

MEMORANDUM

To: Mr. B.R. Davis,
Bridge Engineer,
Bridge Office,
Admin. Bldg.

FROM: Foundation Section,
Materials & Testing Office,
Room 107, Lab. Bldg.

ATTENTION: Mr. S. McCombie

DATE: January 14, 1970

OUR FILE REF.

IN REPLY TO

JAN 1 1970

SUBJECT:

FOUNDATION INVESTIGATION REPORT
For
STRUCTURE #6
Proposed Overhead at the Crossing of
The Reconstructed Q.E.W. and the
Revised T.T.C. Tracks
Twp. of Etobicoke - County of York
District No. 6 (Toronto)
W.J. 69-F-78 -- W.P. 314-65-7 & 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.

ACS/MdeF

Attach.

cc: Messrs. B. R. Davis (2)
H. A. Tregaskes
D. W. Farren
G. K. Hunter (2)
F. G. Allen
W. S. Melinyshyn
T. J. Kovich
B. A. Singh

Foundations Files ✓
Gen. Files

A. G. Sternac
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PRINCIPAL FOUNDATION ENGINEER

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FOUNDATION INVESTIGATION REPORT
For
STRUCTURE #6
Proposed Overhead at the Crossing of
The Reconstructed Q.E.W. and the
Revised T.T.C. Tracks
Twp. of Etobicoke - County of York
District No. 6 (Toronto)
W.J. 69-F-78 -- W.P. 314-65-7 & 11

1. INTRODUCTION:

Major reconstruction is proposed for the Q.E.W. complex, commencing at a point about 1/4 mile east of Mimico Creek, in the southeastern portion of the Township of Etobicoke, Metropolitan Toronto. This complex will involve the construction of 5 structures and related retaining walls. In conjunction with this project, the Foundation Section was requested, in a memo from Mr. W. S. Melinyshyn, Regional Bridge Planning Engineer, Central Region, dated September 10, 1969, to carry out subsurface investigations at the proposed sites of all the structures and their ancillary elements. An investigation was subsequently carried out by this Section to determine the subsoil, bedrock and groundwater conditions at the respective structure sites.

This report deals with the proposed overhead structure at the crossing of realigned Q.E.W. and its associated ramps and the revised T.T.C., designated as Structure No. 6. All the factual data obtained at this site, together with recommendations pertaining to the foundations of the structure, as well as the stability and settlement of the approach embankments, are discussed in this report.

Foundation reports will be submitted for other structures, as well as for the associated retaining walls, all located within this complex.

2. DESCRIPTION OF THE SITE AND GEOLOGY:

The site is situated south of the C.N.R. tracks and immediately north of Lakeshore Blvd., in the Township of Etobicoke. A number of motels are located on the south side of Lakeshore Blvd. The surrounding terrain is flat to gently undulating in relief between elevations 262 to 268; the gentle topography was often obtained by placing fill.

An existing single-span (approx. 40 feet wide) rigid frame overhead structure, which carries: i) the C.N.R. (5 sets of tracks), ii) the W.B.L. of the Q.E.W., and iii) the ramp to Lakeshore Blvd., over the T.T.C. tracks, is located immediately to the north. The profile grade of the T.T.C. tracks varies from elevation 262 to 264, while the grade across the structure is between elevations 280 and 282. The associated approach fills (with side slopes between 2:1 and 2-1/2:1) are between 18 and 21 feet in height.

The E.B. lanes of the Q.E.W. are carried over the T.T.C. on a 500-foot long multi-span structure. The profile grade of the Q.E.W., varies from elevation 279, at the east end of the structure, to elevation 292, at the west end. With these grades the east and west approach fills are approximately 12 and 20 feet high, respectively. Because of space restrictions between the fill and Lakeshore Blvd., the south side of the east approach is being retained by a wall.

Physiographically the site is situated in the "Iroquois Plain", specifically in the "Toronto" sub-section. In this sub-section the predominant overburden deposit is composed of a clayey silt stratum some 20 to 30 feet thick; this deposit is of pre-Iroquoian Age. The cohesive stratum is underlain by a thin basal glacial till sheet, which, in turn, is followed by grey shale bedrock of the Meaford-Dundas formation, Ordovician Period.

3. FIELD AND LABORATORY WORK:

During the progress of the field investigation the Regional Bridge Planning Section advised us that major revisions for the proposed complex had been initiated by the design consultants. The borings, put down prior to this notification have been included, as well as the strategically located borings for the modified complex. In all, a total of 19 boreholes, all of which were accompanied by a dynamic cone penetration test, were put down at the proposed site. The majority of the borings were advanced by a diamond drill rig adapted for soil sampling purposes. At a few boring locations the holes were put down by a Penndrill employing power auger techniques; at the majority of these locations bedrock was proven using the diamond drill rigs.

Samples of the fill and overburden were recovered, at required depths, in a 2" O.D. split-spoon sampler, which was hammered into the soil in accordance with the specifications for carrying out the Standard Penetration Test. The same method was used to advance the dynamic cone penetration tests. Wherever possible, these samples were supplemented by manually or hydraulically pushing 2" I.D. Shelby tube samples into the cohesive portion of the overburden. In addition, in situ field vane tests were carried out within the softer, more compressible portions of this stratum. Bedrock was proven in 13 of the borings, by obtaining BXL size rock core samples.

The groundwater level conditions across the site, at the time of the investigation, were determined by recording the water levels in all the open boreholes.

The location and elevation of all the borings were surveyed by personnel from the Central Region Engineering Surveys Section. The borings are shown in plan on Drawing No. 69-F-78A. Two estimated stratigraphical sections are shown on the aforementioned drawing. All elevations given in this report are referenced to a Geodetic datum.

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

All samples were subjected to a careful visual examination in the field and subsequently in the laboratory. Following this examination, laboratory testing was carried out on selected representative samples to determine the following engineering properties of the overburden:

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

The results of this testing are plotted on the Record of Borelog sheets and summarized on Figures 1 to 4, inclusive, all contained in Appendix I of this report.

