

G.I.-30 SEPT. 1976

GEOCRES No. 3165-80DIST. 9 REGION W.P. No. 13-68-06/07CONT. No. 73-191W. O. No. STR. SITE No. 3-302 A & BHWY. No. 417LOCATION Hwy 417 & C.P.R. CrossingNo. of PAGES -OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.REMARKS:

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

MEMORANDUM

TO: Mr. T. C. Kingsland, (2)  
Regional Bridge Planning Engineer,  
Eastern Region,  
Kingston, Ontario.

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

ATTENTION:

DATE: February 17, 1972.

OUR FILE REF.

IN REPLY TO

FEB 21 1972

SUBJECT:

31G5-80

FOUNDATION INVESTIGATION REPORT

For

Proposed New Structures

At the Crossing of

Hwy. #417 and C.P.R.

Regional Municipality of Ottawa-Carleton

District #9 - Ottawa

W.O. 71-11126 -- W.P. 13-68-06

CONT. 73-191

13-68-07

Site 3-302A  
3-302B

31G5-80

SPONSOR No.

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

AGS/ao  
Attach.

cc: Messrs. D. W. Farren

B. R. Davis

A. Rutka

S. J. Markiewicz

J. E. Callaghan

B. J. Giroux

E. R. Saint

G. A. Wrong

B. A. Singh

DeLew Carter, Ottawa.

Foundations Files

Documents

*A. G. Stermac*  
A. G. Stermac,

PRINCIPAL FOUNDATION ENGINEER.

## TABLE OF CONTENTS

1. INTRODUCTION.
  2. DESCRIPTION OF THE SITE AND GEOLOGY.
  3. FIELD AND LABORATORY WORK.
  4. SUBSOIL AND BEDROCK CONDITIONS.
    - 4.1) General.
    - 4.2) Silty Sand with Some Gravel.
    - 4.3) Shale Bedrock.
  5. GROUNDWATER CONDITIONS.
  6. DISCUSSIONS AND RECOMMENDATIONS.
    - 6.1) General.
    - 6.2) Structure Foundations.
      - 6.2.1) Piers.
      - 6.2.2) Abutments.
    - 6.3) Approach Embankments.
  7. MISCELLANEOUS.
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# FOUNDATION INVESTIGATION REPORT

For

Proposed New Structures

At the Crossing of

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Regional Municipality of Ottawa-Carleton

District #9 - Ottawa

W.O. 71-11126 - W.P. 13-68-06

13-68-07

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## 1. INTRODUCTION:

The Foundations Office was requested to carry out a subsurface investigation at the proposed crossings of eastbound lane and westbound lane of Hwy. #417 and the Canadian Pacific Railway in the Township of Gloucester, Regional Municipality of Ottawa-Carleton. The request was contained in a memo from Mr. T. C. Kingsland, Regional Bridge Planning Engineer, Eastern Region, dated October 23, 1971. An investigation was subsequently carried out by this Office to determine the subsoil, bedrock and groundwater conditions at the sites.

The report contains the factual results obtained from the investigation, together with recommendations pertaining to the foundations of the proposed structures as well as the stability and settlement considerations associated with the approach fills.

## 2. DESCRIPTION OF THE SITE AND GEOLOGY:

The area under investigation is located approximately 800 feet south of existing Innes Road and some 1,200 feet north of Sheffield Rd. in the Township of Gloucester, Regional Municipality of Ottawa-Carleton. The terrain is flat to gently undulating in relief between approximate elevations 210 and 215. The C.P.R. in this vicinity is a twin track with one spur line constructed

on an embankment of 5 feet. The land is primarily used for farming purposes with occasional light commercial enterprises.

The present physical features of the region are of a varied origin and are the result of erosion and deposition by various agencies. During a long period of time, the region was above sea level\*. During this time the major features of the bedrock topography were formed by processes of weathering and stream erosion. During Pleistocene time the region was invaded by one or more ice sheets advancing from the north. The pre-glacial land surface was modified by glacial erosion and by deposition, in places, of material eroded by the ice sheet. Near the close of Pleistocene time when the ice sheet began to retire, the area was, in large part, below sea level, so that as the ice retired or melted back, the sea entered and overspread the Ottawa Valley to a depth, in places, of several hundred feet. In this arm of the sea, known as the Champlain Sea, thick deposits of sand, silt and clay were laid down. As the ice sheet still further retired, uplift took place and the land gradually emerged from the sea. This area is now commonly called "Ottawa Valley Clay Plains"\*\*. Here extensive sensitive clay deposits are interrupted by ridges of sand and/or bedrock. The clay is generally underlain by glacial till which in turn is followed by Collingwood and Gloucester shale of the Billings Formation, Ordovician period.

.....3

\*Johnston, W.A., "Pleistocene and Recent Deposits in the Vicinity of Ottawa, With a Description of the Soils." Geol. Surveys #84, Dept. of Mines.

\*\*Chapman, L.V. and Putnam, D.F., "Physiography of Southern Ontario." University of Toronto Press 1967.

