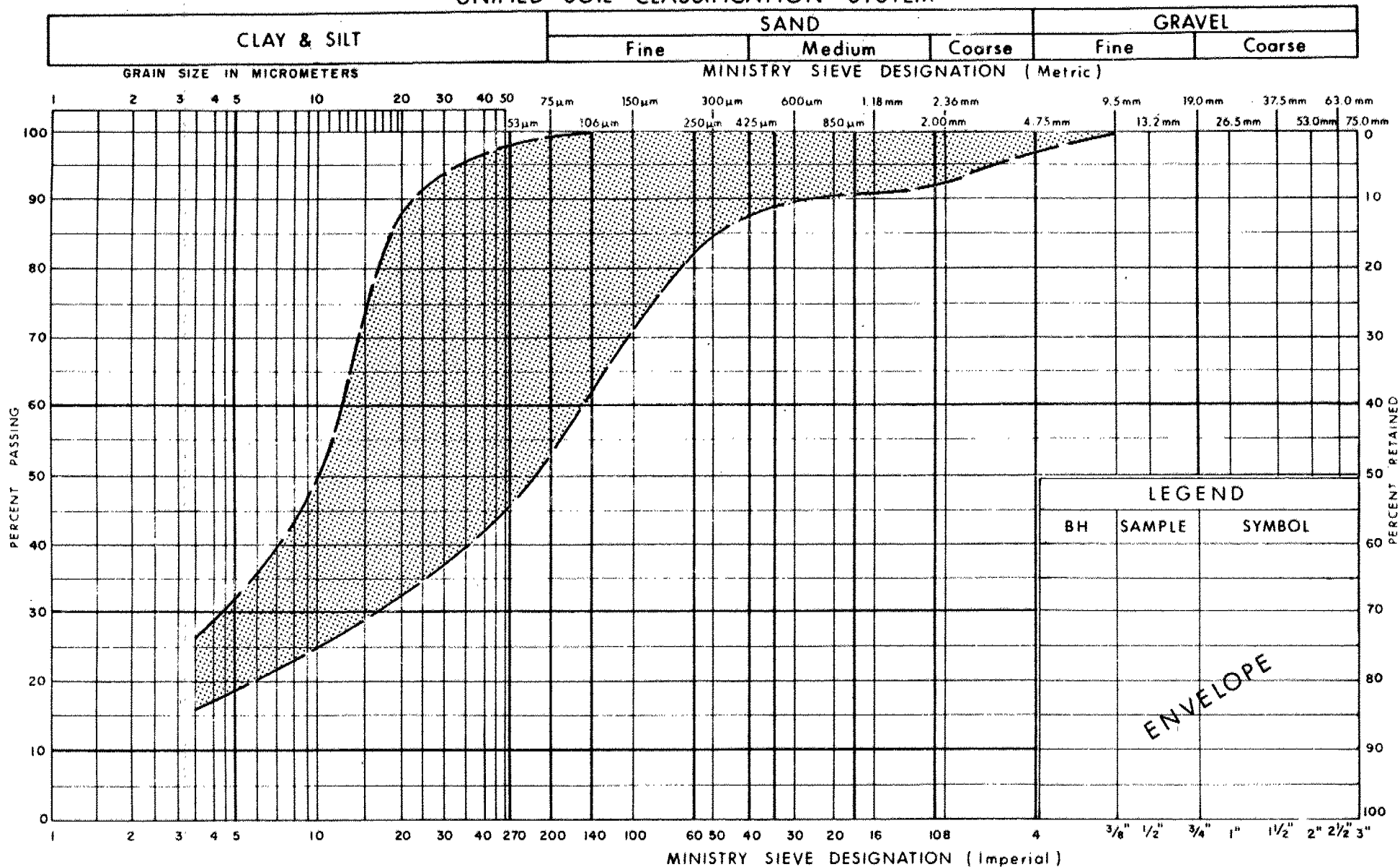
Ontario

PLASTICITY CHART
CLAYEY SILT (Glacial Till)
TRACE SAND & GRAVEL, OCC COBBLES & BOULDERS

FIG No 2

W P 145-87-02/03

UNIFIED SOIL CLASSIFICATION SYSTEM



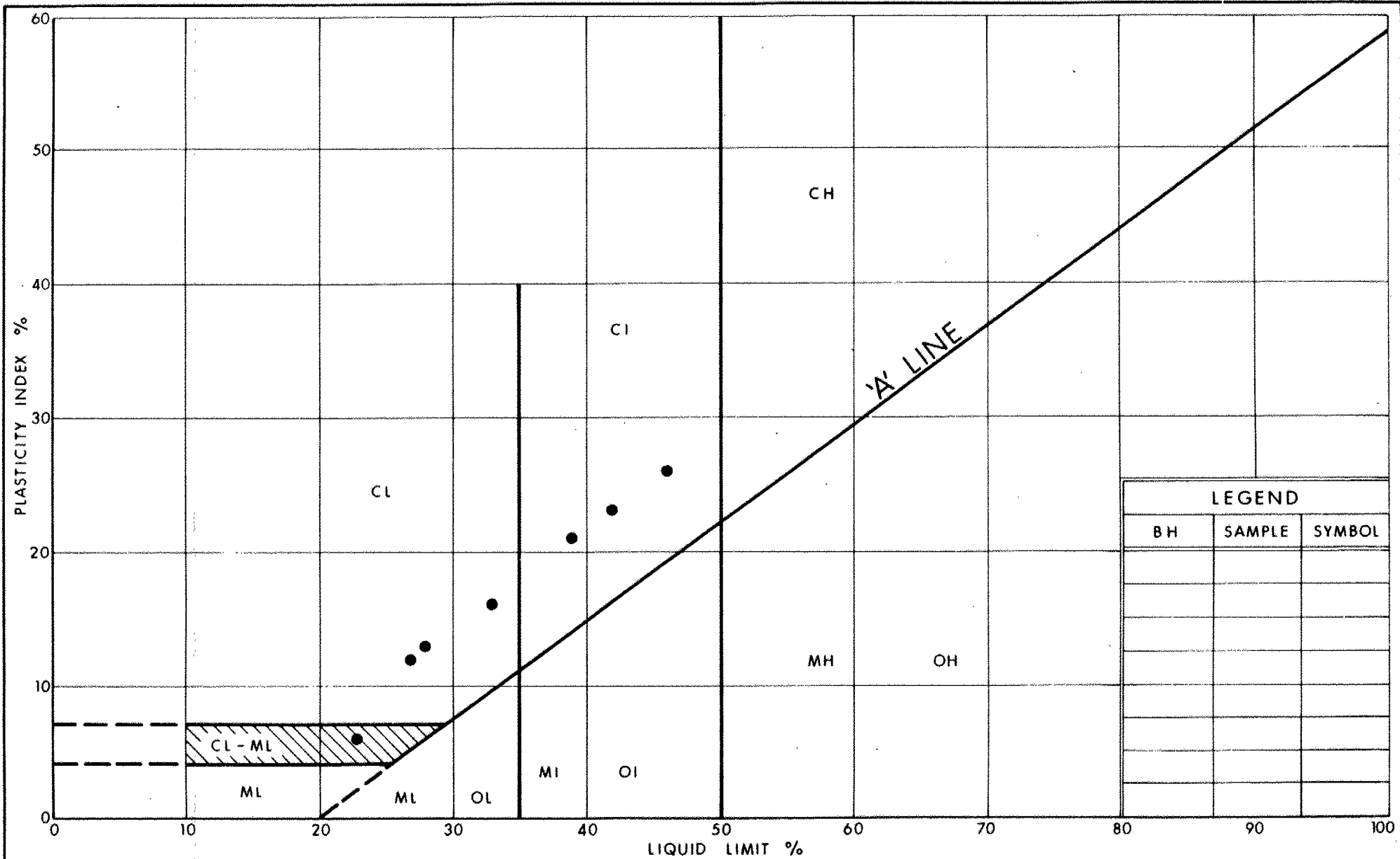
Ontario

Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
CLAYEY SILT (Glacial Till)
TRACE SAND & GRAVEL, OCC COBBLES & BOULDERS

