

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 417-45

DIST. 18 REGION

W.P. No. 278-85-01

CONT. No. 87-213

W. O. No.

STR. SITE No. 385-22

HWY. No. 556

LOCATION KINNIHAN CREEK

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:



DETO

DATE \_\_\_\_\_

REMARKS \_\_\_\_\_

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There is no handwriting or other markings on the paper.

# memorandum



To: Mr. O. E. Ramakko,  
Head, Structural Section,  
NORTHWESTERN REGION - Thunder Bay

Date: 86 03 17

From: Engineering Materials Office,  
Foundation Design Section,  
Central Building, Room 315

Re: Foundation Investigation Report  
Kinnihan Creek Structure  
Hwy. 556, (Site: 38S-22)  
District #18, Sault Ste. Marie  
W. P. 278-85-01

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Peto MacCallum Ltd. was retained by this section to carry out a foundation investigation at the above-noted site and provide recommendations for the design and construction of the proposed culvert and associated fills.

During the progress of the project, this section reviewed the draft version of the report and comments on the technical contents were made. The attached final report addresses most of our concerns, however, we make the following comments:

1. The loadings given in Sect. 4.1 (page 7) of the report should be changed to 100 kPa S.L.S. II, and 200 kPa U.L.S.
2. The peat soils must be completely removed for 1 m beyond the plan limits of the embankment fill. The Regional Geotechnical Section should make recommendations with regards to the removal of organics in areas beyond the area covered in this report.
3. At the C.S.P. culvert inlet, a seal of cohesive material (CI-CH clay) with a minimum thickness of 0.6 m should be provided to prevent erosion of the underlying non-cohesive material. The requirements of this seal are shown on the attached figure.

A headwall could be provided for the concrete box culvert.

4. The Hydrology Section should be consulted with regards to the requirement of channel protection. The soil is scourable and there may be a need for rip-rap.

....2

Mr. O. E. Ramakko

- 2 -

86 03 17

Re: Foundation Investigation Report  
Kinnihan Creek Structure  
Hwy. 556, (Site: 38S-22)  
District #18, Sault Ste. Marie  
W. P. 278-85-01

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5. The attached report discusses the need for a dewatering system (page 8). If the perimeter ditches are used, the drains should be installed at a distance of 2 m from the plan limits of the culvert, and at a depth of 0.4 m below the founding elevation.

If you have any questions or require further information please do not hesitate to contact the undersigned.



L. Politano,  
Project Foundations Engineer

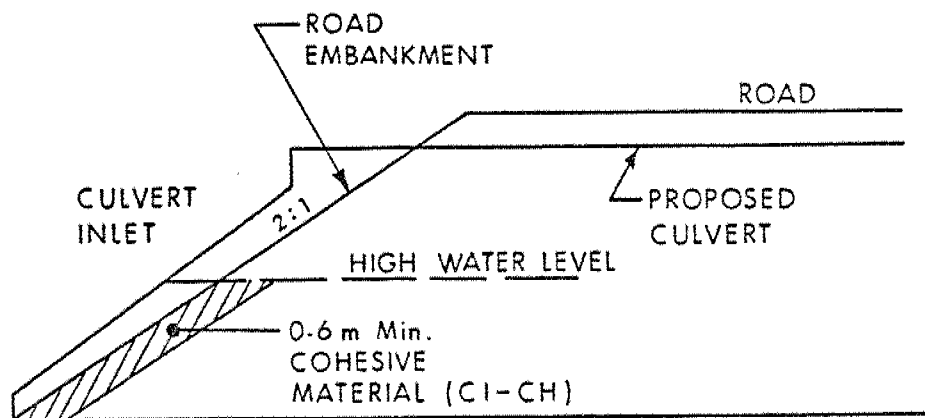
for

M. Devata,  
Chief Foundations Engineer  
(East)

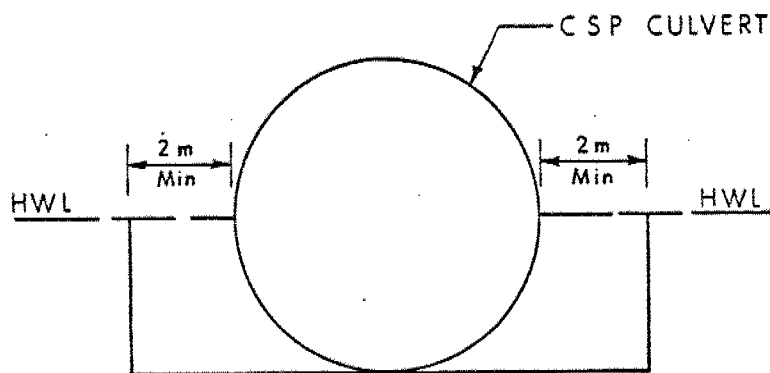
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encl.

Distribution -Northwestern Region



NTS  
LONGITUDINAL SECTION



NTS  
FRONT VIEW

Culvert Inlet Seal

W.P. 278-85-01

# OVERSIZE DRAWING

# memorandum



Tel: 7101

To: O. Ramakko  
Head, Structural Section  
Northwestern Region

Date: 1987 02 20

From: Foundation Design Section  
Room 315, Central Building

RE: Additional Borings at  
Kinniham Creek  
W.P. 278-85-01, Site 38S-22  
Hwy. 556, Dist. 18 - Sault Ste. Marie

As discussed in our memorandum dated 86 11 04, this Section has advanced additional borings at the above-noted site. The additional borings were necessary because the proposed culvert location was shifted approximately 20 m to the east after the initial investigation was carried out.

The additional fieldwork consisted of 3 sampled boreholes (B.H. 10, 11, 12) and 5 dynamic cone penetration tests and was carried out on 87 01 20. The sampled borings were 4.4 m in depth and were advanced by means of hollow stem augers. The attached plan indicates the location of all the borings carried out at this site, including the boreholes (B.H. 1 to 9) advanced for the original investigation in February, 1986.

The following is a brief description of the subsurface conditions encountered in the most recent borings. Draft versions of the Record of Borehole Sheets for B.H. 10 to B.H. 14 are attached for your information.

## Peat

Peat was encountered in all sampled boreholes extending from the ground surface down to depths ranging between 0.8 and 2.1 m. The peat was generally black in colour and contained numerous roots and decaying wood and leaves.

## Sand some silt, some gravel

Underlying the surficial organic deposit is a stratum of sand some silt, some gravel. From the drilling, it is inferred that occasional cobbles may be encountered. Based on the interpretation of Standard Penetration Test 'N' values, the non-cohesive deposit is generally in a loose state. Within the deposit, seams of fine sand may also be encountered.

It should be noted that when this deposit is subjected to an unbalanced hydrostatic pressure 'boiling' may result.

At this time, no laboratory test results are available.

.....2

Groundwater Conditions

At the time of the investigation, the groundwater level was found to be at Elev. 351.8±.

RECOMMENDATIONS

Recommendations pertaining to the design and construction of the culvert were presented in the 1986 report prepared for this Section by Peto MacCallum Limited in 1986 and the associated covering letter.

I would request that you append this memorandum to your copy of the foundation report for this project for future reference. If you have any questions or require clarification, please do not hesitate to contact the undersigned.

A handwritten signature in black ink, appearing to read 'L. Politano', followed by a horizontal line.

L. Politano  
Project Foundations Engineer

for

M. Devata  
Chief Foundations Engineer  
(East)

LP/MD/mmj

c.c. - J.B. MacMaster  
G.D. Newell  
C.E. Pritchard  
K. Bassi  
J.H. Peer

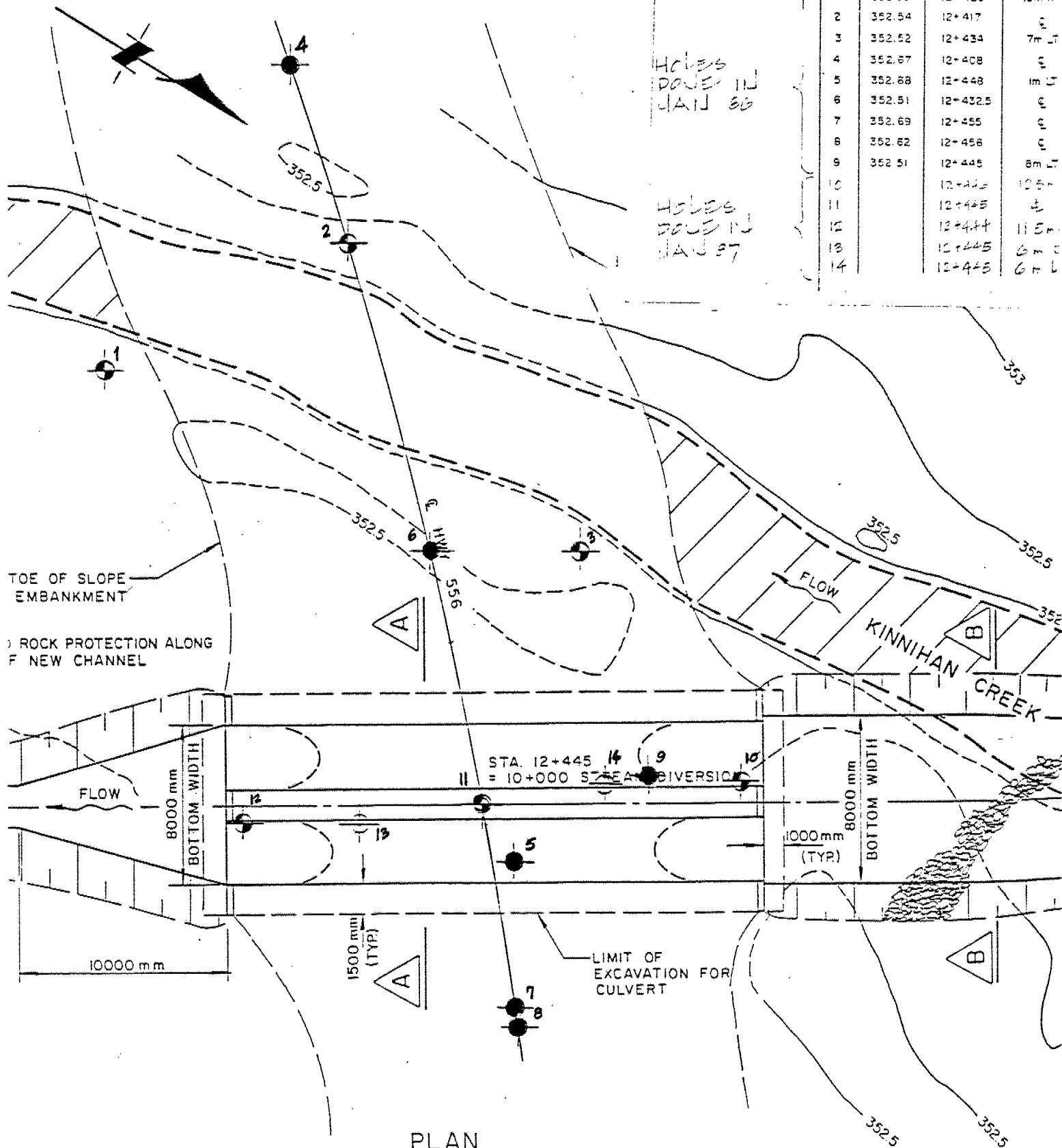


# KINNIHAN CREEK

No	ELEVATION	STATION	OFFSET
1	352.39	12+420	13m R
2	352.54	12+417	5
3	352.52	12+434	7m L
4	352.67	12+408	5
5	352.88	12+448	13 L
6	352.51	12+432.5	5
7	352.69	12+455	5
8	352.62	12+456	5
9	352.51	12+445	8m L
10		12+445	10m
11		12+445	5
12		12+444	11.5m
13		12+445	6m
14		12+445	6m L

HOLES  
DOUGLAS  
JAN 86

HOLES  
DOUGLAS  
JAN 87



PLAN  
SCALE 1:250

a) $\mu = 0$		b) $\mu = 1$		c) $\mu = 2$	
$\alpha$	$\beta$	$\alpha$	$\beta$	$\alpha$	$\beta$
0.1	0.1	0.1	0.1	0.1	0.1
0.1	0.2	0.1	0.2	0.1	0.2
0.1	0.3	0.1	0.3	0.1	0.3
0.1	0.4	0.1	0.4	0.1	0.4
0.1	0.5	0.1	0.5	0.1	0.5
0.1	0.6	0.1	0.6	0.1	0.6
0.1	0.7	0.1	0.7	0.1	0.7
0.1	0.8	0.1	0.8	0.1	0.8
0.1	0.9	0.1	0.9	0.1	0.9
0.1	1.0	0.1	1.0	0.1	1.0
0.1	1.1	0.1	1.1	0.1	1.1
0.1	1.2	0.1	1.2	0.1	1.2
0.1	1.3	0.1	1.3	0.1	1.3
0.1	1.4	0.1	1.4	0.1	1.4
0.1	1.5	0.1	1.5	0.1	1.5
0.1	1.6	0.1	1.6	0.1	1.6
0.1	1.7	0.1	1.7	0.1	1.7
0.1	1.8	0.1	1.8	0.1	1.8
0.1	1.9	0.1	1.9	0.1	1.9
0.1	2.0	0.1	2.0	0.1	2.0
0.1	2.1	0.1	2.1	0.1	2.1
0.1	2.2	0.1	2.2	0.1	2.2
0.1	2.3	0.1	2.3	0.1	2.3
0.1	2.4	0.1	2.4	0.1	2.4
0.1	2.5	0.1	2.5	0.1	2.5
0.1	2.6	0.1	2.6	0.1	2.6
0.1	2.7	0.1	2.7	0.1	2.7
0.1	2.8	0.1	2.8	0.1	2.8
0.1	2.9	0.1	2.9	0.1	2.9
0.1	3.0	0.1	3.0	0.1	3.0
0.1	3.1	0.1	3.1	0.1	3.1
0.1	3.2	0.1	3.2	0.1	3.2
0.1	3.3	0.1	3.3	0.1	3.3
0.1	3.4	0.1	3.4	0.1	3.4
0.1	3.5	0.1	3.5	0.1	3.5
0.1	3.6	0.1	3.6	0.1	3.6
0.1	3.7	0.1	3.7	0.1	3.7
0.1	3.8	0.1	3.8	0.1	3.8
0.1	3.9	0.1	3.9	0.1	3.9
0.1	4.0	0.1	4.0	0.1	4.0
0.1	4.1	0.1	4.1	0.1	4.1
0.1	4.2	0.1	4.2	0.1	4.2
0.1	4.3	0.1	4.3	0.1	4.3
0.1	4.4	0.1	4.4	0.1	4.4
0.1	4.5	0.1	4.5	0.1	4.5
0.1	4.6	0.1	4.6	0.1	4.6
0.1	4.7	0.1	4.7	0.1	4.7
0.1	4.8	0.1	4.8	0.1	4.8
0.1	4.9	0.1	4.9	0.1	4.9
0.1	5.0	0.1	5.0	0.1	5.0
0.1	5.1	0.1	5.1	0.1	5.1
0.1	5.2	0.1	5.2	0.1	5.2
0.1	5.3	0.1	5.3	0.1	5.3
0.1	5.4	0.1	5.4	0.1	5.4
0.1	5.5	0.1	5.5	0.1	5.5
0.1	5.6	0.1	5.6	0.1	5.6
0.1	5.7	0.1	5.7	0.1	5.7
0.1	5.8	0.1	5.8	0.1	5.8
0.1	5.9	0.1	5.9	0.1	5.9
0.1	6.0	0.1	6.0	0.1	6.0
0.1	6.1	0.1	6.1	0.1	6.1
0.1	6.2	0.1	6.2	0.1	6.2
0.1	6.3	0.1	6.3	0.1	6.3
0.1	6.4	0.1	6.4	0.1	6.4
0.1	6.5	0.1	6.5</		

CH 128420 E. MS

COMPILED BY L.P.

