DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

To: Mr. E. R. Davis,
Bridge Engineer,
Bridge Division,
Main. Bldg.

Attention: Mr. S. McCombie

From: Foundation Section,
Materials & Testing Div.,
Room 107, Lab. Bldg.

Date: September 26, 1968

Our File Ref:

In Reply to: CPT - 308

Subject:

FOUNDATION INVESTIGATION REPORT
For
Eastbound Lane and Westbound Lane
Structures at the Crossing of
Ramsay Creek and Proposed Hwy. #417
District No. 9 (Ottawa)
W.J. 68-F-54 -- W.P. 34-66-00 10-11

Attached, we are forwarding to you, our detailed foundation investigation report on the subsoil conditions existing at the above structure site.

We believe that the factual data and recommendations contained therein, will prove adequate for your design requirements. Should additional information be required, please do not hesitate to contact our Office.

A. G. Stermac
PRINCIPAL FOUNDATION ENGINEER

AGS/RdeF
Attach.
cc: Messrs. E. R. Davis (2)
E. A. Tregaskes
D. W. Farren
S. J. Markiewicz
C. R. Robertson
J. E. Gruspier
J. D. Forster
G. Scott
B. A. Singh

Foundations Files
Gen. Files

C. B. Crawford, National Research Council

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1. INTRODUCTION:

The Foundation Section was requested to carry out an investigation at the proposed crossing of Ramsay Creek and Hwy. #417. The request was contained in two memos from the Kingston Bridge Location Section (Mr. G. Scott, Regional Bridge Location Engineer), dated June 14, for a preliminary investigation, and July 24, 1968, for a final investigation.

Upon receipt of the memos, the respective investigations were carried out by this Section to determine the subsoil and groundwater conditions at this site.

This report contains the results of the investigations, together with the recommendations pertaining to the foundations of the proposed structures as well as the stability of the approach embankments.

2. DESCRIPTION OF THE SITE AND GEOLOGY:

The site is located about one-quarter mile south of Russell Road at Ramsay Creek. The creek meanders along the floor of a narrow valley. The valley is about 25 ft. deep with a flat floor about 120 ft. wide. The natural side slopes stand at approximately 3 horizontal to 1 vertical. The creek has cut through the valley floor a narrow ditch about 4 ft. deep and 10 ft. wide with nearly vertical banks. The water in the creek was about 1 foot deep during the time of the field investigation. The immediate area at and surrounding the site is open, but it has been recently reforested.

cont'd. /2 ...

2. DESCRIPTION OF THE SITE AND GEOLOGY: (cont'd.) ...

Physiographically, the site is situated on the northern edge of the area known as "The Russell and Prescott Sand Plains". In this area a sand mantle, 10 to 15 feet in thickness, overlies an extensive deposit of marine clay deposited by the Champlain Sea, which inundated the area during the post-glacial period following the Wisconsin Glacial Age. The clay stratum is underlain by a glacial till, which in turn, is underlain by grey to black calcareous shale of the Lorraine formation, Ordovician Period.

3. FIELD AND LABORATORY WORK:

A total of ten sampled boreholes, each with an accompanying dynamic cone penetration test, was carried out. Four boreholes were put down during the preliminary investigation and supplemented by six boreholes during the course of the final field investigation. The borings were advanced by means of conventional diamond drill rigs adapted for soil sampling purposes.

Samples were recovered at required depths in 2" and 3" O.D. Shelby tubes which were manually pushed into the soil. In an effort to reduce the degree of disturbance, some Shelby tubes were advanced using a piston technique. In addition, samples of glacial till and occasional samples of the cohesive overburden were obtained using a 2" O.D. split-spoon sampler, which was hammered into the soil in accordance with the specifications for the Standard Penetration Test. The same method was used to advance the dynamic cone penetration tests. Field vane tests were carried out to determine the undrained shear strength of the clay stratum. Bedrock was proven at six of the boring locations by obtaining AXT size rock core samples.

The groundwater level conditions across the site were determined by installing sealed piezometers in four of the boreholes. This information was supplemented by recording the groundwater level in the open holes at the remaining boring locations. Water samples were obtained from three of the boreholes

cont'd. /3 ...

3. FIELD AND LABORATORY WORK: (cont'd.) ...

in order to carry out chemical analyses of the groundwater. Artesian conditions and gas pockets were encountered in 4 of the borings put down in the valley floor. The emission of gas and water was properly sealed by conventional methods at the appropriate elevation.

The locations and elevations of all the borings were surveyed in the field by personnel from the Kingston Regional Engineering Surveys Section, and are shown on Drawings 68-F-54A (E.B.L.) and 68-F-54B (W.B.L.), together with the estimated stratigraphical profile at the respective crossings. All elevations given in the report are referenced to a Geodetic datum.

All samples were subjected to a careful visual examination in the field and subsequently in the laboratory. Following this inspection, laboratory tests were carried out on selected representative samples to determine the physical properties of the subsoil, namely:

Bulk Densities
Natural Moisture Contents
Atterberg Limits
Grain-Size Distributions
Organic Contents
Undrained Shear Strengths
Consolidation Characteristics

On completion of these tests, the various soil samples were classified as to type and consistency, or relative density in accordance with the Unified Soil Classification System - (Oct. 1963).

The results of the laboratory testing are plotted on the Record of Borelog sheets and summarized in Appendix I of this report.

cont'd. /4 ...

4. SOIL TYPES AND SOIL CONDITIONS:

4.1) General:

The valley floor is surficially covered by a thin layer of clayey silt with some sand, about 5 feet thick. Underlying this surficial cover on the valley floor and directly under a thin (6") layer of topsoil on the valley banks, is the predominant overburden stratum across the site. This deposit is composed of a soft to very stiff sensitive clay extending down to about elevation 117 to 127 - i.e., some 106 to 125 feet in depth. The clay stratum is underlain by a firm to hard cohesive glacial deposit composed of clayey silt with sand and some gravel, which in turn, is underlain by shale bedrock.

The boundaries between the various deposits as determined at the boring locations, are shown on the accompanying borehole sheets. The stratigraphical profiles, inferred from this data, are shown on Drawings 68-F-54A and 68-F-54B.

From ground surface downwards, the various soil types encountered are described as follows:

4.2) Surficial Deposit - Clayey Silt with some Sand:

In the borings put down near or on the valley floor (with the exception of B.H. #6), a surficial layer, composed of a brown to grey clayey silt with some sand, was encountered. The thickness of this layer is approximately 5 feet.

Atterberg limit tests, carried out on representative samples of the deposit, indicate that the liquid limit and plastic limit range from 27% to 36% and 15% to 20%, respectively, with the natural water content slightly above the plastic limit.

Standard penetration tests, carried out within this deposit, gave 'N' values from 7 to 8 blows per foot, indicating a firm to stiff consistency.

4.3) Sensitive Clay:

Directly underlying the surficial cover or a thin layer of topsoil, is the predominant overburden stratum across the site,

cont'd. /5 ...

4. SOIL TYPES AND SOIL CONDITIONS: (cont'd.) ...

4.3) Sensitive Clay: (cont'd.) ...

a sensitive marine clay with occasional inclusions of organic matter. The overall thickness of the clay stratum ranges from 106 to 125 feet. Within this deposit occasional layers of silty clay up to 2" thick were encountered in all the borings. Samples recovered from this stratum indicate that the clay deposit is predominately grey in colour; however, it contains occasional bands of light and dark grey clay up to 1 inch in thickness. In addition, occasional layers of brown clay up to 2" in thickness were observed within the upper 16 feet of this deposit.

Grain-size distribution curves obtained from samples of the clay stratum are shown on Figures 3 and 4 in the Appendix.

The engineering properties of the stratum, as determined by field and laboratory testing, are summarized on Figure 1; a brief resume follows:

		Range	
		Sensitive Clay	Silty Clay Layers
Liquid Limit (%)	(W_L)	51 - 86	35 - 49
Plastic Limit (%)	(W_P)	23 - 32	17 - 28
Natural Moisture Content (%)	(W)	39 - 93	28 - 64
		Range	Average
Bulk Density (p.c.f.)	(δ)	93 - 108	100
Liquidity Index	(I_L)	0.4 - 2.5	1.1
Initial Void Ratio	(e_o)	1.98 & 2.14	
Compression Index	(C_c)	1.32 & 1.55	
Undrained Shear Strength (p.s.f.)	(C_u)	Range (C_u)	Range Sensitivity (S)
i) Field Vanes		480 - 2,000	2 - 11
ii) Lab. Vanes		660 - 2,364	2 - 16
iii) Lab. Testing		313 - 2,260	

cont'd. /6 ...

4. SOIL TYPES AND SOIL CONDITIONS: (cont'd.) ...

4.3) Sensitive Clay: (cont'd.) ...

The Atterberg limit tests, summarized on the foregoing page, are also plotted on the Plasticity Chart, Figures 5 and 6. These results indicate that, in general, the clay is inorganic and of high plasticity with occasional layers of silty clay of intermediate plasticity. The natural water content is generally at or greater than the liquid limit. The consistency of the overall stratum, as determined from the undrained shear strength testing, increases from firm to stiff with depth from elev. 230 to elev. 170. This increase is represented by a C_u/P_o ratio of about 0.55, where P_o is the effective overburden pressure. Below elev. 170 the shear strength varies in a random fashion, but generally increases to very stiff with depth. On the valley banks above elev. 230, the consistency of the stratum ranges from very stiff near the surface, decreasing with depth to firm about elev. 230.

The undrained shear strength values obtained from the laboratory testing, generally gave lower values than that obtained from the field vane tests. It is considered that this is primarily due to unavoidable sample disturbance caused by the field and laboratory handling and subsequent testing of the sensitive clay.

The consolidation characteristics of the stratum were determined by carrying out two laboratory consolidation tests, the results of which are shown as Void Ratio vs. Pressure Plots, on Figures 8 and 9. The results of this testing indicate that the clay is preconsolidated by about 1,300 to 1,800 p.s.f. in excess of the existing overburden pressure on the top of the valley banks, whereas on the valley floor it is preconsolidated by about 2,000 to 2,500 p.s.f. in excess of existing overburden pressure. The relatively high values obtained for the initial void ratio (e_o) and the compression index (C_c) for this material are not uncommon for a sensitive 'Leda Clay'.

cont'd. /7 ...

4. SOIL TYPES AND SOIL CONDITIONS: (cont'd.) ...

4.4) Clayey Silt with Sand and some Gravel - (Glacial Till):

This heterogeneous, but generally cohesive deposit, was encountered immediately below the clay stratum, between elevations 118 and 127. The glacial till deposit was penetrated to its maximum depth at B.H.'s #1, 2, 5, 7, 8, and 10; at these locations the thickness varies from 41 to 45 ft. Random seams and layers of sand and silt up to 2 feet thick, were observed throughout the glacial till. Grain-size distribution curves for samples of the deposit are shown on Figure 4 in the Appendix of this report.

The Atterberg limit tests, carried out on representative samples of the glacial till, are plotted on the Plasticity Chart, Figure 7. These results indicate that the liquid limit and plastic limit range from 16% to 33% and 11% to 18%, respectively. The corresponding natural water content is generally below the plastic limit. Based on these results, it is estimated that the matrix of the glacial till is of low plasticity.

The standard penetration resistance, or 'N' values, vary from 18 blows/ft. to as high as 150 blows/4 inches, indicating that the consistency of the deposit ranges from very stiff to hard with depth. In B.H.'s #7 and 8 the upper 10 to 15 ft. of the glacial till is in a softened condition. 'N' values in this upper zone range from 9 to 21 blows per foot, indicating a firm to very stiff consistency.

4.5) Shale Bedrock:

Bedrock was established in six of the borings, namely: B.H.'s #1, 2, 5, 7, 8, and 10, by obtaining from 5 to 8 ft. of AXT rock core. At these boring locations the depth at which bedrock was encountered ranged from elevations 76 to 79.

The bedrock is composed of a grey calcareous shale. The upper 10 inches of the bedrock is generally in a fractured condition; below this the bedrock is generally sound with occasional vertical fractures.

cont'd. /8 ...

5. GROUNDWATER CONDITIONS:

Groundwater level observations have been carried out during the period of the investigation, in i) sealed piezometers installed in boreholes #2, 6, 7, and 8, and ii) the open holes at the remaining boring locations. These observations are recorded on the Borelog sheets and summarized on Drawings 68-F-54A and 68-F-54B. The results of the measurements indicate that the piezometric groundwater level within the clay stratum is about elevation 237 on the valley banks and about elevation 228 on the valley floor.

The piezometer installed in the lower portion of the glacial till (B.H. #8) indicated that the piezometric groundwater level within this deposit was about elevation 240 - i.e., about 12 feet above the valley floor. This represents an artesian pressure with respect to ground surface on the valley floor, and corresponds with the artesian head encountered while drilling B.H.'s #1, 2, 5, and 6. A slight flow of natural gas was observed with the artesian water. Past experience in the area indicates that an artesian condition often exists in the lower portion of the glacial till and upper fractured zone of the bedrock. The factors which provide the favourable environment for this artesian condition are:

i) The glacial till and fractured bedrock are more pervious than the overlying cohesive overburden and underlying sound bedrock.

ii) These zones are in hydraulic communication with groundwater from the surrounding higher terrain - i.e., the zones are continuously being charged and thus act as an aquifer.

cont'd. /9 ...

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

It is proposed to construct two parallel bridges to carry the East and Westbound lanes of proposed Highway #417 over Ramsay Creek. The Westbound lane structure (W.B.L.) will be located some 400 feet north of the Eastbound lane structure (E.B.L.). Present proposals call for four-span structures (60'-60'-60'-60' for both the W.B.L. and E.B.L.). The proposed profile grade of Hwy. #417 in the vicinity of the crossings is about elevation 254. At this grade the associated approach embankments will vary in height from about 2 ft. to 12 ft. at the abutment locations. The E.B.L. and W.B.L. of Hwy. #417 will each incorporate two paved lanes with provision for a future paved lane.

The predominant deposit across the site is a stratum of firm to very stiff sensitive marine clay varying from 106 to 125 feet in thickness. The clay is underlain by up to 45 ft. of firm to hard cohesive glacial till which, in turn, is followed by shale bedrock.

6.2) Structure Foundations:

The presence of an extensive deposit of firm and highly compressible clay at a relatively shallow depth requires that the structures must be supported on piled foundations. End-bearing piles or, alternatively, friction piles can be considered.

6.2.1) End-bearing Piles:

The piers and abutments can be supported on end-bearing piles driven to the sound bedrock surface at approximate elevation 75 to 78. The allowable pile loads would be dependent on the pile section chosen. For example, a safe design load of 90 tons/pile may be used for 14 BP 73 steel H-piles driven to sound bedrock. Since the glacial till deposit does not contain any large size boulders, no difficulty can be anticipated for the steel H-piles

cont'd. /10 ...

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.2) Structure Foundations: (cont'd.) ...

6.2.1) End-bearing Piles: (cont'd.) ...

penetrating to the sound bedrock surface. End-bearing piles will reduce the settlement of the structure components to a negligible amount and, therefore, a continuous structure could be employed. No bouldery or rock fill should be placed in areas where piles are to be driven.

6.2.2) Frictional Piles:

As an alternative to end-bearing piles, the abutments and piers can be founded on piles located within the clay stratum. Such piles would primarily derive their capacity from the adhesion between the foundation soil and the shaft of the pile. The allowable pile load would be dependent on the pile type and section chosen - for example, No. 14 timber piles driven 45 feet into original ground could be designed for an allowable pile capacity of 20 tons/pile.

In addition to timber piles, it is considered that closed-end 12-3/4" O.D. tubular steel piles could be employed. The allowable capacities for this size of tubular pile driven various lengths into natural ground, are given on Figure 2 in the Appendix.

The structure units, founded on frictional piles, will undergo settlement due to the consolidation of the foundation soil under application of load. The actual magnitude of the settlement at the various locations will be dependent on a number of factors, including

i) Pile type and length
ii) Configuration of the pile group
iii) Applied load
iv) Influence of approach fills

cont'd. /11 ...

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.2) Structure Foundations: (cont'd.) ...

6.2.2) Frictional Piles: (cont'd.) ...

A true settlement analysis, therefore, can only be carried out once the structure details have been finalized. A few qualitative points, however, can be made, namely:

a) The settlement of the piles at the abutment and the pier locations will be influenced by the approach fills. Differential settlements, therefore, can be expected between the abutments and end piers. This being the case, it is recommended that the end spans of the structure be simply supported.

b) If friction piles are employed to support the structural elements, then it is recommended that the allowable pile loads be determined by carrying out full-scale pile loading tests at the site.

Pile caps should be founded at sufficient depth below finished grade so as to ensure adequate frost protection.

Excavations for the pier pile caps may be carried out below the groundwater level. Since the subsoil is relatively impermeable, no major dewatering problems are anticipated. Any minor seepage from the excavations can be controlled by ordinary pumping methods.