FIG No 3

W P 145-87-02/03



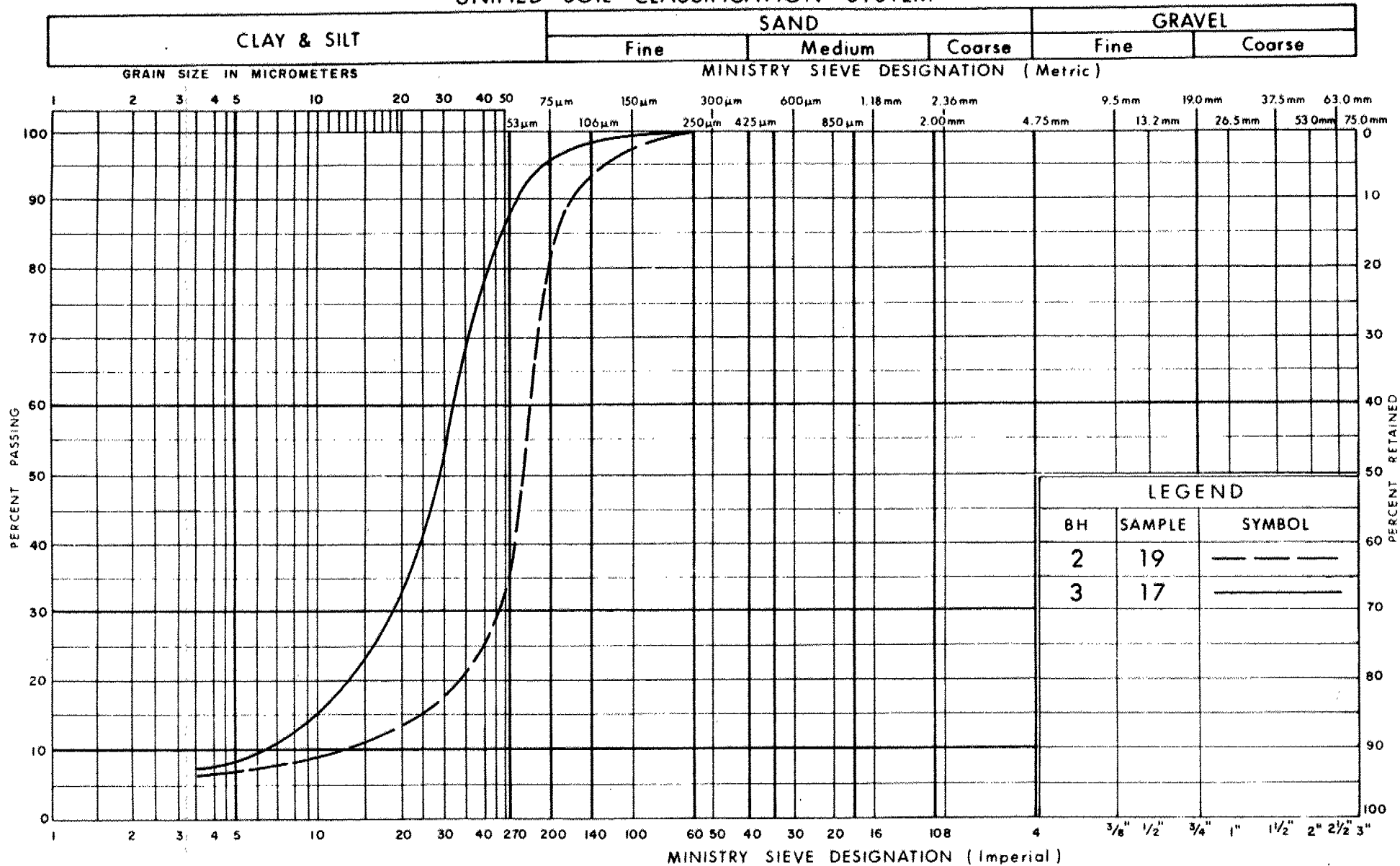
Ministry of
Transportation

PLASTICITY CHART SILTY CLAY TRACE SAND

FIG No 4

W P 145-87-02/03

UNIFIED SOIL CLASSIFICATION SYSTEM

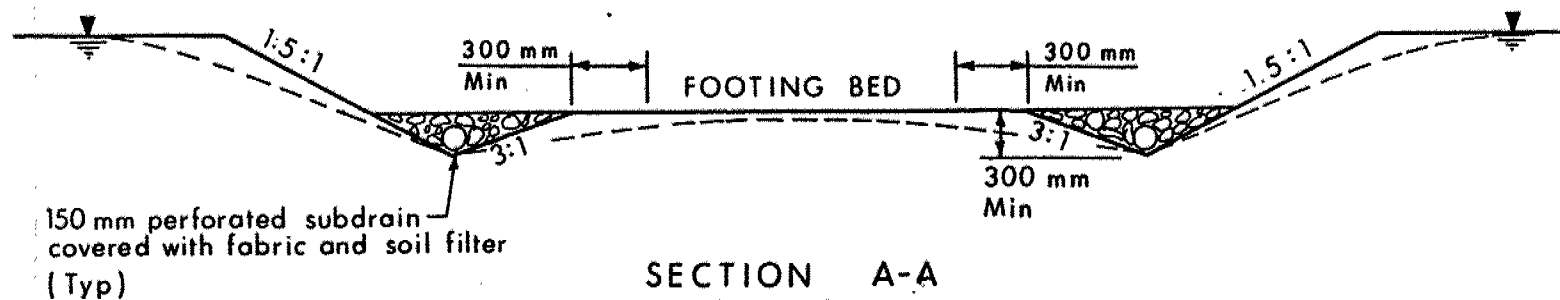
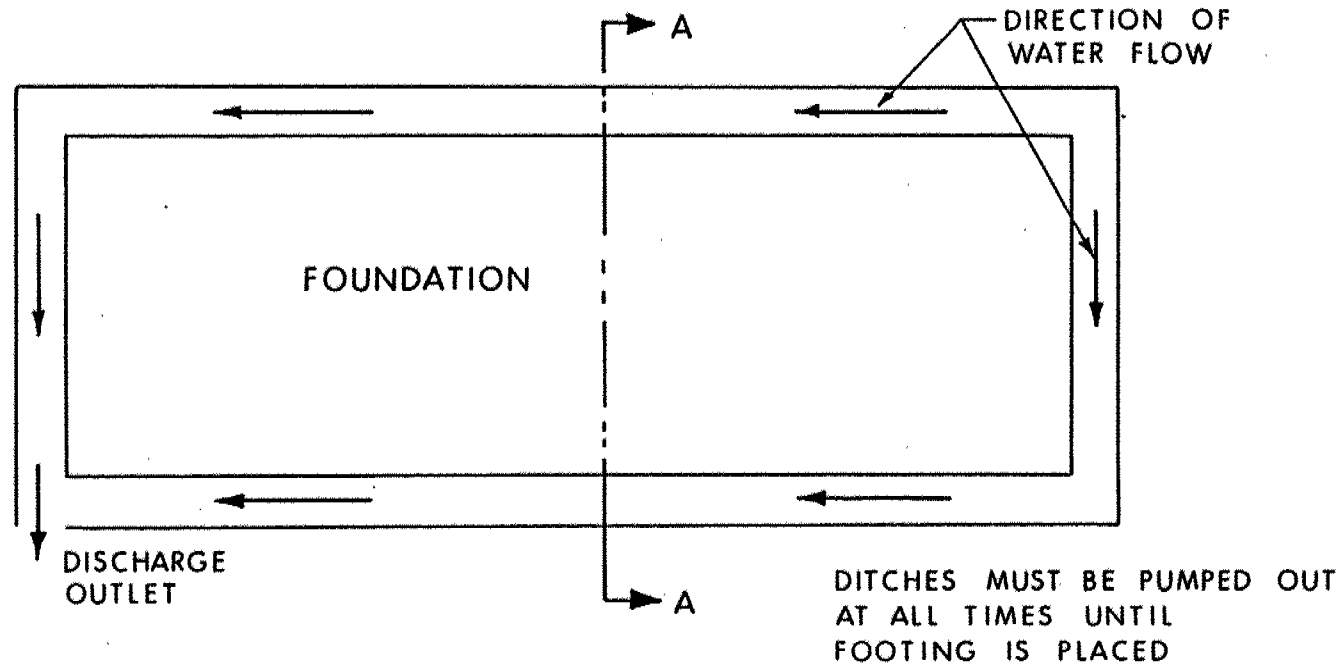


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SILT
SOME SAND, TRACE CLAY

FIG No 5

W P 145-87-02/03



SECTION A-A
(NTS)

DEWATERING SCHEME - PERIMETER DITCHES

RECORD OF BOREHOLE No 1

1 OF 1 METRIC

W.P. 145-87-02/03 LOCATION N 4 850 878.5 E 308 101.5 ORIGINATED BY DK
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger, Cone COMPILED BY DK
 DATUM Geodetic DATE 91 04 29 CHECKED BY DD