CHECKED BY

1. $\sigma_u$ , MPa	2. $\sigma_u$ , MPa	3. $\sigma_u$ , MPa	4. $\sigma_u$ , MPa	5. $\sigma_u$ , MPa	6. $\sigma_u$ , MPa	7. $\sigma_u$ , MPa	8. $\sigma_u$ , MPa	9. $\sigma_u$ , MPa	10. $\sigma_u$ , MPa	11. $\sigma_u$ , MPa	12. $\sigma_u$ , MPa	13. $\sigma_u$ , MPa	14. $\sigma_u$ , MPa	15. $\sigma_u$ , MPa	16. $\sigma_u$ , MPa	17. $\sigma_u$ , MPa	18. $\sigma_u$ , MPa	19. $\sigma_u$ , MPa	20. $\sigma_u$ , MPa	21. $\sigma_u$ , MPa	22. $\sigma_u$ , MPa	23. $\sigma_u$ , MPa	24. $\sigma_u$ , MPa	25. $\sigma_u$ , MPa	26. $\sigma_u$ , MPa	27. $\sigma_u$ , MPa	28. $\sigma_u$ , MPa	29. $\sigma_u$ , MPa	30. $\sigma_u$ , MPa	31. $\sigma_u$ , MPa	32. $\sigma_u$ , MPa	33. $\sigma_u$ , MPa	34. $\sigma_u$ , MPa	35. $\sigma_u$ , MPa	36. $\sigma_u$ , MPa	37. $\sigma_u$ , MPa	38. $\sigma_u$ , MPa	39. $\sigma_u$ , MPa	40. $\sigma_u$ , MPa	41. $\sigma_u$ , MPa	42. $\sigma_u$ , MPa	43. $\sigma_u$ , MPa	44. $\sigma_u$ , MPa	45. $\sigma_u$ , MPa	46. $\sigma_u$ , MPa	47. $\sigma_u$ , MPa	48. $\sigma_u$ , MPa	49. $\sigma_u$ , MPa	50. $\sigma_u$ , MPa	51. $\sigma_u$ , MPa	52. $\sigma_u$ , MPa	53. $\sigma_u$ , MPa	54. $\sigma_u$ , MPa	55. $\sigma_u$ , MPa	56. $\sigma_u$ , MPa	57. $\sigma_u$ , MPa	58. $\sigma_u$ , MPa	59. $\sigma_u$ , MPa	60. $\sigma_u$ , MPa	61. $\sigma_u$ , MPa	62. $\sigma_u$ , MPa	63. $\sigma_u$ , MPa	64. $\sigma_u$ , MPa	65. $\sigma_u$ , MPa	66. $\sigma_u$ , MPa	67. $\sigma_u$ , MPa	68. $\sigma_u$ , MPa	69. $\sigma_u$ , MPa	70. $\sigma_u$ , MPa	71. $\sigma_u$ , MPa	72. $\sigma_u$ , MPa	73. $\sigma_u$ , MPa	74. $\sigma_u$ , MPa	75. $\sigma_u$ , MPa	76. $\sigma_u$ , MPa	77. $\sigma_u$ , MPa	78. $\sigma_u$ , MPa	79. $\sigma_u$ , MPa	80. $\sigma_u$ , MPa	81. $\sigma_u$ , MPa	82. $\sigma_u$ , MPa	83. $\sigma_u$ , MPa	84. $\sigma_u$ , MPa	85. $\sigma_u$ , MPa	86. $\sigma_u$ , MPa	87. $\sigma_u$ , MPa	88. $\sigma_u$ , MPa	89. $\sigma_u$ , MPa	90. $\sigma_u$ , MPa	91. $\sigma_u$ , MPa	92. $\sigma_u$ , MPa	93. $\sigma_u$ , MPa	94. $\sigma_u$ , MPa	95. $\sigma_u$ , MPa	96. $\sigma_u$ , MPa	97. $\sigma_u$ , MPa	98. $\sigma_u$ , MPa	99. $\sigma_u$ , MPa	100. $\sigma_u$ , MPa

1. THEORY OF THE CASE

**DRAFT COPY**  
FOR DISCUSSION ONLY

RECORD OF BOREHOLE No 11

METRIC

W.P. 278-85-01

LOCATION Sta. 12+445 at C Hwy 556

ORIGINATED BY M.S.

DIST 18 HWY 556

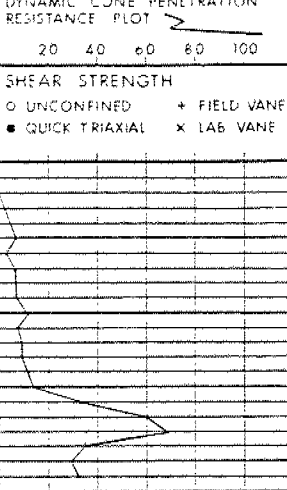
BOREHOLE TYPE Hollow Stem Auger Cone Test

COMPILED BY L.P.

DATE GEODETIC

DATE 1987 01 20

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES								
352.5	Ground surface												
0.0	Peat		1	SS	0								
351.7			2	SS	0								
0.0													
5	Sand, some silt, gravel		3	SS	5								
	well-graded		4	SS	5								
10	fine sand		5	SS	4								
	Loose		6	SS	6								
15	End of Borehole												
14.4													
20	End of Cone Test												
346.5													
0.0													
25													
30													
35													
40													
45													
50													
55													
60													
65													
70													
75													
80													
85													
90													
95													
96													

+3, x5: Numbers refer to Sensitivity

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

DRAFT COPY  
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12

27B-BS-01  
DIST 18 HWY 556 BOREHOLE TYPE 4 1/2 in. Stem Auger and Cone Test  
DATUM GEODETIC DATE 1987.01.20  
ORIGINATOR M.E. COMPILED BY LF CHECKED BY

SOIL PROFILE		SAMPLED			GROUND WATER CONTENTS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE (LOT)		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PICT	NUMBER	TYPE			20 40 60 80 100						
353.5	Ground Surface												GP SA SI CL
0.0	Peat		1	SS		352							
5.0	Sand, some silt, gravel well-sorted		2	SS		351							
			3	SS		350							
			4	SS		349							
	Loose fine sand		5	SS		348							
	fine sand		6	SS		347							
	End of borehole					346							
	End of Cone Test					345							

OFFICE REPORT ON SOIL EXPLORATION

2, 3, 6: Numbers refer to  
Sensitivity  
27  
12 K-1 (5%) STRAIN AT FAILURE  
15

Figure 1. Schematic representation of the experimental design. The subjects were divided into two groups: the control group (CG) and the experimental group (EG). The CG was divided into two subgroups: the control group (CG) and the control group (CG). The EG was divided into two subgroups: the experimental group (EG) and the experimental group (EG). The CG was divided into two subgroups: the control group (CG) and the control group (CG). The EG was divided into two subgroups: the experimental group (EG) and the experimental group (EG).

2.  $\lambda'$  denotes refer to  $\lambda$  in the  $n$ -th iteration.

2. 2. Journeys refer to  
journeys.

**DRAFT COPY**  
FOR DISCUSSION ONLY

OFFICE REPORT ON SOIL EXPLORATION

PROJECT: 273-35-01 LOCATION: Sta 12+245 ± 6 W. 4 H. 556 ORIGINATED BY: NS  
 DIST: 18 HWY: 556 BORERHOLE TYPE: Cone Test COMPILED BY: LP  
 DATUM: CEODETIC DATE: 1987 01 25 CHECKED BY: \_\_\_\_\_

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE (PLC) <u>✓</u> 20 40 60 80 100	PLASTIC LIMIT Vp	NATURAL MOISTURE CONTENT W	LIQUID LIMIT WL	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA S' CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT NUMBER	TYPE VALUES								
352.5 0.0					352						
351					351						
350					350						
349					349						
348					348						
347					347						
346	End of Cone Test										

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100

FOUNDATION INVESTIGATION  
KINNIHAN CREEK STRUCTURE  
HIGHWAY 556, (SITE 38S-22)  
DISTRICT OF SAULT STE. MARIE  
FOR  
MINISTRY OF TRANSPORTATION  
AND COMMUNICATIONS  
W.P. 278-85-01

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FEBRUARY, 1986

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# PETO MacCALLUM LTD.

165 CARTWRIGHT AVENUE, TORONTO, ONTARIO M6A 1V5

CONSULTING ENGINEERS

Phone (416) 789-4105

Job No. 86 F 11

February 25, 1986

Ministry of Transportation  
and Communications  
1201 Wilson Avenue  
Room 315, Central Building  
Downsview, Ontario  
M3M 1J8

Attention: Mr. M. Devata, P. Eng.  
Chief Foundations Engineer

Dear Sirs:

Re: Foundation Investigation  
Kinnihan Creek Structure  
Highway 556, (Site 38S-22)  
District 18, Sault Ste. Marie

We are pleased to present our report on the foundation investigation carried out for the above referenced site, as authorized in agreement 4238-9085-134.

The stratigraphy encountered at the proposed culvert site generally comprises of surficial topsoil and peat deposits overlying competent strata of gravelly sand and sandy gravel, containing numerous cobbles and boulders.

The stabilized groundwater level corresponds to the water level in the existing creek, and is expected to fluctuate seasonally.



In general, the subsurface conditions are favourable to support the proposed concrete box culvert or twin S.P.C.S.P. However, overexcavation will be required to remove peat which extends below the founding level of the culvert by about 1.0 m at the northeast. The area can be raised to the founding level with compacted granular backfill.

Stream diversion and groundwater control will be required to enable culvert construction. Dewatering may be achieved by either a well point system or with high capacity pumps located in sump pits around the perimeter of the excavation.

The attached report provides details of the project methodology, site conditions and engineering analysis together with guidelines regarding design and construction of the proposed culvert. The report also provides recommendations pertaining to approach embankment construction.

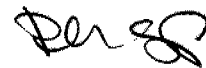
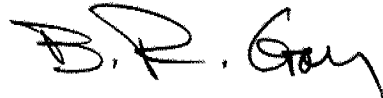
We believe the report has been completed within our terms of reference and trust the information presented herein is sufficient for your present requirements.

Should you have any questions, or when we may be of further assistance to you during the construction phase of the project, please do not hesitate to contact our office.

We appreciate this opportunity to be of service to the  
Ministry of Transportation and Communications.

Yours very truly,

PETO MacCALLUM LTD.



Brian R. Gray, P. Eng.  
Vice President  
Geotechnical Engineering

BRG/mc

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TABLE I pH Value and Sulphate Content of Water Sample

FIGURES 1, 2 AND 3 Grain Size Distribution Charts

RECORD OF BOREHOLES

DRAWING 2788501-A

## 1. INTRODUCTION

Peto MacCallum Ltd. was authorized by the Ministry of Transportation and Communications, Agreement Number 4238-9085-134 dated December 4, 1985, to carry out a foundation investigation for the proposed Kinnihan Creek Structure on Highway 556 in the District of Sault Ste. Marie, Ontario.

The purpose of the investigation was to determine detailed subsurface soil and groundwater conditions at the site and based on that information to provide this engineering report with detailed geotechnical recommendations pertaining to design and construction of the proposed structure and approach embankments.

## 2. FIELD WORK

The originally proposed field investigation involved three (3) boreholes programmed to 7.5 m depth for the proposed structure and two (2) boreholes to 3.0 m depth for the approach embankments. However, the field investigation disclosed discontinuous weak soil deposits and additional boreholes were drilled to delineate the poor soils.

The actual field programme involved three (3) boreholes drilled to depths of between 7.3 and 8.0 m for the proposed structure, and six (6) boreholes advanced to depths of 0.6 to 3.2 m for the approach embankments.

Dynamic cone penetration tests were driven adjacent to the boreholes for the structure, to determine the relative density of the overburden deposits. The boreholes and cone test locations are illustrated on the appended Drawing 2788501-A. Prior to drilling the boreholes, the site was cleared of snow with a "bulldozer" to facilitate drillrig access.

The actual drilling work was carried out on 1986 02 03 through 1986 02 05, with a CME-55 Bombardier mounted drillrig equipped with continuous flight hollow stem augers. The drillrig was supplied and operated by Masters Soil Investigations Limited.

In the boreholes, representative samples of the overburden were secured at regular intervals throughout the depth explored. Standard penetration tests were carried out during sampling operations using conventional split spoon equipment.

Dynamic cone penetration tests were performed to provide a continuous record of the relative density of the granular deposits in the vicinity of the proposed structure.

Groundwater observations were carried out in the boreholes during and after the completion of drilling.

The field work was supervised throughout by a member of our engineering staff who directed the drilling and sampling process, prepared the stratigraphic logs, monitored groundwater conditions and cared for the recovered samples.

The locations and ground surface elevations of the boreholes and dynamic cone penetration tests were established in the field by Peto MacCallum Ltd. The ground surface elevations have been referred to the following temporary benchmark (T.B.M.), as shown on MTC Plan E-8054-1 dated 1985 01.