4. SUBSOIL AND BEDROCK CONDITIONS:

4.1) General:

The predominant parent stratum across the site is composed of a stiff to hard clayey silt with occasional silt layers throughout; the thickness of this deposit ranges from 5 to 15 feet. The cohesive stratum is overlain by fill whose composition ranges from loose to compact sandy silt and gravel to firm to very stiff clayey silt. The fill is anywhere from 4.5 to 24 feet in depth. At some random locations the clayey silt is underlain by a thin basal glacial till sheet, which, in turn, is followed by fractured to sound shale bedrock.

The boundaries of the various deposits, are shown on the accompanying borelog sheets. The stratigraphical sections, plotted on Drawing No. 69-F-78A, have been inferred from this data.

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

4. SUBSOIL AND BEDROCK CONDITIONS: (cont'd.) ...

4.2) Fill Material:

Fill was placed over the majority of the site as part of the grading and levelling operations carried out for the T.T.C. - C.N.R., Q.E.W. complex, located to the north of Lakeshore Blvd. The thickness of the fill generally varies from about 4.5 feet to 12 feet. At B.H.'s #213 and 215, put down through the existing east approach embankment, the fill is up to 24 feet in depth.

The majority of the fill is composed of a stiff to hard ('N' values 3 to 65 blows/ft.) brown to grey clayey silt, with a trace of sand. Elsewhere, particularly in the vicinity of the existing west approach embankment (refer to B.H.'s #207, 208, and 210), the fill is composed of a loose to dense ('N' values between 6 and 36 blows/ft.) brown sandy silt and gravel, with cinders, bricks, and other extraneous material. Grain-size distribution curves, obtained on representative samples of the fill, are plotted on Figure #1.

At B.H.'s #205 and 206A, a thin layer of organic topsoil (less than 1.5 feet in thickness), was found between the fill and the natural subsoil.

4.3) Clayey Silt Stratum:

Directly underlying the fill, is the predominant stratum across the site, composed of a brown to grey clayey silt with a trace of sand. Numerous layers of silt up to 2" thick are randomly located throughout the stratum. The thickness of the clayey silt varies from 5 to 15 feet, being on the average, about 10 feet thick. At B.H. #205 a 7-foot thick deposit of compact silt was encountered rather than the cohesive stratum. Grain-size distribution curves for samples of the clayey silt, as well as one for the granular zone encountered in B.H. #205, are plotted on Figure #2.

The engineering properties of the stratum, as determined by field and laboratory testing, are presented in tabular form:

4. SUBSOIL AND BEDROCK CONDITIONS: (cont'd.) ...

4.3) Clayey Silt Stratum: (cont'd.) ...

<u>Identity Tests:</u>		<u>Range</u>	<u>Average</u>
Bulk Density (p.c.f.)	(γ)	120 - 128	(126)
Liquidity Limit (%)	(W_L)	22 - 43	(28)
Plastic Limit (%)	(W_p)	15 - 25	(19)
Natural Moisture Content (%)	(W)	13 - 34	(22)
Liquidity Index	(I_L)	neg. - 0.9	(0.4)

Consolidation Characteristics:

Initial Void Ratio	(e_o)	(0.77
Compression Index	(C_c)	1 (0.26
Degree of Preconsolidation (p.s.f.)	($P_c - P_o'$)	Test (6,500

<u>Undrained Shear Strength</u>	(C_u)	1,150 to >2,000 (>2,000)
(p.s.f.)		

<u>Standard Penetration Tests</u>	'N'	4 - 34 (24)
(Blows/ft.)		

The Atterberg limit tests, summarized above, are also plotted on the Plasticity Chart, Figure #3. These results indicate that the cohesive stratum is inorganic with a plasticity in the low to intermediate range. In the deposit the natural moisture content ranges randomly from a few percent below the plastic limit to values between the liquid and plastic limits, as represented by liquidity indices between 0.2 and 0.8.

4. SUBSOIL AND BEDROCK CONDITIONS: (cont'd.) ...

4.3) Clayey Silt Stratum: (cont'd.) ...

Based on the undrained shear strength testing carried out, it is estimated that the consistency of the cohesive stratum varies from stiff to hard, being typically in the very stiff range. The aforementioned pattern was corroborated by the standard penetration testing carried out within the deposit.

A laboratory oedometer test was carried out on a sample from a more compressible portion of the stratum; the results of this test are plotted as a Void Ratio vs. Pressure plot on Figure #4. The results indicate that the clayey silt subsoil, within this zone, is preconsolidated by about 6,500 p.s.f. in excess of the existing overburden pressure. The majority of the stratum is preconsolidated by a magnitude which would be in excess of the aforementioned value. The values for the initial void ratio (e_0) and the compression index (C_c) are within the normal range for cohesive deposits encountered in this area.

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

At some locations the cohesive stratum is underlain by a very stiff to hard ('N' values 11 blows/ft. to greater than 100 blows/ft.) glacial till deposit composed of clayey silt with sand and gravel. The thickness of this deposit, where encountered, varies from 1 to 5.5 feet. Occasional random granular zones are present throughout the glacial till; in these areas the subsoil is composed of silt and sand binding gravel.

The Atterberg limit tests, carried out on samples of this deposit, are plotted on Figure #3. This testing indicates that the cohesive matrix has a plasticity in the low range. The corresponding natural moisture content is consistently at or slightly below the plastic limit.

4.5) Shale Bedrock:

The glacial till, where it exists, or the clayey silt stratum elsewhere, is underlain by bedrock which was proven in 13 of

4. SUBSOIL AND BEDROCK CONDITIONS: (cont'd.) ...

4.5) Shale Bedrock: (cont'd.) ...

the borings by obtaining from 5 to 11 feet of BXL size rock core samples. Over the area under investigation the surface of the bedrock was found to vary between elevations 238.5 to 248.5; the surface of the bedrock slopes in an easterly direction.

The bedrock is composed of a grey, horizontally bedded shale with occasional limestone interbeds. The upper 1 to 3 feet of the bedrock is generally in a fractured and jointed condition. Below this upper zone the bedrock is relatively sound.

5. GROUNDWATER CONDITIONS:

Groundwater level observations have been carried out, during the period of the investigation, in the open holes. The observations are recorded on the borelog sheets and summarized on Drawing No. 69-F-78A.