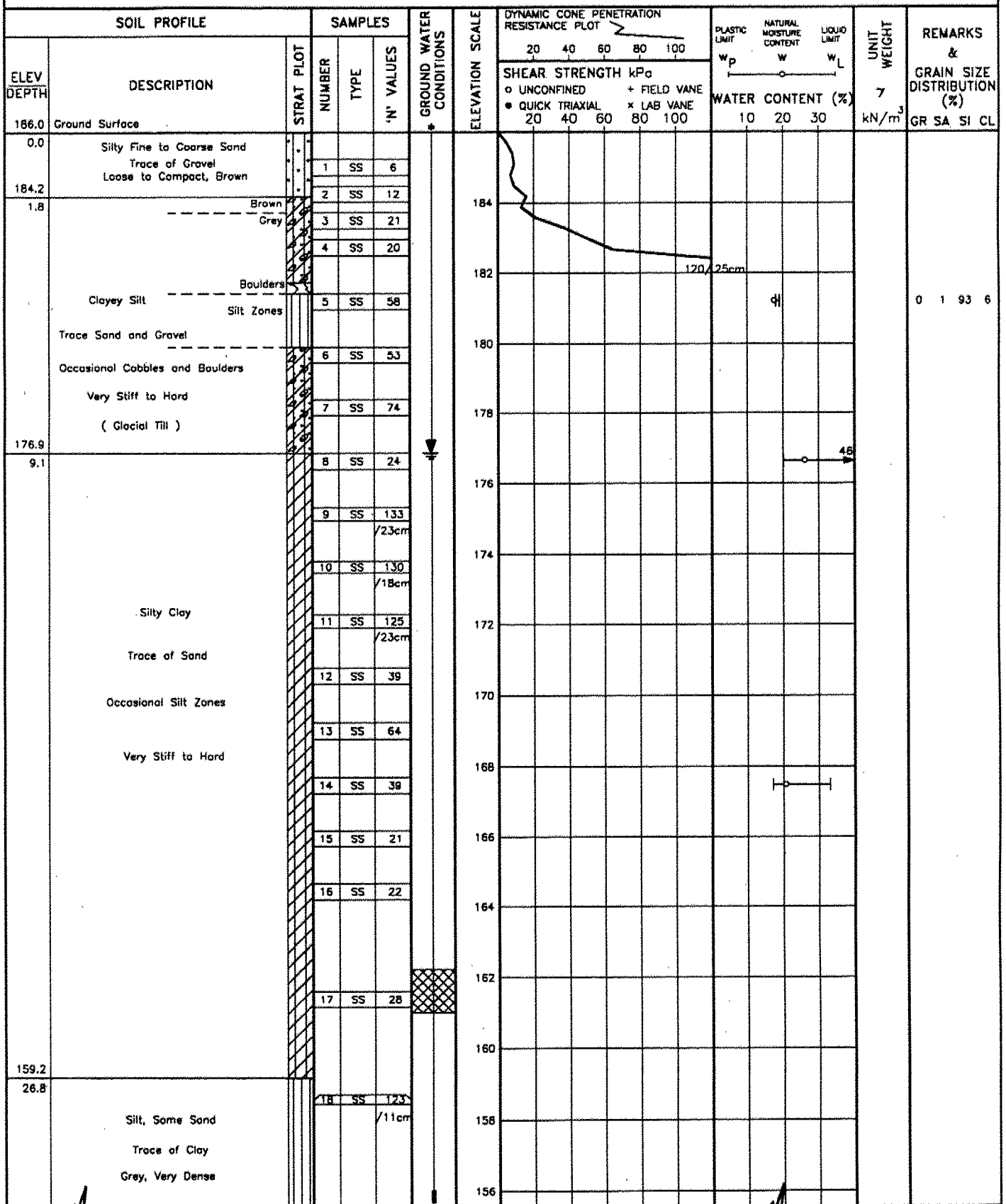
SOIL PROFILE			SAMPLES			GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
185.9	Ground Surface													
0.0	Silty Sand, Trace of Gravel Loose, Brown		1	SS	7									
184.4			2	SS	6									
1.5	Cloyey Silt		3	SS	12									
	Trace of Gravel		4	SS	30									
	Some Sand		5	SS	60									
	Frequent Silt Zones		6	SS	64									
	Occasional Cobbles and Boulders		7	SS	100									
	Grey, Firm to Hard		8	SS	77									
	(Glacial Till)		9	SS	98									
175.2			10	SS	88									
10.7	Silty Clay, Trace Sand													
173.2	Grey, Hard													
12.6	End of Borehole													

RECORD OF BOREHOLE No 2

1 OF 2

METRIC

W.P. 145-87-02/03 LOCATION N 4 850 854.0 E 308 121.5 ORIGINATED BY DK
DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger, Cone, Tricone COMPILED BY DK
DATUM Geodetic DATE 91 04 30 CHECKED BY DD



Continued

+3, x3: Numbers refer to
Sensitivity

20
15-5 (% STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 2

2 OF 2 METRIC

W.P. 145-87-02/03 LOCATION N 4 850 854.0 E 306 121.5 ORIGINATED BY DK
 DIST 8 HWY 407 BOREHOLE TYPE Hollow Stem Auger, Cons. Tricone COMPILED BY DK
 DATUM Geodetic DATE 91 04 30 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80	100	W _p	W			W _L				
30.5	End of Borehole		10	SS	1.32	15 cm															
91 05 02 * GROUND WATER CONDITIONS <table border="1"> <tr> <th>PIEZO. NO.</th> <th>GROUND WATER ELEVATION (Metres)</th> </tr> <tr> <td>1</td> <td>176.86</td> </tr> </table>		PIEZO. NO.	GROUND WATER ELEVATION (Metres)	1	176.86																
		PIEZO. NO.	GROUND WATER ELEVATION (Metres)																		
		1	176.86																		

RECORD OF BOREHOLE No 3

1 OF 2 METRIC

W.P. 145-87-02/03 LOCATION N 4 850 930.0 E 308 104.0 ORIGINATED BY DK
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger, Cone COMPILED BY DK
 DATUM Geodetic DATE 91 05 02 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC UNIT W _p	NATURAL MOISTURE CONTENT W	LIQUID UNIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			20 40 60 80 100	20 40 60 80 100					
186.3	Ground Surface													
0.0	Silty Sand, Trace of Gravel Scattered Woodchips and Organics, Brown, Compact		1	SS	12		186							
184.0			2	SS	22		184							
2.3	occasional wet sand seams		3	SS	21									
			4	SS	52									
	Clayey Silt		5	SS	35		182							
	Trace of Sand and Gravel		6	SS	82		180							
	Occasional Cobbles and Boulders		7	SS	90		178							
	Grey, Very Stiff to Hard (Glacial Till)		8	SS	97		176							
175.6			9	SS	40		174							
10.7			10	SS	67		172							
	Silty Clay		11	SS	94		170							
	Trace of Sand		12	SS	50		168							
	Occasional Silt Zones		13	SS	38		166							
	Grey, Hard		14	SS	23		164							
	becoming very stiff		15	SS	22		162							
159.8			16	SS	120		160							
26.5	Silt, Trace of Fine Sand and Clay Grey, Very Dense				/18cm		158							

Continued

+3, x²: Numbers refer to
Sensitivity

20
15-0-5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 3

2 OF 2

METRIC

W.P. 145-87-02/03 LOCATION N 4 850 930.0 E 306 104.0 ORIGINATED BY DK
DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger, Cone COMPILED BY DK
DATUM Geodetic DATE 91 05 02 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80	100	W _p	W		
155.4	Continued		17	SS	127											
30.9	End of Borehole				23cm											
91 05 06 * GROUND WATER CONDITIONS																
PIEZO. NO.		GROUND WATER ELEVATION (Metres)														
1		176.61														

RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 145-87-02/03 LOCATION N 4 850 910.5 E 308 122.0 ORIGINATED BY DK
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger, Cone COMPILED BY DK
 DATUM Geodetic DATE 91 05 03 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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
186.2	Ground Surface						186							
0.0	Silty Sand, Trace of Gravel Occasional Woodchips Brown and Grey Loose to Compact		1	SS	10		184							
183.9			2	SS	6									
2.3	Clayey Silt Some Sand, Trace of Gravel ----- Boulders ----- Some Silt Zones Occasional Cobbles and Boulders Grey Very Stiff to Hard (Glacial Till)		3	SS	24									
			4	SS	39									
			5	SS	56									
			6	SS	62									
			7	SS	74									
			8	SS	74									
175.5			9	SS	50									
10.7	Silty Clay Trace of Sand													
173.5	Gray, Hard		10	SS	85									
12.6	End of Borehole													

RECORD OF BOREHOLE No 5

1 OF 1 METRIC

W.P. 145-87-02/03 LOCATION N 4 850 886.0 E 306 145.0 ORIGINATED BY DK
 DIST 6 HWY 407 BOREHOLE TYPE Solid Stem Auger, Cone COMPILED BY DK
 DATUM Geodetic DATE 91 05 06 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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
185.8	Ground Surface													
0.0	Silty Sand, Trace of Gravel Clay and Organics Brown and Compact		1	SS	20									
			2	SS	13									
182.7	Sand and Gravel, Grey		3	SS	19									
3.0			4	SS	37									
	Silt, Trace Clay Occasional Wet Sand Seams		5	SS	106									
	Clayey Silt		6	SS	48									
	Trace of Sand and Gravel Some Silt Zones Occasional Cobbles and Boulders Grey, Hard (Glacial Till)		7	SS	76									
			8	SS	41									
175.1			9	SS	78									
10.7	Silty Clay Trace of Sand Occasional Silt Zones Grey, Hard		10	SS	80									
173.1														
12.6	End of Borehole													