T.B.M.      Nail in root of 0.45 m diameter Spruce tree  
             32.8 m left of centreline at Station  
             12+347.0.  
             Elevation: 353.659 (Geodetic, metric).

All recovered samples obtained during the investigation were returned to our laboratory for detailed examination and routine classification testing.

The laboratory testing programme consisted of:

- i) natural moisture content determination tests on all recovered samples with results shown on the appended Record of Borehole sheets;
- ii) four (4) particle size distribution analyses with results illustrated in Figures 1 to 3; and
- iii) two (2) pH value and sulphate contents of water samples.

### 3. SUMMARIZED SITE AND SUBSURFACE CONDITIONS

#### 3.1 Surficial Features

The Kinnihan Creek is approximately 5 m wide in the vicinity of the proposed structure and the water was flowing at about 0.5 m depth at the time of the field work.

The creek channel is about 1.0 m deep and flows through a flood plain which is approximately 50 to 60 m wide. The flood plain is vegetated with small bushes whereas the ground to the east and west of the flood plain is vegetated with mature deciduous and coniferous trees.

#### 3.2 Subsurface Stratigraphy

We refer to the appended Record of Borehole sheets for details of the field work including soil classifications inferred stratigraphy, standard penetration "N" values, dynamic cone penetration tests, groundwater observations in the open boreholes during and upon completion of drilling and laboratory moisture content determination test results.

The summarized subsurface conditions are presented on sections and profiles included on the appended plan.

The stratigraphy at the creek crossing generally comprises either topsoil or peat overlying major fluvial deposits of gravelly sand and sandy gravel.

### 3.2.1 Topsoil/Peat

Boreholes 2, 4 and 8 put down on the east and west sides of the flood plain encountered 150 to 300 mm of dark brown sandy silt topsoil.

Elsewhere boreholes 1, 3, 5, 6, 7 and 9 drilled within the flood plain environment encountered shallow peat deposits extending to depths between 1.0 and 2.1 m. The peat deposits were thickest to the north of the proposed road centreline.

### 3.2.2 Gravelly Sand/Sandy Gravel

Underlying the surficial peat and topsoil, the boreholes encountered major deposits of gravelly sand and sandy gravel to the termination depths. Grain size distribution analyses carried out on split spoon samples are illustrated on Figures 1, 2 and 3. It should be noted that the sampling procedures exclude particles larger than about 40 mm and consequently the gravel contents in the field are higher than indicated by the laboratory tests. The deposits typically contain numerous cobbles and boulders.

The granular soils are generally loose to very dense with depth based on standard penetration "N" values and dynamic cone penetration tests ranging from 3 to in excess of 100 blows per 0.3 m. The native soils are generally saturated below depths of about 1.0 m and may boil when subjected to an unbalanced hydrostatic head.



### 3.3 Groundwater

The groundwater observations carried out in the open boreholes during and upon completion of drilling indicate that the stabilized groundwater level at the site presently matches the water level in the creek which is at about elevation 351.9. The groundwater levels would be expected to fluctuate seasonally with the creek level.

Two (2) chemical analysis conducted on samples of the groundwater are summarized on Table I and indicate pH values of 7.4 and 7.5 with sulphate contents as  $\text{SO}_4$  of 58 and 96 ppm.

## 4. DISCUSSION AND RECOMMENDATIONS

The project involves the proposed construction of a 25 m long concrete box culvert or twin 3.048 m diameter structural plate corrugated steel culverts (S.P.C.S.P.) to carry the relocated Highway 556 (Line "C") across Kinnihan Creek, about 70 km northeast of Sault Ste. Marie (Site 38S-22). The invert level of the new structures will match the existing creek bottom level at about elevation 351.4.

The soil conditions contacted at the site are generally favourable for construction of the above two alternatives.

#### 4.1 Foundation Considerations

We do not anticipate any major bearing problems for either the box culvert or S.P.C.S.P. since the native mineral soils available below elevation 350.4 at the north and 351.2 at the south are capable of carrying loads of up to 200 kPa at the serviceability limit states, and 300 kPa at the ultimate limit states, and it is unlikely that the applied loads will approach these values. Beneath the pipe at the northeast, in the vicinity of borehole 3, peat soils overlie the native mineral soils and extend below the proposed founding levels of the structures by about 1.0 m.

The peat soils must be completely removed for at least 1.0 m beyond the plan limits of the culvert and the excavation backfilled up to the subgrade level with 200 mm thick horizontal lifts of granular material compacted to at least 100% Standard Proctor maximum dry density.

For the box culvert, the base slab may be founded on a minimum 300 mm thick cushion of granular base compacted to 100% Standard Proctor maximum dry density. The granular base course to support the S.P.C.S.P. should be prepared in a similar manner. However, the base materials should not be compacted within 300 mm of the culvert in accordance with the Ontario Provincial Standard Drawing (OPSD) 802.01. The subgrade should be shaped to support the pipe.

Backfilling of the pipe and culvert with granular material and end treatment with an upstream and downstream cutoff to protect against scour erosion should be carried out in accordance with the Ontario Provincial Standards.

Any foundations exposed to freezing temperatures must be provided with a minimum 2.0 m of earth cover or equivalent insulation to provide adequate protection against possible frost damage.

#### 4.2 Groundwater Control

Excavations to remove the peat and prepare the culvert base will extend up to 1.8 m below the present groundwater level. Following a suitable stream diversion, dewatering may be accomplished with a vacuum well point system or by high capacity pumps pumping from perforated pipes placed in large keg wells, located around the perimeter of the excavation.

If a well point system is considered, the contractor should be aware that difficulty may be encountered advancing the well points due to the presence of boulders and cobbles. The precise type, number, depth and locations of the dewatering system should be left to the Contractor's discretion. However, the system should meet a performance specification to maintain and control the groundwater at least 0.3 m below the excavation base, with appropriate standby capacity in case of equipment failure.

The keg wells should consist of a perforated pipe wrapped with filter cloth and surrounded by 19 mm clear crushed stone. The wells should be spaced such that the groundwater levels are maintained at least 0.30 m below the excavation base, and should be installed by a Contractor experienced in this type of dewatering system.

Considering the remote location of the site and relative cost, keg wells may prove to be a more appropriate dewatering method.

The complete groundwater control system should be maintained effective until backfilling operations have been completed to at least 1 m above to the stabilized groundwater level prior to site dewatering. It is imperative that the recharge of the groundwater be regulated to prevent possible buildup of hydrostatic pressure at the level of the culvert which could result in loss of ground and subsequent structural damage. Installation of observation wells, prior to excavation, would be prudent to evaluate the groundwater control methods as construction progresses.

Any temporary excavation slopes at the site should be trimmed back at 1.5 horizontal to 1 vertical with the dewatering system in operation.

#### 4.3 Earth Pressures

The culvert walls should be designed to resist the unbalanced lateral forces acting on the wall. In this regard, provided that the culverts are backfilled in accordance with OPSD 803.01, involving the provision of free draining granular backfill behind the wall, design can be based on the following geotechnical parameters:

##### Granular "A"

Friction angle between granular backfill and concrete,	$\delta = 28^\circ$
Friction angle of compacted granular backfill,	$\phi = 35^\circ$
Bulk density of compacted granular backfill behind the wall,	$\gamma = 22.0 \text{ kN/m}^3$

##### Granular "B"

Friction angle between granular backfill and concrete,	$\delta = 24^\circ$
Friction angle of compacted granular backfill,	$\phi = 30^\circ$
Bulk density of compacted granular backfill behind the wall,	$\gamma = 21.2 \text{ kN/m}^3$

#### 4.4 Approach Embankments

Prior to construction of the 3 m high embankments, all peat and organic topsoil should be removed beneath the plan area of the embankment and replaced with approved local inorganic soils compacted to 95% Standard Proctor maximum dry density.

The local borrow material may be carried up to the subgrade level of the proposed roadway. Special procedures are required in the vicinity of the culvert to reduce the effect of differential frost heave. The backfill requirements are outlined in OPSD 803.01.

Groundwater control will be necessary to facilitate peat removal and replacement, and should be carried out as outlined in Section 4.2.

We recommend permanent slopes be constructed at a maximum inclination of 2 horizontal to 1 vertical for the approach embankments. Provided suitable borrow material is employed and OPS construction procedures are observed, we do not anticipate any slope or base stability problems. Slope protection involving seeding or sodding should be observed to control erosion due to surface runoff.

GM/mc



PETO MacCALLUM LTD.

A handwritten signature in cursive script, appearing to read "G. Mitchell".

G. Mitchell, P. Eng.

A handwritten signature in cursive script, appearing to read "S. Pilch".

S. Pilch, P. Eng.  
Chief Geotechnical Engineer

JOB NO. 86 F 11  
Feb. 26, 1986

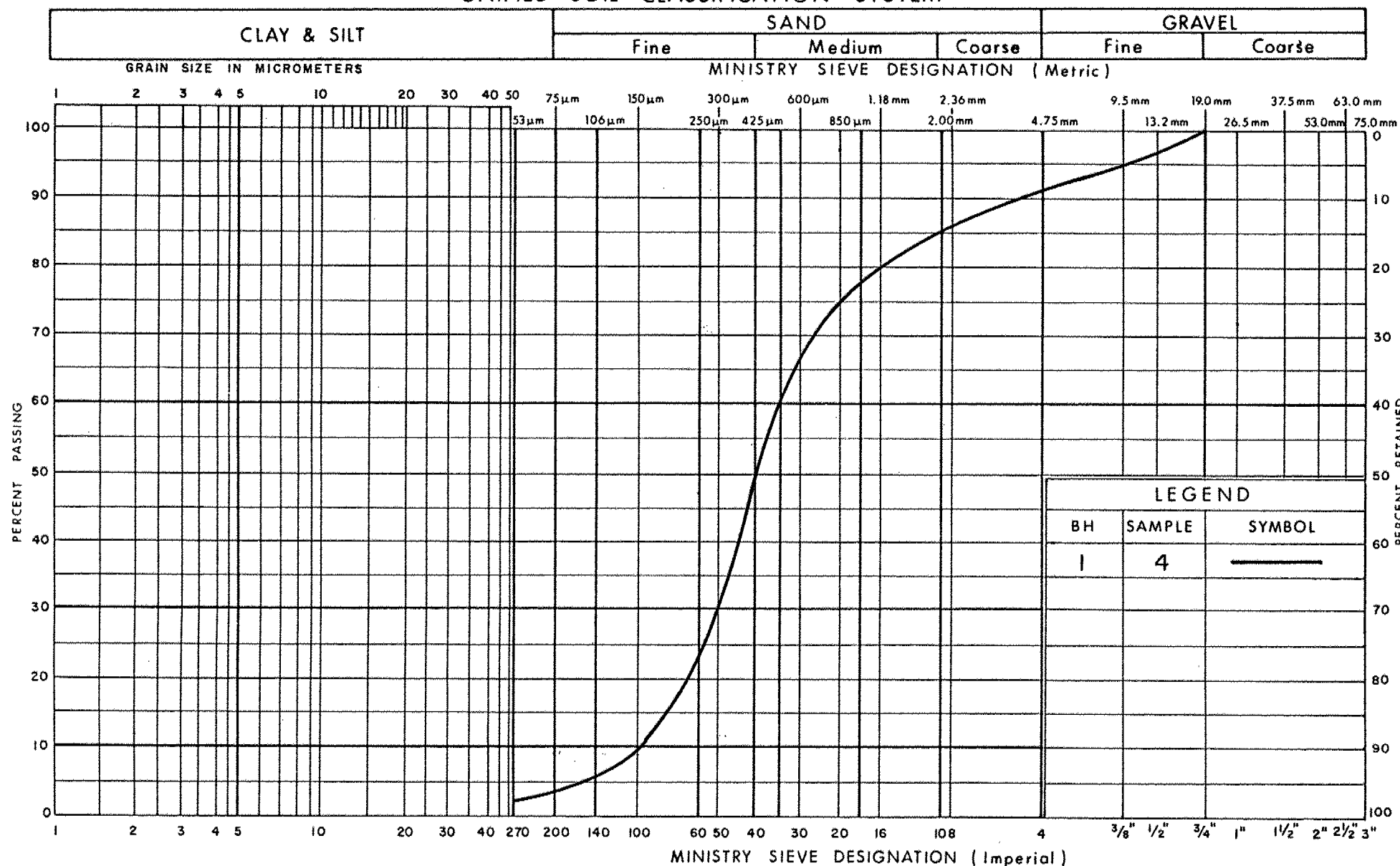
TABLE I  
pH VALUE AND SULPHATE CONTENT OF WATER SAMPLES

KINNIHAN CREEK STRUCTURE  
HIGHWAY 556  
DISTRICT OF SAULT STE. MARIE

<u>BOREHOLE NO.</u>	<u>DEPTH (m)</u>	<u>pH VALUE</u>	<u>SULPHATE CONTENT ppm as SO<sub>4</sub></u>	<u>RELATIVE DEGREE SULPHATE ATTACK ON CONCRETE</u>
4	1.0	7.5	96	Negligible
2	1.0	7.4	58	Negligible

PETO MacCALLUM LTD.