The recorded observations indicate that the groundwater level in the overburden deposits, at the time of the investigation, varies between elevations 252 and 261, which correspond to depths ranging from 6 to 11 feet below existing ground surface. However, in the vicinity of the existing east approach fill (B.H.'s #213 and 215), the groundwater level is some 25 feet below the ground surface, which corresponds to elevation 257.

6. EXISTING STRUCTURES AND APPROACH FILLS:

The bridge drawings for the existing multi-span structure (E.B.L. of the Q.E.W.), as well as the single-span rigid frame structure (C.N.R. & W.E.L. of the Q.E.W.), both of which cross the T.T.C., were studied. These indicate that the foundations for these structures are supported on end-bearing piles driven to practical refusal into the lower portion of the basal glacial till sheet or, alternatively, to bedrock. As discussed in Section 2), the height of the existing approach fills (with 2:1 to 2-1/2:1 slopes) vary from 12 to 20 feet.

6. EXISTING STRUCTURES AND APPROACH FILLS: (cont'd.) ...

Visual examinations, carried out at the time of the investigation, indicate that:

i) the approach embankments are inherently stable. Further, no cracking or dishing was noticed along the Q.E.W. paved lanes. This would infer that no appreciable total or differential settlements have occurred due to the surcharge loading of the subsoil, and

ii) the existing structures appear to be in a satisfactory condition.

7. DISCUSSION AND RECOMMENDATIONS:

7.1) General:

It is proposed to extend the existing single-span - (approximately 40 feet wide) rigid frame overhead structure about 220 feet in a southerly direction. The extended structure (designated as Structure #6) will carry the reconstructed Q.E.W. (E.B. and W.B. lanes), as well as the associated ramps to and from Lakeshore Blvd., over the revised T.T.C.

The profile grade of the reconstructed Q.E.W., at the structure location, will be at about elevations 281 and 282, while the T.T.C. grade will remain at elevation 262. In the vicinity of the structure this will involve cuts of between 2 to 5 feet below ground surface, and approach fills which extend 13 to 16 feet above ground surface. In addition, the existing approach fills shall be heightened and widened and incorporated into the proposed approaches.

Due to space restrictions between the proposed east approach fill and the realigned Lakeshore Blvd., a retaining structure is proposed for this area (Retaining Wall No. R-11). This will be discussed in our Report No. 69-F-120.

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

7.1) General:

The predominant deposit across the site is a 5 to 15-foot thick stiff to hard clayey silt stratum, which is occasionally underlain by a thin hard glacial till deposit, followed by shale bedrock. The overburden is generally overlain by fill, which varies from 4.5 to 24 feet in depth.

The presence of the clayey silt stratum is of primary importance as far as foundation design is concerned, since it will be necessary to ensure that it is not overstressed by either the structure element or approach fill surcharge loadings. These will be discussed in the sub-sections to follow:

7.2) Structure Foundations:

In view of the variable thickness and random composition of the fill material, as well as the variable consistency of the underlying clayey silt stratum over the site, the abutment foundations should be supported on end-bearing piles driven to bedrock (estimated pile tip elevations between 242 and 246). The base of the pile caps should be provided with at least 4 feet of earth cover for frost protection purposes.

The piles can be designed for the maximum allowable load for the respective pile section selected (e.g., 12 BP 74 steel H-piles may be designed for 90 tons/pile).

No major dewatering problems are anticipated for the construction of the pile caps, in view of the relatively impermeable nature of the subsoil. Any minor seepage or surface run-off occurring in the excavations could be handled by employing conventional techniques, such as pumping from sumps.

If the structure is designed as a rigid frame, then a coefficient of earth pressure at rest (K_0) of 0.5 should be assumed for the granular fill material behind the wall, when designing the abutments. However, if some movement of the top of the wall is permitted, then a coefficient of active earth pressure (K_a) of 0.33 can be used.

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

7.3) Approaches:

Immediately behind the abutments, the east and west approaches will have a height of the order of 19 and 21 feet, respectively. Elsewhere, the embankments will have a maximum height of 22 feet above the existing ground surface. No stability problems are anticipated for the proposed embankments or cuts (with standard 2:1 side slopes).

The cohesive foundation subsoil will undergo settlement due to consolidation, over a period of time, under the weight of the approach embankments. The induced stresses will not exceed the degree of preconsolidation of the cohesive subsoil. This being the case, the majority of the settlement will be of a recompression nature. Settlement computations were carried out, the results of which will be discussed herein.

The magnitude of the settlement, occurring beneath the centre-line of an approach fill whose height is 22 feet (maximum proposed), will be of the order of 2 to 2.5 inches.

East of Station 16+00, along the east approach, and west of Station 20+00, along the west approach, the future embankments will be formed by increasing the height of and widening the existing fills. Differential settlement, between the old and fill sections, could be of the order of 1 to 1-1/2 inches.

It is anticipated that the majority of the aforementioned settlements will take place during or immediately following the construction of the fill sections.

In order to have a smooth transition from the existing fill to the new fill sections, it is suggested that:

i) all topsoil be stripped from the existing fill slopes prior to placing future fill, and

ii) the future fill be "keyed" into the existing approaches in accordance with current D.E.O. methods.

8. MISCELLANEOUS:

The field work was performed during the period of September 25 to October 30, 1969.

The equipment was owned and operated by Master Soil Investigation Ltd., and Canadian Longyear Ltd., Toronto.

This report was written by Mr. B. T. Darch, Senior Foundation Engineer. This project was carried out under the general supervision of Mr. M. Devata, Supervising Foundation Engineer, who reviewed this report.