RECORD OF BOREHOLE No 6

1 OF 1 METRIC

W.P. 145-87-02/03 LOCATION N 4 850 853.5 E 306 081.5 ORIGINATED BY DK
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger COMPILED BY DK
 DATUM Geodetic DATE 91 04 29 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	20 40 60 80 100					
191.7	Ground Surface													
0.0														
			1	SS	7									
			2	SS	22									
			3	SS	24									
			4	SS	19									
			5	SS	10									
			6	SS	32									
			7	SS	29									
			8	SS	42									
			9	SS	72									
179.5														
179.1	Silty Clay, Trace Sand, Hard		10	SS	55									
12.6	End of Borehole													

RECORD OF BOREHOLE No 7

1 OF 1 METRIC

W.P. 145-87-02/03 LOCATION N 4 850 897.5 E 306 080.5 ORIGINATED BY DK
 DIST 5 HWY 407 BOREHOLE TYPE Hollow Stem Auger, Cone COMPILED BY DK
 DATUM Geodetic DATE 91 05 01 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p W W _L	WATER CONTENT (%)	10 20 30			
185.9	Ground Surface													
0.0	Silty Sand, trace of Gravel Some Wood Fibres and Organics Brown and Grey Loose to Compact		1	SS	14									
183.6			2	SS	5									
2.3	Clayey Silt, Some Sand Trace of Gravel Occasional Cobbles and Boulders becoming more Clayey Very Stiff to Hard Grey (Glacial Till)		3	SS	21									
			4	SS	31									
			5	SS	54									
			6	SS	62									
			7	SS	69									
			8	SS	90									
175.2			9	SS	47									
10.7	Silty Clay Trace of Sand													
173.2	Grey, Hard		10	SS	70									
12.6	End of Borehole													

RECORD OF BOREHOLE No 8

1 OF 1 METRIC

W.P. 145-87-02/03 LOCATION N 4 850 927.5 E 306 132.5 ORIGINATED BY DK
 DIST 5 HWY 407 BOREHOLE TYPE Solid Stem Auger, Cone COMPILED BY DK
 DATUM Geodetic DATE 91 05 06 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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
186.3	Ground Surface																
0.0	Silty Sand, Trace of Clay Brown and Grey		1	SS	10		186										0 48 36 16
184.0	Very Loose to Compact		2	SS	3		184										
2.3			3	SS	11												
			4	SS	130 /28cm												
	Silt Zones		5	SS	119												0 10 80 10
	Clayey Silt becoming more Clayey		6	SS	104		180										
	Trace of Gravel		7	SS	103		178										
	Some Sand		8	SS	90		176										
	Occasional Cobbles and Boulders		9	SS	48												
	Grey, Stiff to Hard (Glacial Till)		10	SS	148 /28cm		174										
174.1	Silty Clay, trace Sand, Grey, Hard																
173.8	End of Borehole																
12.5																	

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 - 30	30 - 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						

METRIC

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

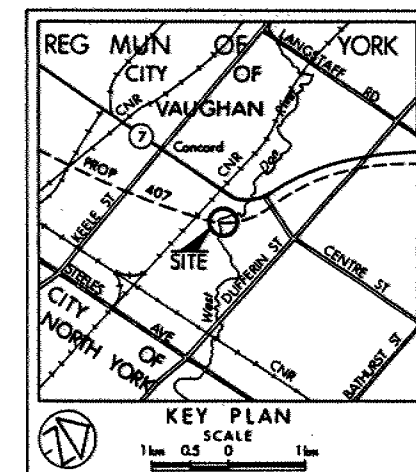
CONT No
WP No 145-87-02/03

WEST DON RIVER

BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L. at time of investigation 9104&05
- W.L. in piezometer

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	185.9	4850 878.5	306 101.5
2	186.0	4850 854.0	306 121.5
3	186.3	4850 930.0	306 104.0
4	186.2	4850 910.5	306 122.0
5	185.8	4850 886.0	306 145.0
6	191.7	4850 853.5	306 081.5
7	185.9	4850 897.5	306 080.5
8	186.3	4850 927.5	306 132.5

NOTE

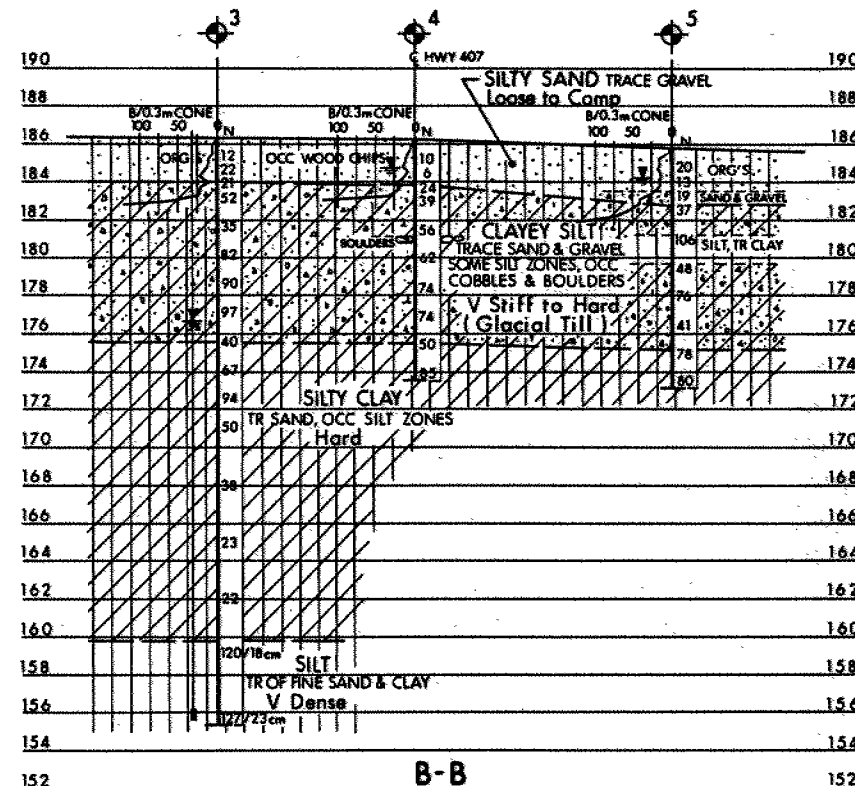
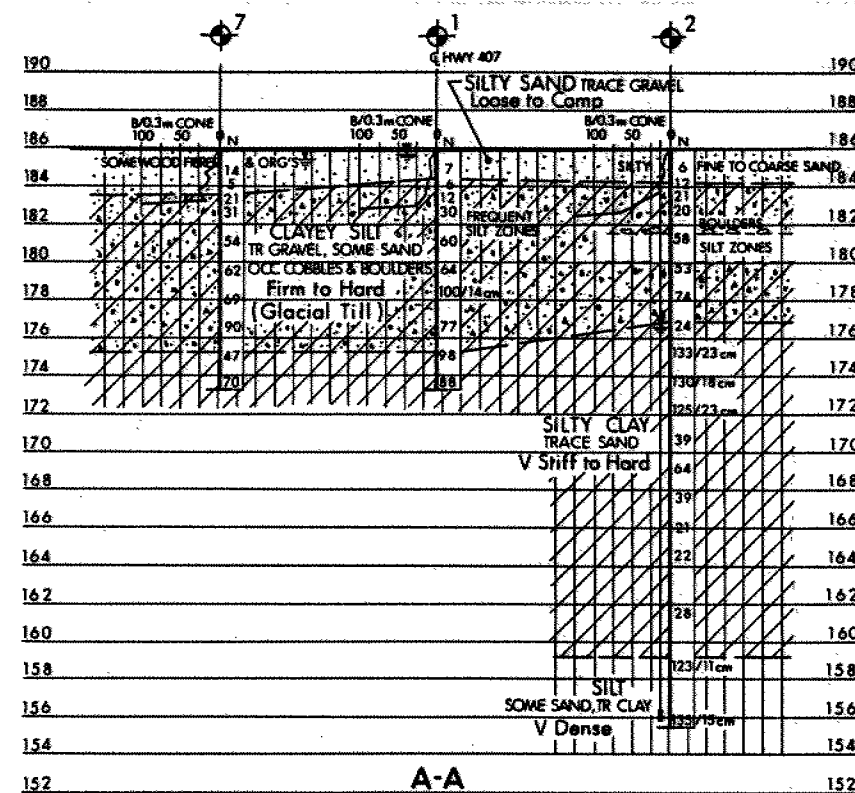
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