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of  
Transportation and  
Communications

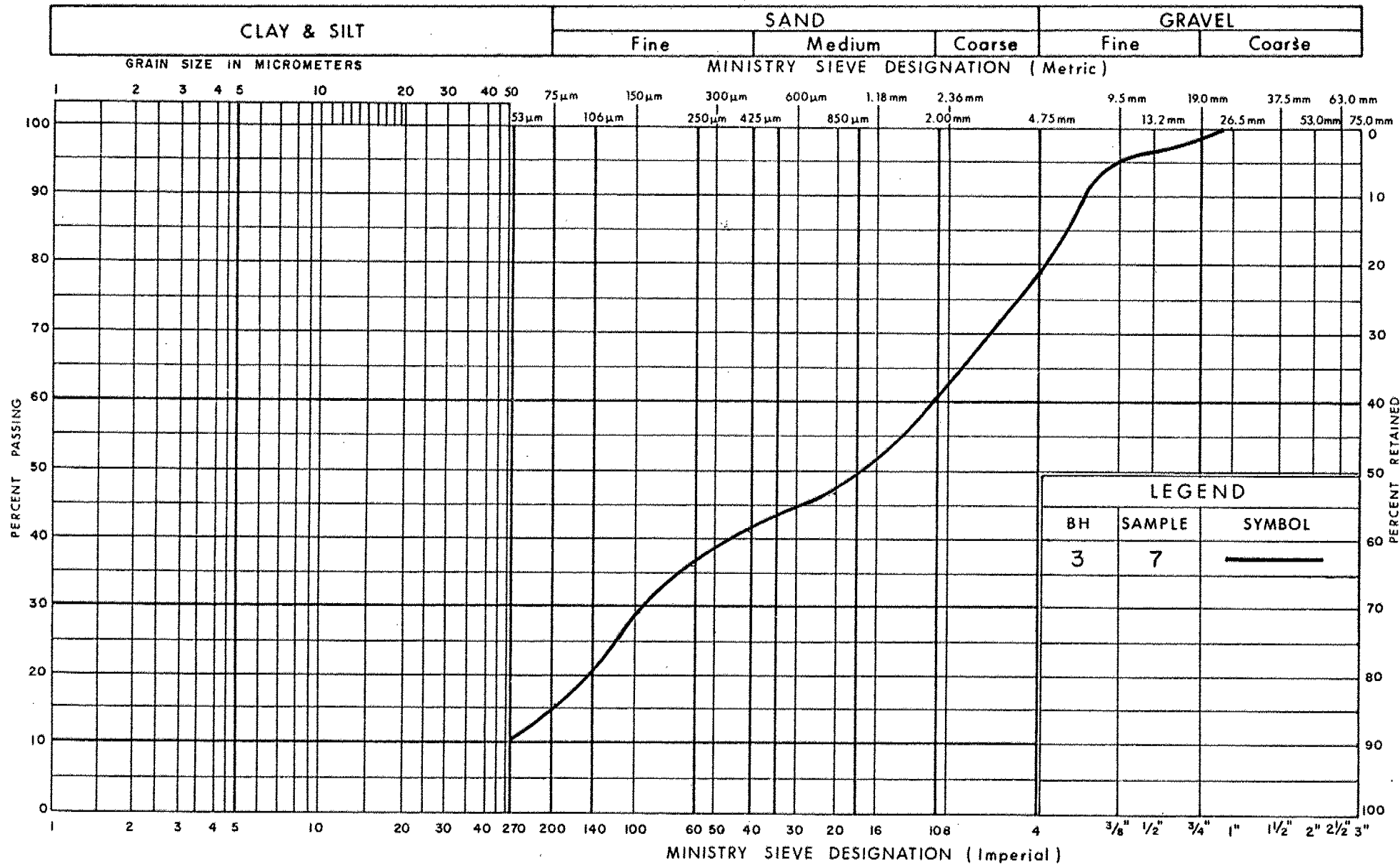
GRAIN SIZE DISTRIBUTION  
GRAVELLY FINE TO MEDIUM SAND  
TRACE SILT, NUMEROUS COBBLES

FIG No 1

W P 278 - 85 - 01



## UNIFIED SOIL CLASSIFICATION SYSTEM



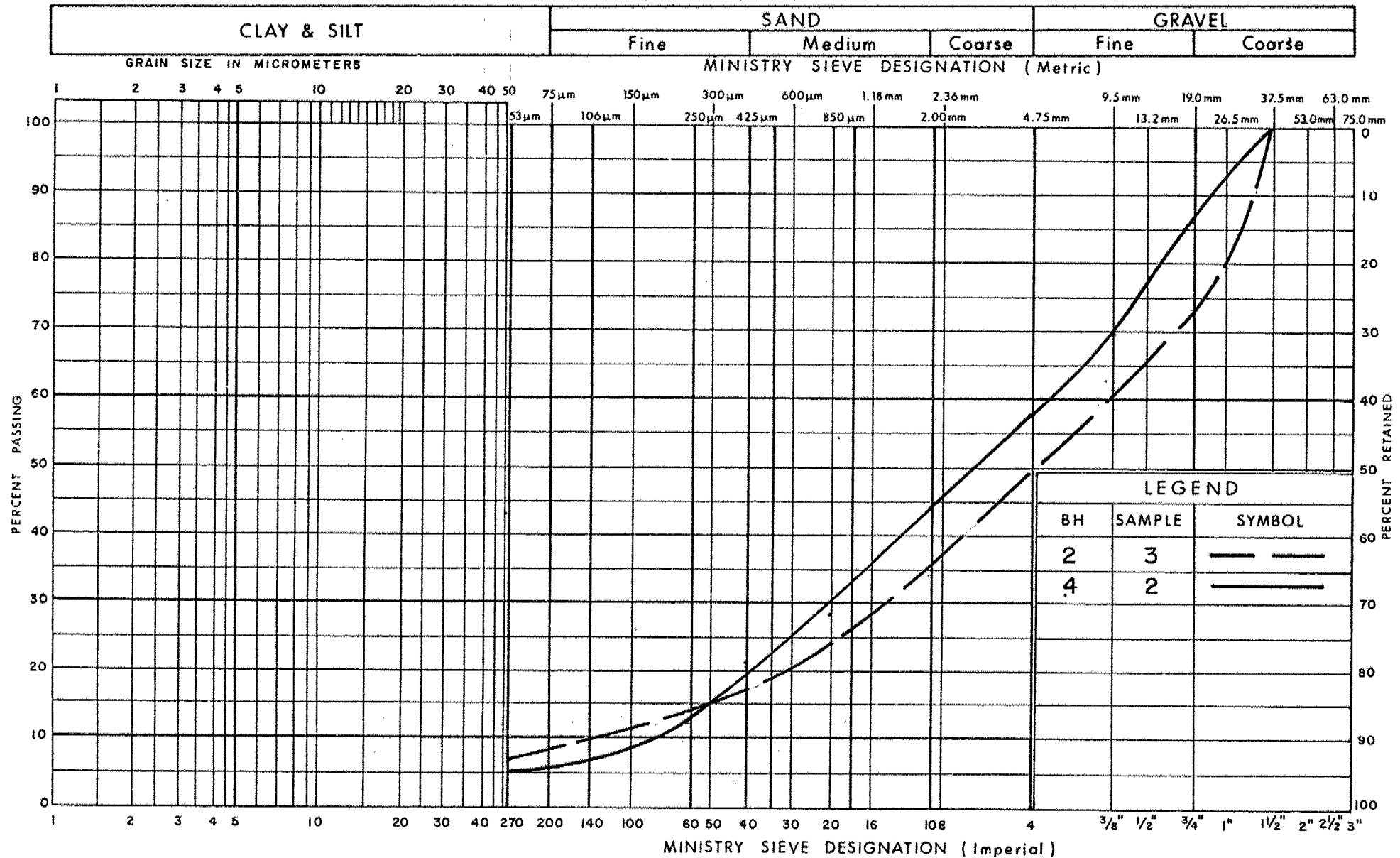
Ministry of  
Transportation and  
Communications

**GRAIN SIZE DISTRIBUTION**  
**GRAVELLY FINE TO COARSE SAND**  
 TRACE SILT, NUMEROUS COBBLES

FIG No 2

W P 278 - 85 - 01

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

**GRAIN SIZE DISTRIBUTION**  
**SANDY GRAVEL**  
TRACE SILT, NUMEROUS COBBLES & BOULDERS

FIG No 3

W P 278 - 85 - 01

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

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

**JOINTING AND BEDDING:**

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

### MECHANICAL PROPERTIES OF SOIL

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

### STRESS AND STRAIN

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

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	$\text{kg}/\text{m}^3$	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	$\text{kg}/\text{m}^3$	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	$\text{kg}/\text{m}^3$	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	$\text{kg}/\text{m}^3$	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	$\text{m}^3/\text{s}$	RATE OF DISCHARGE
$\gamma_d$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{sat}$	$\text{kg}/\text{m}^3$	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{sat}$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	$\text{kg}/\text{m}^3$	DENSITY OF SUBMERGED SOIL	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE	j	$\text{kN}/\text{m}^2$	SEEPAGE FORCE
$\gamma'$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SUBMERGED SOIL						

# RECORD OF BOREHOLE No 1

METRIC

W P 278-85-01 LOCATION Sta. 12 + 420 o/s 13m Rt. 2 Line 'C' ORIGINATED BY PC  
DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger, Wash Boring & Cone Test COMPILED BY GM  
DATUM Geodetic DATE 1986 02 04 CHECKED BY Jhm

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					
352.39	Ground Level												
0.00	Peat		1	SS	14*								*Frozen
351.19	Very Soft Dark Brown		2	SS	2								
1.20	Gravelly fine to medium sand, trace silt, numerous cobbles		3	SS	10								
	Loose to Compact Brown		4	SS	8								
			5	SS	10								
348.39	Sandy gravel, trace silt, numerous cobbles and boulders		6	SS	25								
4.00	Compact to Very Dense Brown		7	SS	56								
344.34			8	SS	50								
8.05	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 2

METRIC

W P 278-85-01 LOCATION Sta. 12 + 417 @ Line 'C' ORIGINATED BY PC  
 DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY GM  
 DATUM Geodetic DATE 1986 02 04 CHECKED BY JH

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20					
352.54	Ground Level												
352.24	Topsoil dark brown		1	SS	19								
0.30	Sandy gravel, trace silt, numerous cobbles and boulders		2	SS	33								
	Compact to Very Dense		3	SS	55								
	Brown		4	SS	15								
			5	SS	68								
			6	SS	28								
			7	SS	23								
345.19			8	SS	13								
7.35	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

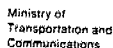
# RECORD OF BOREHOLE No 3

METRIC

W P 278-85-01 LOCATION Sta. 12 + 434 o/s 7m Lt. & Line 'C' ORIGINATED BY PC  
DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger, Wash Boring & Cone Test COMPILED BY GM  
DATUM Geodetic DATE 1986 02 04 CHECKED BY *gm*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
352.52	Ground Level																
0.00	Peat		1	SS	4		352									111	
	Very Soft Dark Brown		2	SS	2/45	0mm										83	
350.37			3	SS	2/45	0mm										93	
2.15	Gravelly fine to coarse sand, trace silt, numerous cobbles and boulders		4	SS	7		350										
348.87			5	SS	13												
3.65	Loose to Compact Brown																
	Sandy gravel, trace silt, numerous cobbles and boulders		6	WS			348										
346.42	Compact Brown																
6.10			7	SS	17		346										
	Gravelly fine to coarse sand, trace silt, numerous cobbles																
344.47	Compact Brown		8	SS	23												
8.05	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION



## METRIC

W P 278-85-01 LOCATION Sta. 12 + 408 @ Line 'C' ORIGINATED BY PC  
DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GM  
DATUM Geodetic DATE 1986 02 04 CHECKED BY gm

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) 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 (%) 20 40 60
352.67	Ground Level															
352.49	Topsoil dark brown		1	SS	11		352									
0.18	Sandy gravel, trace silt, numerous cobbles and boulders		2	SS	26									42 52 (6)		
			3	SS	50/45											
	Compact to Dense		4	SS	49		350									
349.42	Brown		5	SS	55/20											
3.25	End of Borehole															
*Note: High "N" value due to presence of boulders and cobbles.																

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

# RECORD OF BOREHOLE No 5

METRIC

W P 278-85-01 LOCATION Sta. 12 + 448 o/s 1m Lt. & line 'C' ORIGINATED BY PC  
 DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GM  
 DATUM Geodetic DATE 1986 02 03 CHECKED BY gla

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100					
352.68	Ground Level															
	Peat		1	SS	2/450mm											
	Sand layers below 0.60m															
351.48	Very Soft Dark Brown		2	SS	15											
1.20	Sandy gravel, trace silt, numerous cobbles and boulders		3	SS	10											
349.63	Compact to Loose Grey		4	SS	8											
3.05	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 6										METRIC			
W P 278-85-01		LOCATION Sta. 12 + 432.5 @ Line 'C'						ORIGINATED BY PC					
DIST 18 HWY 556		BOREHOLE TYPE Hollow Stem Auger						COMPILED BY GM					
DATUM Geodetic		DATE 1986 02 05						CHECKED BY gh					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
352.51	Ground Level												
0.00	Peat						352						
351.01	Very soft Dark Brown		1	SS	2/60mm								
1.50	Sandy gravel, trace												
350.36	silt, numerous cobbles		2	SS	3								
2.15	and boulders												
	Very Loose Brown												
	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 7

METRIC

W P 278-85-01 LOCATION Sta. 12 + 455 @ Line 'C' ORIGINATED BY PC  
 DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GM  
 DATUM Geodetic DATE 1986 02 06 CHECKED BY gh

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
352.69	Ground Level																
0.00	Peat																
351.64	Very Soft. Dark Brown						352										
351.29	Sandy gravel, trace		1	SS	4/45mm												
1.40	silt, numerous cobbles and boulders Very Loose - Brown																
	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 8

METRIC

W P 278-85-01 LOCATION Sta. 12 + 456 @ Line 'C' ORIGINATED BY PC  
 DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GM  
 DATUM Geodetic DATE 1986 02 05 CHECKED BY gh

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
352.62	Ground Level													
352.13	Topsoil Dark Brown		1	AS			352							
351.93	Sandy gravel, trace silt, numerous cobbles and boulders													
0.65	Dark Brown to Brown													
	End of Borehole (Refusal to auger on boulder)													
	Note: No water encountered during drilling.													