3. FIELD AND LABORATORY WORK:

Twelve sampled boreholes, ten of which were accompanied by a dynamic cone penetration test, were put down at the site during the field investigation, using conventional diamond drill rigs, adapted for soil sampling purposes.

Samples in the overburden were obtained at various depths by means of a 2-inch O.D. split-spoon sampler which was hammered into the soil in accordance with the specifications for the Standard Penetration Resistance Test. The same procedure was used to advance the dynamic cone penetration tests.

In order to establish the groundwater conditions in the area, a total of 3 piezometers (Peaker type) was installed at different depths within the overburden. The specific location and elevations of these piezometers, together with the information obtained, will be discussed in the section on groundwater conditions.

Bedrock was proven in four of the boreholes by obtaining BX size rock core samples.

The soil, bedrock and groundwater conditions encountered at the boring locations, are presented on the Record of Borehole sheets appended to this report. The locations and elevations of the various boreholes were provided by personnel from the Eastern Region Engineering Surveys Section. The elevations in this report are referenced to a geodetic datum. These locations were subsequently referred to a coordinate system. The boring locations and elevations are shown on Drawing No. W.O. 71-11126 A. Stratigraphical profiles, inferred from the boring data are also presented on the aforementioned drawing.

All the 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 in order to determine the physical properties of the overburden, namely:

- Natural Moisture Content
- Atterberg Limits
- Grain-Size Distribution

The results of this testing are plotted on the Record of Borehole sheets and summarized on Figure #1, all contained in the Appendix of this report.

#### 4. SUBSOIL AND BEDROCK CONDITIONS:

##### 4.1) General:

The predominant stratum across the site is composed of a loose to very dense silty sand, with some gravel. The thickness of this deposit varies from 32 feet to 39 feet. This granular deposit is underlain by shale bedrock.

The boundaries of the various deposits, as determined in the boreholes, are shown on the accompanying Record of Borehole sheets. From ground surface downward, the various soil types encountered are as follows.

##### 4.2) Silty Sand with Some Gravel:

Directly beneath the nominal cover of topsoil is a predominant stratum of silty sand with some gravel. The thickness of this granular soil varies from 32 feet at B.H. #10 to 19 feet at B.H. #3. Occasional seams of clayey silt up to 1 inch thick were encountered throughout the overburden. Random boulders up to 8 inches were encountered within this deposit below elevation 180 in B.H. #2, and below elevation 135 in B.H. #7. Grain-size distribution curves for representative samples of this granular deposit are plotted in envelope form on Figure #1.

The Standard Penetration Tests, carried out within the granular stratum are plotted on the Record of Borehole sheets. This testing gave 'N' values which ranged randomly from 4 blows/ft. to 123 blows/ft. Based on these values it is estimated that the relative density of the deposit ranges from loose to very dense, generally being in the compact range.

##### 4.3) Shale Bedrock:

The granular overburden is directly underlain by bedrock, which was proven in four of the boreholes by obtaining up to

14 feet of BX size rock core samples. Over the site the bedrock surface was found to vary between elevations 172 and 178, which corresponds to depths below ground surface of from 32 feet to 39 feet. The bedrock is composed of a grey calcareous shale; the upper 3 to 9 feet of which is in a weathered and fractured state. Below this zone the bedrock is in a sound condition, as evidenced by the high percentage of core recovered.

The bedrock core samples were examined by Mr. K. Ingham, Geologist, Department of Transportation and Communications. Mr. K. Ingham presented the result of his bedrock examination in a memo to this Office, dated February 15, 1972, which is appended to this report.

5. GROUNDWATER CONDITIONS:

Groundwater level observations have been carried out during the period of observation in the open boreholes. In addition a total of three Peaker-type piezometers was installed at different elevations in the granular overburden. The location and the relative depths of the various piezometer, as well as the groundwater levels observed in the installations and open boreholes are shown in the accompanying drawing.

These observations indicate that the groundwater level varies between 205 and 208, which corresponds to depths of between 1.5 and 5 feet below existing ground surface.

6. DISCUSSIONS AND RECOMMENDATIONS:

6.1) General:

The design and construction of the rural portion of Hwy. #417, south-easterly of Ramsayville to Quebec border will be completed by 1974. The Department and the Regional Municipality of Ottawa-Carleton have undertaken a study to determine the most appropriate alignment for the urban portion of Hwy. #417 in the Ottawa area. A preliminary Foundation Report W.O. 70-11115, for

various corridors of Hwy. #417, from Ramsayville northerly to the Ottawa Queensway (west of Blair Rd.) was submitted on March 23, 1971. The finalized alignment requires interchanges at Hunt Club Rd., Walkley Rd. Extension, Innes Rd. and Ottawa Queensway. In addition, structures will be required at the crossings of Baseline Rd., Canadian National Railways and Canadian Pacific Railway with the proposed Hwy. #417.

This discussion deals with the proposed overhead twin structures at the crossing of eastbound and westbound lanes of Hwy. #417 and Canadian Pacific Railway. Discussions with regard to other structures on this portion of the Freeway will be covered under separate foundation reports.