January, 1970

APPENDIX I

JOB 69-F-78
W.P. 314-65-7
DATUM Geodetic

FOUNDATION SECTION

JOB	69-F-78	LOCATION	184, 652N - 228, 536 E	ORIGINATED BY	BC
W.P.	314-65-7	BORING DATE	October 27 & 28, 1969	COMPILED BY	SO
DATUM	Geodetic	BOREHOLE TYPE	PennDrill- Washboring-BX Casing- BXL Rock Core	CHECKED BY	SL

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — w_L		BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS/FOOT		BLOWS/FOOT	PLASTIC LIMIT — w_p	WATER CONTENT — w	WATER CONTENT %		
260.6	Ground Level										
0.0	Clayey silt, with pockets of silt and sand (FILL) (Brown to Grey)	1	SS	33	260						253.1
250.6	Hard	2	SS	31							
10.0	Clayey Silt, with a trace of sand (occasional layers of silt up to 2" thick through out) (Grey)	3	SS	41	250						
		4	SS	21							
240.5	Very Stiff	5	SS	14							
20.1	Shale Bedrock, inter beds of limestone	6	SS	30/3"	240						
235.1	(Grey) Sound		BXL								
25.5	End of Borehole	7	Rc	95%	230						

FOUNDATION SECTION

ORIGINATED BY FB

COMPILED BY SO

CHECKED BY

Dynamic Cone Penetration Test

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FOUNDATION SECTION

ORIGINATED BY FB

COMPILED BY SO

CHECKED BY *[Signature]*

Dynamic Cone Penetration Test

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS / FOOT	BLOWS / FOOT					WATER CONTENT				
						20	40	60	80	100	W _p	W _L	W _u		
260.4	Ground Level					SHEAR STRENGTH PSF					WATER CONTENT %				
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB. VANE									
0.0	Clayey Silt, with pockets of silt, occasional rock fragments														
255.4	FILL) VERY STIFF		1	SS	11										
5.0	Clayey Silt, trace of sand (occasional silt layers up to 2" thick throughout)		2	SS	9										
	(Grey)		3	SS	4										
245.4	Very Stiff		4	SS	27										
15.0	Fractured Shale Bedrock,		5	SS	65.3"										
	Interbeds of limestone up to 5" thick		6	BXL	95%										
236.8	(Grey) Sand		7	BXL	100%										
23.6	End of Borehole														

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 205

FOUNDATION SECTION

JOB 69-F-78

LOCATION

184, 294N - 228, 215 E

ORIGINATED BY

FB

W.P. 314-65-7

BORING DATE

October 1, 1969

COMPILED BY

SO

DATUM Geodetic

BOREHOLE TYPE

Washboring, NX, BX Casing- BXL Rock Core

CHECKED BY

Dynamic Cone Penetration Test

SOIL PROFILE			SAMPLES		DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— %			BULK DENSITY	REMARKS		
ELEV DEPTH	DESCRIPTION	STRAT. PROF.	NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	BLOWS / FOOT					PLASTIC LIMIT ——— %				
							20	40	60	80	100	WATER CONTENT ——— %				
SHEAR STRENGTH PSF							+ FIELD VANE					WATER CONTENT %			Y	
○ UNCONFINED							x LAB. VANE									
												10 20 30			P.C.F.	
264.2	Ground Level															
	Clayey silt, with pockets of silt, cind. & brick fragments (Fill) (Brn to Grey)		1	SS	15	260										
255.2	Very Stiff		2	SS	26									255.1		
253.7	Organic Silt		3	SS	6											
10.5	Silt, trace of clay and sand (Brown)		4	TW	PM											
			5	SS	18	250								0-9-83-8		
	Compact		6	SS	12											
17.5	Clayey Silt with sand & gravel		7	SS	71											
244.2	Fractured Shale Bedrock, intbeds of limestone (Sound)		8	BXL	97%	240										
20.0			9	BXL	100%											
237.7																
26.5						230										

FOUNDATION SECTION

Dynamic Cone Penetration Test

[illegible]

DEPARTMENT OF HIGHWAYS- ONTARIO		RECORD OF BOREHOLE No. 205B		FOUNDATION SECTION	
MATERIALS & TESTING OFFICE					
JOB	69-F-78	LOCATION	104, 307N - 22B, 2483	ORIGINATED BY	FB
W.P.	314-65-7	BORING DATE	October 8 & 9, 1969	COMPILED BY	SO
DATUM	Geodetic	BOREHOLE TYPE	Washboring, NX Casing	CHECKED BY	

Dynamic Cone Penetration Test

SOIL PROFILE		STRAT PLOT	SAMPLES		BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— w _L PLASTIC LIMIT ——— w _p WATER CONTENT ——— w		BULK DENSITY Y	REMARKS
ELEV. DEPTH	DESCRIPTION		NUMBER	TYPE			20	40	60	80	100	SHEAR STRENGTH PSF ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE			
261.6	Ground Level														
261.0	Clayey silt, pockets of silt, fragments of brick, cinders, etc. (FILL) (Brown)		1	SS	14	260									
253.1	Very Stiff		2	SS	11										
8.5	Clayey Silt, trace of sand (occasional pocket of silt) (Brown)		3	SS	28	250									
247.6	Very Stiff		4	SS	23										
244.4	Clayey silt with sand & gravel (Glacial Till)		5	SS	50/8"										
244.4	Hard		6	SS	100/3"										
17.2	End of Borehole Probably Bedrock					240									

FOUNDATION SECTION

F2

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Dynamic Cone Penetration Test

SOIL PROFILE		SAMPLES			DYNAMIC PENETRATION RESISTANCE	LIQUID LIMIT ——— % PLASTIC LIMIT ——— % WATER CONTENT ——— %	BULK DENSITY Y P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT	20 40 60 80 100			
					SHEAR STRENGTH P.S.F.	WATER CONTENT %		
					○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	10 20 30		
266.0	Ground Level							
0.0	Sandy Silt with pockets of clayey silt & fragments of rock (FILL) (Grey & Brown)	1	SS	20				
257.0	Compact	2	SS	28				3-33-57-7
9.0	<u>Clayey Silt</u> to <u>Silty Clay</u> , traces of sand (occasional layers of silt up to 3" thick throughout)	3	SS	11				= 257.9
246.0	Very stiff to Hard	4	SS	43				
20.0	Clayey silt, with sand & gravel (Glacial Till), Hard	5	SS	40				
243.5	Fractured	6	SS	18				
22.5	<u>Shale Bedrock</u> , Interbeds of Limestone up to 3" thick Grey) (Sound)	7	SS	47				
		8	BXL	90%				
		9	BXL	100%				
232.2		10	BXL	100%				
33.8	End of Borehole							