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 9

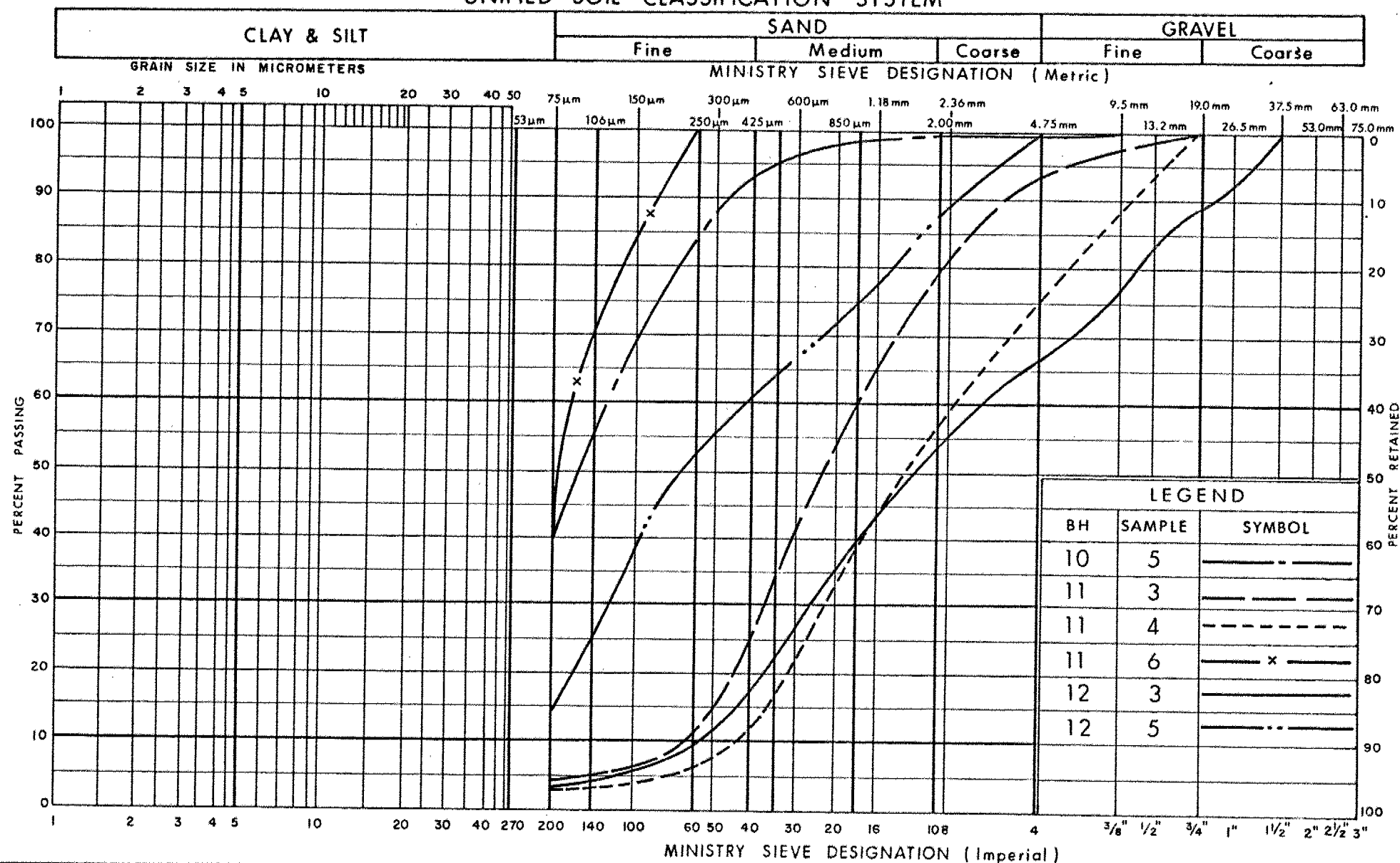
METRIC

W P 278-85-01 LOCATION Sta. 12 + 445 o/s 8m Lt. of Line 'C' ORIGINATED BY PC  
DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GM  
DATUM Geodetic DATE 1986 02 05 CHECKED BY *gjm*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH						
352.51	Ground Level														
0.00	Peat						352								
	Very Soft Dark Brown		1	SS	2/60mm										
351.01															
1.50	Sandy gravel, trace														
350.36	silt, numerous cobbles		2	SS	5										
2.15	and boulders														
	Loose Brown														
	End of Borehole														

OFFICE REPORT ON SOIL EXPLORATION

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

## GRAIN SIZE DISTRIBUTION

FIG No 4

W P 278-85-01

# RECORD OF BOREHOLE No 10

METRIC

W P 278-85-01 LOCATION Sta. 12 + 446 O/S 12.5 Lt Q Hwy 556 ORIGINATED BY MJ  
 DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY LP  
 DATUM Geodetic DATE 1987 01 20 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
352.3	Ground Surface												
0.0	Peat      some gravel Fine sand with silt sand becoming finer with depth Loose		1	SS	1								1 60 (39)
			2	SS	0								
			3	SS	0								
350.2			4	SS	2								
2.1			5	SS	6								
			6	SS	6								
347.9	End of Borehole												
4.4													
345.9													
6.4	End of Cone Test												

+3, x5 : Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10



# RECORD OF BOREHOLE No 11

METRIC

W P 278-85-01 LOCATION Sta. 12 + 445 at Q Hwy. 556 ORIGINATED BY MJ  
 DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY LP  
 DATUM Geodetic DATE 1987 01 20 CHECKED BY sp

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100							WATER CONTENT (%) 10 20 30
								SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE							
352.5	Ground Surface														
0.0	Peat	~	1	SS	0		352								
351.7			2	SS	6										
0.8	Med. Coarse Sand, trace/some gravel, trace silt	•••••	3	SS	5									6 90 (4)	
			4	SS	5									26 71 (3)	
349.5	Loose		5	SS	4										
3.0	Fine sand with silt	•••••	6	SS	6										
348.1	Loose	•••••					348							0 61 (39)	
4.4	End of Borehole														
346.1															
6.4	End of Cone Test						346								

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 12

METRIC

W P 278-85-01 LOCATION Sta. 12 + 444 O/S 11.5 RT Q Hwy. 556 ORIGINATED BY MJ  
 DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY LP  
 DATUM Geodetic DATE 1987 01 20 CHECKED BY 10

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
352.5	Ground Surface													
0.0	Peat		1	SS	1		352							
351.6			2	SS	11									
0.9	Sand, trace/some silt gravel (well-graded)		3	SS	17		350							33 63 (4)
	Loose to Compact		4	SS	2									
			5	SS	9									1 85 14
348.1	fine sand		6	SS	11		348							
4.4	End of Borehole													
346.4														
6.1	End of Cone Test						346							

+3, x5: Numbers refer to  
Sensitivity

20  
15  $\phi$  5 (%) STRAIN AT FAILURE  
10





# RECORD OF BOREHOLE No 13

METRIC

W P 278-85-01 LOCATION Sta. 12 + 445 O/S 6 RT Q Hwy. 556 ORIGINATED BY MJ  
DIST 18 HWY 556 BOREHOLE TYPE Cone Test COMPILED BY LP  
DATUM Geodetic DATE 1987 01 20 CHECKED BY 10

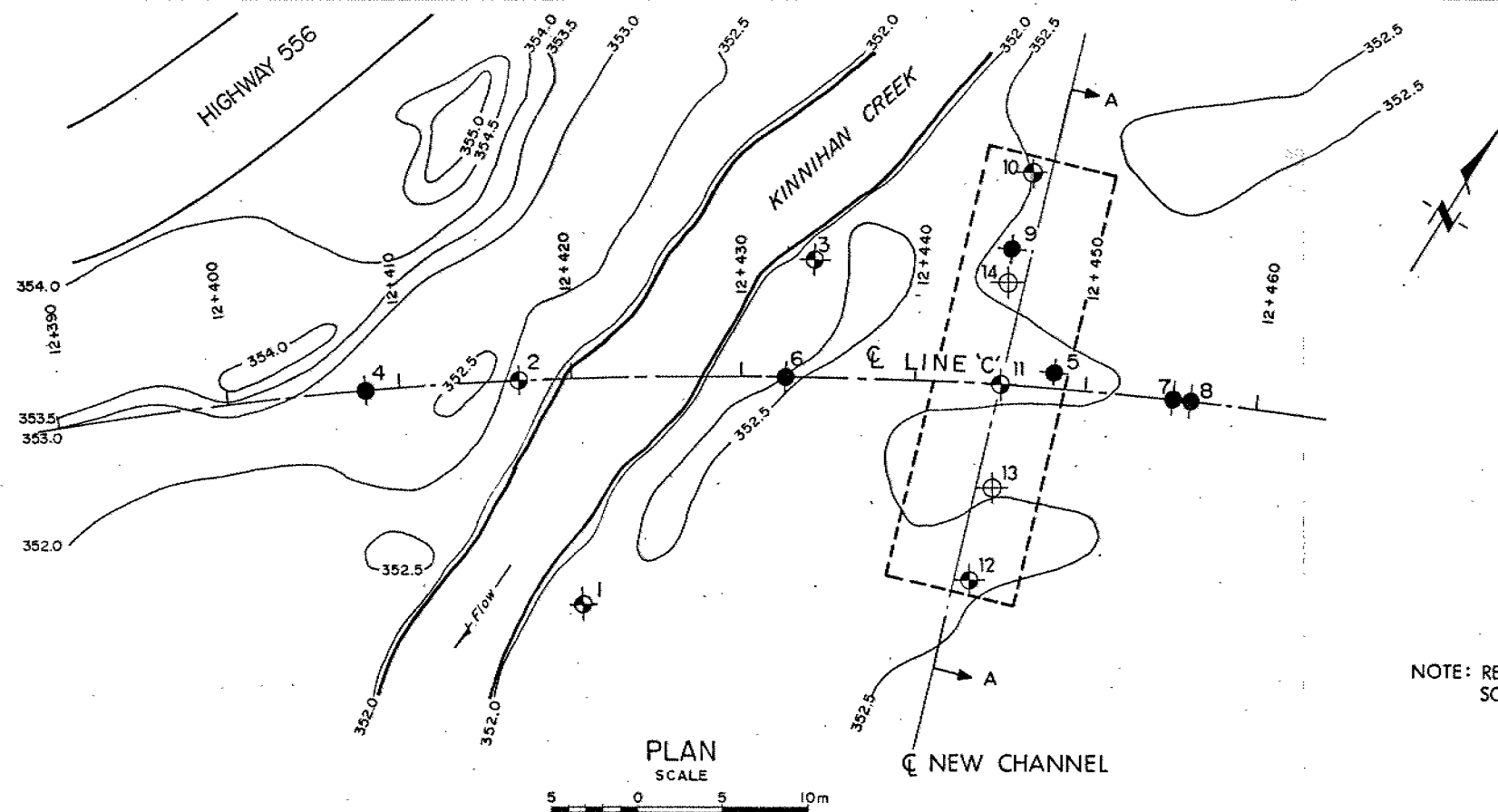
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W <sub>p</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub> WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES							
352.5 0.0	Ground Surface						352					
							350					
							348					
346.1												
6.4	End of Cone Test											

# RECORD OF BOREHOLE No 14

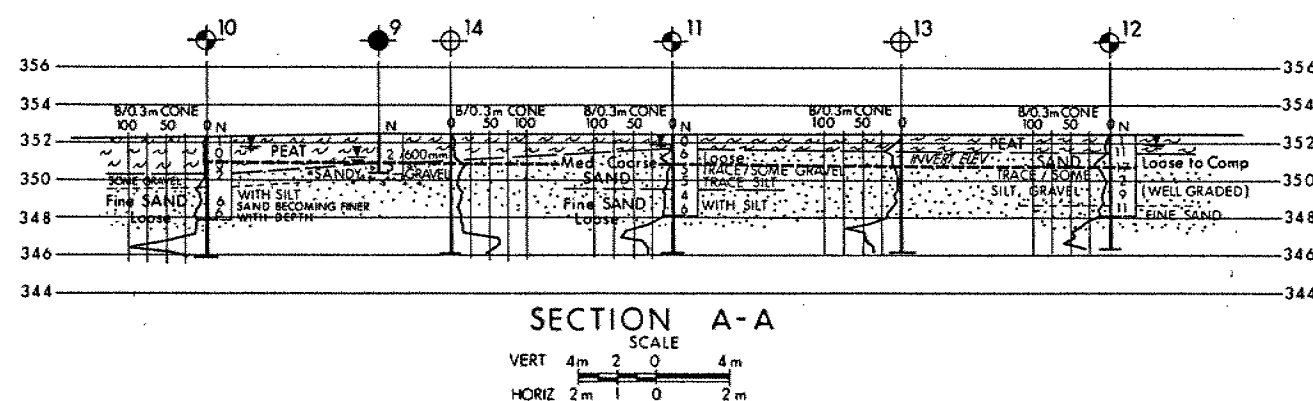
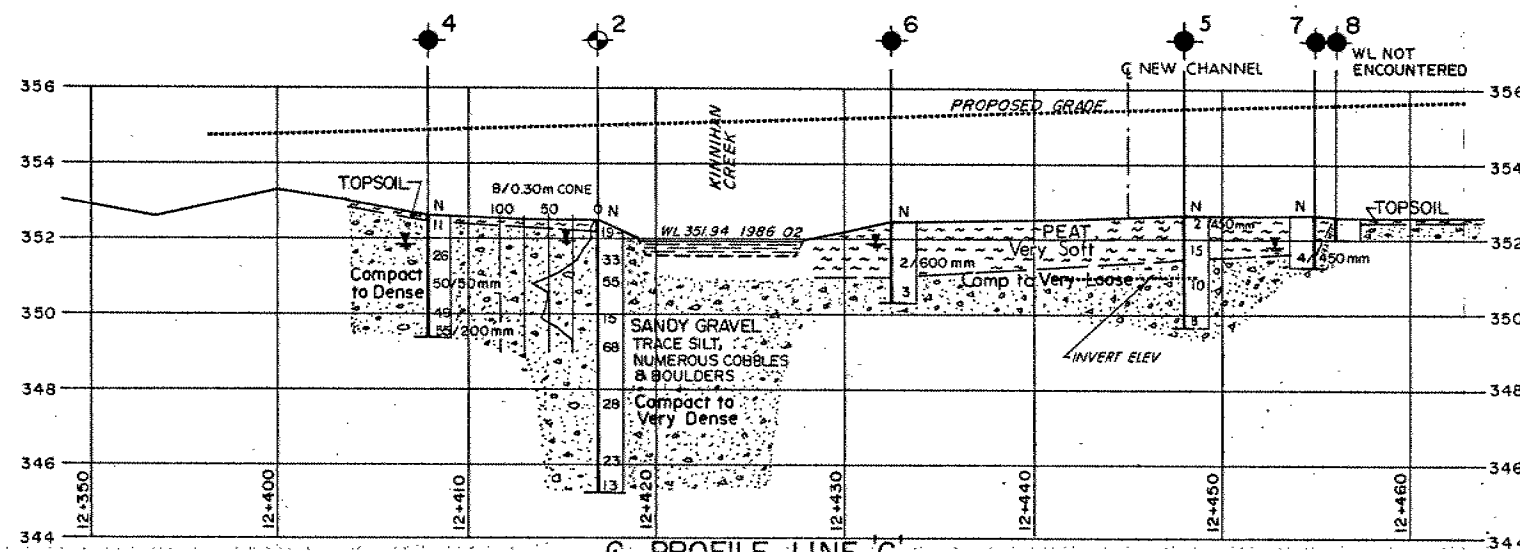
METRIC

W P 278-85-01 LOCATION Sta. 12 + 445 O/S 6 LT C Hwy. 556 ORIGINATED BY MJ  
 DIST 18 HWY 556 BOREHOLE TYPE Cone Test COMPILED BY LP  
 DATUM Geodetic DATE 1987 01 20 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
352.5													
0.0													
346.1													
6.4	End of Cone Test												



NOTE: REFER TO RECORD OF BORE HOLE FOR SOIL DESCRIPTION FOR BH 1 & 3



**METRIC**

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

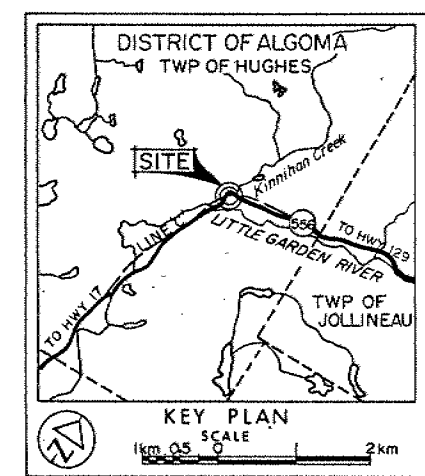
CONT No  
WP No 278-85-01

KINNIHAN CREEK STRUCTURE  
AT HIGHWAY 556  
BORE HOLE LOCATIONS & SOIL STRATA



SHEET

PETO MACCALLUM LTD.