The eastbound lane and westbound lane structures will be four and three span structures respectively with span ratios of (74' - 88' - 88' - 74') and (85' - 90' - 85').

The profile grade of the eastbound and westbound lanes of Hwy. #417 in the vicinity of the crossings will be about elevation 247. The elevation of the C.P.R. tracks at the overhead locations will remain at elevation 215 with surrounding ground at approximate elevation 210. The associated approaches, will be 37 feet in height, both in the longitudinal and transverse directions.

The predominant stratum across the site is composed of a loose to very dense stratum of silty sand, with some gravel, the thickness of which varies from 32 to 39 feet. This granular deposit is underlain by shale bedrock.

## 6.2) Structure Foundations:

### 6.2.1) Piers:

The presence of loose to compact granular subsoil at a relatively shallow depth precludes the use of an economical spread footing type of foundation for the structures. The piers can be supported on end-bearing piles driven to bedrock. For

estimating purposes, it can be assumed that the pile tips will be located between elevation 172 and 178. The allowable loads will depend on the pile section chosen (e.g. 12 HP 74 steel H-piles may be designed for 95 tons/pile).

The excavations for the pier caps may be carried out to a depth below the prevailing groundwater level encountered at the time of the Foundation Investigation. In view of the pervious nature of the subsoil, seepage may occur into the excavations from the side slopes. In addition, 'boiling' of the foundation material may take place due to the unbalanced hydrostatic head. In order to prevent such conditions, a dewatering scheme may be necessary for the pier caps during construction.

All pile caps should be provided with a minimum cover of 4 feet for frost protection purposes.

It should be noted that any excavations carried out in the proximity of C.P.R. tracks may require track protection during construction.

Alternatively, the pier columns may be extended down to the sound shale bedrock by means of bored-in concrete caissons. In order to minimize dewatering problems with regard to caisson construction the liner for these caissons should extend well above the prevailing groundwater level. It is believed that steel liner for the caisson extending into the shale bedrock will not seal off all the water since the bedrock is somewhat weathered and fractured. In such a case, it may be necessary to adopt tremie concrete methods. The upper portion of the weathered shale with numerous horizontal seams may not provide adequate support for the caissons. Therefore, the caissons should be "keyed" in at least a minimum of one foot into the sound shale bedrock. The allowable loads would depend on the size of the caisson chosen. For example, a 30-inch diameter caisson may be designed for a design load of 250 tons per caisson.

#### 6.2.2) Abutments:

The "perched" abutments can be constructed within the fills supported on end-bearing piles driven to bedrock. The pile

capacities on probable pile tip elevation will be similar to those discussed in Subsection 6.2.1.

No rock fill or bouldery fill should be placed in areas where piles are to be driven. A minimum of 4 feet of earth cover should be provided to the underside of all abutment footings for frost protection requirements.

For the design of the abutments the following values may be used:

Coefficient of Earth Pressure at Rest  $K_o = 0.5$  (rigid wall)

Coefficient of Active Earth Pressure  $K_a = 0.33$  (Some Movement at the Top of Wall Permitted)

Coefficient of Passive Earth Pressure  $K_p = 3.0$  (In Front of the Abutment)

The differential settlements between the abutments and the piers for any combinations of the aforementioned schemes will be negligible.

### 6.3) Approach Embankments:

The approach fills, for the eastbound lane and westbound lane structures, will be of the order of 37 feet above the existing ground surface. Fills of this height will be inherently stable against a deep-seated rotation type of failure, provided standard 2:1 slopes are adopted and constructed with properly compacted fill material.

The granular subsoil will settle due to the surcharge loading of the approach fills. This settlement will be elastic in nature and up to 2 inches in magnitude; the majority of this settlement will take place during or immediately after the construction of the approaches.

### 7. MISCELLANEOUS:

The field work performed during the period of November 28 to December 12, 1971, was under the immediate supervision of Mr. S. A. Ahmad, who also prepared this report.

Equipment used was owned and operated by F. E. Johnston  
Drilling Co. Ltd., Ottawa.

This report was reviewed by Mr. M. Devata, Supervising  
Foundation Engineer.

*Shahen Ahmad*

S. A. Ahmad, P. Eng.



*M. Devata*

M. Devata, P. Eng.

SAA/ao  
Feb. 16/72

APPENDIX I

FOUNDATION SECTION

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION	RESISTANCE	LIQUID LIMIT ——— $w_L$	PLASTIC LIMIT ——— $w_p$	BULK DENSITY $\gamma$ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	20 40 60 80 100	100	WATER CONTENT ——— $w$			10 20 30
							SHEAR STRENGTH P.S.F.		$w_p$ ——— $w$ ——— $w_L$				WATER CONTENT %
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE							
202.2	Ground Level												
0.0	Silty sand with some gravel.  Compact to Very Dense  Brown Grey					200						208.2	
			1	SS	37								( 6 )
			2	SS	16								
			3	SS	15								
			4	SS	47								
			5	SS	25							7 91 ( 2 )	
187.9			6	SS	74	190						0 96 (4)	
22.0	End of Borehole					180							