6.3) Approach Embankments:

No stability problems are anticipated for the 12-ft. high embankments provided standard side slopes of 2 horizontal to 1 vertical are used.

The underlying compressible clay stratum will undergo settlements due to consolidation under the weight of the approach embankments. Settlement computations carried out, indicate that settlements of up to 6 inches can be expected under the centre-line of the embankment.

cont'd. /12 ...

7. SUMMARY:

A foundation investigation at the crossing of Hwy. #417 and Ramsay Creek, in the Township of Gloucester, County of Carleton, is reported.

The predominant deposit across the site is a stratum of firm to very stiff sensitive clay some 106 to 125 feet thick, overlying up to 45 feet of a firm to hard, basically cohesive glacial till. The glacial till is underlain by shale bedrock, the surface of which was encountered between elevations 76 and 79. The groundwater level in the subsoil is about 3 to 5 feet below ground surface. An artesian water pressure head (about 12 ft. above the valley floor) was encountered in the lower portion of the glacial till and the upper fractured portion of the bedrock along the valley floor.

The piers and abutments can be supported either on end-bearing piles driven to refusal on the sound bedrock, or on frictional piles, founded within the extensive clay stratum.

The approach embankments will have a height of up to 12 ft. Fills of this height will be stable provided 2:1 side slopes are employed. Consolidation settlements, induced in the foundation subsoil due to the surcharge loading, will be in the order of 6 inches.

8. MISCELLANEOUS:

The preliminary field work for this project was carried out during the period of June 26 to July 18, 1968, under the supervision of Mr. P. B. Schnabel, Project Foundation Engineer. The final investigation was carried out during the period of August 7 to 26, 1968, under the supervison of Mr. W. G. Hutton, Project Foundation Engineer, who also prepared this report.

The investigation was carried out under the general supervision of Mr. B. T. Darch, Senior Foundation Engineer. The report was reviewed by Mr. M. Devata, Supervising Foundation Engineer.

The equipment was owned and operated by F. E. Johnston Drilling Co. Ltd.

September 1968.

APPENDIX I

DEPARTMENT OF HIGHWAYS – ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO 1

FOUNDATION SECTION

JOB 68-F-54 LOCATION Hwy.417, Sta. 220 + 40 EBL ℄ ORIGINATED BY PBS

W.P. 34-66-01 BORING DATE June 26 - July 3, 1968 COMPILED BY PBS

DATUM Geodetic BOREHOLE TYPE Diamond Drill, NX - BX Casing, AXT Core CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT
227.2	Ground Level				
222.2 / 5.0	Clayey silt. Firm. Brown to grey.		1	TP	PM
			2	TP	PM
			3	TP	PM
			4	TP	PM
			5	TP	PM
			6	TP	PM
			7	TP	PM
			8	TP	PM
	Sensitive clay		9	TP	PM
	occasional inclusions		10	TP	PM
	of organic matter.		11	TP	PM
			12	TP	PM
	Firm to stiff.		13	TP	PM
			14	TP	PM
	Grey with occasional black mottling		15	TP	PM
119.2					
108.0	Clayey silt with sand and some gravel (Glacial Till)		16	SS	17
	Layers of silt and sand up to 2' thick		17	SS	26
	(Compact to dense)		18	SS	22
	Very stiff to hard. Grey		19	SS	18
77.2			20	SS	62
152.0 / 70.2	Sound calcerious sable grey.			AXT	60%
157.0	End of Borehole				

ELEV SCALE

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100

SHEAR STRENGTH P.S.F + Field Vane • Triaxial × Lab Vane 400 800 1200 1600 2000

LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w WATER CONTENT % 20 40 60

BULK DENSITY γ P.C.F.

Art. Head ▼ 240.7

REMARKS

Gr. Sa. Si. Cl

▼ 224.

0 16 33 51

27 39 25 9

5 53 32 10

▼ 152.

Art. pressure encountered

20 15 5 10 Axial strain at failure

FORM OB-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 68-F-54 LOCATION Hwy. 417 Sta. 221 + 30 WBL ORIGINATED BY BHL

W.P 34-66-01 BORING DATE July 4-9, 1968 COMPILED BY PS

DATUM Geodetic BOREHOLE TYPE Diamond Drill, NX, BX Casing, AXT Core CHECKED BY

SOIL PROFILE ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT
227.1	Ground Level				
222.1 / 5.0	Clayey silt with ½" layer of sand. Firm. Brown to grey.		1	SS	7
			2	TP	PM
			3	TP	PM
			4	TP	PM
			5	TP	PM
	Sensitive clay occasional inclusions of organic matter		6	TP	PM
			7	TP	PM
			8	TP	PM
			9	TP	PM
	Firm to very stiff		10	TP	PM
			11	TP	PM
			12	TP	PM
			13	TP	PM
	Grey with occasional glack mottling.		14	TP	PM
			15	TP	PM
			16	TP	PM
120.1			17	TP	PM
107.0	Clayey silt with sand and some gravel. (Glacial Till)		18	SS	27
	Layers of silt & sand up to 2' thick (compact to very dense)		19	SS	30
			20	SS	44
	Very stiff to hard. Grey.		21	SS	18
77.1 / 150.0 / 72.1	Sound calcarious shale Grey.			AXT	58%
155.0	End of Borehole				

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100

SHEAR STRENGTH P.S.F. 400 800 1200 1600 2000

+ Field Vane ○ Unconfined × Lab Vane ● Triaxial

ELEV SCALE 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70

LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_P WATER CONTENT ——— w

WATER CONTENT % 20 40 60

BULK DENSITY γ P.C.F. 97.5 96 93 104

REMARKS

Art. Head 237

224 W.L.

230 Gr.Sa.Si.Cl

Piez. tip elev.127.

3 89 (8)

Art.pressure encountered

20 15 10 5 Axial Strain at Failure

FORM DB-MT-126
66-4346

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 68-F-54 LOCATION Hwy. 417 Sta. 219 + 95 WBL ORIGINATED BY PBS
W.P. 34-66-01 BORING DATE July 10-11, 1968 COMPILED BY PBS
DATUM Geodetic BOREHOLE TYPE Diamond Drill, NX Casing CHECKED BY

ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE
250.8	Ground Level					
	Sensitive clay Occasional inclusions of organic matter. Firm to very stiff.		1	SS	17	
			2	SS	22	
			3	SS	9	
			4	TP	PM	
			5	TP	PM	
			6	TP	PM	
			7	TP	PM	
			8	TP	PM	
			9	TP	PM	
			10	TP	PM	
			11	TP	PM	
	Grey with occasional black motiling.		12	TP	PM	
			13	TP	PM	
			14	TP	PM	
			15	TP	PM	
			16	TP	PM	
124.0			17	TP	PM	
126.8	Clayey silt with sand & some gravel. (Glacial till)		18	SS	30	
104.3	Layers of silt & sand up to 2' thick (dense) Very stiff to hard. Grey.		19	SS	46	
146.5	End of Borehole					

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT
20 40 60 80 100
SHEAR STRENGTH P.S.F.
+ Field Vane
400 800 1200 1600 2000

LIQUID LIMIT — w_L
PLASTIC LIMIT — w_P
WATER CONTENT — w
w_P w w_L
WATER CONTENT %
20 40 60

W=87.1%

BULK DENSITY
P C F

106

REMARKS
Gr.Sa.Si.Cl

▼24.5.

12 2 56 30

66-4346

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

JOB 68-F-54 LOCATION Hwy. 417 Sta. 222 + 75 EBL ORIGINATED BY BHL
W.P. 34-66-01 BORING DATE July 15-17, 1968 COMPILED BY PBS
DATUM Geodetic BOREHOLE TYPE Diamond Drill, NX Casing CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE
249.6	Ground Level					
0.0	Sensitive clay Occasional inclusions of organic matter. Firm to very stiff. Grey with occasional black mottling		1	SS	18	240
			2	SS	15	
			3	SS	11	
			4	TP	PM	
			5	TP	PM	230
			6	TP	PM	
			7	TP	PM	220
			8	TP	PM	
			9	TP	PM	
			10	TP	PM	210
			11	TP	PM	200
			12	TP	PM	190
			13	TP	PM	180
			14	TP	PM	170
			15	TP	PM	160
			16	TP	PM	150
			17	SS		140
124.6						
125.0	Clayey silt with sand & some Grey (Gl.till). Very stiff.		18	SS	27	130
119.6			19	SS		
130.0	End of Borehole					

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT (20, 40, 60, 80, 100)
SHEAR STRENGTH P.S.F (400, 800, 1200, 1600, 2000)
+ Field Vane × Lab Vane ● Triaxial ○ Unconfined

LIQUID LIMIT w_L
PLASTIC LIMIT w_P
WATER CONTENT w
WATER CONTENT % (20, 40, 60)

BULK DENSITY P.C.F: 102, 98.5

REMARKS

20 15 10 5 Axial Strain at failure

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

JOB 68-F-54 LOCATION Sta. 219 + 50 ℄ Hwy. 417 EBL o/s 18' Lt. ORIGINATED BY WH

W.P. 34-66-01 BORING DATE Aug. 7-15, 1968 COMPILED BY WH

DATUM Geodetic BOREHOLE TYPE Diamond Drill - Washboring CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT
237.8	Ground Level				
0.0	Clayey silt Stiff		1	SS	8
3.0			2	SS	PH
			3	TW	PH
			4	TW	PH
			5	TW	PH
			6	TW	PH
	Sensitive clay occasional inclusions of organic matter.		7	TW	PH
			8	TW	PH
			9	TW	PH
	Firm to very stiff		10	TW	PH
			11	TW	PH
			12	TW	PH
			12A	TW	PH
	Grey with occasional black mottling		13	TW	PH
			14	TW	PH
			15	TW	PH
			16	TW	PH
			17	TW	PH
119.8					
118.0	Clayey silt with sand & some gravel. (Glacial till)		18	SS	18
			19	SS	21
	Layers of silt & sand up to 2' thick (compact to very dense).		20A	SS	31
	Very stiff to hard.		21	SS	23
	Grey.		22	SS	100/6"
79.0					
158.8	Sound calcarious shale		23	AXT	86% RC
73.5	Grey		24	AXT	97% RC
164.3	End of Borehole				

ELEV SCALE: 230, 220, 210, 200, 190, 180, 170, 160, 150, 140, 130, 120, 110, 100, 90, 80, 70

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100

SHEAR STRENGTH P.S.F
+ Field Vane o Unconfined
× Lab Vane • Triaxial
400 800 1200 1600 2000

LIQUID LIMIT — w_L
PLASTIC LIMIT — w_P
WATER CONTENT — w
w_P w w_L
WATER CONTENT % 20 40 60

BULK DENSITY γ P.C.F.
106
97
100
108.5
98

Gr.Sa.Si.Cl.

REMARKS
Art. Head
▼ 241.
▼ 236.

24 43 23 10

34 42 21 3

▼ Art. pressure encountered

Axial Strain at failure
20
5 0 5
10

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 6

FOUNDATION SECTION

JOB 68-F-54 LOCATION Sta. 221 + 30 ℄ Hwy. 417 EBL o/s 18' Lt. ORIGINATED BY WH

W.P 34-66-01 BORING DATE August 16 - 21, 1968 COMPILED BY WH

DATUM Geodetic BOREHOLE TYPE Diamond Drill - Washboring CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS / FOOT
228.3 / 0.0	Ground Level				
	Sensitive clay Occasional inclusions of organic matter. Firm to very stiff. Grey with occasional black mottling.		1	CS	
			2	TW	PM
			3	SS	1/12"
			4	TW	PM
			5	SS	2/2"
			6	TW	PM
			7	SS	1
			8	TW	PM
			9	SS	1
			10	TW	PM
			11	SS	2/10"
			12	TW	PM
			13	SS	3
			14	TW	PM
			15	SS	3
			16	TW	PM
			17	SS	4
			18	TW	PM
118.3					
110.0	Clayey silt with sand and some gravel (Glacial till) Layers of silt & sand up to 2' thick (compact to dense). Very stiff to hard. Grey.		19	SS	17
			20	SS	-
			21A	SS	25
			22	SS	100/5"
			Hammer bouncing		
79.6					
148.7	End of Borehole Probable Bedrock				

ELEV SCALE: 220, 210, 200, 190, 180, 170, 160, 150, 140, 130, 120, 110, 100, 90

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT: 20 40 60 80 100

SHEAR STRENGTH P.S.F. + Field Vane ● Triaxial × Lab Vane ○ Unconfined: 400 800 1200 1600 2000

LIQUID LIMIT ——— w_L
PLASTIC LIMIT ——— w_P
WATER CONTENT ——— w
w_P w w_L
WATER CONTENT %: 20 40 60

BULK DENSITY γ P.C.F.: 94, 95, 97.5, 101

Art. Head ▼ 241

REMARKS: Gr. Sa. Si. Cl

▼ 228

Piez. tip elev. 184.

0 2 35 63

11 44 36 9

▼ El. 80.

Art. pressur encountered

20
15 10 5 Axial strain at failure

FORM OB-MT-123
58-4546

OFFICE REPORT ON SOIL EXPLORATION

7

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 7

FOUNDATION SECTION

JOB 68-F-54 LOCATION Sta. 222 + 00 ℄ Hwy. 417 EBL o/s 18' Rt. ORIGINATED BY WH
W.P 24-66-01 BORING DATE August 12 - 19, 1968 COMPILED BY WH
DATUM Geodetic BOREHOLE TYPE Diamond Drill - Washboring CHECKED BY

ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT
243.0	Ground Level				
0.0	Sensitive clay Occasional inclusions of organic matter. Firm to very stiff. Grey with occasional black mottling.		1	CS	
			2	SS	5
			3	TW	PM
			4	3"TW	PM
			5	TW	PM
			6	3"TW	PM
			7	3"TW	PM
			8	SS	1/18"
			9	3"TW	PM
			10	SS	1
			11	3"TW	PM
			12	SS	1
			13	3"TW	PM
			14	SS	2
			15	3"TW	PM
			16	SS	2
			17	TW	PM
			18	SS	3
			19	TW	PM
			20	SS	4
120.0			21	TW	PM
123.0	Clayey silt with sand & some gravel (Glacial till) Occ. layers of silt & sand up to 1' thick (compact to dense) Stiff to hard. Grey.		22	SS	18
			23	SS	9
			24	SS	17
			25	SS	20
76.1			26	SS	45
166.9 70.4	Sound calcareous shale Grey		27	AXT RC	91% Rec
172.6	End of Borehole				

ELEV SCALE: 240, 230, 220, 210, 200, 190, 180, 170, 160, 150, 140, 130, 120, 110, 100, 90, 80, 70

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT
20 40 60 80 100

SHEAR STRENGTH P.S.F.
+ Field Vane ● Triaxial
× Lab Vane ○ Unconfined
400 800 1200 1600 2000

LIQUID LIMIT ——— W_L
PLASTIC LIMIT ——— W_P
WATER CONTENT ——— W
W_P W W_L
WATER CONTENT %
20 40 60

BULK DENSITY
P.C.F.
97.5
94.5
95
107
111

REMARKS
Gr. Sa. Si. Cl
0 2 29 69
237.
piez. tip. el. 207.
3 13 69 15

15 (20 / 10) 5 Axial strain at failure

66-4546

8

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 8

FOUNDATION SECTION

JOB 68-F-54 LOCATION Sta. 220 + 40 ℄ Hwy.417 WBL o/s 18' Rt. ORIGINATED BY WH

W.P 34-66-01 BORING DATE August 7, 14, 1968 COMPILED BY SW

DATUM Geodetic BOREHOLE TYPE Diamond Drill, Washboring CHECKED BY AK.

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT
243.0	Ground Level				
0.0	Sensitive clay occasional inclusions of organic matter. Firm to very stiff. Grey with occasional black mottling.		1	SS	7
			2	TW	PM
			3	TW	PM
			4	5"TW	PM
			5	TW	PM
			6	TW	PM
			7	3"TW	PM
			8	TW	PM
			9	3"TW	PM
			10	TW	PM
			11	3"TW	PM
			12	TW	PM
			13	TW	PM
			13A	TW	PM
			14	3"TW	PM
			15	3"TW	PM
			15A	3"TW	PM
			16	TW	PM
			17	3"TW	PM
120.0			18	TW	PM
123.0	Clayey silt with sand Occ. layers of silt & sand up to 2" thick (loose to dense). Firm to hard. Grey		19	TW	PM
			20	SS	21
			21	SS	7
			22	SS	11
			23	SS	9
			24	ST	46
75.5			25	SS	25
167.5	Sound calcareous shale grey		26	AXT RC	88% Rec
67.2			27	AXT RC	92% Rec
175.8	End of Borehole				

ELEV SCALE: 240, 230, 220, 210, 200, 190, 180, 170, 160, 150, 140, 130, 120, 110, 100, 90, 80, 70, 60

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT: 20 40 60 80 100

SHEAR STRENGTH P.S.F: + Field Vane ○ Unconfined × Lab Vane ● Triaxial; 400 800 1200 1600 2000

LIQUID LIMIT — w_L; PLASTIC LIMIT — w_P; WATER CONTENT — w; WATER CONTENT % 20 40 60

BULK DENSITY γ P.C.F.: 106, 99, 101·5, 94, 103·5

REMARKS: Gr.Sa.Si.Cl; ▼240.; 5 63 89 33 39; Piez. tip elev. 67.2

15 20 Axial strain at failure.