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

REV.	DATE	BY	DESCRIPTION
1			

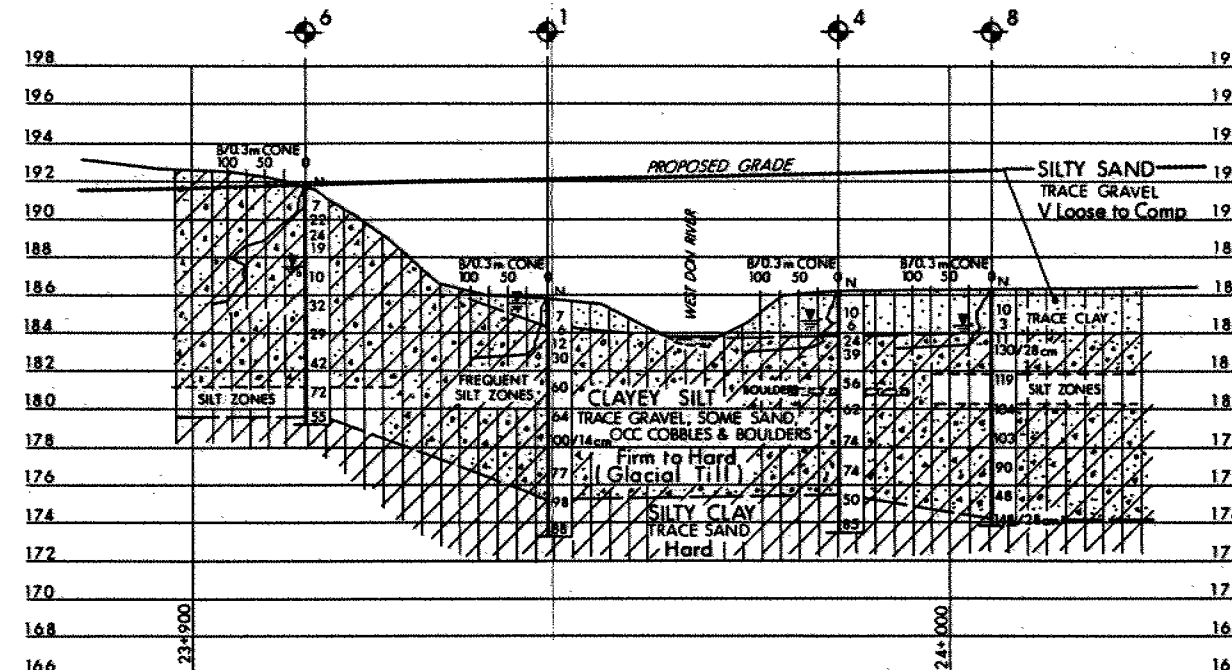
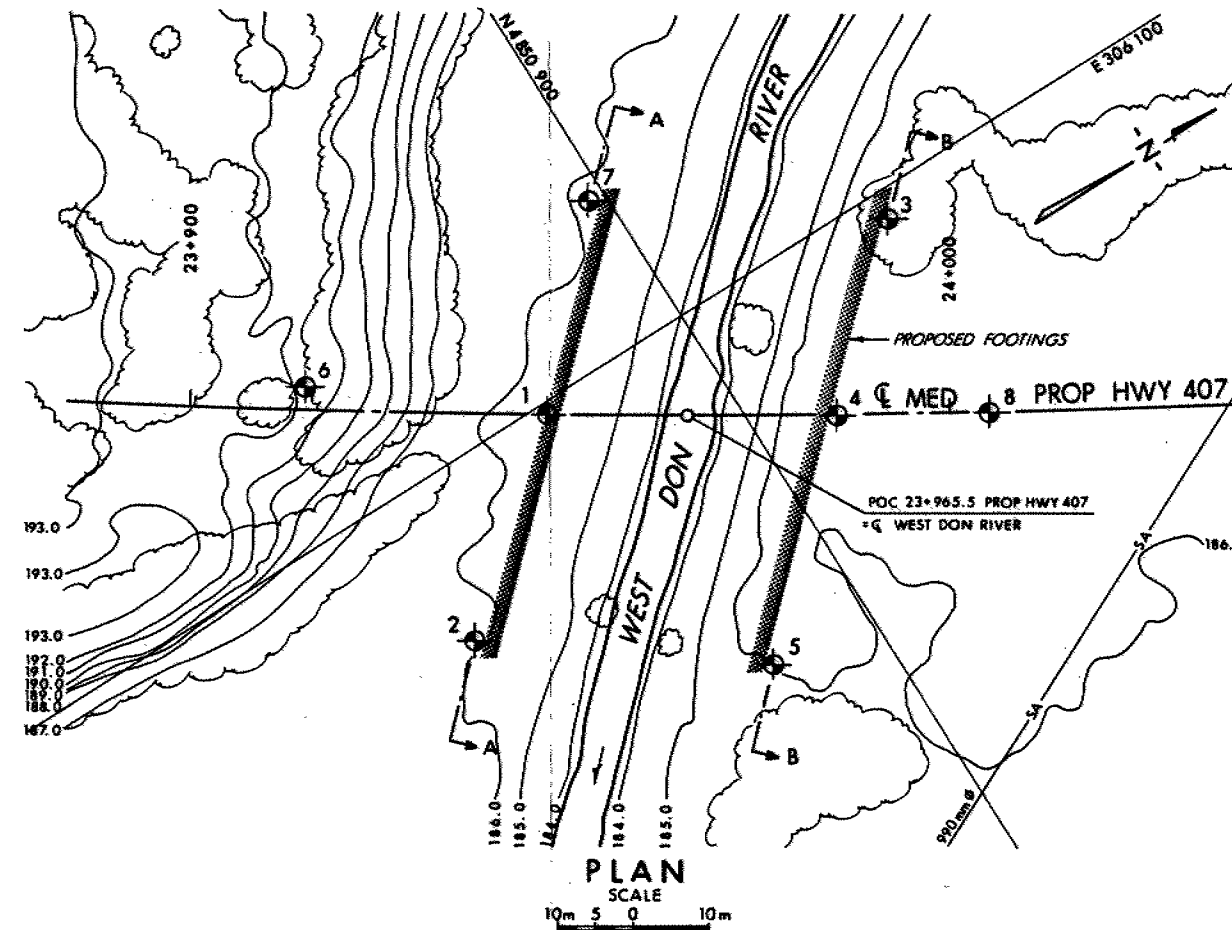
Geocres No 30M14-219

HWY No 407	SUBMD DK	CHECKED	DATE 1991 09 25	DIST 6
DRAWN SO	CHECKED	DATE	SITE 37-1394	DWG 1458702/03-A



SECTIONS

SCALE
10m 5 0 10m Hor
4m 2 0 4m Vert



E PROFILE PROPOSED HWY 407

SCALE
10m 5 0 10m Hor
4m 2 0 4m Vert

MEMORANDUM

(416)235-3731

To: V.F. Boehnke, P. Eng. 1994 05 30
Head, Structural Section
Central Region

Attn.: L. Mikhailovsky, P. Eng.

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

Re: Proposed Stormwater Sewer Outlet (Flow Splitter)
Near, Proposed Highway 407 Bridge at West Don River
W.P. 145-87-00, Site 37-1394
Hwy 407, District 6, Toronto

The above noted structure is proposed to be constructed near the south side of the west abutment of the West Don River bridge. The structure would be of trapezoidal shape about 15m long and 8.7m and 12.1m wide on each side. The height of the structure would be about 4.7m. The proposed founding elevation of the structure is below 184m. The exact location and function of the structure is not known.

Based on our previous foundation investigation at the site (W.P. 145-87-02/03, Hwy 407 West Don River Bridges), reference boreholes BH2 and BH5, the soil consists of competent materials at relatively shallow depths. For further soil information please refer to Foundation Report W.P. 145-87-02/03.

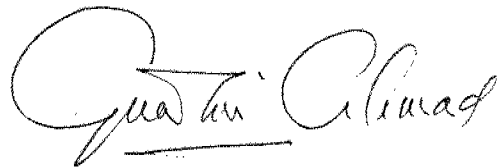
The proposed structure can be founded on spread footing. For footing founded at or below elevation 184m, the following bearing capacities as per the OHBDC should be utilized:

Factored Bearing Capacity at U.L.S. = 300 kPa.
Bearing Capacity at S.L.S. Type II = 200 kPa

Simple dewatering such as oversized excavation with perimeter drains may be required to lower the water table below footing excavation.

The footing should have a minimum earth cover of 1.2m for frost protection.

If you have any questions please call our office.

A handwritten signature in cursive script, appearing to read 'K.S.Q. Ahmad', written in dark ink.

K.S.Q. Ahmad, P. Eng.
Foundation Engineer

For

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

M.T.O.
Bridge Construction
Hwy 407 / West Don River
SITE 37-1394, DISTRICT 6



- Looking south
(downstream)



- Looking west along
Hwy 407 centreline

NAME: L. Mikhailovsky
DATE: Jan. 22, 1991

M.T.O.
Bridge Construction
Hwy 407 / West Don River
SITE 37-1394, DISTRICT 6



-- Looking north
(upstream)



-- Looking east along
Hwy 407 centreline

E: L. Mikhailovsky
DATE: Jan. 22, 1991

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M14-219

DIST. 6 REGION

W.P. No. 145-87-02/03

CONT. No.