FOUNDATION SECTION

CHECKED BY *[Signature]*

[illegible]

FOUNDATION SECTION

ORIGINATED BY WH

COMPILED BY SAA

CHECKED BY *SA*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — $w_L$		BULK DENSITY $\gamma$ P.C.F.	REMARKS		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT		PLASTIC LIMIT — $w_p$					
							20	40	60	80			100	WATER CONTENT — $w$
							SHEAR STRENGTH P.S.F.						WATER CONTENT %	
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE		$w_p$ — $w$ — $w_L$						
211.1	Ground Level													
0.0	Silty sand with some gravel, occ. seams of clayey silt up to 1" thick.  Compact to Very Dense  Brown - Grey					210								
			1	SS	9								▼ 207.0	
			2	SS	17								3 92 ( 5	
			3	SS	26									
			4	SS	14								20-75 ( 5	
			5	SS	12									
			6	SS	15								15 73 (12)	
			7	SS	65									
			8	SS	25									
			9	SS	20								43 47 ( 10	
			10	SS	10									
172.2			11	SS	150/3"									
38.9	End of Borehole Probable Bedrock					170								

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

# RECORD OF BOREHOLE No. 4

FOUNDATION SECTION

JOB 71-11126

### LOCATION

Co-ords. 16,503,788 N; 1,230,600 E.

ORIGINATED BY WH

W.P. 13-68-06

BORING DATE

November 19, 1971.

COMPILED BY SAA

DATUM      Geodetic

BOREHOLE TYPE

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT ——— $w_L$ PLASTIC LIMIT ——— $w_p$ WATER CONTENT ——— $w$			BULK DENSITY $\gamma$ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE	$w_p$ ——— $w$ ——— $w_L$ WATER CONTENT % 10      20      30				
217.2	Ground Level											
0.0	Grey silty sand with some gravel.					210						
			1	SS	16							
			2	SS	12							
	Compact to Dense											
			3	SS	30	200						
	Brown - Grey											
			4	SS	25							
			5	SS	41	190						
184.2			6	SS	17							
27.0	End of Borehole					180						

FOUNDATION SECTION

CHECKED BY *[Signature]*

[illegible]

FOUNDATION SECTION

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			BULK DENSITY $\gamma$ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT		WATER CONTENT %				
							20	40	60	80	100		
							SHEAR STRENGTH P.S.F.						
							○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    x LAB. VANE						

211.6	Ground Level					210								
0.0	Silty sand with trace of gravel, occ. clayey silt seams.		1	SS	25									207.6
			2	SS	29									12 73 (15)
			3	SS	22									
	Compact to Very Dense		4	SS	30	200								
			5	SS	58									11 83 (6)
	Brown-Grey		6	SS	42									
			7	SS	53	190								
			8	SS	19									2 93 (5) 7 59 25 9
			9	SS	11									
178.7			10	SS	98	180								
			11	SS	123									
32.9	End of Borehole					170								

FOUNDATION SECTION

ORIGINATED BY VK

COMPILED BY SAA

CHECKED BY *AK*

[illegible]

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 8

FOUNDATION SECTION

JOB 71-11126

LOCATION Co-ords. 16,503,885 N; 1,230,570 E.

ORIGINATED BY AO

W.P. 13-68-06

BORING DATE November 24, 1971

COMPILED BY SAA

DATUM Geodetic

BOREHOLE TYPE Washboring, BX and NX Casing

CHECKED BY *[Signature]*

[illegible]

FOUNDATION SECTION

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — $w_L$		BULK DENSITY $\gamma$ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT		WATER CONTENT — $w$			
							20	40	60	80		
209.2	Ground Level						SHEAR STRENGTH P.S.F.		WATER CONTENT %			
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE		$w_p$ — $w$ — $w_L$			
0.0	Silty sand with some gravel, occ. seams of clayey silt.		1	SS	13	200					15 82 ( 3 )	206.2
	2		SS	31								
	3		SS	23								
	4		SS	23								
	5		SS	22								
	6		SS	20								
	7		SS	26								
	8		SS	29								
177.3	End of Borehole		9	SS	67							
31.9	Probable Bedrock					170						

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 10

FOUNDATION SECTION

JOB 71-11126

LOCATION Co-ords. 16,503,790 N; 1,230,788 E.

ORIGINATED BY WH

W.P. 13-68-06

BORING DATE November 19, 1971

COMPILED BY SAA

DATUM Geodetic

BOREHOLE TYPE

CHECKED BY

[illegible]

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 11

FOUNDATION SECTION

JOB 71-11126

LOCATION Co-ords. 16,503,778 N; 1,230,886 E.