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 9

FOUNDATION SECTION

JOB 68-F-54 LOCATION Sta. 222 + 20 ℄ Hwy. 417 WBL o/s 18' Lt. ORIGINATED BY WH

W.P. 34-66-01 BORING DATE Aug. 21-23, 1968 COMPILED BY WH

DATUM Geodetic BOREHOLE TYPE Diamond Drill, Washboring CHECKED BY AK

ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV SCALE
228.5	Ground Level					
0.0 / 223.5	Clayey Silt some Sand stiff Brown to Grey		1	CS		
			2	TW	PH	
5.0			3	SS	2	
			4	TW	PH	
			5	SS	1/0"	
			6	TW	PH	
	Sensitive clay.		7	SS	1	
	Occasional inclusions of organic matter.		8	TW	PH	
	Firm to very stiff.		9	SS	2	
			10	TW	PH	
	Grey with occasional black mottling		11	SS	6	
			11A	SS	5	
			12	TW	PH	
			13	SS	4	
			14	TW	PH	
			15	TW	PH	
117.5			16	SS	-	
111.0	Clayey silt with sand & some gravel (Glacial till)		16A	SS	15	
104.5	Very stiff. Grey.		17	SS	20	
124.0	End of Borehole					

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT — 20 40 60 80 100

SHEAR STRENGTH P.S.F. + Field Vane ● Undrained Triax. × Lab Vane ○ Unconfined — 400 800 1200 1600 2000

LIQUID LIMIT — w_L PLASTIC LIMIT — w_P WATER CONTENT — w

WATER CONTENT % 20 40 60

BULK DENSITY γ P.C.F.

BULK DENSITY	REMARKS
120	
	0 11 40 49
107	
	14 39 26 21

Gr.Sa.Si.Cl

20 / 15 / 10 — 5 Axial strain at failure

66-4996

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 10

FOUNDATION SECTION

JOB 68-F-54 LOCATION Sta. 222 + 80 ℄ Hwy. 417 EBL o/s 18' Rt. ORIGINATED BY WH
W.P. 34-66-01 BORING DATE Aug. 15-22, 1968 COMPILED BY WH
DATUM Geodetic BOREHOLE TYPE Diamond Drill, Washboring CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT
245.6	Ground Level				
0.0	Sensitive clay Occasional inclusions of organic matter. Firm to very stiff Grey with occasional black mottling		1	CS	
			2	SS	15
			3	SS	10
			4	SS	4
			5	TW	
			6	SS	2
			7	TP	PM
			8	SS	PM
			9	TP	PM
			10	SS	0
			11	TP	PM
			12	SS	0
			13	TP	PM
			14	SS	1/10"
			15	TP	PM
			16	SS	1/10"
			17	TP	PM
			18	SS	0
			19	TP	PM
120.6			20	SS	9
125.0	Clayey silt with sand & some gravel (Glacial till) Occ. layers of silt & sand up to 2' thick (compact to dense). Very stiff to hard.		21	SS	21
			22A	SS	60
			23	SS	46
			24	SS	150/4"
78.9	grey.				
166.7	Sound calcareous shale		25	AXT	100%
74.9	grey.				
170.7	End of Borehole				

ELEV SCALE

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100
SHEAR STRENGTH P.S.F
+ Field Vane ● Triaxial
× Lab Vane ○ Unconfined
400 800 1200 1600 2000

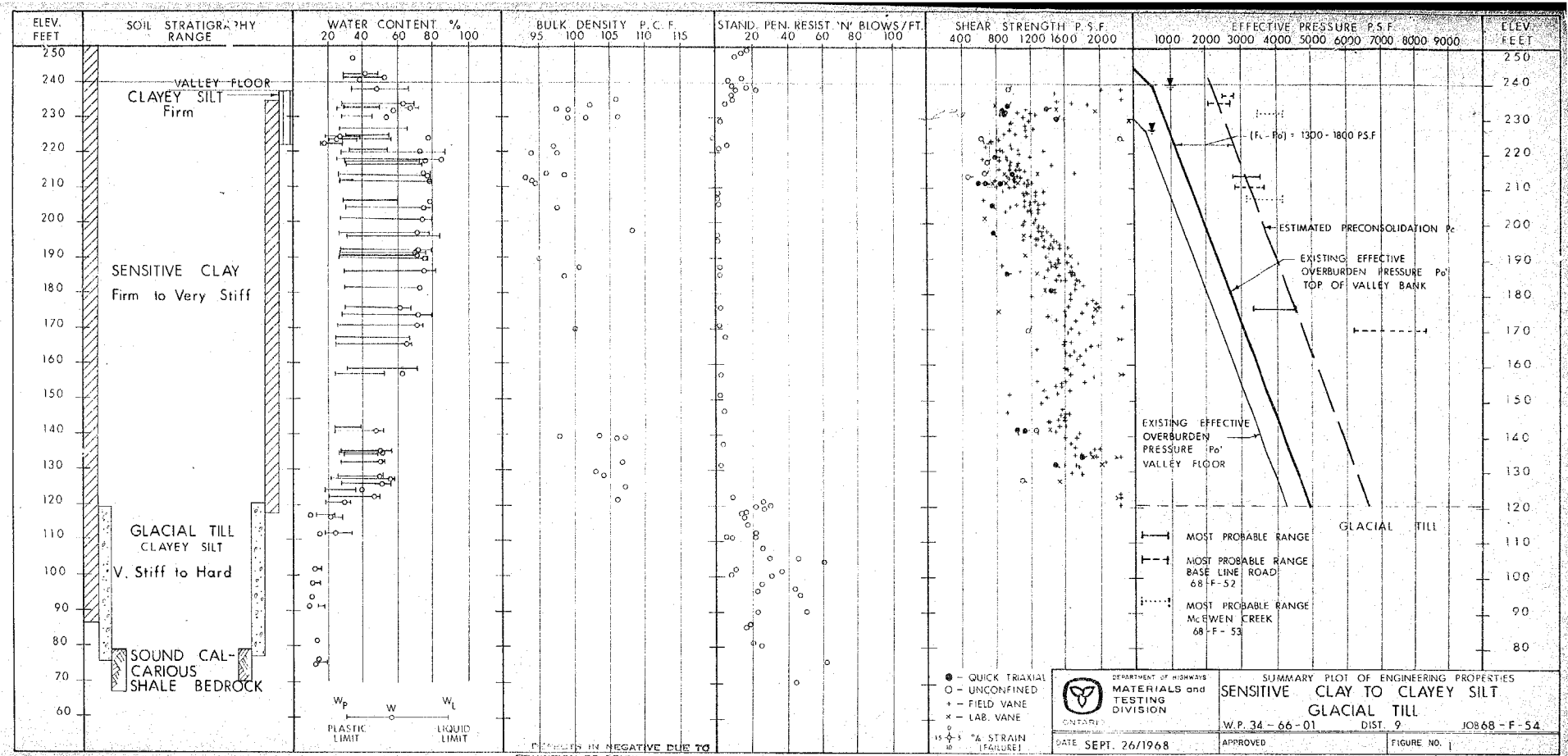
LIQUID LIMIT ——— w_L
PLASTIC LIMIT ——— w_P
WATER CONTENT ——— w
WATER CONTENT % 20 40 60

BULK DENSITY γ P.C.F.

REMARKS

241
104
97.5
107
0 1 55 44

Axial strain at failure



DEFECTS IN NEGATIVE DUE TO CONDITION OF ORIGINAL DOCUMENT

ALLOWABLE PILE LOADS

(Closed end 12 3/4" O.D Tubular Piles)