FOUNDATION SECTION

ORIGINATED BY FB
COMPILED BY SO
CHECKED BY

Dynamic Cone Penetration Test

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT PLASTIC LIMIT WATER CONTENT			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT	20	40	60	80	100	WATER CONTENT %				
266.4	Ground Level					SHEAR STRENGTH PSF									
0.0	Clayey silt, with pockets of silt and sand, related organic matter, wood fibre etc (FILL) (Brown) Stiff		1	SS	12										257.15 9-12-67-12
253.9			2	SS	2										
252.4	Organic Silt		3	SS	3										
14.0	Clayey silt, trace of sand, (occasional layers of silt up to 2" thick throughout)		4	SS	9										
244.4			5	SS	12										
22.0	End of Borehole Probably Bedrock		6	SS	25										
			7	SS	40										

MATERIALS & TESTING OFFICE

FOUNDATION SECTION

ORIGINATED BY PB

COMPILED BY 50

BOREHOLE TYPE Washboring, NX, BX Casing-BXL Rock Core

WECKED BY 11

Dynamic Cone Penetration Test

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION TEST	LIQUID LIMIT		REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE		BLOWS / FOOT	BLOWS / FOOT	PLASTIC LIMIT	
					20 40 60 80 100			
					SHEAR STRENGTH PSF			
					○ UNCONFINED + FIELD VANE			
					● QUICK TRIAXIAL x LAB VANE			
							WATER CONTENT %	
							10 20 30	
269.4	Ground Level							
	Sandy silt, layers of clayey silt, occasional fragments of rock (FILL) BROWN	1	SS	6				
		2	SS	9				
260.4	Loose							
9.0	Clayey Silt; trace of sand (occasional layers of silt up to 3" thick throughout) (Grey) Very Stiff	3	SS	12	260			
		4	SS	27				
		5	SS	24				
250.4								
19.0	Clayey silt, with sand and gravel (Glac. Till)	6	SS	20	250			
246.6	Hard	7	SS	47				
22.8	Fractured Shale Bedrock, interbeds of limestone up to 5" thick Grey Sand	8	EXL	50%				
239.3		9	EXL	40%	240			
30.1	End of Borehole							

FOUNDATION SECTION

ORIGINATED BY FR

COMPILED BY SO

1945

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100	LIQUID LIMIT PLASTIC LIMIT WATER CONTENT	BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE					
267.6	Ground Level							
0.0	Sand silt, pockets of clayey silt (FILL) (Brown) Dense	1	SS	36				
261.8		2	SS	35				
5.8	Clayey Silt, trace of sand (occasional pockets of silt up to 4" thick throughout) (Brown) Very stiff to Hard	3	SS	21				
		4	SS	18				
248.6		5	SS	42				
247.1	Glacial Till Hard	6	SS	47				
20.5	Fractured	7	SS	55/6"				
241.8	Shale Bedrock, interbeds of limestone (Grey) Sound	8	EXL	95%				
25.8	End of Borehole							

FOUNDATION SECTION

ORIGINATED BY **FB**

COMPILED BY SO

BOREHOLE TYPE Washboring, NX, BX, BXL Rock Core

RECORDED BY

Dynamic Cone Penetration Test

SOIL PROFILE							DYNAMIC CONE PENETRATION TEST					LIQUID LIMIT PLASTIC LIMIT WATER CONTENT			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT									
							20	40	60	80	100					
							SHEAR STRENGTH - P.S.F.					WATER CONTENT %				
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE									
												10 20 30			P.C.F.	GR. SA. SI. CL.
264.2	Ground Level															
0.0	Clayey Silt occasional pockets of silt (Fill) (Brown)	X	1	SS	8	260										258.4
257.7	Stiff	X	2	SS	35											
6.5	Clayey silt, trace of sand (occasional layer of silt up to 2" thick throughout) (Brown)	X	3	SS	48											
247.2	Very stiff to Hard	X	4	SS	43	250										
246.0	Glacial Till Hard	X	5	SS	14											
18.2	Fractured Shale Bedrock, intbeds of limestone Sound	X	6	SS	50/2"											
240.9			7	BXL	95%	240										
23.3	End of Borehole															

FOUNDATION SECTION

ORIGINATED BY BC

COMPILED BY SO

CHECKED BY

Dynamic Cone Penetration Test

SOIL PROFILE						DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT PLASTIC LIMIT WATER CONTENT			BULK DENSITY Y P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	20	40	60	80	100	%	%	%		
267.0	Ground Level					SHEAR STRENGTH PSF 400 800 1200 1600 2000					WATER CONTENT % 10 20 30				
255.0	Clayey Silt, pockets of silt, related organic matter brick fragments etc (FILL) (Grey & Brown) Hard to Stiff	1	SS	53											
		2	SS	65	260										
		3	SS	8											
12.0	Clayey silt, trace of sand, (occasional pockets of silt up to 2" thick throughout Stiff)	4	TW	PM											
		5	TW	PM	250										
248.0	Het. Mixt. of clay, silt, sand & gravel	6	SS	7 1/2 / 9"											
242.4	(Glacial Till) Hard														
24.6	<u>Shale Bedrock</u> , numerous limestone interbeds) Grey Sound	7	BXL	100%	240										
237.4															
29.6	End of Borehole														

FOUNDATION SECTION

ORIGINATED BY FB

COMPILED BY SO

CHECKED BY

[illegible]

FOUNDATION SECTION

ORIGINATED BY FB

COMPILED BY SO

04/08/94

Test

SOIL PROFILE			SAMPLES		DYNAMIC PENETRATION BLOWS / FOOT	RESISTANCE	LIQUID LIMIT	PLASTIC LIMIT	WATER CONTENT	BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. FLOT.	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F.	%	%	%	
							20 40 60 80 100				
							400 800 1200 1600 2000				
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL * LAB. VANE				
								WATER CONTENT %			
								10 20 30			
265.9	Ground Level										
0.0	Clayey silt, with sand (pockets of sandy silt throughout) (FILL)		1	SS	14	260					
259.0	(Brown) Very Stiff		2	SS	36						
6.9	<u>Clayey Silt</u> , trace of sand & occ layers of silt up to 2" thick throughout (Brown to Grey)		3	SS	84						254.6
249.4	Very Stiff to Hard		4	SS	66						
16.5	Clayey silt, trace of sand & gravel (Glacial)		5	SS	11	250					
245.1	Till) V. Stiff to Hard		6	SS	11						
20.8	End of Borehole Probably Bedrock		7	SS	70/1"	240					