ORIGINATED BY SAA

W.P. 13-68-06

BORING DATE November 23, 1971

COMPILED BY SAA

DATUM Geodetic

BOREHOLE TYPE

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			BULK DENSITY $\gamma$	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT					WATER CONTENT %					
							20	40	60	80	100	$w_p$ — $w$ — $w_L$					
						SHEAR STRENGTH P.S.F.											
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE											
210.3	Ground Level					210											
0.0	Silty sand with some gravel, occ. seams of clayey silt.		1	SS	4												
			2	SS	3												
			3	SS	62												
	Very Loose-Very Dense		4	SS	86												
	Brown Grey		5	SS	60												
			6	SS	40												
			7	SS	96												
			8	SS	79												
178.3	Fractured weathered shale.		9	RC	59%												
32.0			10	SS	60/2"												
169.3	Grey		11	RC	37%												
41.0	Shale Bedrock		12	RC	100%												
163.5	Sound Grey																

205.

53 (42)

0 97 (3)

Piez.  
Tip  
El. 181.0

FOUNDATION SECTION  
A0

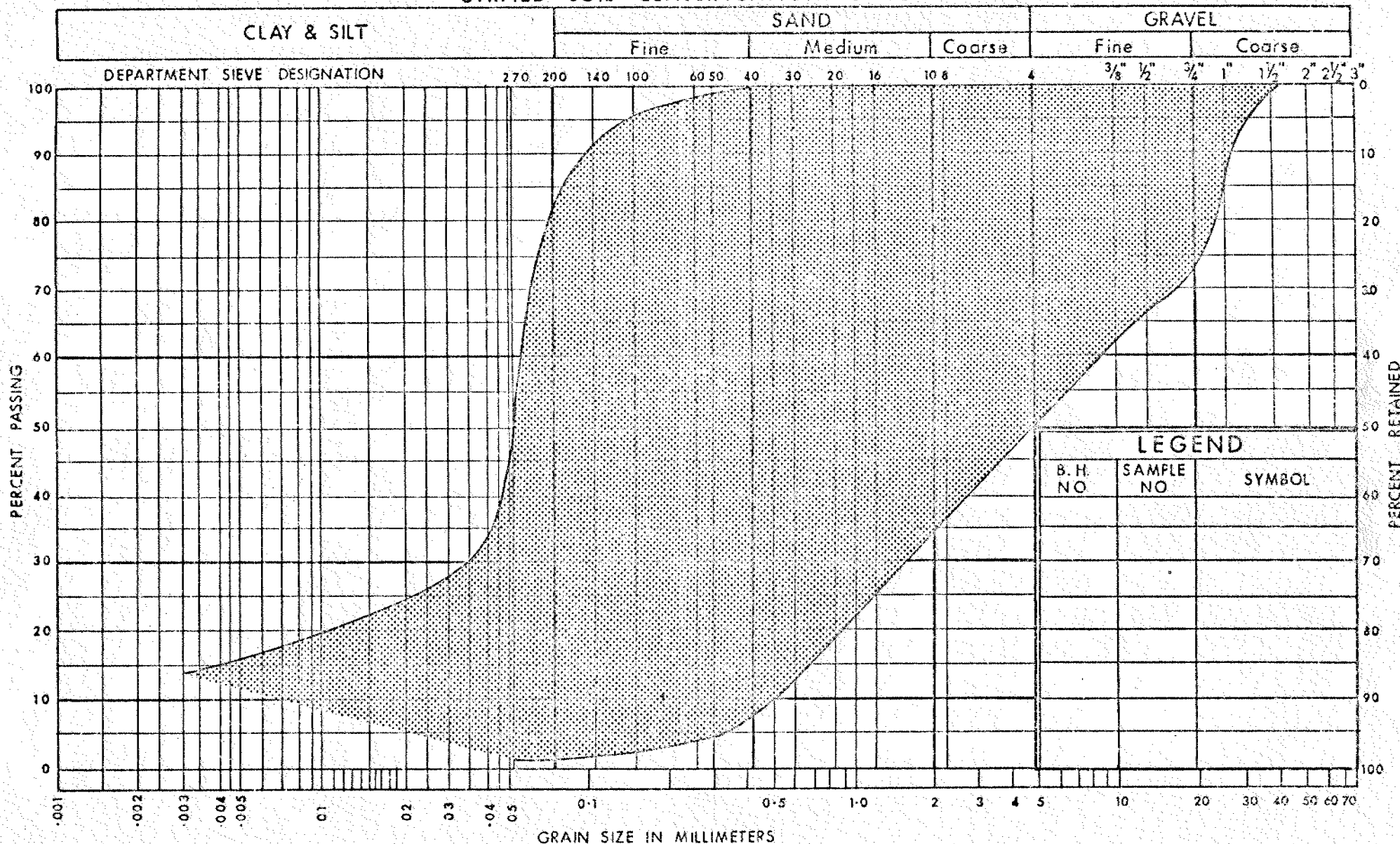
40

SAA

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$		BULK DENSITY $\gamma$ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE		WATER CONTENT % 10 20 30			
211.2	Ground Level											
0.0	Silty sand with some gravel, occ. seams of clayey silt.  Loose to Dense  Brown to Grey		1	SS	9	210						Nov. 25/72 206.2 4.83 (13)
			2	SS	36	200						30 60 (10)
			3	SS	31							
			4	SS	36	190						
184.2			5	SS	34							1 94 (5)
27.0	End of Borehole					180						
175.2												
36.0	End of Cone Test					170						