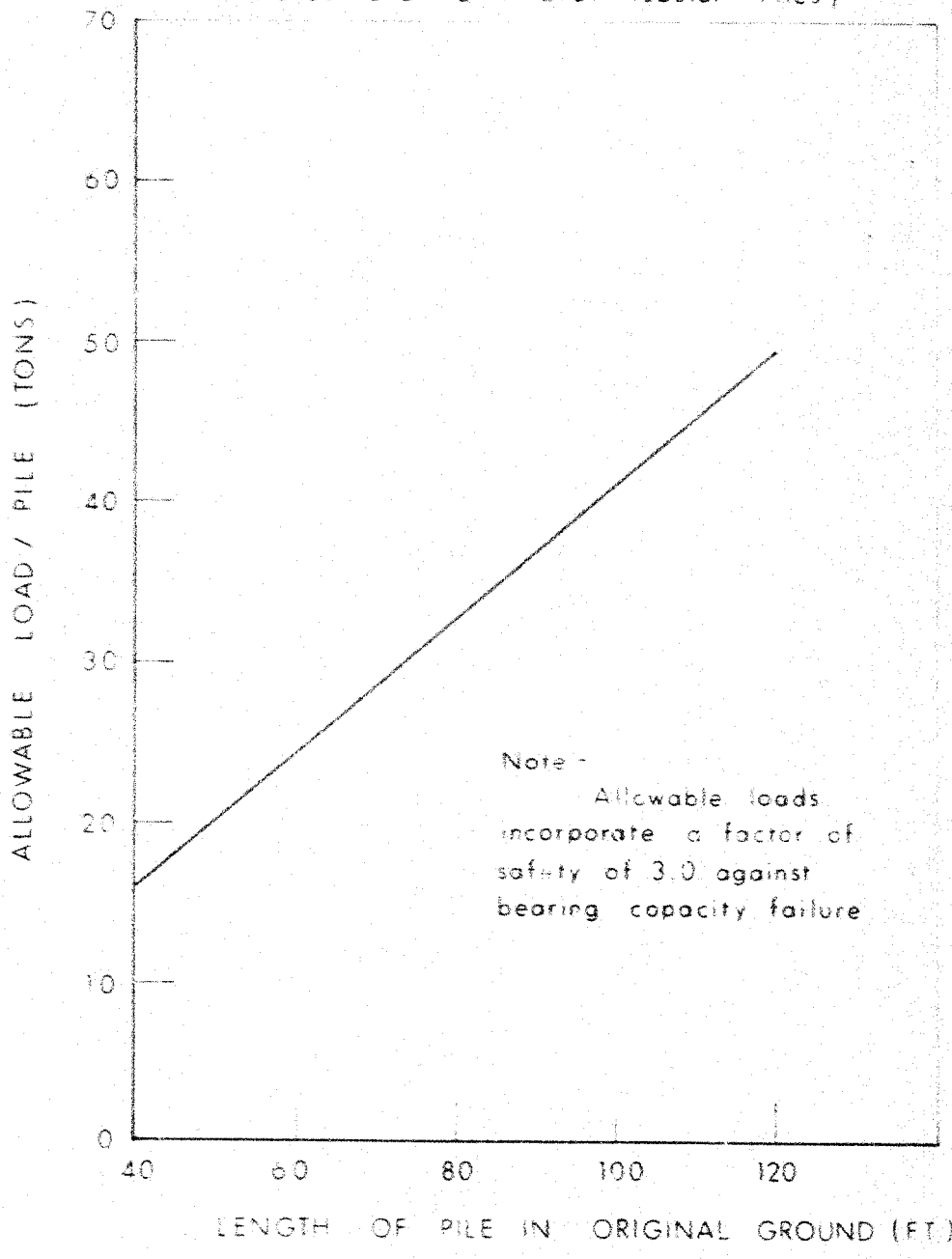


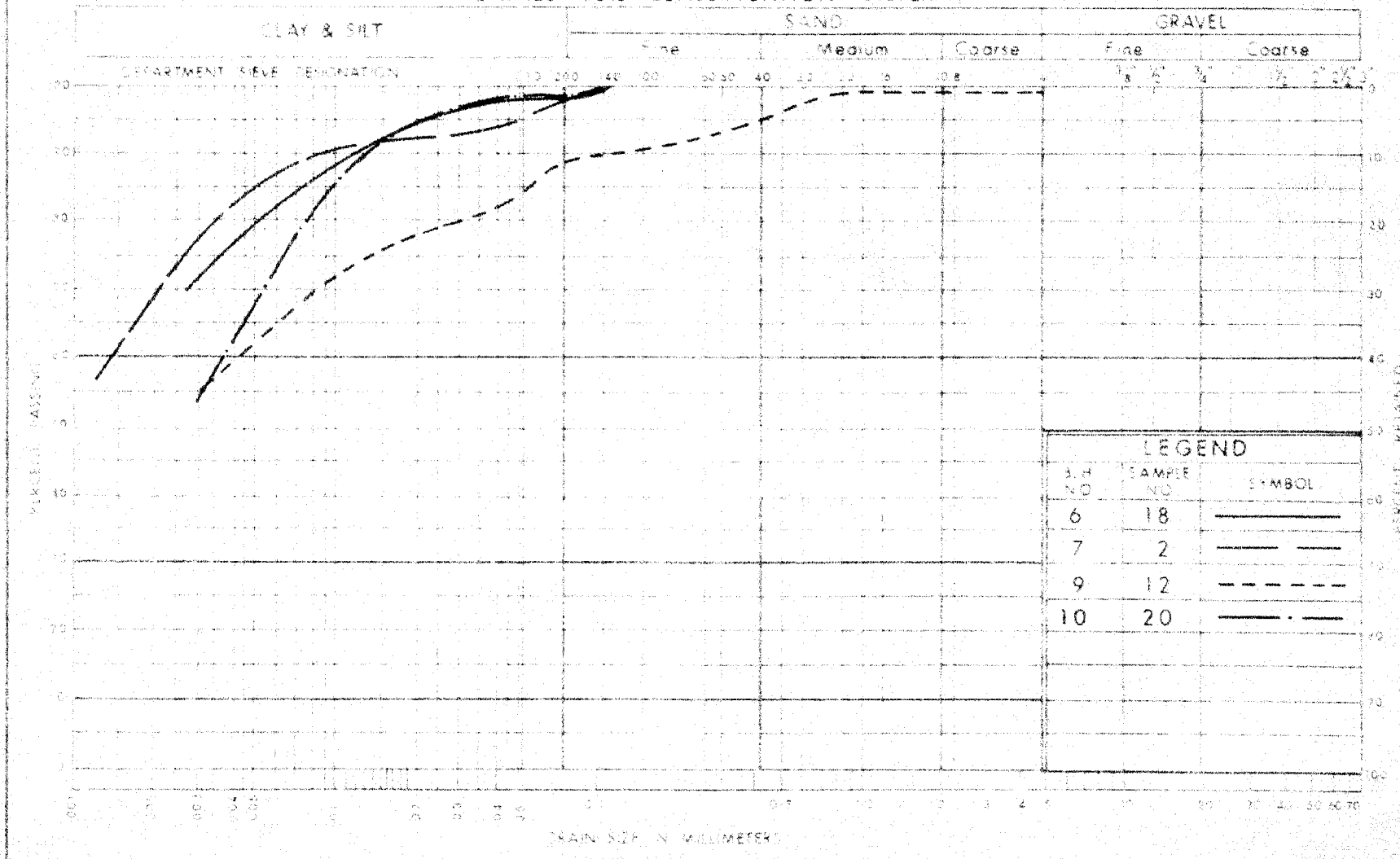
FIG 2

68 - F - 54

FORM DB MT - 17
REV. APR. 1965

DEFECTS IN NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMENT

UNIFIED SOIL CLASSIFICATION SYSTEM



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

GRAIN SIZE DISTRIBUTION

SENSITIVE CLAY

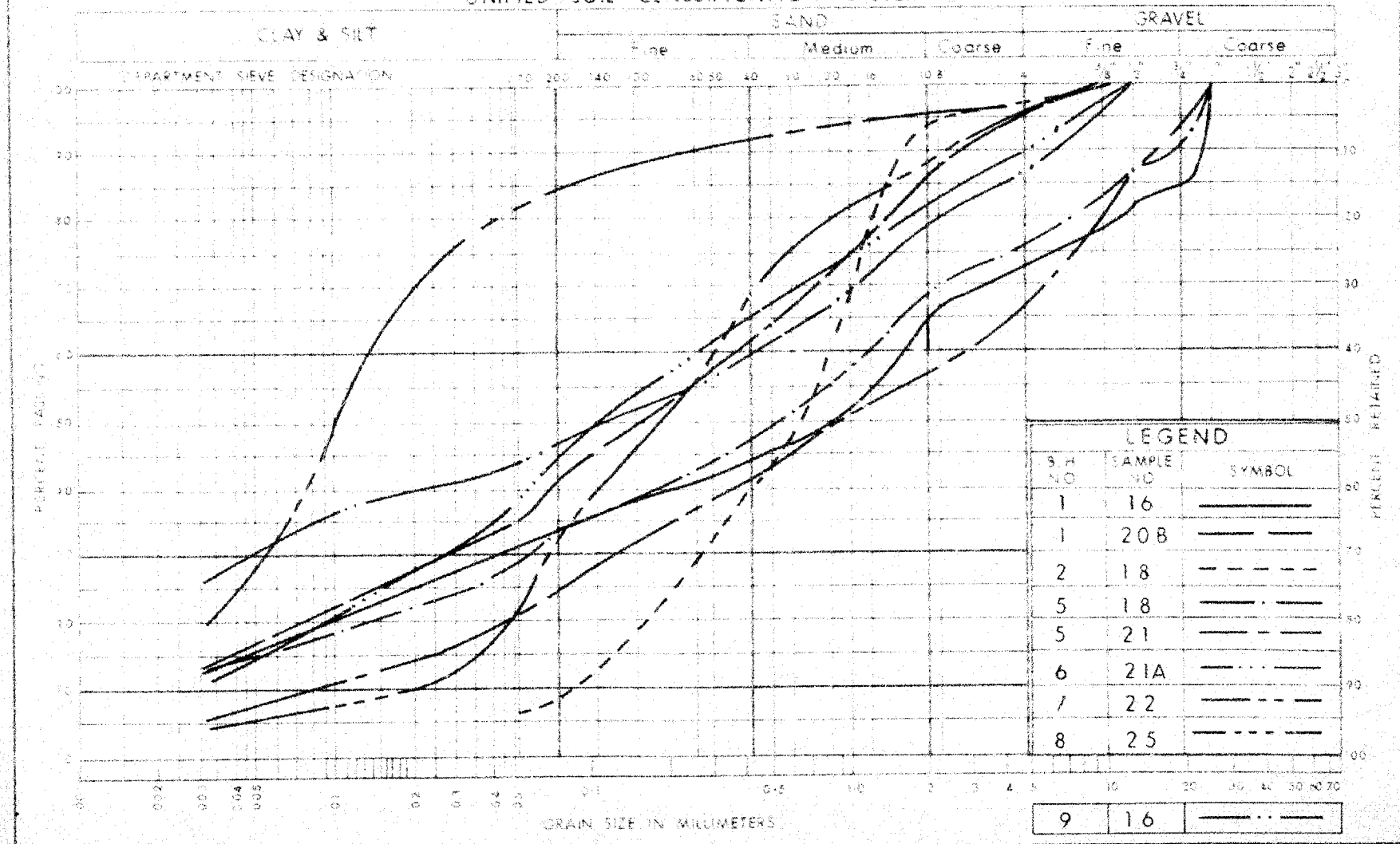
W.P. No. 34-66-01

JOB No. 68-F-54

FIG. 3

FORM DB M1 - 17
REV APR 1965

DEFECTS IN NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMENT



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

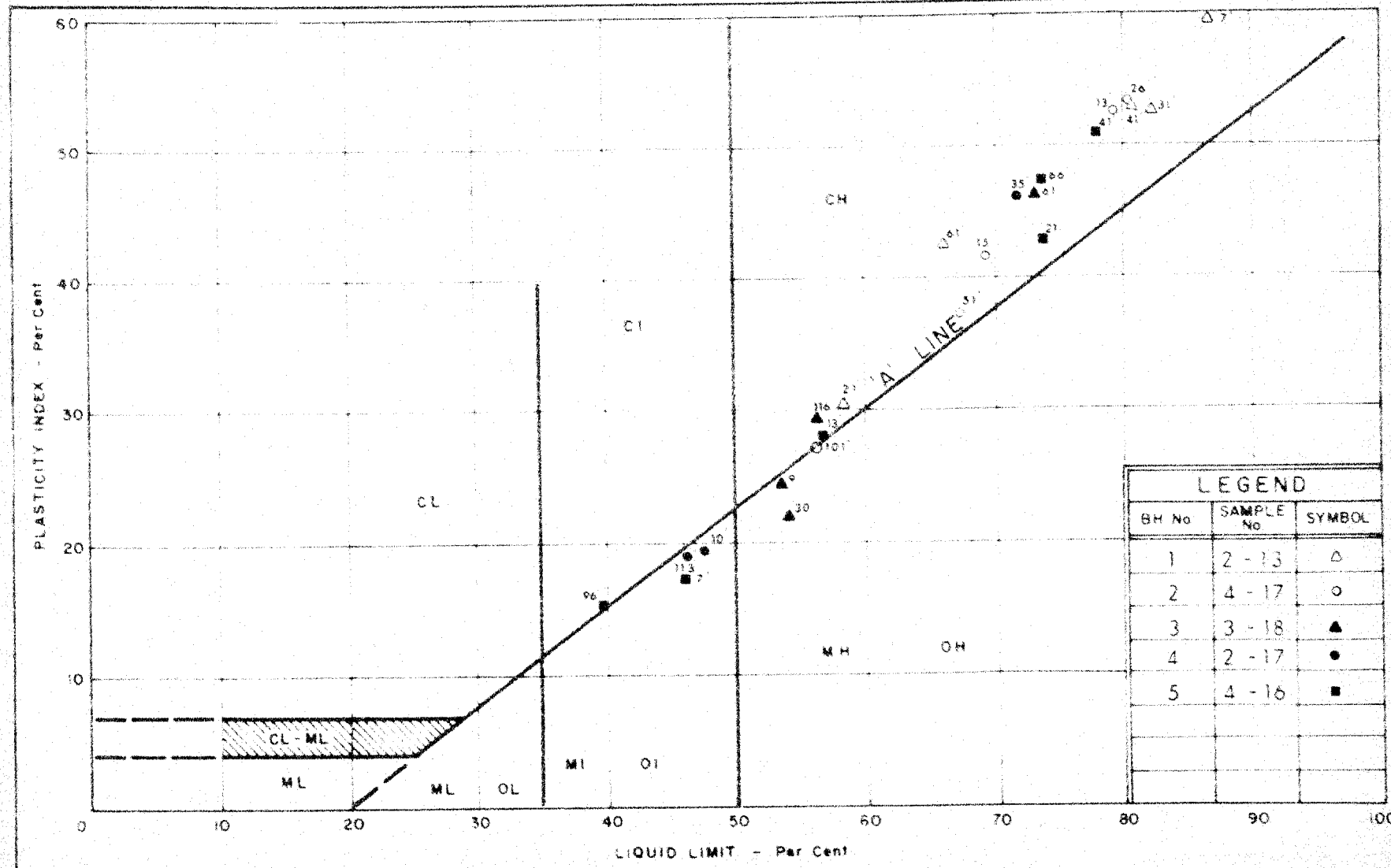
GRAIN SIZE DISTRIBUTION

CLAYEY SILT
WITH SAND & SOME GRAVEL
(GLACIAL TILL)

W.P. No. 34 - 66 - 01
JOB No. 68 - F - 54
FIG. 4

FORM OB-MT-252
REVISED JULY, 1966

DEFECTS IN NEGATIVE DUE TO CONDITION OF ORIGINAL DOCUMENT



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

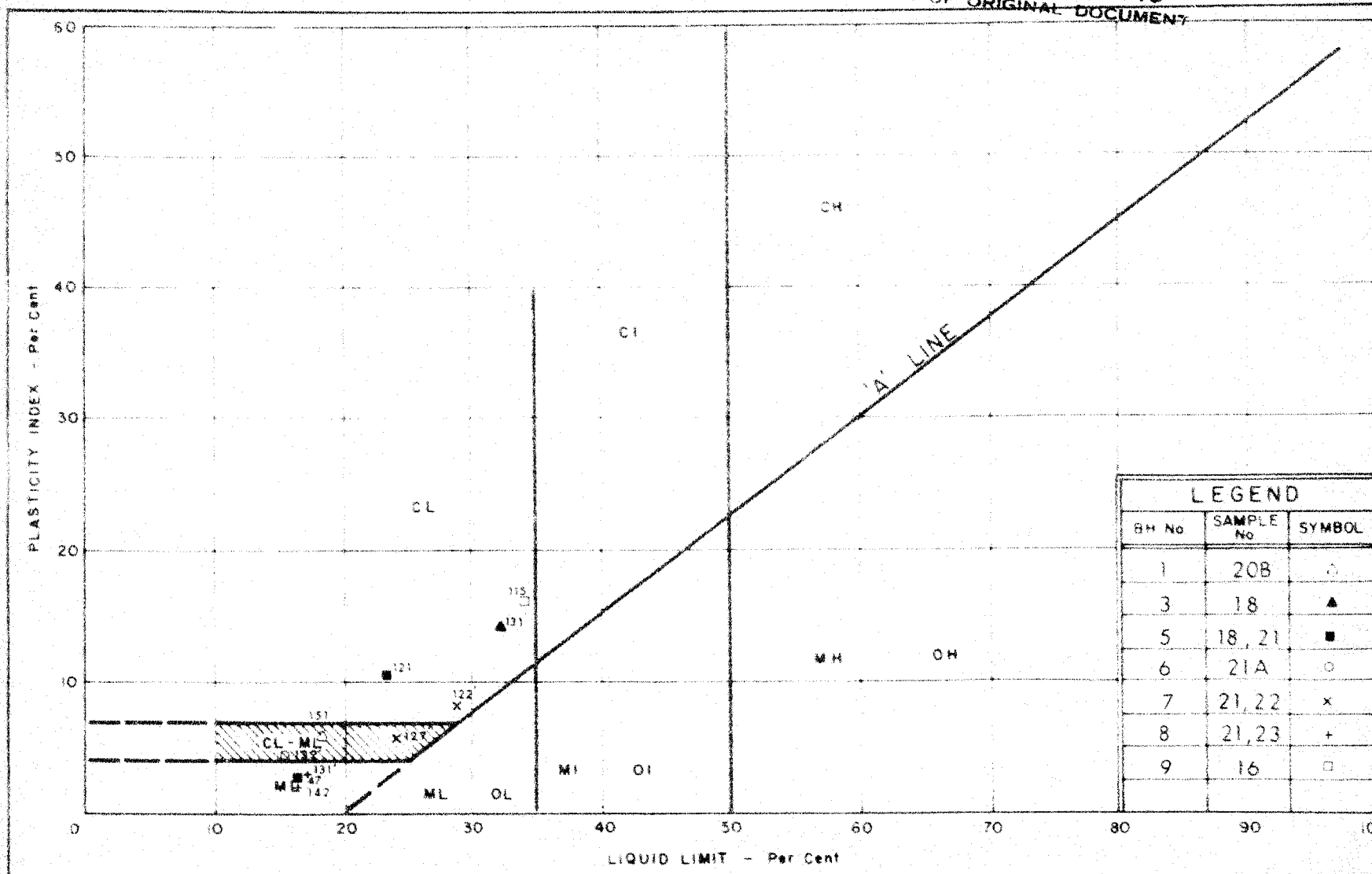
PLASTICITY CHART

SENSITIVE CLAY

W.P. No. 34 - 66 - 01
JOB No. 68 - F - 54
FIG. No. 5

FORM 08-MT-252
REVISED JULY [illegible] 66

DEFECTS IN NEGATIVE DUE TO CONDITION OF ORIGINAL DOCUMENT



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

PLASTICITY CHART

CLAYEY SILT
WITH SAND, SOME GRAVEL
(GLACIAL TILL)

W.P. No. 34-66-01
JOB No. 68-F-54
FIG. No. 7

VOID RAT'O vs PRESSURE

W_L = 79.0
W_P = 26.9
W = 78.7
C_c = 1.55

BORE HOLE 2
SAMPLE 4
DEPTH 12' - 11"
ELEV. 214.0

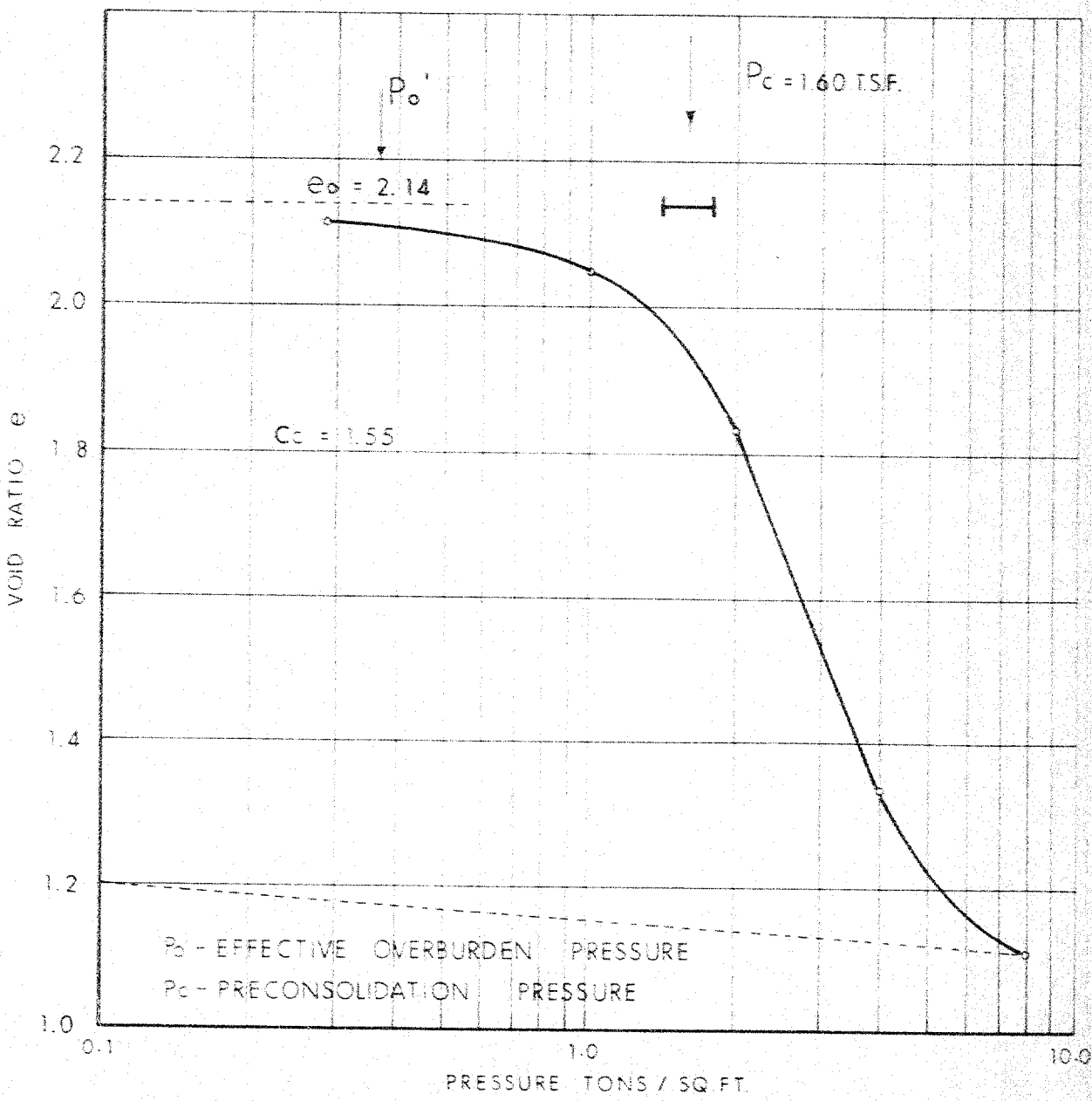
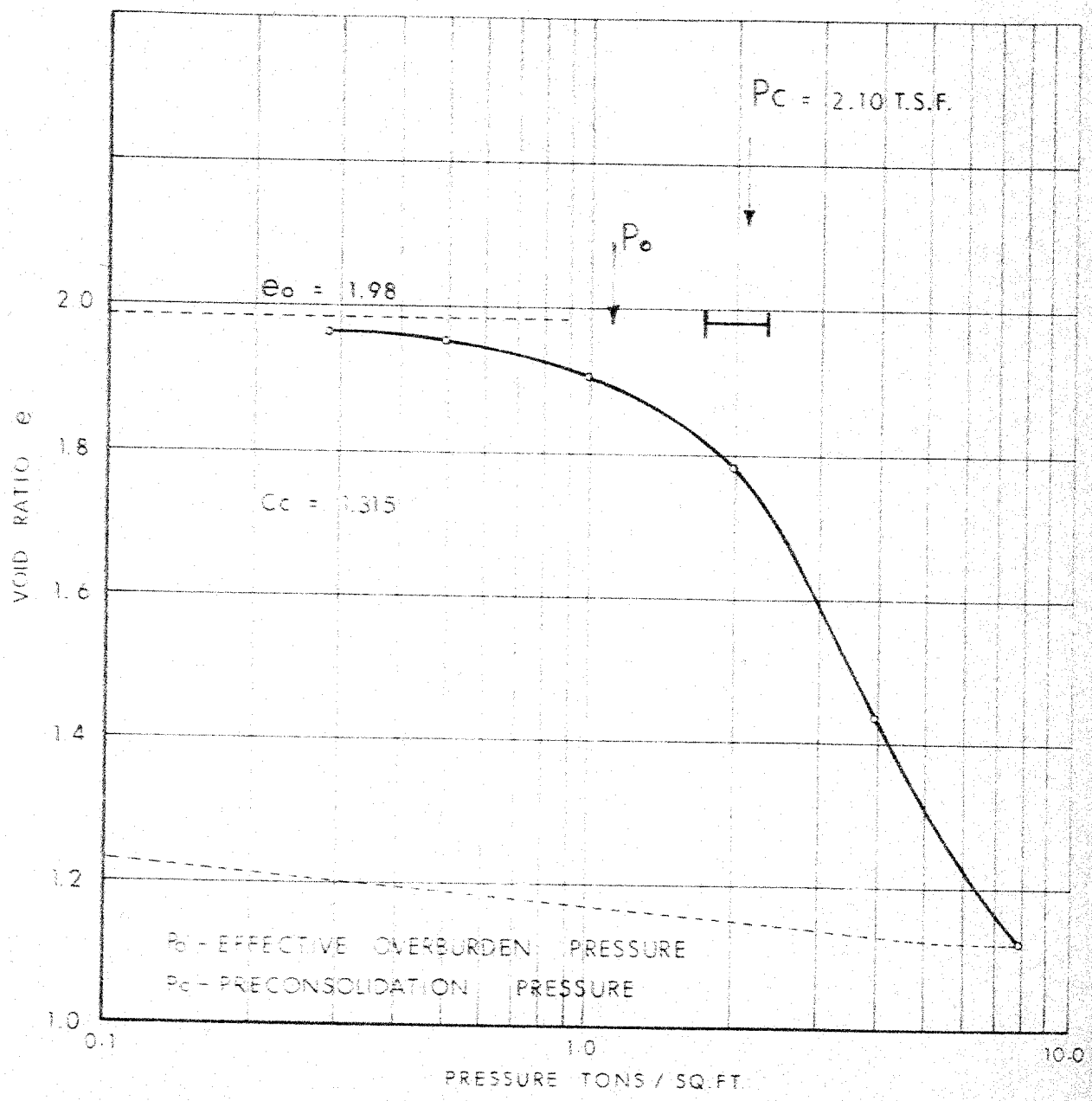