**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 1986 02 & 1987 01

No	ELEVATION	STATION	OFFSET
1	352.39	12+420	13m RT
2	352.54	12+417	℄
3	352.52	12+434	7m LT
4	352.67	12+408	℄
5	352.68	12+448	1m LT
6	352.51	12+432.5	℄
7	352.69	12+455	℄
8	352.62	12+456	℄
9	352.51	12+445	8m LT
10	352.3	12+446	12.5 m LT
11	352.5	12+445	℄
12	352.5	12+444	11.5 m RT
13	352.5	12+445	6 m RT
14	352.5	12+445	6 m LT

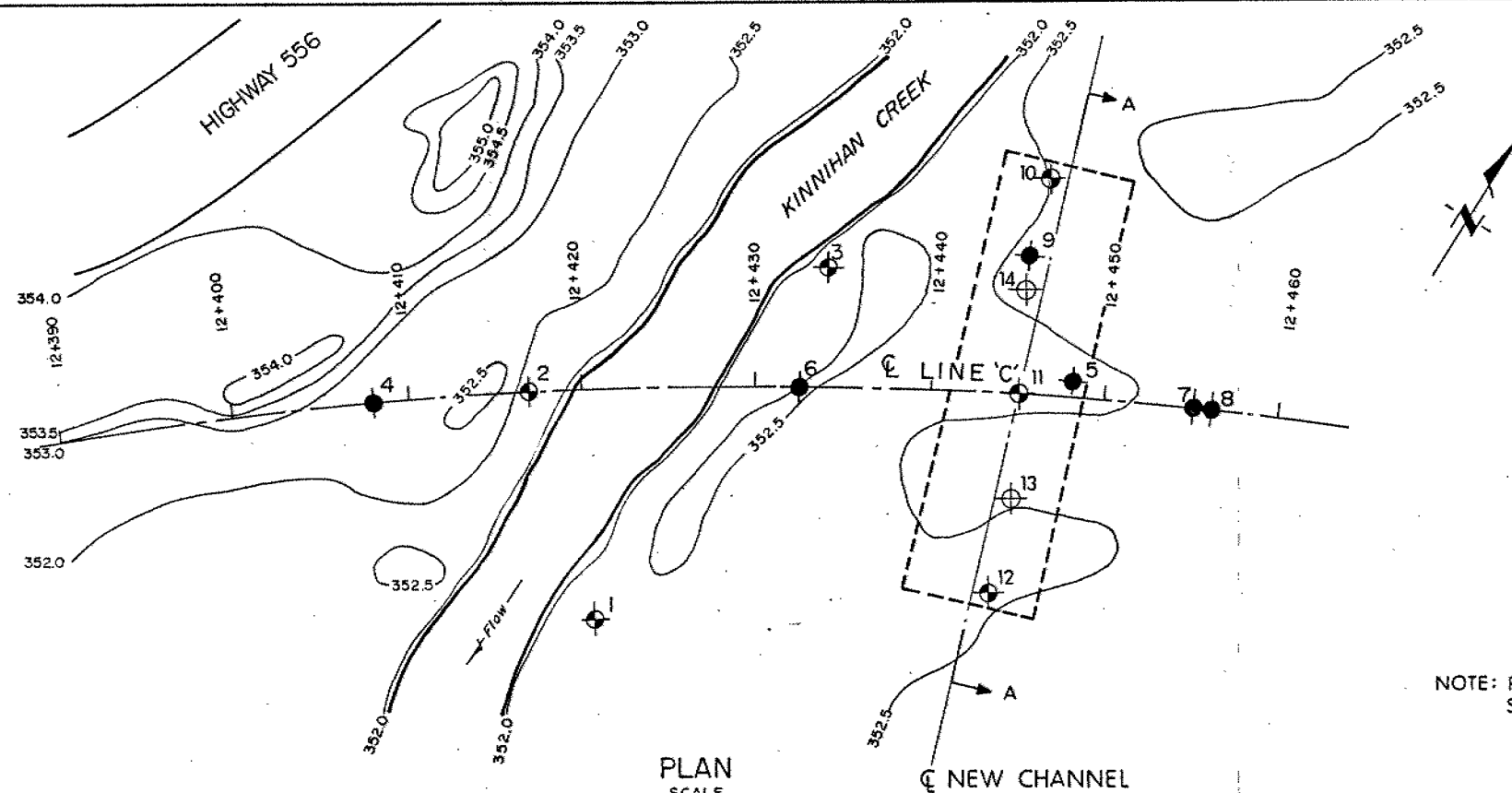
1987 01  
MTC

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

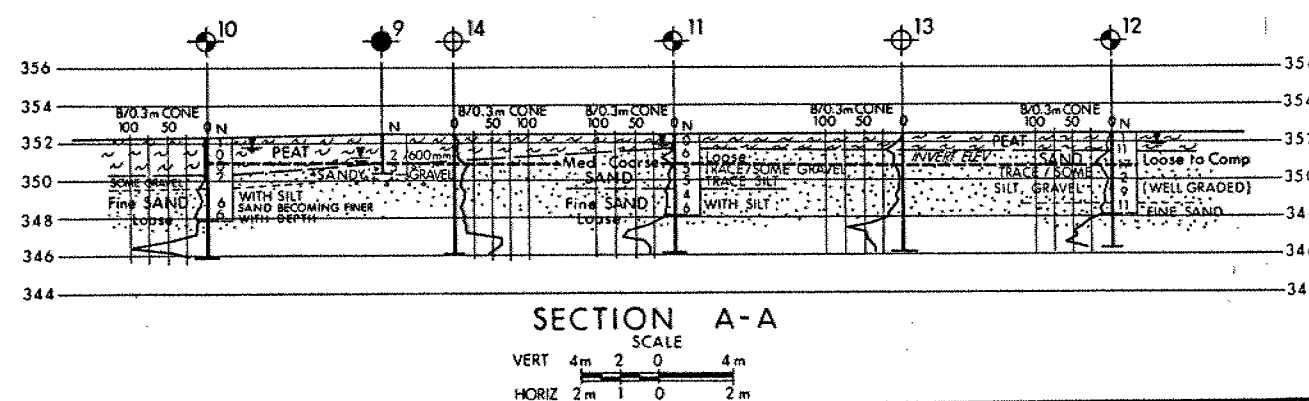
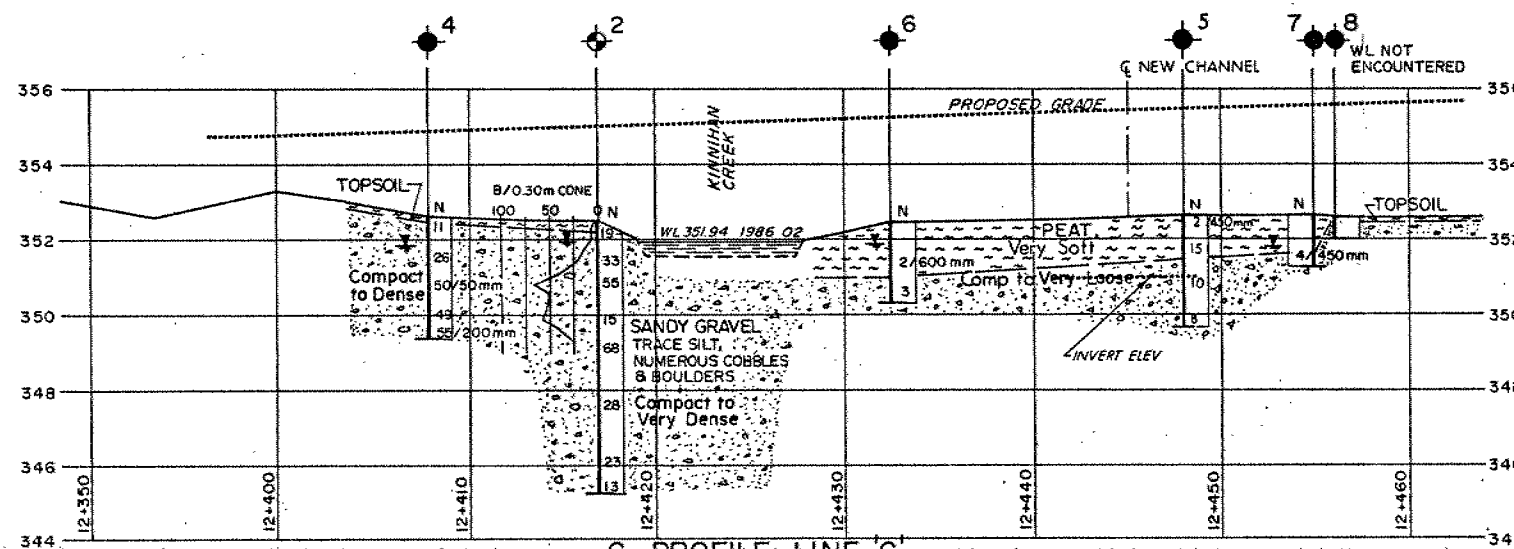
NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2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

DATE	BY	DESCRIPTION
8703	SO	SECTION A-A REVISED

Geocres No	41J - 45
HWY No	556 LINE 'C'
SUBM'D GM	CHECKED/DATE 1986 02 24
DRAWN	KE/CHECKED/DATE 1986 02 24
DIST	18
SITE	385-22
DWG	2788501-A



NOTE: REFER TO RECORD OF BORE HOLE FOR SOIL DESCRIPTION FOR BH 1 & 3



**METRIC**

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

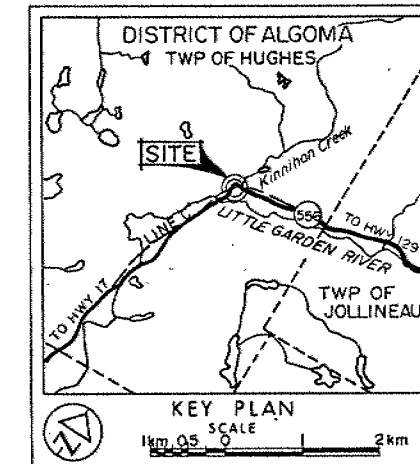
CONT No  
WP No 278-85-01

KINNIHAN CREEK STRUCTURE  
AT HIGHWAY 556  
BORE HOLE LOCATIONS & SOIL STRATA



SHEET

PETO MacCALLUM LTD.



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 1986 02 & 1987 01

No	ELEVATION	STATION	OFFSET
1	352.39	12+420	13m RT
2	352.54	12+417	€
3	352.52	12+434	7m LT
4	352.67	12+408	€
5	352.68	12+448	1m LT
6	352.51	12+432.5	€
7	352.69	12+455	€
8	352.62	12+456	€
9	352.51	12+445	8m LT
10	352.3	12+446	12.5 m LT
11	352.5	12+445	€
12	352.5	12+444	11.5 m RT
13	352.5	12+445	6 m RT
14	352.5	12+445	6 m LT