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 213

FOUNDATION SECTION

JOB 69-F-78

LOCATION

184, 565 N - 228, 367 E

ORIGINATED BY

BC

W.P. 314-65-7

BORING DATE

October 27, 1969

COMPILED BY

SO

DATUM Geodetic

BOREHOLE TYPE

PannDrill, Dynamic Cone Penetration Test

CHECKED BY

A

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — % PLASTIC LIMIT — % WATER CONTENT — %			BULK Y DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE		20	40	60	80	100	W _L	W _P	W		
275.2	Ground Level														
	Clayey silt, trace of sand, pockets of silt, throughout, related organics cinders and wood fibre (FILL)		1	SS	30										
	Very Stiff to Hard		2	SS	15										
			3	SS	20										
			4	SS	29										
			5	SS	42										
253.2	Sandy Silt (Fill) Loose		6	SS	8										
22.0	Clayey Silt, trace of sand (occasional layers of silt up to 2" thick)		7	SS	12										
246.2	Very Stiff														
29.0	Clayey silt, with sand & gravel (Glac Till) Hd		8	SS	116										
243.4															
31.8	End of Borehole Probably Bedrock														

256.5

Q-26-68-6

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 214

FOUNDATION SECTION

JOB 69-F-78

LOCATION 184, 312N - 228, 155 E

ORIGINATED BY FB

W.P. 314-65-7

BORING DATE October 16 & 17, 1969

COMPILED BY SO

DATUM Geodetic

BOREHOLE TYPE Washboring NX, BX Casing, BXL Rock Core

CHECKED BY

SOIL PROFILE		SAMPLES		ELEV	SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT			REMARKS
ELEV	DEPTH	NUMBER	TYPE			BLOWS / FOOT					PLASTIC LIMIT			
						20	40	60	80	100	WATER CONTENT %			
						SHEAR STRENGTH P.S.F.					WATER CONTENT %			
						○ UNCONFINED + FIELD VANE								
						● QUICK TRIAXIAL + LAB. VANE								
											WATER CONTENT %			
											10 20 30			
266.8	Ground Level													
0.0	Clayey silt, some sand and gravel tr. of organic matter fragments of brick etc (Fill) (Brown)	1	SS	24										258.0
257.3	Very Stiff	2	SS	9	260									
9.5	Clayey silt, trace of sand (occasional lay- of silt up to 3" thick throughout)	3	SS	21										
	Brown to Grey	4	SS	28										
246.8	Very Stiff	5	SS	12	250									
244.8	Glacial Till Hard	6	SS	8										
22.0	Shale Bedrock Interbeds of Limestone up to 5" thick Sound	7	SS	50/2"										
235.5		8	BXL	90%	240									
31.3	End of Borehole	9	BXL	95%										
					230									