FIG. 8

VOID RATIO vs PRESSURE

W_L = 67.4
W_P = 30.2
W = 61.2
C_c = 1.315

BORE HOLE 2
SAMPLE 12
DEPTH 51'
ELEV. 176.0



DEFECTS IN NEGATIVE DUE TO CONDITION OF ORIGINAL DOCUMENT

FIG. 9

68 - F - 54

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

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

CONSISTENCY	'N' BLOWS / FT.	c LB / SQ FT	DENSENESS	'N' BLOWS / FT.
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

TYPE OF SAMPLE

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

P.H SAMPLE ADVANCED HYDRAULICALLY

P.M SAMPLE ADVANCED MANUALLY

SOIL TESTS

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

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_P	PLASTIC LIMIT
I_P	PLASTICITY INDEX
S	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX $= \frac{w - w_P}{I_P}$
I_C	CONSISTENCY INDEX $= \frac{w_L - w}{I_P}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE $= \frac{-\Delta e}{(1+e)\Delta\sigma'}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX $= \frac{\Delta e}{\Delta \log_{10} \sigma'}$
T_v	TIME FACTOR $= \frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
	IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
	IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 3·1416
e	BASE OF NATURAL LOGARITHMS 2·7183
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF σ
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF σ TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ε	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNGS MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_o	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_P	PLASTIC LIMIT
I_P	PLASTICITY INDEX
s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX $= \frac{w - w_P}{I_P}$
I_C	CONSISTENCY INDEX $= \frac{w_L - w}{I_P}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE $= \frac{-\Delta e}{(1+e)\Delta \sigma'}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX $= \frac{\Delta e}{\Delta \log_{10} \sigma'}$
T_v	TIME FACTOR $= \frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT — IN TERMS OF EFFECTIVE STRESS
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION — $\tau_f = c' + \sigma' \tan \phi'$
c_u	APPARENT COHESION — IN TERMS OF TOTAL STRESS
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION — $\tau_f = c_u + \sigma \tan \phi$
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF σ
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF σ TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ε	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNGS MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_o	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

TO: Mr. T. C. Kingsland,
Reg. Structural Planning Engr.,
Eastern Region,
Kingston.

FROM: Foundations Office,
Design Services Branch,
West Bldg., Downsview.

ATTENTION:

DATE: January 4, 1973.

OUR FILE REF.

IN REPLY TO JAN 11 1973

SUBJECT: *Ramsay Creek Culvert*
Hwy. #417 (E.B.L.)
Regional Municipality of Ottawa-Carleton
District # 9 (Ottawa)
W.O. 68-11054 - W.P. 84-66-10

The structure at the crossing of Hwy. #417 (E.B.L.) and Ramsay Creek has been constructed. It is now proposed to realign Baseline Road so that it will be carried beneath this structure, specifically between Pier# 2&3. It will be, therefore, necessary to divert Ramsay Creek some 60 feet to the east of its present location. The diversion of the Ramsay Creek requires a 150 feet long, 20 feet by 13 feet, Structural Plate Pipe Arch culvert beneath the structure. In addition, the diversion will be in open channel sections of 150 and 300 feet long at south and north of the culvert respectively. This letter contains the recommendations pertaining to the foundations of the proposed structural plate pipe arch culvert as well as the stability conditions associated with the cut sections of the open channelized Ramsay Creek as per request from the consultants, M. M. Dillon Limited, Ottawa. The request was contained in a letter from Mr. J. A. Lyle, Project Manager, dated December 21st, 1972.

Structural Plate Pipe Arch Culvert:

Detailed subsurface investigations were carried out at the crossing of Hwy. 417 (E.B.L.) and (W.B.L.) and Ramsay Creek in 1968 and 1972. Subsoil conditions at this general area were presented in our Foundations Report Nos. 68-11054 and 72-11052.

One of the boreholes put down for the Hwy. 417 (E.B.L.) structure is at the proposed culvert location (B.H. #6, W.C. 68-11054). This boring revealed that the overburden consists of a 110 feet thick, firm to very stiff sensitive clay overlying 38 feet of very stiff to hard, basically cohesive glacial till. The overburden is underlain by shale bedrock.

It is understood that a structural plate pipe arch culvert will be employed at this site. It is recommended that

.../2

the culvert be placed on a mat of granular material with sufficient thickness.

i) to provide adequate frost protection (minimum 4 feet)

and ii) to distribute the critical corner bearing pressure so that the stress increase, induced in the cohesive foundation subsoil, will not exceed the allowable bearing capacity of this stratum, which is 1,500 p.s.f.

The bedding and backfilling for the culvert should be carried out in accordance with current M.T.C. standards No. DD-808-B-Type 5 and No. DD-813-A. However, the thickness of the bedding should be modified as discussed previously.

Consolidation settlements, induced in the foundation subsoil due to the imposed mat pressure will be of the order of 3 inches. It is believed that the magnitude of this settlement will not alter the free flow of water inside the culvert. However, if it is necessary sufficient camber should be provided.

The excavation for the culvert will extend some 10 feet below the groundwater level recorded at the time of the investigation (August, 1968). Since the excavation will be carried out within the relatively impervious cohesive subsoil, no major dewatering problems are anticipated. Any minor seepage and surface runoff into the excavation, could be handled by employing standard techniques, for example, pumping from sumps, etc.

To ensure the stability of the valley bank slopes of Ramsay Creek during the construction certain measures will be necessary. The excavation for the culvert should be carried out in strips not greater than 20 feet in length and for the full width of the culvert, commencing from the north end. The installation of the culvert and the backfilling to finish grade, should be completed before commencing the excavation for the next strip.

Stability Considerations of the Open Channel Section:

The natural east bank of the Ramsay Creek Valley north of the culvert including the Ramsay Creek notch as well as the earth fill forming the east approach to the existing structure will have a maximum clear height of 38 feet and overall slope of approximately 3:1. Stability analyses indicate that the slope would be stable (F.S. = 1.3) provided that the cut slopes for the open channel sections are no steeper than 2:1.

We trust that the recommendations presented in this memo are sufficient for your immediate needs. If we can

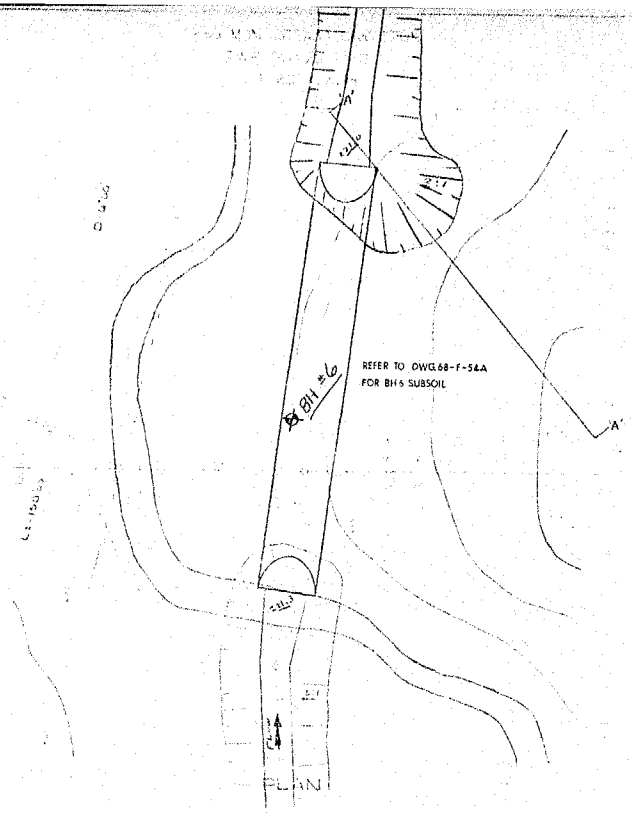
be of any further assistance on this project, please feel free to contact this Office.

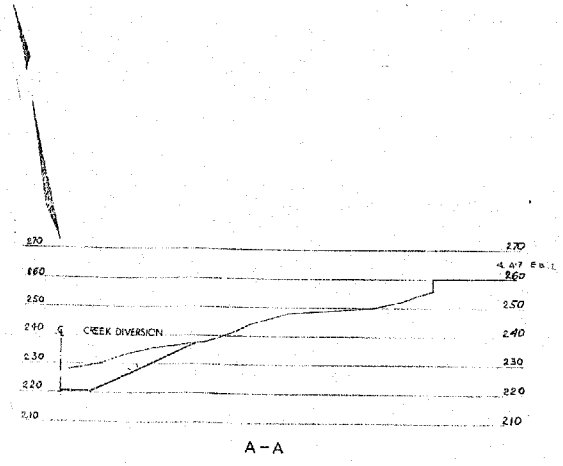
C. S. Poon, P. Eng.
Project Foundations Engineer.
For: M. Devata, P. Eng.
Supervising Foundations Engineer.

CSP/ck

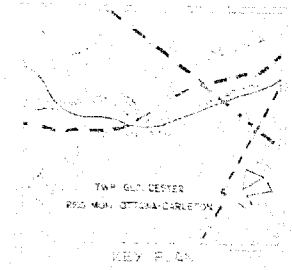
c.c. E. J. Orr
B. R. Davis
A. Rutka
J. Percy
J. F. Callaghan
B. J. Giroux
E. R. Saint
G. A. Wrong
B. A. Singh
M. M. Dillon & Co. Ltd. Ottawa
(Attn: Mr. J. A. Lyle)

Foundations Files ✓
Documents

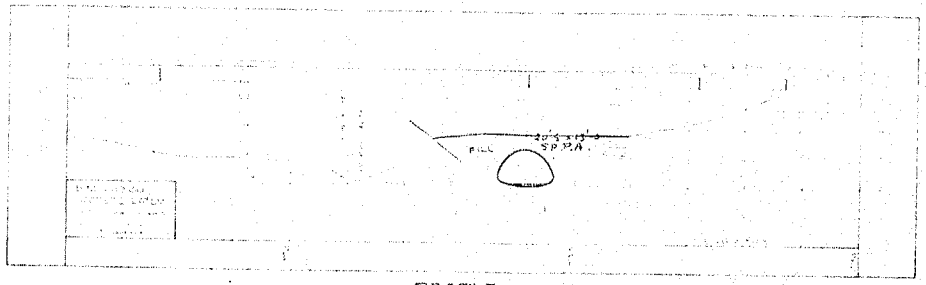




A-A



W.P. 10-69-01
STR. W.P.



GBM N.G.S. 98
ELEV. 251.794

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS
ONTARIO

BRIDGE SITE

PROPOSED DIVERSION

DUMAY CREEK

EXIST. ... AIT E.B.L.

FOUNDATIONS OFFICE
DWG. No. 68-F-54C

DEFECTS IN NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMENT

M. Devata
15th May/73

M. M. DILLON LIMITED

consulting engineers and planners

280 METCALFE STREET, OTTAWA, ONTARIO, K2P 1R7 • 613-236-9569

OUR FILE: 6830-00
YOUR FILE:

14 May 1973

Ministry of Transportation
and Communications
Design Services Branch
West Building
1201 Wilson Avenue
Downsview 464, Ontario

Attention: Mr. M. Devata, P.Eng.
Supervising Foundation Engineer

68-F-54

Ramsay Creek Bridge E.B.L.
W.P. 34-66-10, Site 3-265
Hwy. 417, District 9, Ottawa

Dear Sirs:

Enclosed herewith are two (2) prints of sheet C1 of W.P. 10-69-01 modified to indicate construction staging of the roadway embankment and culvert backfill adjacent to the above structure.

We would appreciate it if you could review the proposed staging of fills to ensure that all geotechnical requirements have been met and in particular that the sequence of construction will minimize any tendency towards tilting of the existing piers during construction.

We understand that you have previously reviewed the structure protection shown on the above drawing and have found it to be satisfactory.

continued ...

M.T.C.
Att: M. Devata

14 May 1973

We would appreciate your comments by May 17, 1973 in order that they be available prior to the head office review of the project. This review has been scheduled for May 18, 1973.

If you have any questions regarding this submission please do not hesitate in contacting the writer.

Yours truly,

M. M. DILLON LIMITED

W.W. Irwin, P.Eng.
for J.A. Lyle, P.Eng.
Project Manager

WWI:ls
Encl.

c.c. K.G. Bassi, P.Eng.
(1 print enclosed)

Advised W. Irwin that an item, stating that the excavation for the culvert should be carried out in 20-foot lengths, should be added to the "Construction Sequence", although this was shown in the Longitudinal section.

C.V. Moore May 16/73.

DILLON

File 68-F-054

M. M. DILLON LIMITED

consulting engineers and planners

280 METCALFE STREET, OTTAWA, ONTARIO, K2P 1R7 • 613-236-9569

OUR FILE: 6830-00
YOUR FILE:

2 May 1973

Foundations Office
Design Services Branch
Ministry of Transportation
and Communications
West Building
1201 Wilson Avenue
Downsview, Ontario

Attention: Mr. M. Devata, P.Eng.

Ramsay Creek Bridge E.B.L.
Site 3-265 W.P. 34-66-10
Hwy. 417 - District 9, Ottawa

Dear Sirs:

We are enclosing herewith 2 prints of sheets 60 & 61 of W.P. 10-69-01 describing proposed protection for the above structure during the construction of the SSP pipe arch carrying Ramsay Creek under the bridge.

We would appreciate it if you could review the geotechnical aspects of the design and comment on its adequacy.

We intend to submit final drawings to the Eastern Region by the beginning of next week and would appreciate preliminary comments by then if possible. If this is not possible, would you please advise us by telephone as to when your review could be completed.

Yours truly,

M. M. DILLON LIMITED

W.W. Irwin, P.Eng.
for J.A. Lyle, P.Eng.
Project Manager

WWI:lc
Encl.
c.c. S.J. Markiewicz
K.G. Bassi
(1 print of each enclosed)

68-1105A

M. M. DILLON LIMITED

consulting engineers and planners

280 METCALFE STREET, OTTAWA, ONTARIO, K2P 1R7 • 613-236-9569

OUR FILE: 6830-13
YOUR FILE:

21 December 1972

Ministry of Transportation
and Communications
Design Services Branch
West Building
1201 Wilson Avenue
Downsview 464, Ontario

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

Ramsay Creek Culvert

Dear Sirs:

We request a foundation report for the proposed 20'-5 x 13'-0 S.P.P.A. culvert at the Ramsay Creek diversion at the existing Highway 417 E.B.L. We also request confirmation of the acceptability of the cut in the existing creek valley at the north end of the proposed culvert. We enclose for your information 2 marked up E-Plans E-5246-1, and cross-sections of Base Line Road Relocation at the culvert. Also enclosed is a plan showing a borehole taken for the existing bridge.