1987 01  
MTC

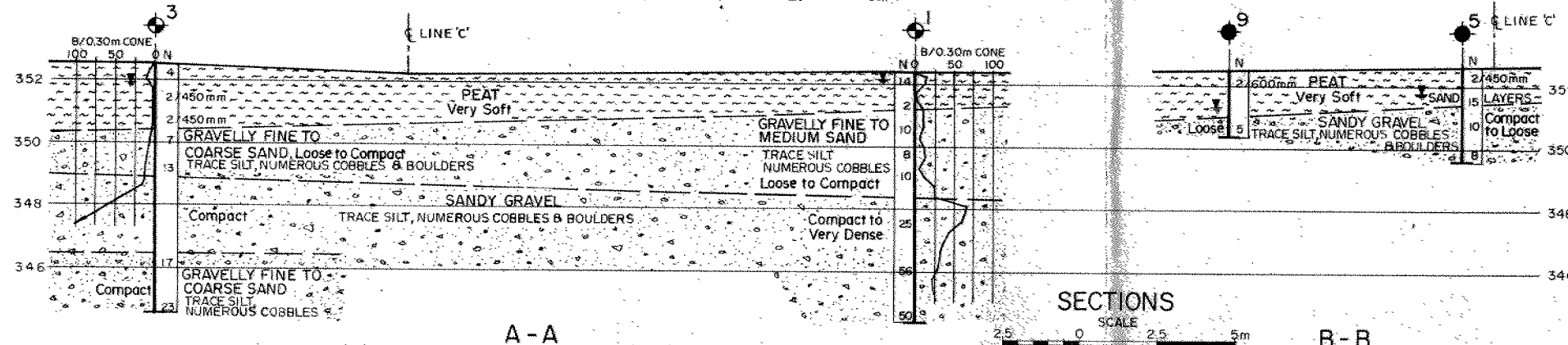
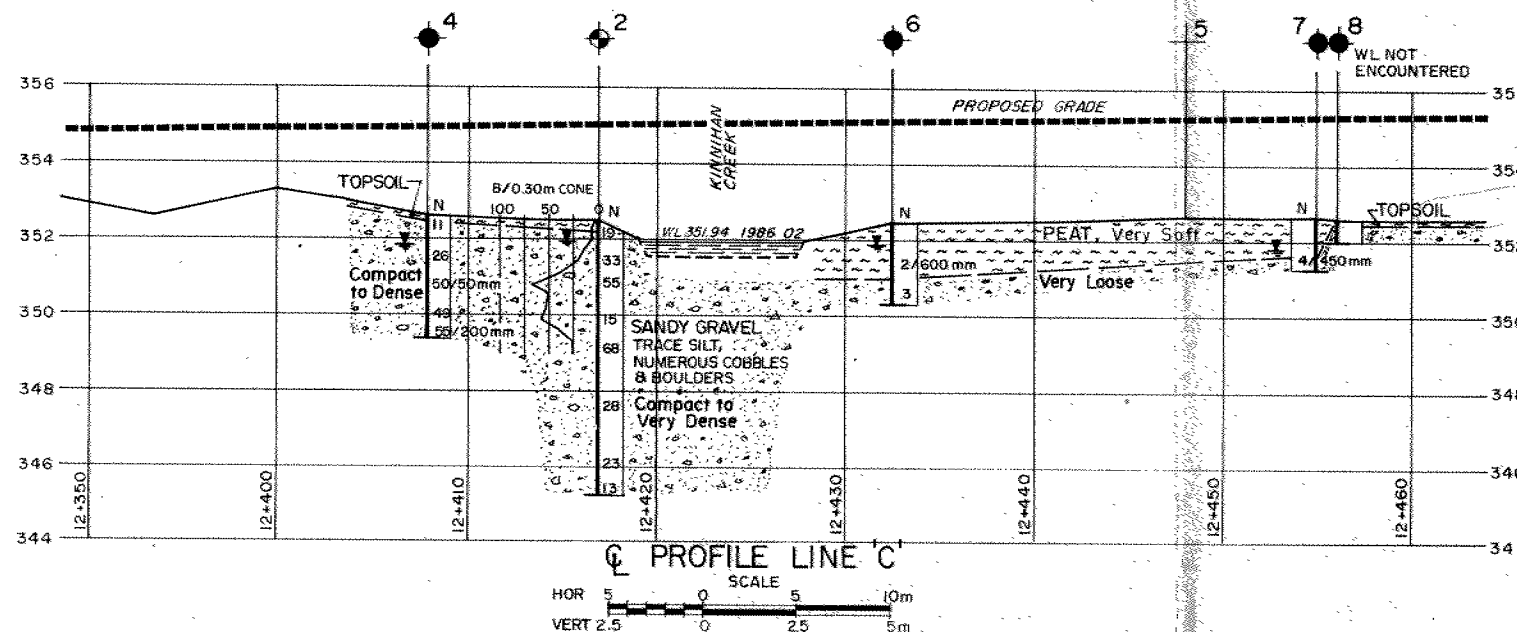
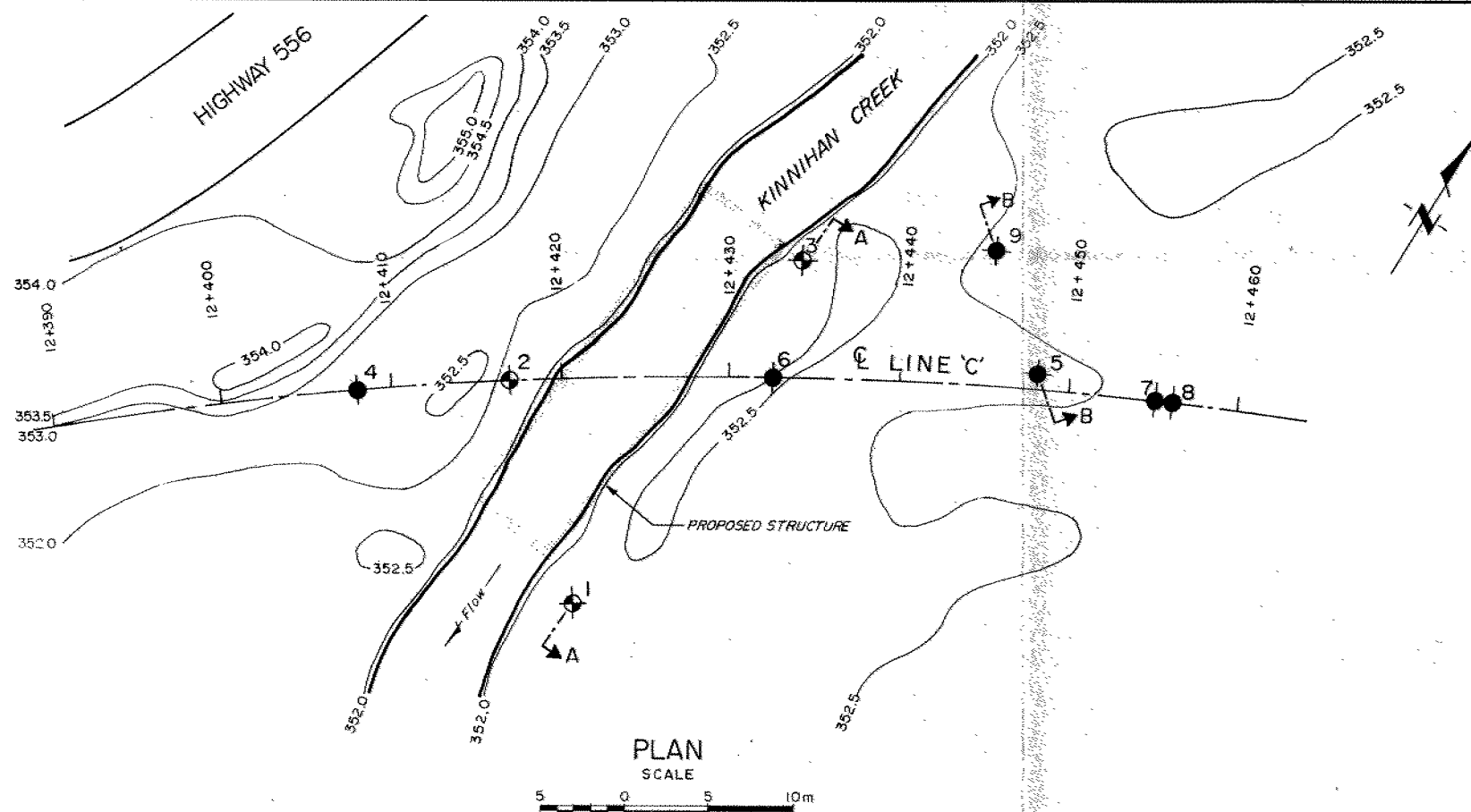
=NOTE=

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.

DATE	BY	DESCRIPTION
8703	SO	SECTION A-A REVISED

Geocres No 41J-45	
HWY No 556 LINE 'C'	DIST 18
SUBM'D GM CHECKED DATE 1986 02 24	SITE 385-22
DRAWN KZ CHECKED SR APPROVED S.P.	DWG 2788501-A



**METRIC**

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

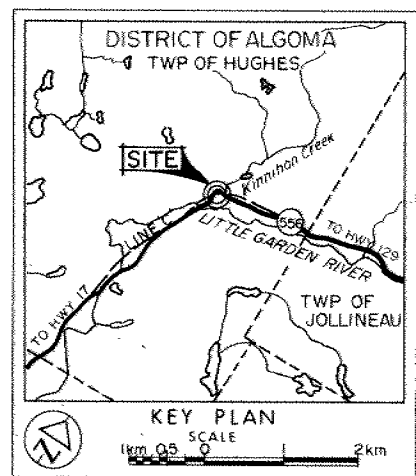
CONT No  
WP No 278-85-01

KINNIHAN CREEK STRUCTURE  
AT HIGHWAY 556  
BORE HOLE LOCATIONS & SOIL STRATA



SHEET

PETO MacCALLUM LTD.



**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 of time of investigation 1986 02

No	ELEVATION	STATION	OFFSET
1	352.39	12+420	13m RT
2	352.54	12+417	℄
3	352.52	12+434	7m LT
4	352.67	12+408	℄
5	352.68	12+448	1m LT
6	352.51	12+432.5	℄
7	352.69	12+455	℄
8	352.62	12+456	℄
9	352.51	12+445	8m LT

**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.

DATE	BY	DESCRIPTION
------	----	-------------

Geocres No 41J-45

HWY No 556 LINE 'C'	DIST 18
SUBMD GM [CHECKED] DATE 1986 02 24	SITE 385-22
DRAWN KC [CHECKED] APPROVED S.D.	DWG 2788501-A

REF No E-8054-1, 1985 01

# memorandum



To: O. Ramakko  
Head, Structural Section  
Northwestern Region

Date: 1987 02 26

Atten: R. Krisciunas

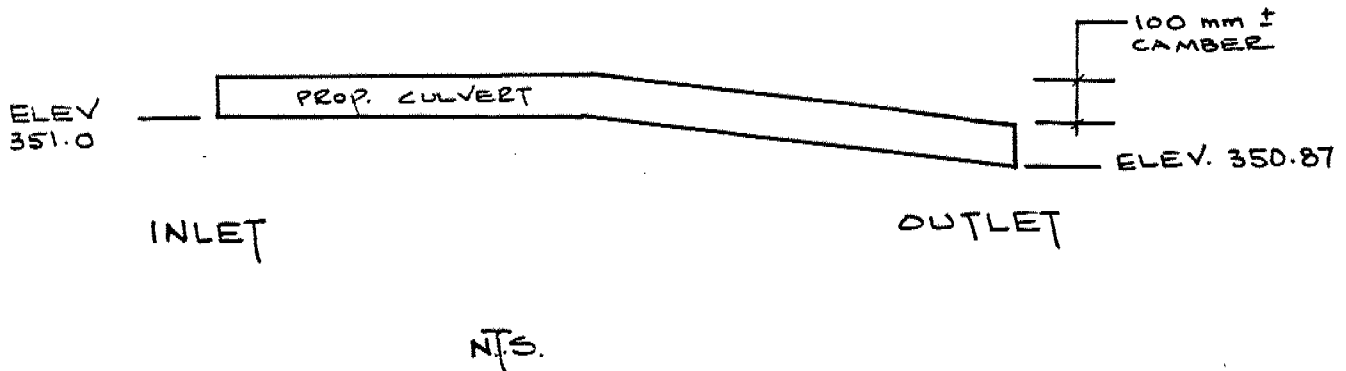
RE: W.P. 278-85-01, Hwy. 556  
Kinnihan Creek Crossing  
District 18 - Sault Ste. Marie

We have reviewed the final General Arrangement Drawing (Dwg.1) dated Sept. 86, for the above-noted project. We have the following comments:

1. Peat and other surficial organic material should be completely removed up to 1 m beyond the plan limits of the embankment fill and for at least 1 m beyond the plan limits of the culverts. In addition, all organic material should be subexcavated from within the proposed channel realignment.
2. All fill placed below 0.3 m above the prevailing groundwater level should consist of granular material.
3. In order to maintain equal lateral pressures around the pipe culverts at all times during installation, the backfill should be placed alternately in lifts so as to keep the same elevation on all sides of the culvert. Maximum difference in fill heights should be restricted to 0.3 m at any time.
4. Dewatering during construction could be accomplished by pumping from sumps in connection with perimeter ditches.
5. In view of the generally well-graded natural granular material across the site, geotextile is not required from a foundation point of view, under the rock protection.

Under no circumstance should a geotextile be provided at the interphase of the clay seal and rock protection at the culvert inlet. The geotextile will provide an artificial sliding surface and may promote a continual requirement for maintenance. At the inlet, the rock protection should be placed directly on the clay seal.

6. When a camber is provided to a culvert, the upstream half of the pipe should be placed almost on flat grade and the downstream half on a steeper grade, to match the outlet invert elevation. A camber of 100 mm should be more than sufficient at this site. The figure below illustrates the camber.



If you have any questions or require additional details, please do not hesitate to contact this Section.

L. Politano  
Project Foundations Engineer

for

M. Devata  
Chief Foundations Engineer  
(East)

LP/MD/mmj

c.c. - K. Bassi

MEMORANDUM



TO: M. Devata  
Chief Foundations Engineer (East)  
Central Building  
Downsview, Ontario

DATE: 1986 11 17

FROM: Structural Section  
Northwestern Region  
807/577-6451 Ext. 300

ATTENTION: L. Politano,  
Project Foundations Engineer

Re: W. P. 277-85-01 - Little Garden River No. 1, Site 38S-20  
W. P. 277-85-02 - Little Garden River No. 2, Site 38S-21  
W. P. 278-85-01 - Kinnihan Creek Bridge, Site 38S-22  
Hwy. 556, District 18, Sault Ste. Marie

This is in reply to your three memos concerning the subject structures and dated 86/11/04 and 07.

i) Little Garden River No. 1:

It is acknowledged that this bridge has been shifted 15 m to the west of the location originally anticipated in our foundation request. We were not overly concerned about this because the soil strata appeared relatively uniform throughout and major changes were not expected 15 m away.

Please note also that the span has been reduced from 22 to 18 m.

ii) Little Garden River No. 2:

The change in span from 22 m to 16 m is a result of using a rectangular rigid frame opening instead of the spill-through abutment design as had originally been anticipated. (this is also the reason for the change in span at Little Garden River No. 1).

Again the soil strata appeared fairly uniform.

iii) Kinnihan Creek Culverts:

It was decided to relocate these culverts to facilitate easier construction and dewatering.

We note that bore holes were extended at the revised culvert location and these indicate relatively uniform strata throughout.



At the Little Garden River sites, you have raised sufficient doubt that we concur with your decision to carry out extra field investigations. Competent bearing material is crucial for the foundations of the proposed structures. Such changes as these are not uncommon in the structure planning and design stage and are often influenced by the foundation investigation results. It is suggested therefore that in future the soil boring program encompass a large enough area to facilitate such changes. (It is acknowledged that in this case suggested bore hole locations were given by our office; a practice which has ceased).

At the Kinnihan Creek site we do question the need for additional borings. The strata appears uniform, the peat deposits will be removed and the native granular material has ample bearing capacity for the anticipated loads. We acknowledge however that the responsibility of ensuring adequate foundation conditions rests with your office and as such the decision is yours to make.