W. O. No.

STR. SITE No. 37-1394

HWY. No. 407

LOCATION WEST DON RIVER WB & EB
BRIDGES

No. of PAGES -

=====
OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

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

CONT
WP No 145-87-02
145-87-03



HWY 407 BRIDGE OVER
THE WEST DON RIVER

SHEET

GENERAL ARRANGEMENT

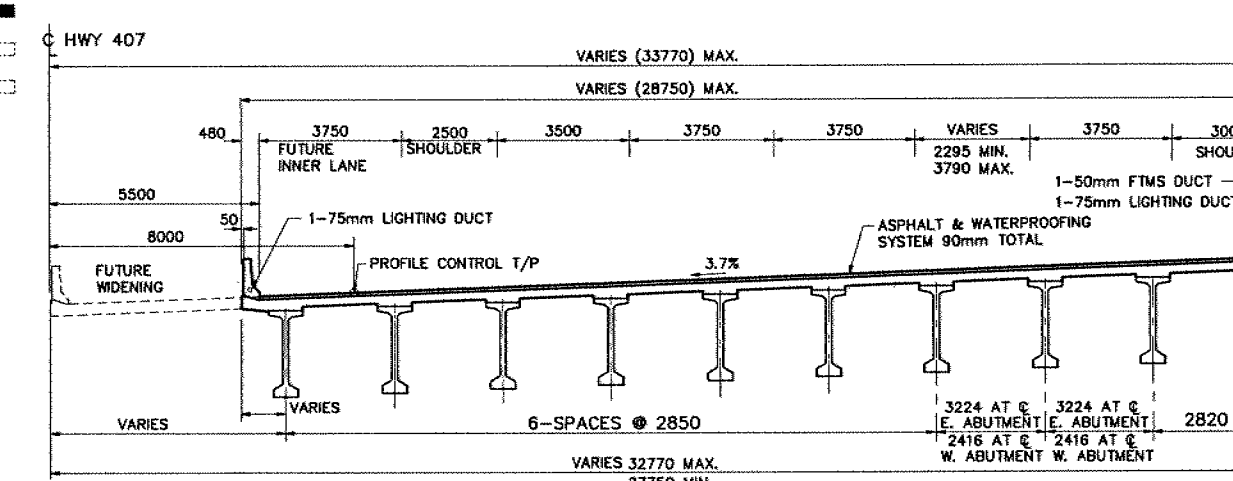
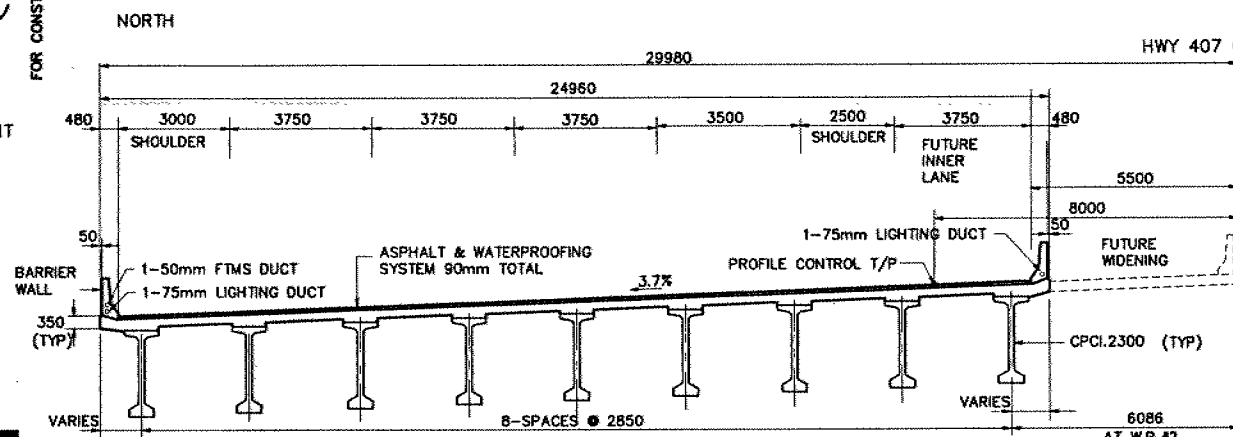
Marshall Macklin Monaghan Limited
Consulting Engineers - Surveyors - Planners

GENERAL NOTES

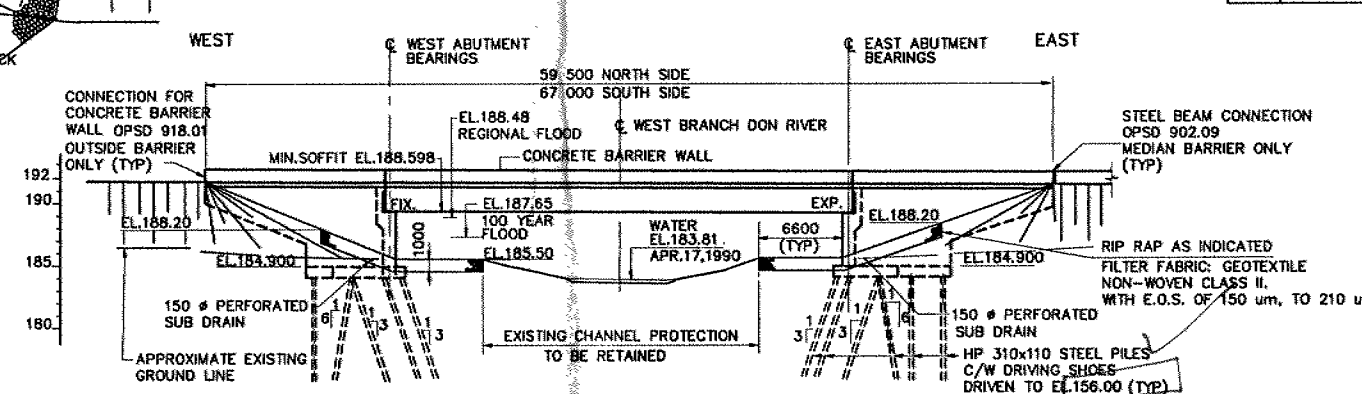
- CLASS OF CONCRETE:
PRECAST CONCRETE GIRDERS 40MPa
REMAINDER 30MPa
- CLEAR COVER TO REINFORCING STEEL:
FOOTINGS 100±25
ABUTMENTS & WINGWALLS:
FRONT FACE 80±20
BACK FACE 70±20
DECK SLAB TOP 70±20
BOT 40±10
REMAINDER 70±20
(UNLESS OTHERWISE NOTED)
- REINFORCING STEEL SHALL BE GRADE 400
UNLESS OTHERWISE SPECIFIED. BAR MARKS
WITH SUFFIX 'C' DENOTE COATED BARS.
- CONSTRUCTION NOTES:
THE CONTRACTOR SHALL ESTABLISH THE BEARING
SEAT ELEVATIONS BY DEDUCTING THE ACTUAL
BEARING THICKNESS FROM THE TOP OF BEARING
ELEVATIONS. IF THE ACTUAL BEARING THICKNESSES
ARE DIFFERENT FROM THOSE GIVEN WITH THE
BEARING DESIGN DATA, THE CONTRACTOR SHALL
ADJUST THE REINFORCING STEEL TO SUIT.

LIST OF DRAWINGS:

- GENERAL ARRANGEMENT ✓
- BOREHOLE LOCATIONS & SOIL STRATA.
- PILE LAYOUT I.
- PILE LAYOUT II.
- FOUNDATION REINFORCEMENT I.
- FOUNDATION REINFORCEMENT II.
- SOUTH WEST ABUTMENT REINFORCING
- NORTH WEST ABUTMENT REINFORCING
- SOUTH EAST ABUTMENT REINFORCING
- NORTH EAST ABUTMENT REINFORCING
- NORTH WING WALL REINFORCING
- SOUTH WING WALL REINFORCING
- PRESTRESSED GIRDERS
- DECK LAYOUT AND SCREED ELEVATIONS
- DECK REINFORCING I.
- DECK REINFORCING II.
- JOINT ANCHORAGE AND ARMOURING
- BARRIER WALL W/O RAILING
- APPROACH SLAB
- AS CONSTRUCTED ELEVATIONS AND DIMENSIONS
- STANDARD DETAILS
- PILE DRIVING-STEAM AND DIESEL HAMMERS ✓
- ELECTRICAL EMBEDDED WORK
- QUANTITIES STRUCTURE I
- QUANTITIES STRUCTURE II