Your early attention would be appreciated.

Yours truly,

M. M. DILLON LIMITED

J.A.Lyle, P.Eng.
Project Manager

JAS:ls
Encls.
c.c. T.C. Kingsland

RECEIVED
FOUNDATIONS OFFICE
DEC 22 1972
Ministry of Transportation & Communications

M. M. DILLON LIMITED

consulting engineers and planners

280 METCALFE STREET, OTTAWA, ONTARIO, K2P 1R7 • 613-236-9569

OUR FILE: 6830-07/10
YOUR FILE:

11 October 1972

Mr. A.G. Stermac
Principal Foundation Engineer
Design Services Branch
Ministry of Transportation
and Communications
Downsview, Ontario

Attention: Mr. B.T. Darch, P.Eng.
Senior Foundation Engineer

Highway 417 - Base Line Road
Relocation

Dear Sirs:

As per our telephone conversation of yesterday, I enclose a plan, cross-sections and some relevant correspondence.

The question of bank stability on the Ramsay Creek Relocation arises on the cross-section Sta. 102+00 Base Line Road relocation. This section does not appear to be similar to that described in your letter of 5 January 1972.

Should there be a problem of stability, the options appear to be flattening the cut slope or extending the pipe arch culvert. The culvert extension would be more desirable in that it maintains the 2:1 slopes throughout.

I would appreciate your comments as soon as convenient.

Yours truly,

M. M. DILLON LIMITED

J.A. Seaborn, P.Eng.
for J.A. Lyle, P.Eng.
Project Manager

JAS:ls
Encls.

ONTARIO

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

MINISTER: HONOURABLE GORDON CARTON, Q.C. DEPUTY MINISTER: A.T.C. McNAB

Structural Planning Office, Postal Bag 4000, Kingston, Ontario

March 24, 1972

M. M. Dillon Limited,
Consulting Engineers,
280 Metcalfe Street,
Ottawa 4, Ontario.

Attention: Mr. J. Lyle

Dear Sirs:

SUBJECT: W.P. 10-69, Hwy. 417, Ramsayville Northerly
W.P. 10-69-07, Ramsay Creek (WBL) Structure Site 3-265
W.P. 10-69-03 & -04 (EBL & WBL) C.N.R. Overhead Structures, Site 3-301

With reference to the above projects I have the following comments to make regarding the relocation of Baseline Road beneath the proposed Ramsay Creek W.B.L. structure and the proposed location of N.C.C. accesses beneath all of the structures mentioned above.

In the case of the E.B.L. structure by virtue of the constraints imposed by the existing pier locations it was necessary to use berms on each side of the road to avoid imposing eccentric loads on the existing pier foundation piles. The Creek will also have to be piped in order to satisfy the necessary berm condition. For your information a half scale copy of Bridge Drawing No. D-6575-1 showing the approximate recommended cross section under the E.B.L. structure is enclosed together with copies of relevant correspondence on the problem of accommodating the relocated road under the existing structure.

In the case of the W.B.L. structure, in the absence of the constraints described above, problems of differential settlement should not arise and it is thought that piping of the Creek, and berms will probably not be necessary. You should liaise with Mr. M. Devata, Foundations Office, during the design of the structure so that the best solution can be achieved.

.....2

With regard to N.C.C. Drawing No. 4527 LA-4 showing their underpass requirements I have the following comments.

Baseline Road will be relocated under the centre span of the E.B.L. structure - not the span shown in their drawing. The pedestrian walkway, etc., can be accommodated on top of the culvert fill shown on the enclosed Drawing D-6575-1. These walkways should be accommodated under the W.B.L. structure without incurring any additional structural expense.

W.P. 10-69-03 & -04 - C. N. R. Overheads

As previously discussed, it is intended to accommodate the 9 ft. service access shown on the N.C.C. drawing on the berms of the E.B.L. and W.B.L. structures. However, we cannot meet the N.C.C.'s vertical clearance requirement of 14 ft. using the berms, the maximum available being about 11 ft. Will you please supply us with sketches showing the proposed location of the access on the berms so that we can take up the question of the reduced clearance with the N.C.C. The sketches should show what vertical clearance can be provided without modifying the structural design.

Yours truly,

T. C. Kingsland
Regional Structural Planning Engineer

TCK/hl
Encls.

Department of Highways Ont
Copy for the information of
T.C. Kingsland

FILE:

Structural Office,
West Bldg., Downsview.

January 21, 1972.

Re: Structure at Crossing of Hwy.#417 E.B.L. and Re-aligned Ramsay Creek--Base Line Road complex.
W.P. 34-66-10, Site 3-265.

The writer held a meeting with Mr. M. Devata this morning to discuss the relocation of Base Line Road under the existing Hwy. #417 E.B.L. structure.

The writer stated that the existing piers #2 and #3 can support the additional vertical loads due to the fill for Scheme #2 placed on top of the footings. Taking this extra load into account and making an allowance of 15 tons/pile for negative skin friction, the loads on the piles will be within acceptable limits. It was, however, felt that the unequal loads on each side of the piers, could at this site cause the piers to tilt. If this occurred it could be very costly to rectify the situation. In order to keep this tilting to a minimum, it was agreed that:

1. The roadway fill slope on the west side be carried at 1:1 down to an elevation 3ft. below the roadway and then at 20:1 to meet the existing ground line.

2. A steel pipe arch (approx. 20'-5" x 13') be placed in the relocated creek channel and level fill placed on top of it up to an elevation 3 ft. below the roadway and extended to meet the roadway fill slope and the existing ground line close to Pier #4.

3. The above two treatments be extended 30 ft. on each side of the ℄ Hwy. 417 E.B.L.

4. The sequence of construction to be specified by the Foundation Office during preparation of design details.

K.G. Bassi,
Reg.Structural Design Engineer.

KGB:sr

c.c. C.S. Grabski
M. Devata
T.C. Kingsland

Copy made for: (TCK/hl) 25/1/72
A. J. Percy

P/W

Department of Transportation and Communications

MEMORANDUM

TO: Mr. T. C. Kingsland,
Regional Bridge Planning Engineer,
Eastern Region,
Kingston, Ontario.

FROM: Foundations Office,
Design Services Branch,
Central Bldg., Downsview.

ATTENTION:

DATE: January 5, 1972.

OUR FILE REF.

IN REPLY TO

SUBJECT: Structure at the Crossing of Hwy. #417 (E.B.L.) and Realigned Ramsay Creek - Base Line Rd. Complex (Scheme #2), Twp. of Gloucester, Reg. Mun. of Ottawa-Carleton, District No. 9 (Ottawa),
W.O. 68-11054 W.P. 34-66-10

The structure at the crossing of Hwy. #417 (E.B.L.) and Ramsay Creek has been constructed. It is now proposed to realign Base Line Road so that it will be carried beneath this structure, specifically between Piers #2 and 3. It will be necessary to divert Ramsay Creek some 60 feet to the east of its present location. This proposal is known as Scheme #2.

Along the floor of the Ramsay Creek Valley Base Line Road will be located on an earth fill embankment, which will extend approximately 12 to 15 feet above the existing ground surface. Elsewhere Base Line Road will be formed in nominal fill and cut sections. The proposed invert elevation of Ramsay Creek will be at about 222; i.e. it will be some 5 feet below the existing ground surface.

Stability and Settlement Considerations

The stability of the following sections were investigated:

i) The Base Line Road earth fill embankment - from the crest of the embankment to the invert of the adjacent Ramsay Creek channel

- clear height - 18 feet
- all slopes 2:1.

ii) The natural east bank of the Ramsay Creek Valley, including the Ramsay Creek channel notch as well as the earth fill forming the east approach to the existing structure

- clear height - 36 feet
- slopes varying between 2:1 and 4:1.

.....2

The stability computations carried out indicated that these sections would be stable.

The underlying compressible clay stratum will undergo settlements due to consolidation under the weight of the Base Line Road embankment. Computations carried out indicate that settlements of up to 6 inches can be expected under the centre line of a 15 foot high embankment.

Other Related Considerations

At the existing structure location Piers #2 and 3 will be located between the toe and the crest of the Base Line Rd. embankment. This being the case the pier columns, at these locations, will be subjected to an additional lateral load component. The design of these piers should be reviewed by the Structural Design Office taking into consideration the additional loads imposed by employing this revised scheme.

We trust that the comments presented in this memo are sufficient for your immediate needs. If we can be of any further assistance on this project, please contact this Office.

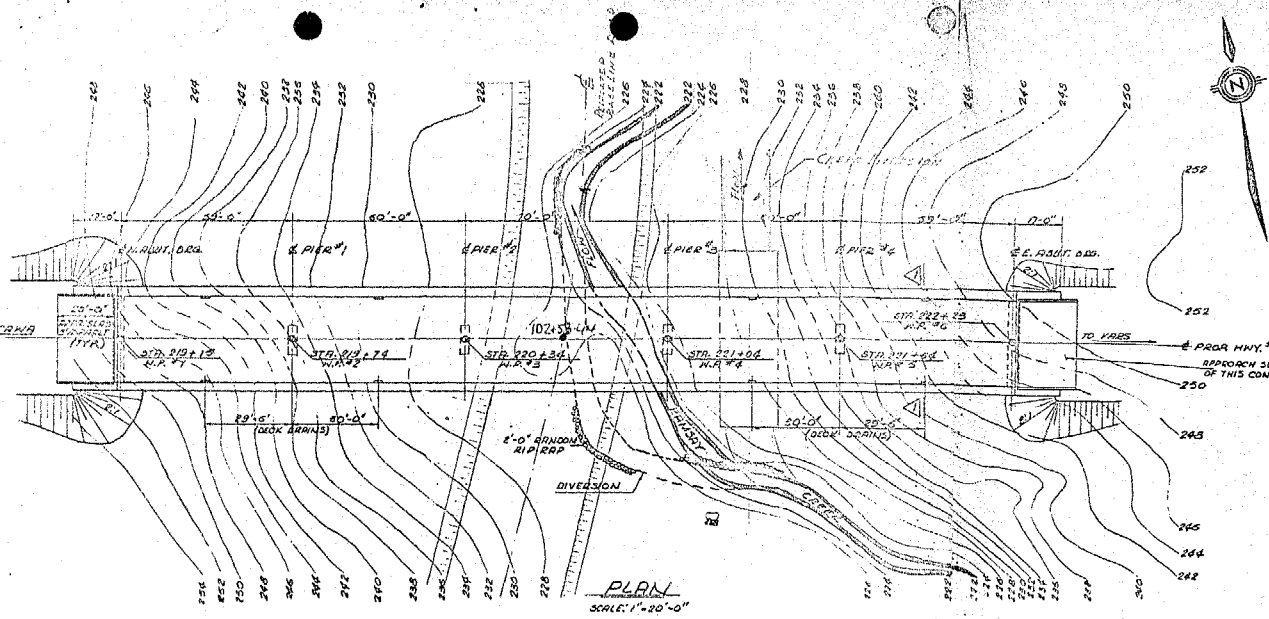
B. T. Darch

BTD/ao

B. T. Darch, P. Eng.
Senior Foundation Engineer,
For: M. Devata, P. Eng.,
Supervising Foundation Engineer.

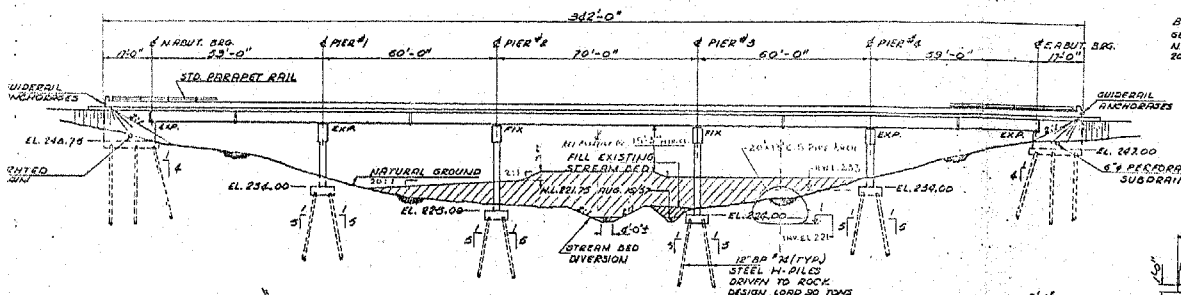
cc: J. Percy
L. Bassi

Foundations Files
Documents



PLAN

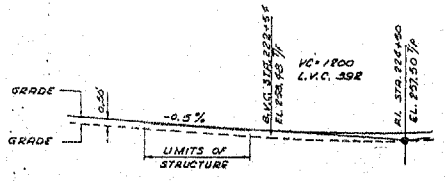
SCALE: 1"=20'-0"



ELEVATION

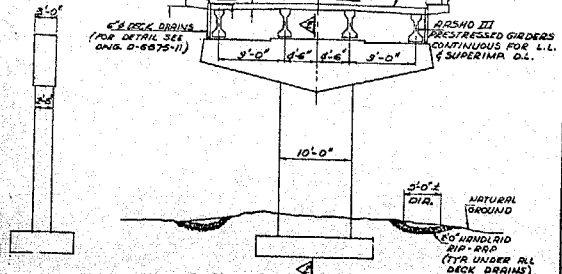
SCALE: 1"=20'-0"

B.M. 256.78
GEODETIC DATUM
NAIL IN IN FACE OF 1'-0" MAPLE
205.0' RT. OF STA 220+30 E.B.L.



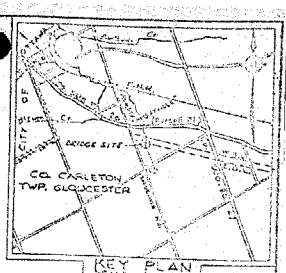
PROP. HWY. #417 E.B.L.

N.T.S.



SCALE: ½"=1'-0"

SCALE: ½"=1'-0"



NOTES:

1. CLASS OF CONCRETE

PRECAST MEMBERS	- 5000 P.S.I.
DECK, CURBS & PARAPET WALLS	- 4000 P.S.I.
REMAINDER	- 3000 P.S.I.

2. CLEAR COVER ON REINFOR. STEEL

FTGS., ABUTS. & PIERS	CURBS	PARAPET WALLS	DECK
3"	2"	1½"	TOP 1½" BOT. 1"

3. CONSTRUCTION NOTES:

THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS TO A LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF ± ⅛".
NO CONCRETE SHALL BE PLACED ABOVE THE ABUTMENT BEARING SEATS UNTIL THE CONCRETE IN THE DECK HAS BEEN PLACED.