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 215

FOUNDATION SECTION

JOB 69-F-78

LOCATION 184, 496 N - 228, 314 E

ORIGINATED BY BC

W.P. 314-65-7

BORING DATE October 24, 1969

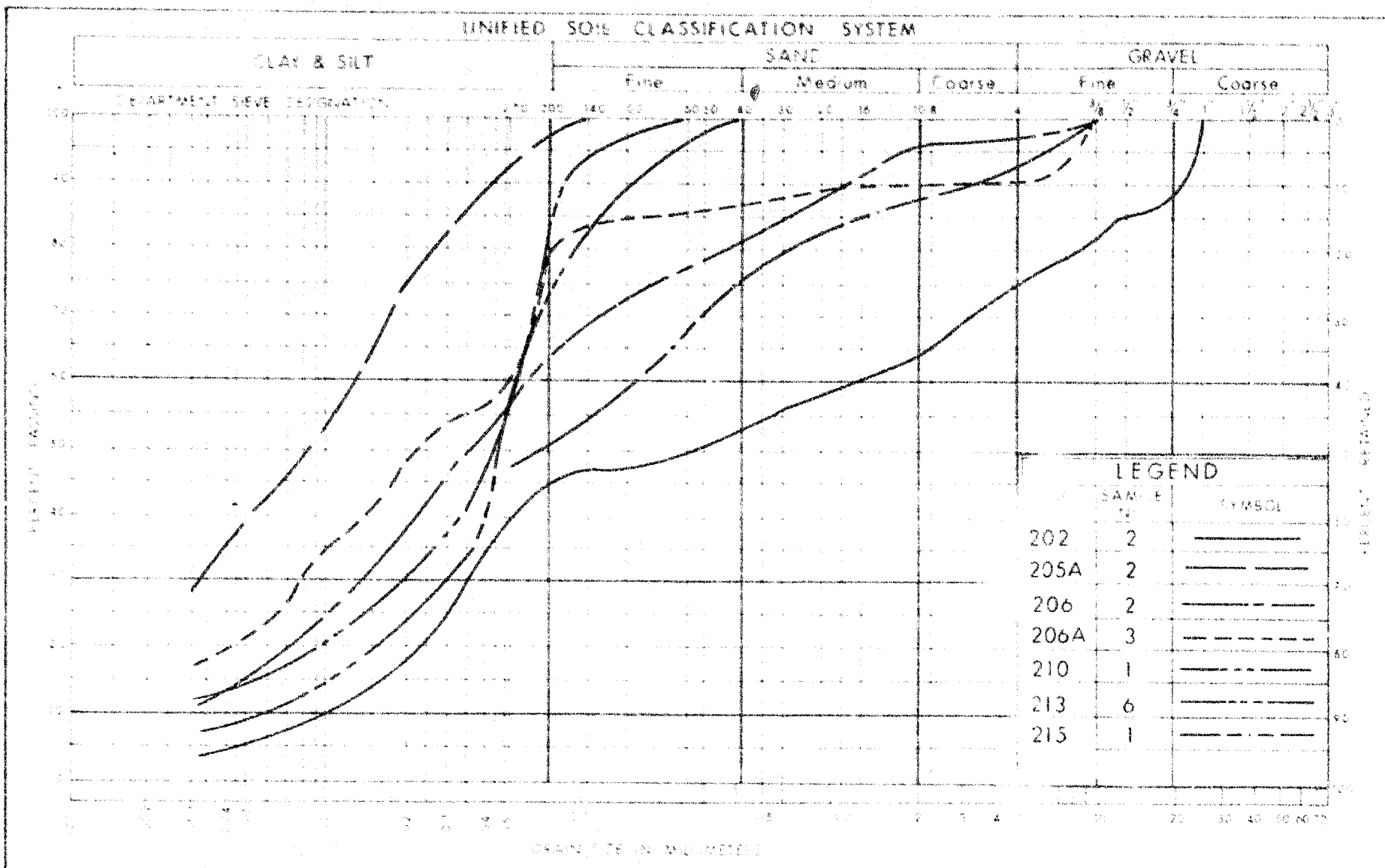
COMPILED BY SO

DATUM Geodetic

BOREHOLE TYPE Penn Drill, Dynamic Cone Penetration Test

CHECKED BY

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— W _L PLASTIC LIMIT ——— W _P WATER CONTENT ——— W			BULK DENSITY Y	REMARKS			
ELEV DEPTH	DESCRIPTION	STRAT PICT	NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	20	40	60	80	100	SHEAR STRENGTH P.S.F.				W _p	W	W _L
278.1	Ground Level												O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE					
								400	800	1200	1600	2000				10	20	30
0.0	Silty sand, pockets of clayey silt (FILL) Dense		1	SS	42													
	Clayey silt, trace of sand and gravel, occasional pockets of silt and sand through out (FILL) (Brown)		2	SS	15	270												
			3	SS	15													
			4	SS	27													
	Very Stiff		5	SS	22													
			6	SS	11	260												
254.1																		
24.0	Clayey Silt, trace of sand (occasional pockets of silt throughout)		7	TW	PM	250												
246.1	Stiff to Hard		8	SS	60													
32.0	Ret. Mixt. of clay silt, sand & gravel)																	
242.6	Glacial Till Hard		9	SS	100/6"													
35.5	End of Borehole Probably Bedrock					240												