PROFILE HWY 407
NTS



ELEVATION
1:300

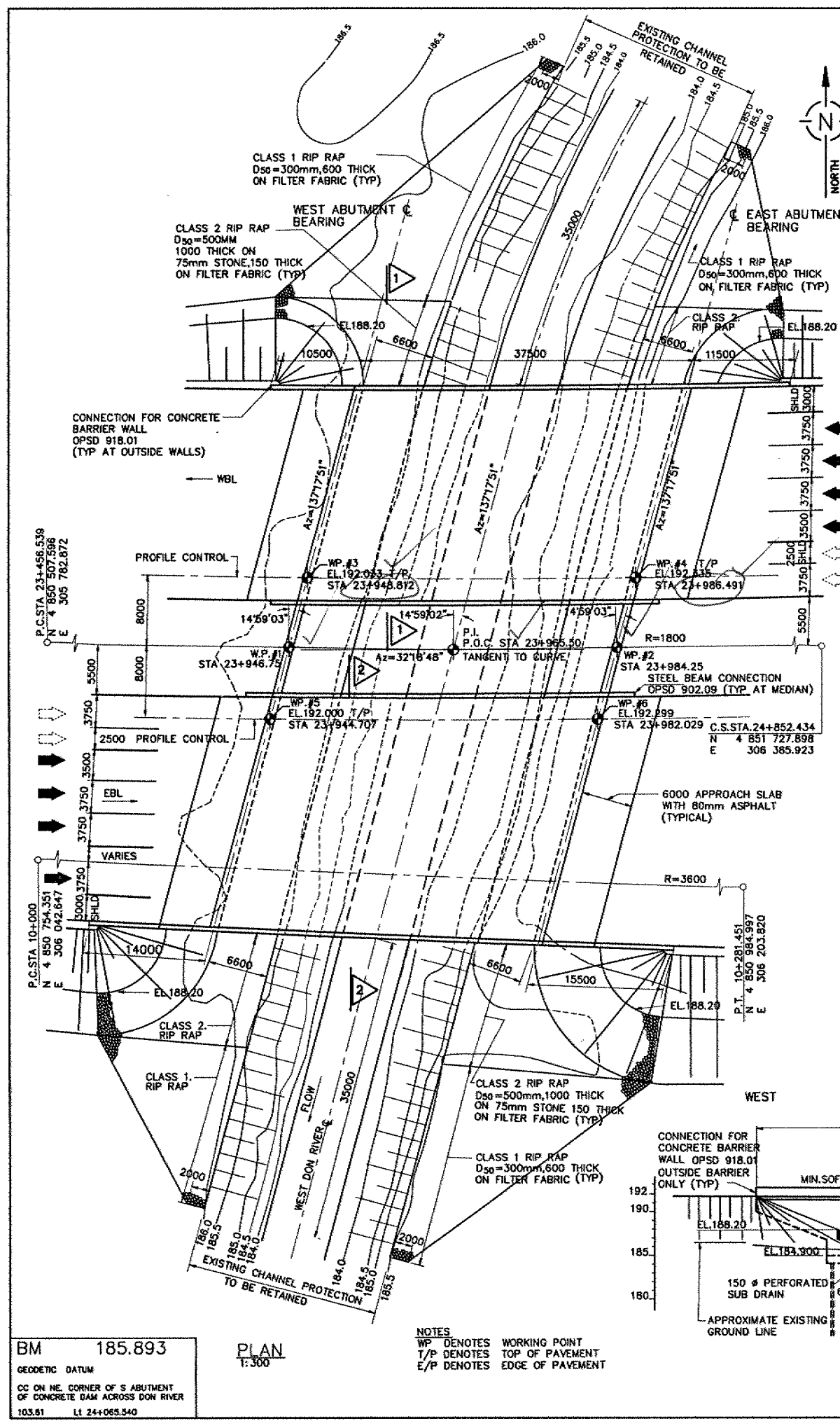
WORKING POINT DATA			
WP.#	STATION	CO-ORDINATES	
		NORTH	EAST
1	23+946.75	4 850 878.027	306 101.629
2	23+984.25	4 850 909.719	306 121.675
3	23+948.812	4 850 884.097	306 096.027
4	23+986.491	4 850 915.823	306 116.041
5	23+944.707	4 850 871.958	306 107.230
6	23+982.029	4 850 903.616	306 127.306



APPLICABLE STANDARD DRAWINGS:
OPSD 3501.00 MINIMUM GRANULAR BACKFILL REQUIREMENTS.
OPSD 918.01 CONNECTION TO CONCRETE BARRIER
OPSD 902.09 STEEL BEAM EMBEDDED CONNECTION FOR NEW STRUCTURE.
OPSD 3489.02 BRIDGE DECK WATERPROOFING.

DATE	BY	DESCRIPTION
DESIGN	S. B. CHK T. S.	CODE OHBDC-83
DRAWN	I. R. CHK S. B.	SITE 37-1394
STRUCT		SCHEME
DWG		1

JOB No.18-91098-C51
DIR: 91098 SCALE: 1:300
DATE PLOTTED: 12:41 NOV 3 1992



BM 185.893
GEODETIC DATUM
CC ON NE CORNER OF S ABUTMENT
OF CONCRETE DAM ACROSS DON RIVER
103.81 LT 24+065.540

NOTES
WP DENOTES WORKING POINT
T/P DENOTES TOP OF PAVEMENT
E/P DENOTES EDGE OF PAVEMENT

PLAN
1:300

file in WP

Environmental Section
Central Region
1201 Wilson Avenue
Atrium Tower, 5th Floor
Tel. (416) 235-5548

MINISTRY OF TRANSPORTATION

MEMORANDUM

DATE: February 25, 1994

TO: Mike Chan, 407 Project Office
Dave Dundas, Foundation Design
Bram Hurd, Cole Sherman

RE: W.P. 145-87-00 - Treatment of West Don River Meander

Further to our meeting and my subsequent memo of February 24 to Bram Hurd, I had a conversation with Leonid Mikhailovsky this afternoon to discuss the proposed protection of the highway embankment at the West Don River meander.

Leonid was of the opinion, and I agreed, that because MNR said they would require fish habitat compensation for temporary destruction of fish habitat, which may cause a delay in obtaining the necessary approval for the project, another option should be considered.

We agreed that, if Mike and Dave are in agreement, the placement of class 1 rip-rap only on the highway embankment up to the level recommended by MMM, and 3.0 metres beyond the toe of slope, would be adequate protection of the MTO facility. The planting of trees and shrubs between the river and the rock may add some measure of stability to the bank, should it tend to erode towards the highway. If we find that the river does start to erode towards the highway, then additional rock can be added to the toe of slope so that rock will fall into the river and stabilize its movement.

Let me know what you think about this proposal.

Feb. 28/94
agreed
noted concern that wide flooding
conditions erosion could still
create an instability.
DD

cc. Fred Leech
Leonid Mikhailovsky

George
George Ivashoff
Environmental Planner



MEMORANDUM

(416)235-3731

To: V.F. Boehnke, P. Eng.
Head, Structural Section
Central Region

Attn.: L. Mikhailovsky, P. Eng.

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

Re: West Don River Bridge
W.P. 145-87-02/03, Site: 37-1394
Hwy 407, District 6, Toronto

1993 03 16

We have reviewed copies of the D4, Special Provisions and half size prints for the above mentioned project. The documents in general meet our Foundation requirements. However, in our opinion it would be economical if the structures could be constructed on spread footings.

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

For

M. Devata, P. Eng.
Chief Foundation Engineer

memorandum



To: Mr. V.F.Boehnke
Head of Structural Section
Central Region
Attention : Mr. L. Mikhailovsky

Date: 91 06 07

From : Foundation Design Section
Room 315, Central Building

Re : Highway 407 West Don River WB and EB Bridges
W.P.145-87-02/03 (WB/EB), Site 37-1394
Highway 407, District 6, Toronto

The field investigation for the above-noted project has been completed. This memorandum provides a summary of the subsurface conditions encountered at the site and engineering recommendations intended for design to proceed. The full foundation report will follow.

The site is located at West Don River, about 400 m south of Highway 7N in the Township of Vaughan, District of Toronto. The width of the river is about 6 m where the proposed structure crosses it.

The field work was conducted between 91 04 29 and 91 05 06 and consisted of eight (8) sampled boreholes taken down to 12.5-30.9 m depths. The subsurface material encountered was predominantly hard clayey silt. Dynamic Cone Penetration test was carried out on all the boreholes. The perched groundwater table was close to the existing ground surface and the base groundwater table was at about 9-10 m depth as measured by the piezometers installed in BH 2 and BH 3. Laboratory tests are being carried out on the soil samples and the results will be included in the final report.

The project comprises construction of two bridge structures across the West Don River to support the westbound and eastbound lanes of the proposed Highway 407. The elevation of the Highway will be at about 192 m, some 9 m above the river bed. The abutments on both sides of the river will be constructed as closed end structures with both ends extended in longitudinally to the road to retain backfill materials.

The following are the engineering recommendations pertaining to the design and construction of the structures.