LIST OF DRAWINGS

J. SMITH

REVISIONS			
DATE	BY	DESCRIPTION	

DEPARTMENT OF HIGHWAYS ONTARIO
EASTERN DIVISION

RAMSAY CREEK BRIDGE

E.B.L. STRUCTURE

(10.8 MILES SOUTHEAST OF RAMSAYVILLE)

KING'S HIGHWAY No. 417 (E.B.L.) DIST. No. 9

CO. CARLETON

TWP. GLOUCESTER LOT 20 CON. 3

GENERAL PLAN

APPROVED [illegible]
EASTERN DIVISION

DESIGN	J.S.	CHECK	S.B.D.
DRAWING	B.S.	CHECK	S.B.D.
DATE	NOV/69	LOADING	M.S.H.-20

SITE No. 3-266 W.P. No. 39-66-10
CONTRACT Nos. 69-28
DRAWING No. D-6575-1

Ramsay Creek 68-F-54

Settlement Due to 16 ft. embankment

Layer 1 $\Delta S = \frac{e_0 - e_1}{1+e_0} \Delta H$

Width of embankment 48'

Δp Plot

Depth	Δp
0	2000
20	1900
30	1800
40	1650
50	1500
60	1450
70	1250
80	1100
90	1050

Layer No	Depth	p_o	$p_o + \Delta p$	e_o	e_1	Δe	$H \frac{\Delta e}{1+e_o}$
1	0	700	2700	2.40	2.38	0.02	0.7"
2	40	1650	3350	2.14	2.02	0.12	19.0"
3	40	2900	4200	1.98	1.96	0.02	3.2"

Total Consol Settlement = 22.9"

2" in 3 months

5" in 1½ years

10" in 6 years

Say 20"

complete settlement in 28 yrs

Ramsay Creek - Time Rate of Settlement

C_v (lab consol. Spec Test) = 3×10^{-2} in²/min

assume radial drainage - ie $H = \frac{120}{2} = 60'$

$$t = \frac{T \times H^2}{C_v}$$

A for 90% Consol. $t = \frac{0.848 \times (60 \times 12)^2}{3 \times 10^{-2}} \times \frac{1}{60 \times 24 \times 365}$

$= 27.8$ yrs

B for 50% Consol

$t = \frac{0.196}{0.848} \times 27.8 = 6.4$ yrs

for 70% Consol

$t = \frac{0.403}{0.848} \times 27.8 = 13$ yrs

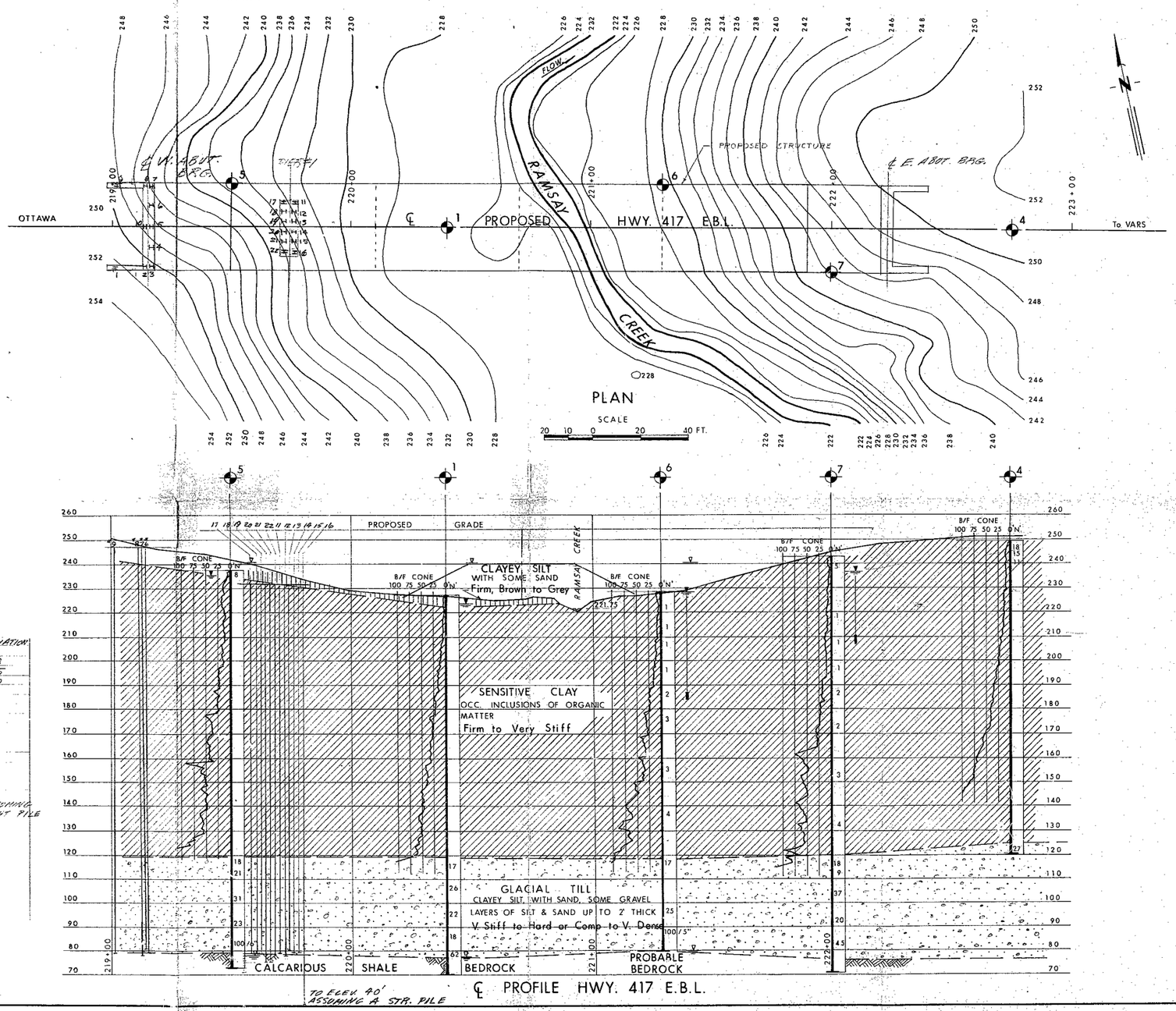
for 25% Consol

$t = \frac{0.049}{0.848} \times 27.8 = 1.6$ yrs

for 10% Consol

$t = \frac{0.0077}{0.848} \times 27.8 = 0.25$ yr

#68-F-54
W.P.# 34-66-10
Hwy# 417
RAMSAY CREEK

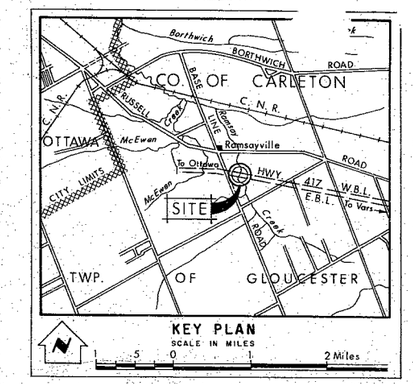


PILE NO.	TIP ELEVATION
6	79.3
7	80.8
8	78.5
9	70.0
10	78
18	79
19	79
20	75
21	75
22	79
11	79
12	78
13	80
14	78
15	79
* 16	40

NO. 16 ELEV. ASSUMING A STRAIGHT PILE

TO ELEV. 40' ASSUMING A STR. PILE

PRINT RECORD		
NO.	FOR	DATE



LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation. AUG. 16/1967
  - Head
  - Encountered
  - } ARTESIAN CONDITION
- PIEZOMETER

NO.	ELEVATION	STATION	OFFSET
1	227.2	220+40	℄ E.B.L.
4	249.6	222+75	℄ E.B.L.
5	237.8	219+50	18' LT.
6	228.3	221+30	18' LT.
7	243.0	222+00	18' RT.

– NOTE –

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

REVISIONS		
DATE	BY	DESCRIPTION

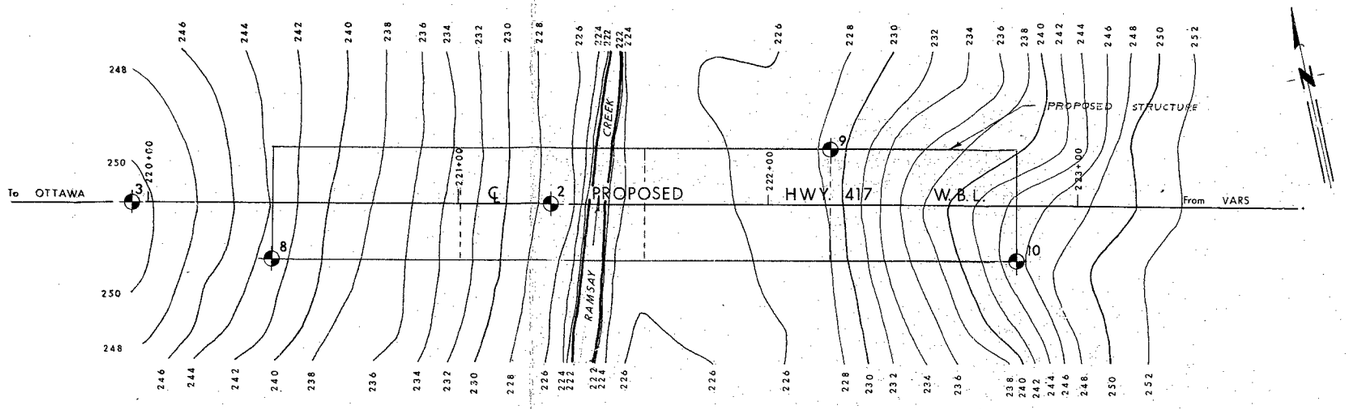
DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING DIVISION – FOUNDATION SECTION

RAMSAY CREEK

KING'S HIGHWAY NO. 417 E.B.L. DIST. NO. 9
CO. CARLETON
TWP. GLOUCESTER LOT 20 CON. V

BOREHOLE LOCATIONS & SOIL STRATA

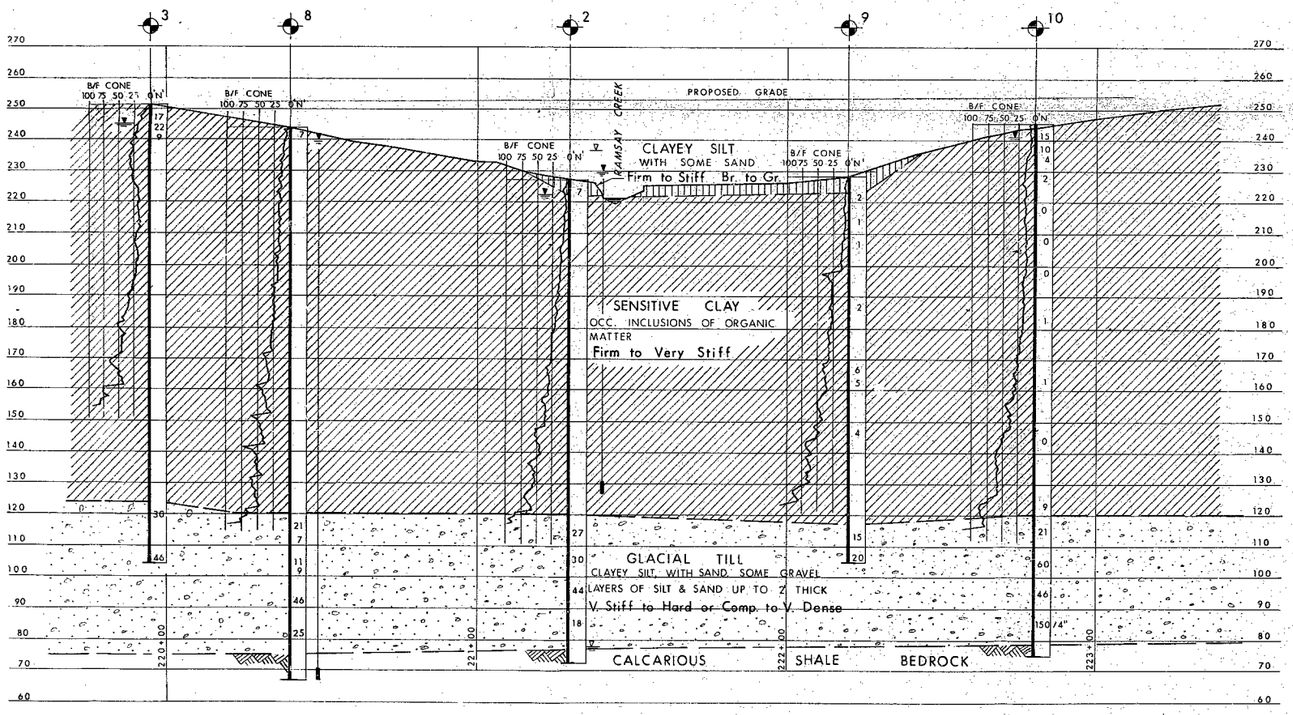
SUBM'D. W.H.	CHECKED A.N.	W.P. NO. 34 - 66 - 01	M.B.T. DRAWING NO. 68 - F - 54A
DRAWN A.N.	CHECKED	JOB NO. 68 - F - 54	
DATE SEPT. 23/1968		SITE NO.	BRIDGE DRAWING NO.
APPROVED A.D. Thomas PRINCIPAL FOUNDATION ENGINEER		CONT. NO.	



PLAN

SCALE

20 10 0 20 40



℄ PROFILE HWY. 417 W.B.L.

Note For Site Plan refer to Dwg. No. 68-F-54A

KEY PLAN
SCALE IN MILES

LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation.
  - Head Encountered } ARTESIAN CONDITION
  - PIEZOMETER

NO.	ELEVATION	STATION	OFFSET
2	227.1	221+30	℄ W.B.L.
3	250.8	219+95	℄ W.B.L.
8	243.0	220+40	18' RT.
9	228.5	222+20	18' LT.
10	245.6	222+80	18' RT

– NOTE –

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

PRINT RECORD		
NO.	FOR	DATE

REVISIONS		
DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING DIVISION – FOUNDATION SECTION

RAMSAY CREEK

KING'S HIGHWAY NO. 417 W.B.L. DIST. NO. 9
CO. CARLETON
TWP. GLOUCESTER LOT 20 CON. V

BOREHOLE LOCATIONS & SOIL STRATA

SUBM'D W.H.	CHECKED	W.P. NO. 34-66-01	M.B.T. DRAWING NO. 68-F-54B
DRAWN A.N.	CHECKED	JOB NO. 68-F-54	
DATE SEPT. 23/1968		SITE NO.	BRIDGE DRAWING NO.
APPROVED (PRINCIPAL FOUNDATION ENGINEER)		CONT. NO.	

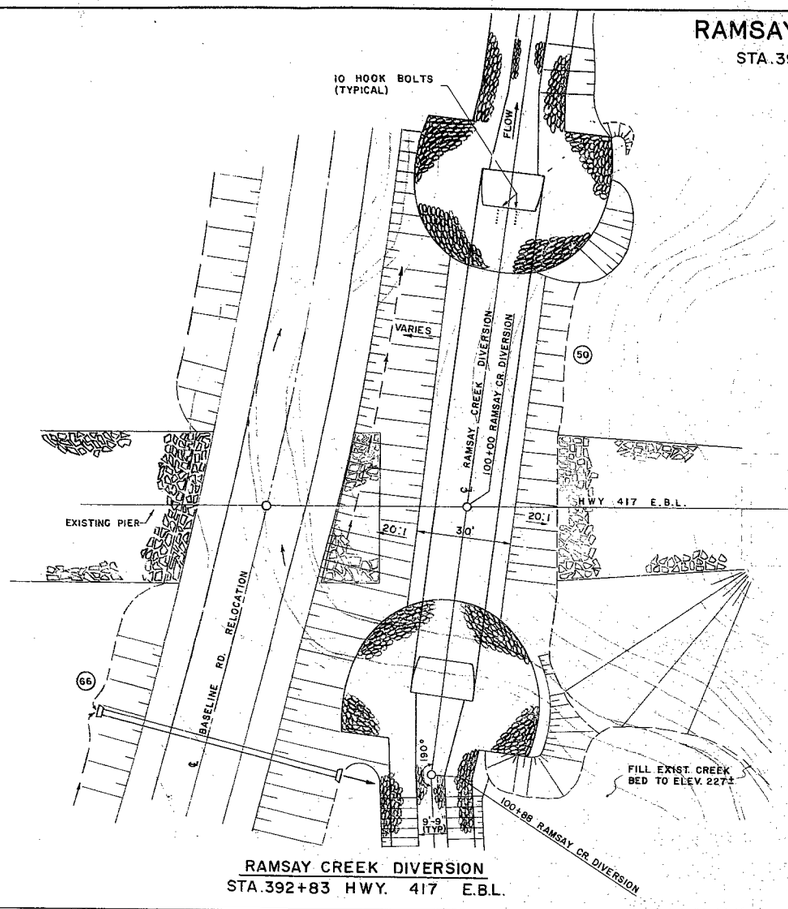
65-6-54

RAMSAY CREEK DIVERSION

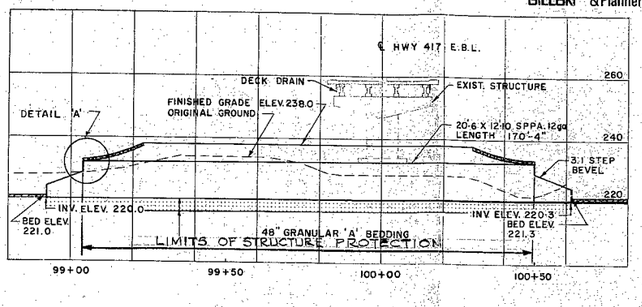
STA. 392+83 HWY. 417 E.B.L.

Consulting Engineers & Planners — DILLON

CONT. No.	
W. P. No. 10-69-01	
RAMSAY CREEK DIVERSION	SHEET 59



RAMSAY CREEK DIVERSION
STA. 392+83 HWY. 417 E.B.L.



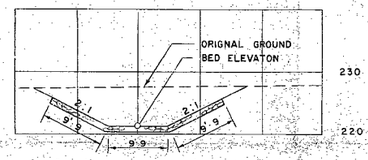
ELEVATION

FOR FURTHER DETAILS OF RIP-RAP SLOPE PROTECTION SEE SHEET 65

LEGEND

12" HANDLAID RIP-RAP

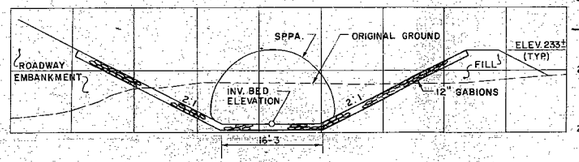
12" THICK GABIONS



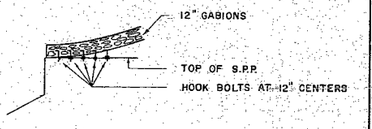
SECTION
STA. 100+88 RAMSAY CREEK DIVERSION
(SIMILAR TO STA. 98+66 RAMSAY CREEK DIVERSION)
N.T.S.