# UNIFIED SOIL CLASSIFICATION SYSTEM



## 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

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

$\gamma$	UNIT WEIGHT OF SOIL (BULK DENSITY)
$\gamma_s$	UNIT WEIGHT OF SOLID PARTICLES
$\gamma_w$	UNIT WEIGHT OF WATER
$\gamma_d$	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
$\gamma'$	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
$\tau_f$	SHEAR STRENGTH
$c'$	EFFECTIVE COHESION INTERCEPT
$\phi'$	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
$c_u$	APPARENT COHESION
$\phi_u$	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
$\mu$	COEFFICIENT OF FRICTION
$S_t$	SENSITIVITY

### GENERAL

$\pi$	= 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
$\sigma$	NORMAL STRESS
$\bar{\sigma}$	NORMAL EFFECTIVE STRESS ( $\bar{\sigma}$ IS ALSO USED)
$\tau$	SHEAR STRESS
$\epsilon$	LINEAR STRAIN
$\gamma$	SHEAR STRAIN
$\nu$	POISSON'S RATIO ( $\mu$ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
$\eta$	COEFFICIENT OF VISCOSITY

### EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
$\delta$	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
$\beta$	ANGLE OF SLOPE TO HORIZONTAL

## APPENDIX II

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

MEMORANDUM

TO: Mr. M. Devata,  
Sup. Foundation Engineer.

FROM: K. W. Ingham

ATTENTION:

DATE: February 10, 1972

OUR FILE REF.

IN REPLY TO

SUBJECT: Foundation Investigation 71-11126;  
Highway 417; Ottawa

A brief description is given below for each of three boreholes drilled to bedrock at this site, together with the appropriate bedrock elevation.

Hole No. 2 Bedrock at 174.0

Dark grey shale; thin to platy bedded; frequent bands of calcareous shale; upper 2.0 ft. badly fractured.

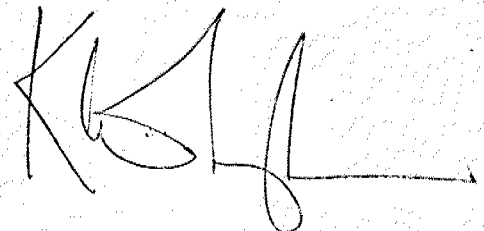
Hole No. 7 Bedrock at 178.0

Dark grey shale; thin bedded; frequent bands of limestone and calcareous shale in the upper 5.0 ft.; rubble and badly fractured rock in the upper 3.0 ft.