Foundation

Due to the existence of competent materials at relatively shallow depths as revealed by the site investigation, it is recommended to support the proposed bridge structure on shallow foundations such as conventional footings. Recommendation on deep foundation is also given below as an alternative in the event that Reinforced Earth false abutments are designed.

Shallow Foundation :

For footings founded on competent clayey silt, the bearing capacities as per the O.H.B.D.C., are as follows.

Factored Bearing Capacity at U.L.S.= 600 kPa

Bearing Capacity at S.L.S. Type II = 400 kPa

For design purpose, the estimated founding elevations are given in Table 1 assuming foundation elevations must be below elevation 184 m for structure geometry purposes.

Table 1

Estimated Founding Elevation (m)

WB Structure

West Abutment	182.0
East Abutment	183.0

EB Structure

West Abutment	182.0
East Abutment	182.5

MEDIAN Retaining Structure

West Side	182.0
East Side	183.0

Backfill to abutments and retaining walls should consist of granular material in accordance with MTO Standard Special Provision #121 (83 10). Computation of earth pressures should be in accordance with Section 6.6.1.2 of the O.H.B.D.C. For design purposes, the following properties for backfill are recommended :

<u>Material</u>	<u>ϕ</u>	<u>γ</u>	<u>Ko</u>	<u>Ka</u>
Granular 'A'	35 degrees	22.8kN/cu.m	0.43	0.27
Granular 'B'	30 degrees	21.2kN/cu.m	0.50	0.33

Sliding resistance between concrete and foundation soil should be calculated in accordance with the O.H.B.D.C. assuming an unfactored ϕ value of 28 degrees.

The footings should have a minimum earth cover of 1.2 m for frost protection.

Since the perched groundwater table is close to the existing ground surface, dewatering is required to allow backfilling and placement of concrete footings to be carried out in the dry. Construction has to be carried out in stages with the river temporarily diverted prior to excavation. This can be done by a detour alignment or by pumping water through pipes in conjunction with an impermeable dyke to block off the river. Dewatering for footing construction can be achieved by carrying out oversized excavation with perimeter drains as shown in Figure 1.

The depth of excavation will be up to 4 m. Temporary slopes should be maintained at 1.5H:1V or flatter.

If Reinforced Earth false abutments are considered, the Foundation Design Section should be contacted for recommendations pertaining to the design. Deep foundations in the form of H-piles can be used to support the structures. Piles driven to the very dense silt layer at about 159 m elevation, and then controlled by the Hiley Formula, would be capable of supporting the structures with minimal settlements. For preliminary planning purposes, it may be estimated that the piles would penetrate to elevation 156 m.

For design purposes, the following values according to the O.H.B.D.C. are recommended.

Table 2

<u>Pile Type</u>	<u>Factored Capacity at U.L.S</u>	<u>Capacity at S.L.S. Type II</u>	<u>Lateral Resistance</u>	
			<u>at U.L.S.</u>	<u>at S.L.S.Type II</u>
HP 310X79	1150 kN/pile	825 kN/pile	60 kN/pile	40 kN/pile
HP 310X110	1600 kN/pile	1150 kN/pile	80 kN/pile	60 kN/pile

Pile driving should be controlled by the Hiley Formula as per MTO Standards SS103-10 or SS103-11, assuming ultimate capacities as indicated below.

Ultimate Capacities for Hiley Formula

HP 310X79

2460 kN/pile

HP 310X110

3450 kN/pile

Due to the existence of a competent intermediate layer across the site, there is a

possibility that piles could develop the required capacity at higher elevations (approximately 174 m). This hard layer may also serve as an end bearing stratum for caisson foundations. Specific recommendations on this will be addressed in the final foundation report if required.

The field investigation has revealed layers of boulders and cobbles in the clayey silt stratum. Provisions should be made in the contract document to take into account possible obstructions during pile driving.

Dewatering for pile cap construction may be carried out in the same manner as mentioned above. Temporary cuts should have a gradient of 1.5H:1V or flatter. Backfill material should have grain size smaller than 75 mm.

Abutment Slopes

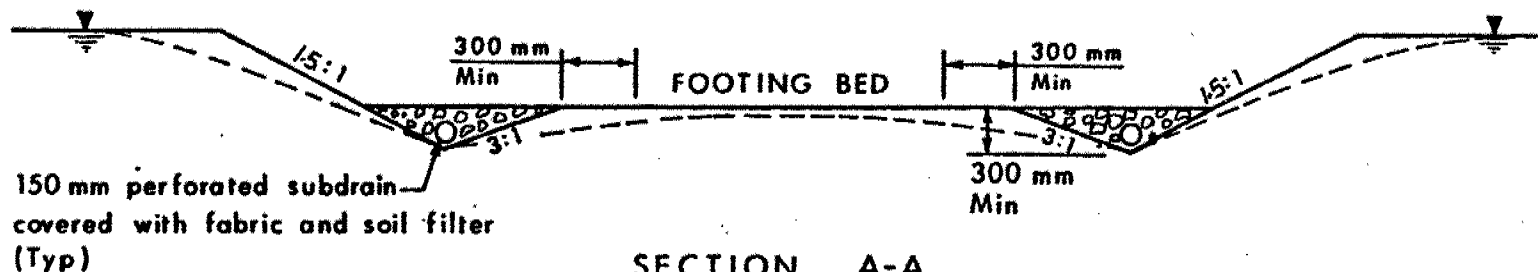
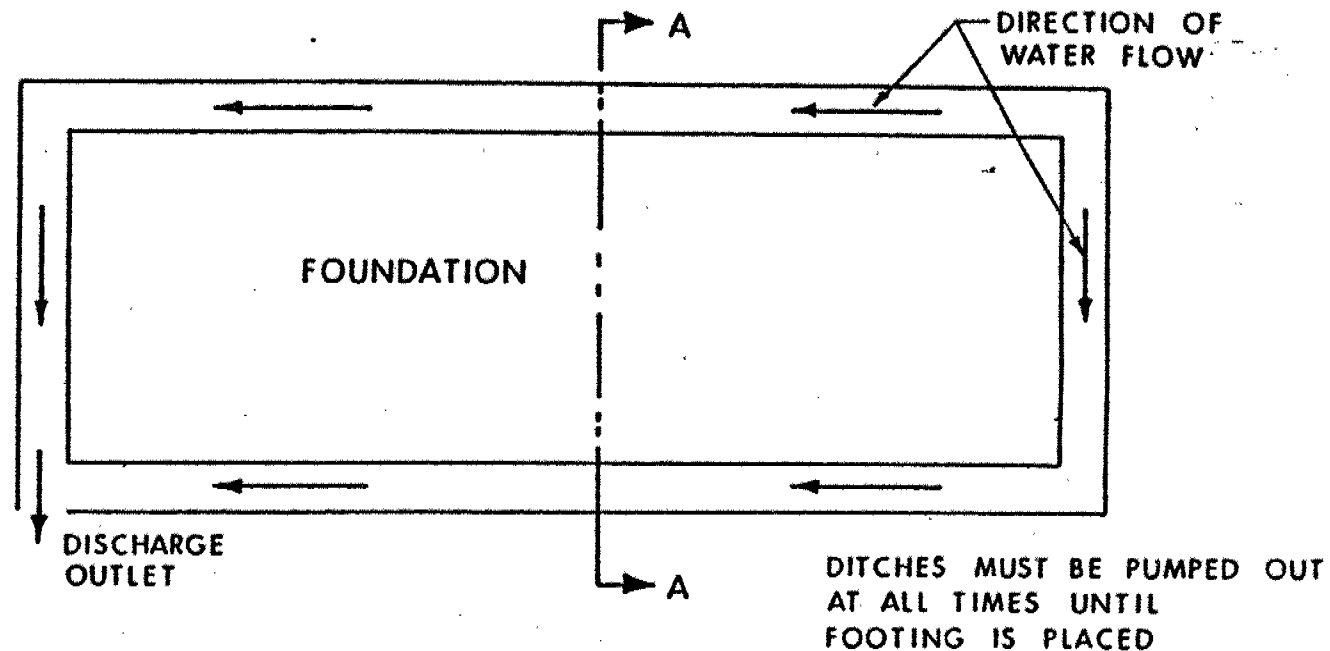
Maximum height of the slopes is about 6.5 m. The slopes may be safely constructed with compacted granular fill to a gradient of 2H:1V. The slope toe should be provided with 0.6 m thick rock protection extending up to the high water mark, and down to cover at least 2 m of the river bed. Since the abutment is situated in a causeway, it is necessary to extend the rock armouring all around it to protect the bridge. It is recommended that any additional requirements of the MTO Hydrology Section should be incorporated into the design.

We believe that the above is sufficient for the present purpose. Should you have any question or require further information, please contact our office.



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for

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SECTION A-A
(NTS)
DEWATERING SCHEME - PERIMETER DITCHES

WP 145-87-02/03
FIG 1