NOTES:

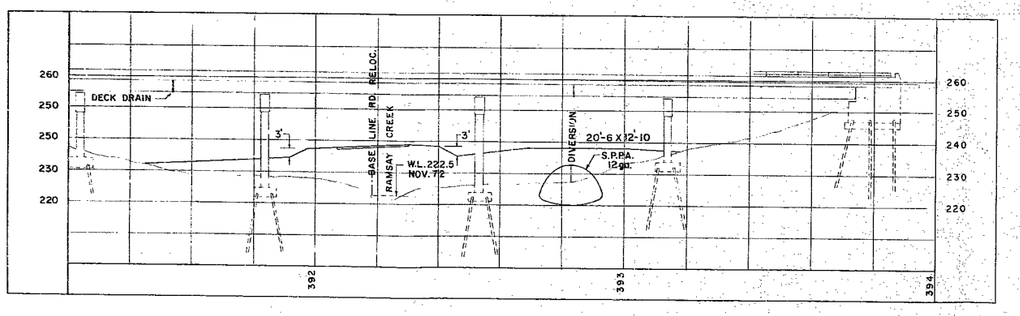
- BEDDING IN ACCORDANCE WITH OD-808-B TYPE 5 EXCEPT THAT DEPTH OF BEDDING TO BE INCREASED FROM 12" TO 48".
- BACKFILL IN ACCORDANCE WITH OD-813-A.
- CULVERTS TO BE INSTALLED IN LENGTHS OF 20' MAX. COMMENCING AT THE DOWNSTREAM END. ~~INSTALLATION AND BACKFILLING TO FINISHED GRADE TO BE COMPLETED BEFORE NEXT SECTION EXCAVATED.~~
- PLACE 5'-0 DIA. HANDLAID RIP-RAP UNDER ALL DECK DRAINS.
- ~~SHEETING AND SHORING REQUIRED TO EACH SIDE OF THE CENTRELINE (MIN. WIDTH 9.0m) TO PROTECT EXISTING STRUCTURE FOUNDATION. CONTRACTOR SHALL SUBMIT DETAILED DRAWINGS OF PROPOSED SHEETING AND SHORING TO THE MINISTRY.~~
- GABIONS TO BE WIRED (13ga., GALVANIZED) TO HOOK BOLTS (8" LONG, GALVANIZED) IN TOP OF CULVERT. HOOK BOLTS TO MATCH HOLES IN PLATES, AT 12" CENTERS.
- CUT OFF WALLS EACH END OF CULVERT IN ACCORDANCE WITH BD 90-1.
- FOR DETAILS OF STRUCTURE PROTECTION SEE SHEET 61.



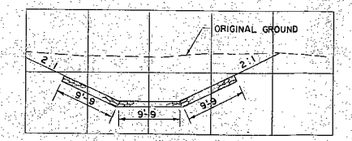
SECTION
STA. 100+62 RAMSAY CREEK DIVERSION
(SIMILAR TO STA. 98+92 RAMSAY CREEK DIVERSION)
N.T.S.



DETAIL 'A'
N.T.S.

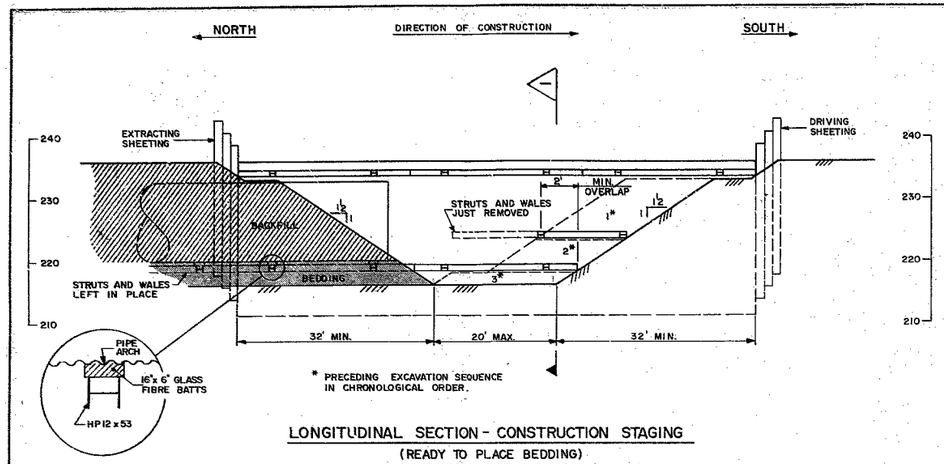


SECTION
STA. 100+00.00 RAMSAY CREEK DIVERSION



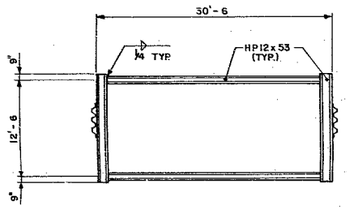
TYPICAL SECTION
CHANNEL RELOCATIONS
N.T.S.

SCALE
10' 0 20'
Horizontal & Vertical

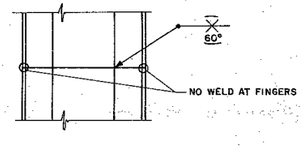


LONGITUDINAL SECTION - CONSTRUCTION STAGING
(READY TO PLACE BEDDING)

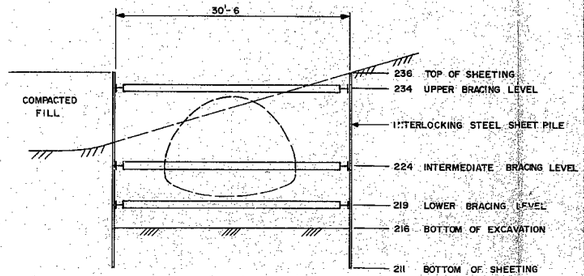
SCALE 5 0 10



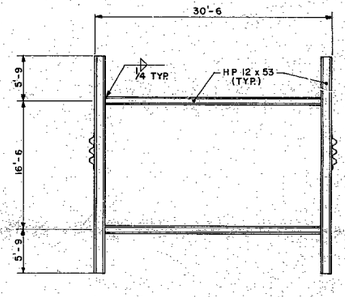
INTERMEDIATE BRACING FRAME
N.T.S.



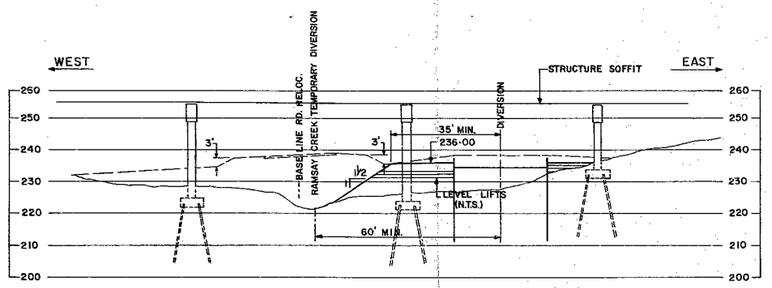
SHEET PILE SPLICE DETAIL
N.T.S.



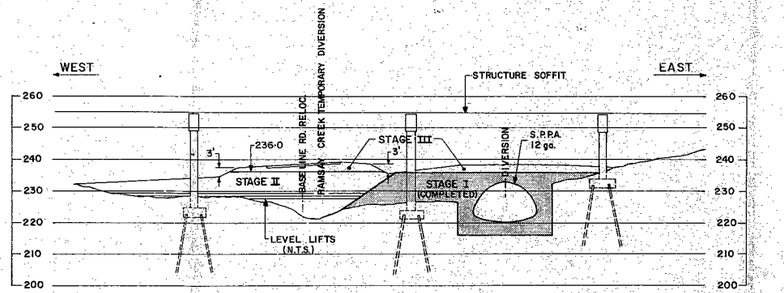
SECTION 1
N.T.S.



UPPER & LOWER BRACING FRAMES
N.T.S.



STAGE I
(READY TO EXCAVATE)



STAGES II & III

CONSTRUCTION STAGING
SCALE 10 20 0 40 20

Consulting Engineers & Planners — DILLON

CONT. No.
W. P. No. 10-69-01

STRUCTURE PROTECTION
RAMSAY CREEK BRIDGE E.B.L.

SHEET 61

NOTES:

- SHEETING SHALL BE USS. SECTION MP 116, BETHLEHEM SECTION DP2 OR AN APPROVED EQUAL.
- SHEETING SHALL BE SUPPLIED AND DRIVEN IN ONE LENGTH WHEREVER VERTICAL CLEARANCE PERMITS. WHERE CLEARANCES DICTATE LESS THAN FULL LENGTH SECTIONS THEY SHALL BE SPLICED USING FULL PENETRATION BUTT WELDS. SPLICES ON ADJACENT SECTIONS SHALL BE STAGGERED.
- WELDING SHALL CONFORM TO THE LATEST ISSUE OF C.S.A. SPECIFICATION W59 AND SHALL BE DONE BY A WELDER QUALIFIED UNDER C.S.A. SPECIFICATION W47.
- MAXIMUM LENGTH OF EXCAVATION OPEN AT ANY TIME SHALL BE 20' MEASURED AT THE BOTTOM.
- ALTERNATE SCHEMES OF STRUCTURE PROTECTION WILL BE CONSIDERED SUBJECT TO THE APPROVAL OF THE MINISTRY.
- LOWER BRACING TO BE TEMPORARILY BLOCKED OR TACK WELDED TO SHEETING WHEN PLACED. IF TACK WELDED, WELDS ARE TO BE BROKEN AS SOON AS BEDDING IS BROUGHT UP TO BRACING LEVEL.

CONSTRUCTION SEQUENCE:

1. DIVERT CREEK TEMPORARILY (SEE SHEET 60)
2. DRIVE SHEETING FULL DEPTH (EL. 211-0).
3. PLACE UPPER BRACING AND TACK WELD TO SHEETING.
4. PLACE AND COMPACT FILL OUTSIDE SHEETING TO TOP OF SHEETING (EL. 236-0). FILL MUST BE BROUGHT UP IN UNIFORM LEVEL LIFTS ON BOTH SIDES OF PROTECTED AREA.

STAGE I

5. EXCAVATE TO ELEVATION 223-5
6. PLACE INTERMEDIATE BRACING AND TACK WELD TO SHEETING.
7. EXCAVATE TO ELEVATION 218-5
8. PLACE LOWER BRACING AND THEN REMOVE INTERMEDIATE BRACING.
9. EXCAVATE TO ELEVATION 216-0 AND PLACE PIPE BEDDING. PLACE 6" GLASS FIBRE BATTS OVER LOWER STRUTS. ASSEMBLE PIPE.
10. BACKFILL TO TOP OF PIPE.
11. REMOVE UPPER BRACING AND EXTRACT SHEETING.

STAGE II

12. DIVERT CREEK THROUGH COMPLETED CULVERT.
13. PLACE FILL TO WEST OF CULVERT UP TO EL. 236-0 IN UNIFORM LEVEL LIFTS.

STAGE III

14. COMPLETE FILL OVER CULVERT.
15. COMPLETE BASE LINE ROAD.

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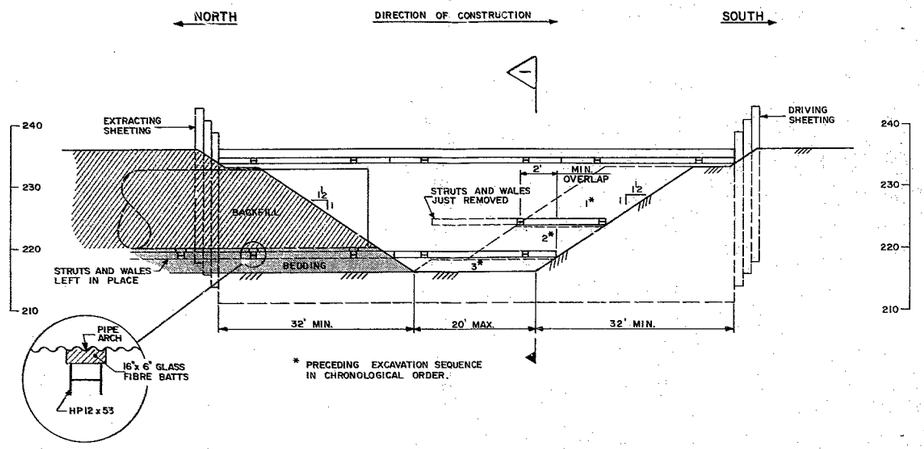
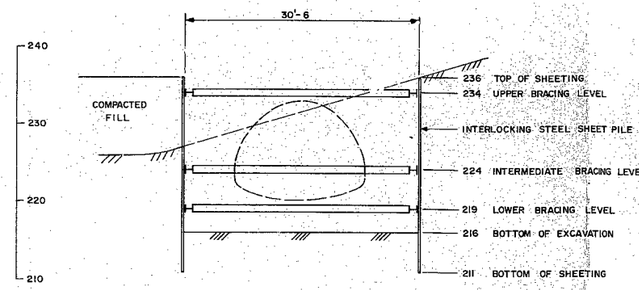
CONT. No.
W. P. No. 10-69-01

STRUCTURE PROTECTION
RAMSAY CREEK BRIDGE E.B.L.

SHEET 61



LONGITUDINAL SECTION - CONSTRUCTION STAGING
(READY TO PLACE BEDDING)



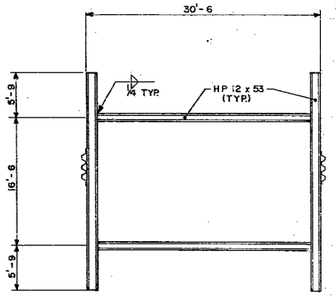
SECTION 1
N.T.S.

CONSTRUCTION SEQUENCE:

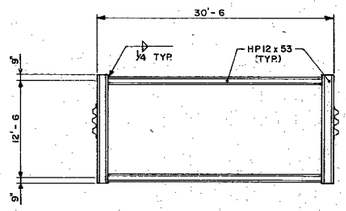
1. DRIVE SHEETING FULL DEPTH (EL. 211·0).
2. PLACE UPPER BRACING AND TACK WELD TO SHEETING.
3. PLACE AND COMPACT FILL OUTSIDE SHEETING TO TOP OF SHEETING (EL. 236·0)
4. EXCAVATE TO ELEVATION 223·5.
5. PLACE INTERMEDIATE BRACING AND TACK WELD TO SHEETING
6. EXCAVATE TO ELEVATION 218·5
7. PLACE LOWER BRACING AND THEN REMOVE INTERMEDIATE BRACING
8. EXCAVATE TO ELEVATION 216·0 AND PLACE PIPE BEDDING. PLACE 6" GLASS FIBRE BATTS OVER LOWER STRUTS. ASSEMBLE PIPE.
9. BACKFILL TO TOP OF PIPE.
10. REMOVE UPPER BRACING AND EXTRACT SHEETING.
11. COMPLETE BACKFILL.

NOTES:

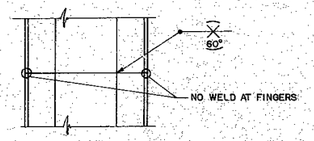
- SHEETING SHALL BE USS SECTION MP 116, BETHLEHEM SECTION DP2 OR AN APPROVED EQUAL.
- SHEETING SHALL BE SUPPLIED AND DRIVEN IN ONE LENGTH WHEREVER VERTICAL CLEARANCE PERMITS. WHERE CLEARANCES DICTATE LESS THAN FULL LENGTH SECTIONS THEY SHALL BE SPLICED USING FULL PENETRATION BUTT WELDS. SPLICES ON ADJACENT SECTIONS SHALL BE STAGGERED.
- WELDING SHALL CONFORM TO THE LATEST ISSUE OF C.S.A. SPECIFICATION W59 AND SHALL BE DONE BY A WELDER QUALIFIED UNDER C.S.A. SPECIFICATION W47.
- MAXIMUM LENGTH OF EXCAVATION OPEN AT ANY TIME SHALL BE 20' MEASURED AT THE BOTTOM.
- ALTERNATE SCHEMES OF STRUCTURE PROTECTION WILL BE CONSIDERED SUBJECT TO THE APPROVAL OF THE MINISTRY.
- LOWER BRACING TO BE TEMPORARILY BLOCKED OR TACK WELDED TO SHEETING WHEN PLACED. IF TACK WELDED WELDS ARE TO BE BROKEN AS SOON AS BEDDING IS BROUGHT UP TO BRACING LEVEL.



UPPER & LOWER BRACING FRAMES
N.T.S.



INTERMEDIATE BRACING FRAME
N.T.S.



SHEET PILE SPLICE DETAIL
N.T.S.

SCALE
5 0 10