DEPARTMENT OF HIGHWAY
MATERIALS AND
TESTING
DIVISION

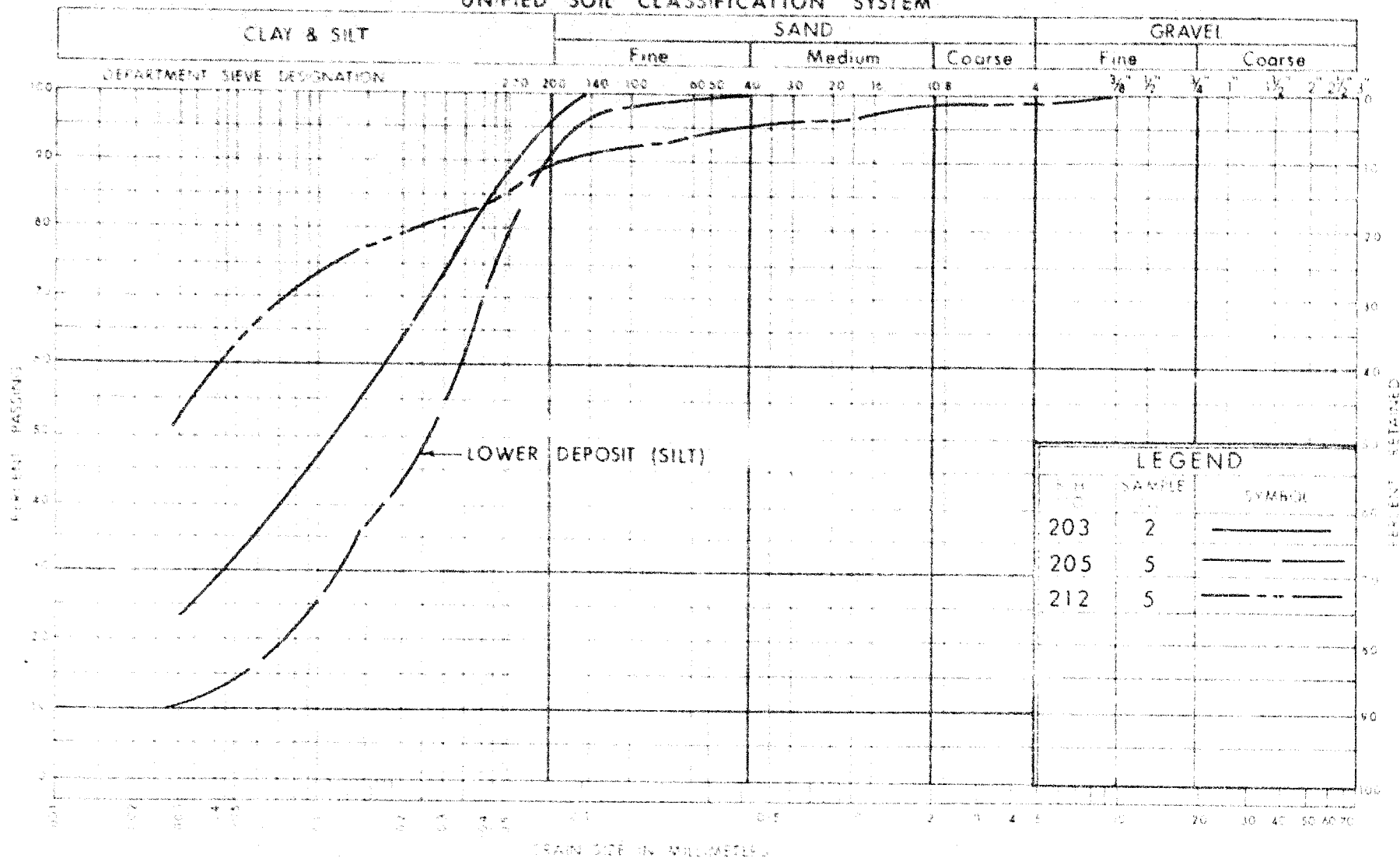
GRAIN SIZE DISTRIBUTION
FILL MATERIAL

WP No. 314 - 65 - 7

JOB No. 69 - F - 78

FIG. 1

UNIFIED SOIL CLASSIFICATION SYSTEM



DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

GRAIN SIZE DISTRIBUTION
CLAYEY SILT
WITH TRACE OF SAND

WP. No. 314 - 65 - 7

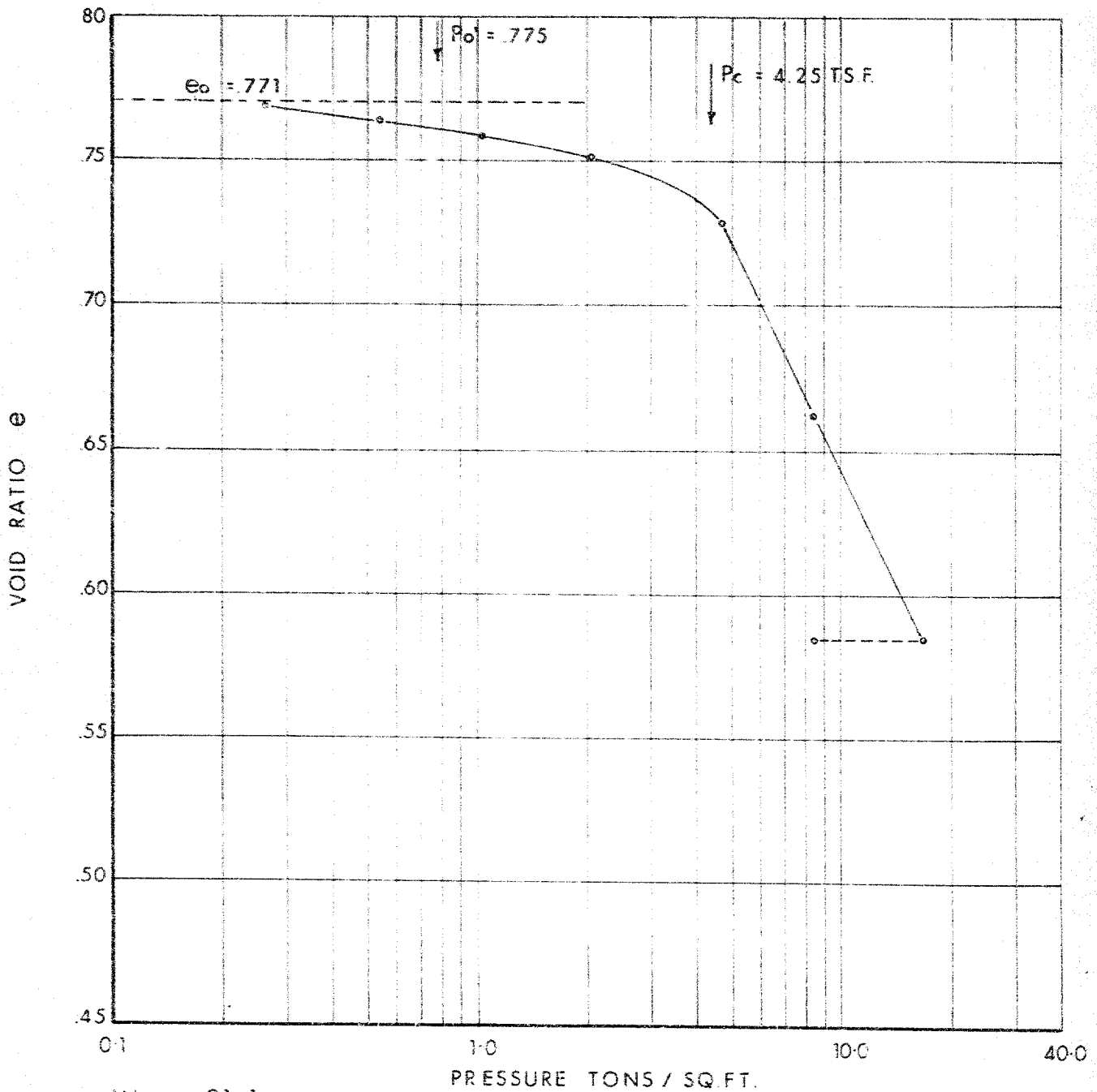
JOB No. 69 - F - 78

FIG. 2

[illegible]

VOID RATIO VS PRESSURE

BORE HOLE 210
SAMPLE 5
DEPTH 16' - 4"
ELEV. 252.0



$W_L = 31.1$
 $W_p = 17.4$
 $W = 25.3\%$
 $C_c = 0.262$

FIG. 4

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 -

<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>C LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
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

Q _u	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Q _{cu}	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Q _d	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
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	$= 3.1416$
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a 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
$\bar{\sigma}$	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
E	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S 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_0	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

MEMORANDUM

TO: Mr. A. Stermac,
Principal Foundation Engineer,
Room 107, Lab. Bldg.

FROM: C.S. Grebski,
Bridge Office

ATTENTION:

DATE: November 12, 1970

OUR FILE REF.

IN REPLY TO


SUBJECT:

T.T.C. Overhead (Bridge #6)
W.P. 314-65-07, Site 37-247
Q.E.W., District No. 6

69-5-28

Attached herewith we are submitting the final bridge drawings which show the foundation design for this structure.

Kindly give us your comments at your earliest convenience.


C.S. Grebski,
Bridge Design Engineer

CSG:rd

Attach.

c.c. Foundation Office

*For comment to
R.D. 11/16/1970*

*M. Lenoir
Nov 19th 1970*

OK

69-F-78

W.P. 314-65-7 AND 11

Q.E.W.

RECONSTRUCTION

T.T.C. OVERHEAD

BRIDGE #6

FENCO No 3671-1K-1