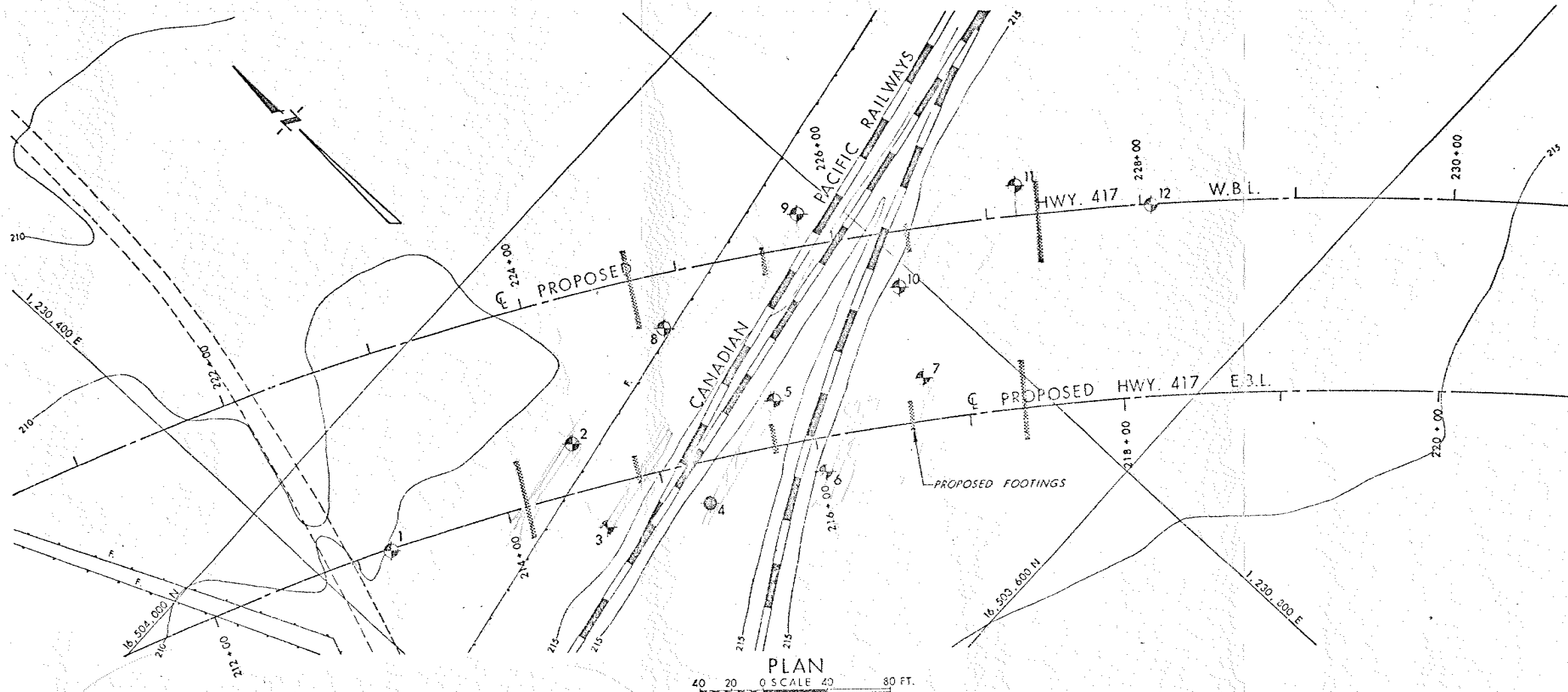
Hole No. 11 Bedrock at 178.0

Dark grey shale; thin to platy bedded; upper 1.5 ft. badly fractured.