R. J. Krisciunas  
Senior Structural Engineer  
(For)  
O. E. Ramakko  
Head, Structural Section  
RJK/eu

# memorandum



To: O. Ramakko  
Head, Structural Section  
Northwestern Region

Attn: R. J. Krisciunas  
Senior Structural Engineer

From: Foundation Design Section  
Room 315, Central Building

Re: w.p. 278-85-01  
Kinnihan Creek, Site 385-22  
Hwy. 556, Dist 18, Sault Ste. Marie

---

Date: 1986 11 04

Further to your memorandum of 86 10 16, we have reviewed the Preliminary General Arrangement drawing (dated Sept. 86) for the above noted project.

We note that subsequent to the issue of the Foundation Investigation and Design Report, the location of the culverts was changed. When we were requested to carry out the foundation investigation for this project, we were informed that the culverts would be located where Kinnihan Creek currently crosses the new alignment of Hwy. 556 (Line C). However, as shown on the preliminary drawing, the twin culverts have been shifted approximately 20 m to the east.

In shifting the culvert location, Kinnihan Creek will have to be realigned and the existing channel will have to be backfilled.

In view of the relocation of the culverts, we feel that additional borings will be required at this site in order to obtain more accurate subsurface information at the revised culvert location.

Based on the information we do have, however, we make the following comments with regards to the culvert construction:

- The culvert inlet varies between Elev. 350.9 and 351. Based on BH 9 and 5, it appears that some removal of peat will be required.
- The limits of the peat removal should be fully described, as per the Foundation Report.
- Dewatering will be required for any excavation extending below Elev. 352 ±.
- As per our cover letter of 86 03 17 and subsequent memorandum of 86 10 14, a clay seal should be provided at the culvert inlet.

..... 2

As previously noted additional fieldwork will be required at this site since the culvert location has been revised. When the additional fieldwork is completed, the preliminary General Arrangement drawing will once again be reviewed and some changes may be required. Please inform us on the proposed schedule of this project so that this section can retain the original consultant and the necessary work can be carried out as soon as reasonably required.

A handwritten signature in black ink, appearing to read 'L. Politano', followed by a horizontal line ending in a dot.

L. Politano  
Project Foundations Engineer

for

M. Devata  
Chief Foundations Engineer  
(East)

LP:cg

# memorandum



Tel: 3282

To: O.E. Ramakko  
Head, Structural Section  
Northwestern Region

Date: 1986 10 14

Atten: R.J. Krisciunas  
Sr. Structural Engineer

From: Foundation Design Section  
Room 315, Central Building

RE: Kinnihan Creek Culvert  
Site 38S-22, Hwy. 556  
W.P. 278-85-01  
Dist. 18 - Sault Ste. Marie

From your memorandum dated 86 10 08 we understand that due to the remoteness of the above-noted site, the clay required for the seal at the culvert inlet is difficult to find. However, we feel that a heavy poly barrier you describe would not be sufficient at this site.

We bring to your attention OPSS Form 1205 dated December, 1983. In this Specification (Section 1205.05.03) an alternative material is described. The material consists of a mixture of bentonite and granular A which can be mixed on site. This material could be used in place of the natural clay.

If you require additional information, please do not hesitate to contact this office.

A handwritten signature in dark ink, appearing to read "L. Politano", with a long horizontal flourish extending to the right.

L. Politano  
Project Foundations Engineer

for

M. Devata  
Chief Foundations Engineer  
(East)

MD/mmj

MEMORANDUM

TO: L. Politano  
Project Foundations Engineer  
Central Building  
Downsview, Ontario

DATE: 1986 10 08  
  
FROM: Structural Section  
Northwestern Region  
807/577-6451 Ext. 300

Re: Kinnihan Creek Culvert Site 38S-22  
W. P. 278-85-01, Hwy. 556, District 18,  
Sault Ste. Marie

In your memorandum of 86 03 17 on the subject structure you recommend the placement of a clay seal at the inlet to prevent erosion of the underlying granular fill. Because of the remoteness of this site clay is extremely difficult to find. Please advise if there is another method such as a heavy poly barrier which would be acceptable.



R. J. Krisciunas  
Senior Structural Engineer  
(For)  
O. E. Ramakko  
Head, Structural Section

RJK/eu



# memorandum



To: Mr. O. E. Ramakko,  
Head, Structural Section,  
NORTHWESTERN REGION - Thunder Bay

Date: 86 03 17

From: Engineering Materials Office,  
Foundation Design Section,  
Central Building, Room 315

Re: Foundation Investigation Report  
Kinnihan Creek Structure  
Hwy. 556, (Site: 38S-22)  
District #18, Sault Ste. Marie  
W. P. 278-85-01

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Peto MacCallum Ltd. was retained by this section to carry out a foundation investigation at the above-noted site and provide recommendations for the design and construction of the proposed culvert and associated fills.

During the progress of the project, this section reviewed the draft version of the report and comments on the technical contents were made. The attached final report addresses most of our concerns, however, we make the following comments:

1. The loadings given in Sect. 4.1 (page 7) of the report should be changed to 100 kPa S.L.S. II, and 200 kPa U.L.S.
2. The peat soils must be completely removed for 1 m beyond the plan limits of the embankment fill. The Regional Geotechnical Section should make recommendations with regards to the removal of organics in areas beyond the area covered in this report.
3. At the C.S.P. culvert inlet, a seal of cohesive material (CI-CH clay) with a minimum thickness of 0.6 m should be provided to prevent erosion of the underlying non-cohesive material. The requirements of this seal are shown on the attached figure.

A headwall could be provided for the concrete box culvert.

4. The Hydrology Section should be consulted with regards to the requirement of channel protection. The soil is scourable and there may be a need for rip-rap.

....2

Mr. O. E. Ramakko

- 2 -

86 03 17

Re: Foundation Investigation Report  
Kinnihan Creek Structure  
Hwy. 556, (Site: 38S-22)  
District #18, Sault Ste. Marie  
W. P. 278-85-01

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5. The attached report discusses the need for a dewatering system (page 8). If the perimeter ditches are used, the drains should be installed at a distance of 2 m from the plan limits of the culvert, and at a depth of 0.4 m below the founding elevation.

If you have any questions or require further information please do not hesitate to contact the undersigned.



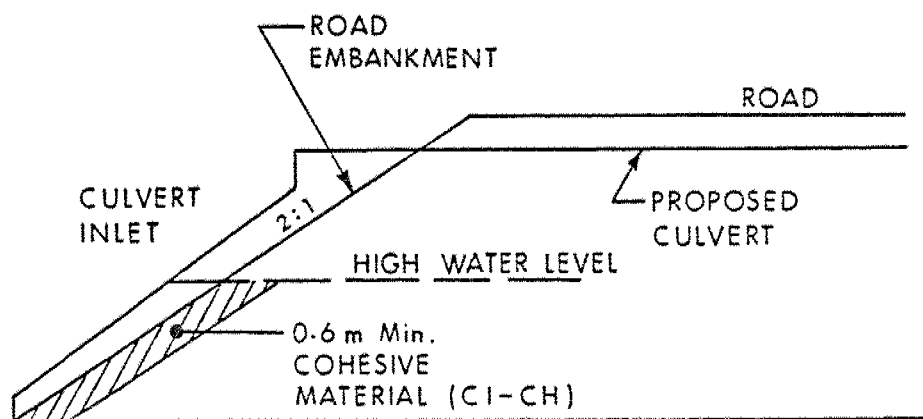
L. Politano,  
Project Foundations Engineer

for

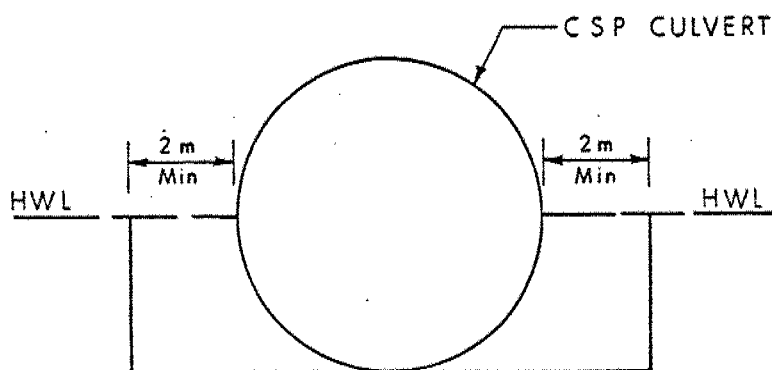
M. Devata,  
Chief Foundations Engineer  
(East)

LP:ma

encl.



NTS  
LONGITUDINAL SECTION

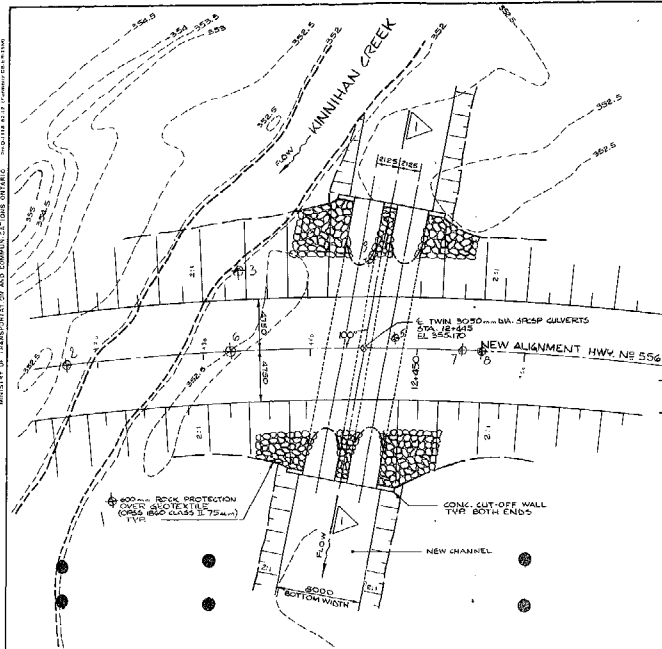


NTS  
FRONT VIEW

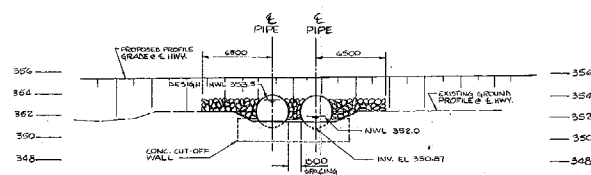
Culvert Inlet Seal

W.P. 278-85-01





**PLAN**  
SCALE 1:200



**ELEVATION**  
SCALE 1:200

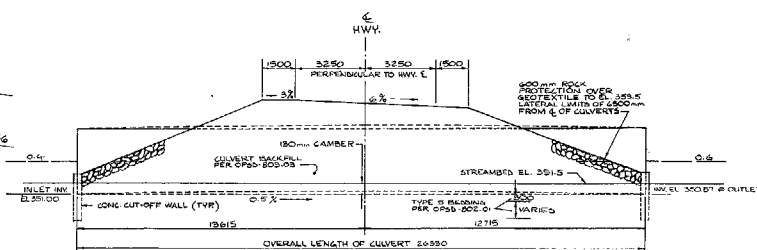
BM 355.659  
METRIC DATUM  
U.S. N. 81-3007 C.L.S.  
SERIAL 81-3007-10  
STA. 15381

BAR NO.	SIZE	WGT.	LENGTH	TYPE
B150001	15M	45	1000	ST.
B150002	15M	20	10000	ST.
B150003	15M	75	1000	ST.
B150004	15M	100	1000	ST.

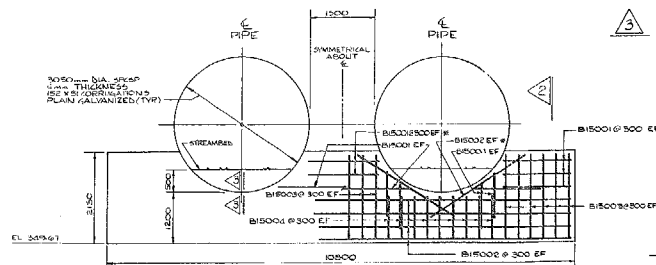
\* CUT TO SUIT  
NOTE:  
\* NUMBER OF BARS SHOWN  
IS TOTAL FOR BOTH WALLS  
\* TOTAL WEIGHT OF  
REINFORCING STEEL = 0.254



**PROFILE @ E. HWY. NO. 556**  
N.T.S.



**SECTION THRU E OF CULVERT INSTALLATION**  
N.T.S.



**CONCRETE CUT-OFF WALL DETAIL**  
SCALE 1:50

**METRIC**  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN  
**northland engineering limited**  
Consulting Engineers and Planners  
SUITE 101 - SUITE 102 - SUITE 103

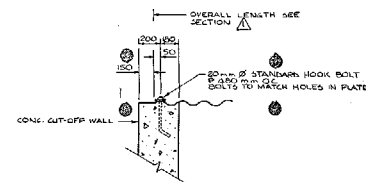
CONT No  
WP No 277-85-00

KINNIHAN CREEK CULVERTS  
HWY No 556 STA 12+445

GENERAL ARRANGEMENT

GENERAL NOTES:

- \* CLASS OF CONCRETE 30 MPa
  - \* REINFORCING STEEL GRADE 400
  - \* CLEAR COVER TO REINFORCING STEEL 75mm
  - \* E.F. DENOTES EACH FACE
  - \* CONCRETE QUANTITY 18.4 m<sup>3</sup> TOTAL BOTH WALLS
- CONSTRUCTION NOTES
- \* ENTIRELY REMOVE ALL PEAT DEPOSITS UNDER CULVERTS AND BACKFILL WITH 200mm LIFTS OF CRUSHED GRANULAR MATERIAL PER OPS 600-800 TYPE C.
  - \* FOR PROTECTION OF CULVERTS AGAINST HEAVY CONSTRUCTION EQUIPMENT SEE STANDARD OPS 600-800.



**TYPICAL HOOK BOLT DETAIL**  
SCALE 1:20

**TYPICAL SECTION THRU CUT-OFF WALL**  
SCALE 1:50



PRELIMINARY

OCT 9 1986

NORTHLAND ENGINEERING



DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

DATE	BY	DESCRIPTION
DESIGN	N.W.C.	CHECK
DRAWING	W.D.C.	CHECK
LOADING	CHD.C.	25-B
DATE	SEP/86	
STG. NO.	35.5-22	100% E