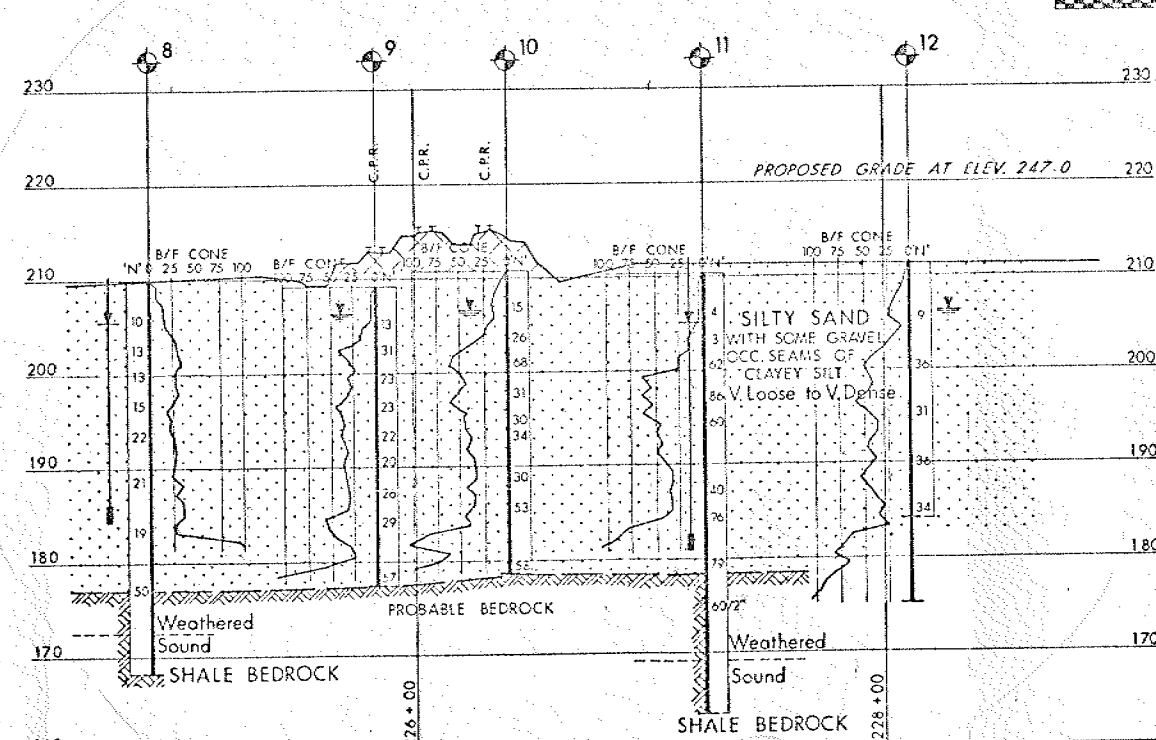
KWI:mv



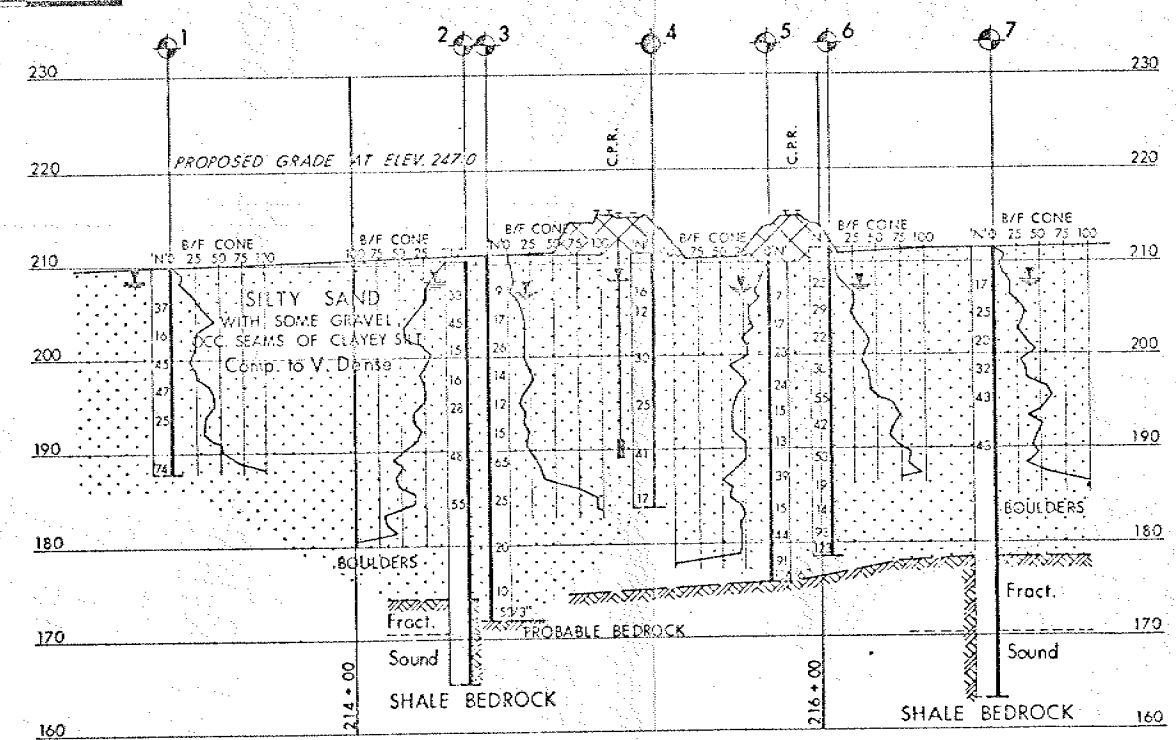
K. W. Ingham,  
Geologist.



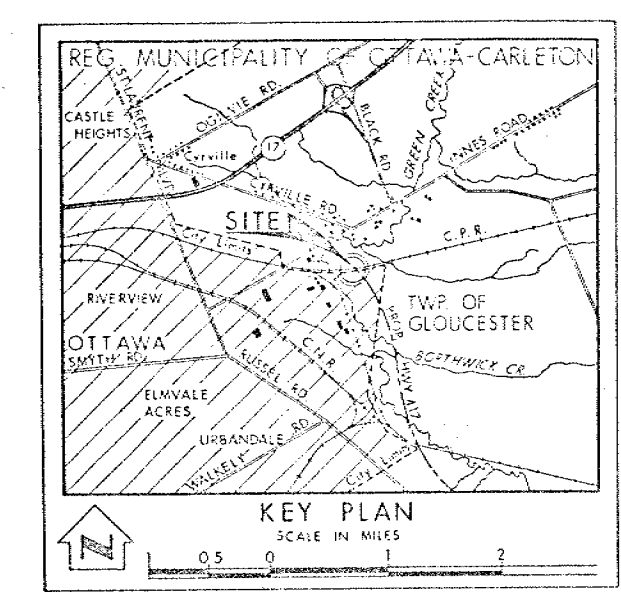
PLAN  
SCALE 40 80 FT.



PROFILE - HWY. 417 W.B.L.  
HORIZ. 40 20 0 SCALE 40 80 FT.  
VERT. 10 5 0 10 20 FT.



PROFILE - HWY. 417 E.B.L.  
HORIZ. 40 20 0 SCALE 40 80 FT.  
VERT. 10 5 0 10 20 FT.



KEY PLAN  
SCALE IN MILES

### LEGEND

- Bore Hole
- Cone Penetration Test
- Bore Hole & Cone Test
- Water Levels established at time of field investigation November 1971
- Piezometric Water Levels

NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	209.9	16,503,915	1,230,442
2	210.3	16,503,876	1,230,571
3	211.1	16,503,826	1,230,546
4	211.2	16,503,786	1,230,600
5	210.1	16,503,796	1,230,650
6	211.6	16,503,742	1,230,670
7	211.3	16,503,738	1,230,755
8	210.1	16,503,885	1,230,370
9	209.2	16,503,872	1,230,780
10	210.8	16,503,790	1,230,755
11	210.3	16,503,778	1,230,586
12	211.2	16,503,705	1,230,936

### 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 TRANSPORTATION & COMMUNICATIONS  
DESIGN SERVICES BRANCH—FOUNDATION OFFICE

**C.P.R. OVERHEAD**

HIGHWAY NO. 417 DIST. NO. 9  
REG. MUNICIPALITY OF OTTAWA - CARLETON  
TWP. LOT CON.

**BORE HOLE LOCATIONS & SOIL STRATA**

SUBWD. W.H. CHECKED: WP NO. 13-15-25 DRAWING NO.  
DRAWN S.R. CHECKED: JOB NO. 71-11126 71-11126 A  
DATE JANUARY 14, 1972 SITE NO. BRIDGE DRAWING NO.  
APPROVED: CONT. NO.