

REMARKS: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

MEMORANDUM

TO: Mr. T. C. Kingsland, (2) FROM: Foundations Office,  
Regional Bridge Planning Engineer, Design Services Branch,  
Eastern Region, Central Bldg., Downsview.  
Kingston, Ontario.

ATTENTION: DATE: February 8, 1972.

OUR FILE REF.

IN REPLY TO

FEB 10 1972

SUBJECT:

31G5-81

FOUNDATION INVESTIGATION REPORT  
For

Proposed Underpass Structure  
At the Crossing of  
Hwy. #417 and Innes Rd.  
Regional Municipality of Ottawa-Carleton  
District #9 (Ottawa)  
W.O. 71-11127 -- W.P. 13-68-05  
CONT 73-191 SITE 3-305

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

*A. G. Stermac*  
for A. G. Stermac,  
PRINCIPAL FOUNDATION ENGINEER.

Foundations Files  
Documents

## 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 a Trace of Gravel.
    - 4.3) Shale Bedrock.
  5. GROUNDWATER CONDITIONS.
  6. DISCUSSIONS AND RECOMMENDATIONS.
    - 6.1) General.
    - 6.2) Structure Foundations.
      - 6.2.1) Centre Pier (Refer to B.H.'s #2 and 3).
      - 6.2.2) Abutments.
    - 6.3) Approach Fills - Stability and Settlement Considerations.
  7. MISCELLANEOUS.
-

FOUNDATION INVESTIGATION REPORT  
For  
Proposed Underpass Structure  
At the Crossing of  
Hwy. #417 and Innes Rd.  
Regional Municipality of Ottawa-Carleton  
District #9 (Ottawa)  
W.O. 71-11127 -- W.P. 13-68-05

---

1. INTRODUCTION:

The Foundation Office was requested to carry out a subsurface investigation at the site of the proposed underpass structure at the crossing of Hwy. #417 and the proposed Innes Road realignment, in the 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 22, 1971. An investigation was subsequently carried out by this Office to determine the subsoil, bedrock and groundwater conditions at this site.

This report contains the factual results obtained from the investigation, together with recommendations pertaining to the foundations of the proposed structure 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 150 feet north of existing Innes Rd. and 1,000 feet south of Cyrville Rd. in the Township of Gloucester, Regional Municipality of Ottawa-Carleton. The terrain is flat to gently undulating in relief between about elevations 209 to 215. The land is primarily used for farming purposes with occasional light commercial enterprises and housing. An east-west running C.P.R. line is present about 1,500 feet south of the proposed interchange.

The present physical features of the region are of varied origin and are the result of erosion and deposition by various agencies. During a long period of time, previous to Pleistocene or Glacial 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, the land gradually emerged from the sea. This area is now commonly called "The Ottawa Valley Clay Plain"\*\*. 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. FIELD AND LABORATORY WORK:

Five sampled boreholes, all accompanied by dynamic cone penetration tests, as well as two additional dynamic cone tests, were put down at the site during the field investigation, using

.....3

\*Johnston, W.A. - "Pleistocene and Recent Deposits in the Vicinity of Ottawa, with a Description of the Soils," Geological Surveys #84, Department of Mines.

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

conventional diamond drill rigs adapted for soil sampling purposes.

Samples of the overburden were obtained by using a 2-inch 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.

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 Borelog 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. The boring locations and elevations are shown on Drawing No. W.O. 71-11127 A. A stratigraphical profile, inferred from the boring data, is 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 to determine the following physical properties of the overburden.

Natural Moisture Content

Atterberg Limits

Grain-Size Distribution

The results of this testing are plotted on the Record of Borelog 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 stratum of silty sand, with a trace of gravel. The thickness of this stratum varies from 11 feet to 16 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 borehole sheets.

From ground surface downward the various soil types and bedrock encountered are as follows.

4.2) Silty Sand with a Trace of Gravel:

Directly beneath the surficial cover of topsoil is a stratum of silty sand with a trace of gravel. The thickness of this granular soil varies from 11 to 16 feet. Occasional seams of clayey silt, up to 1 inch thick, were encountered throughout the deposit. Grain-size distribution curves for representative samples are plotted on Figure #1.

The Standard Penetration Tests, carried out within the granular stratum, are plotted on the Record of Borelog sheets. This testing gave 'N' values which ranged from 7 blows/ft. to 152 blows for 9 inches. Based on these values it is estimated that the relative density of the stratum varies from loose to very dense.

4.3) Shale Bedrock:

The silty sand deposit is directly underlain by bedrock, which was proven in four of the boreholes by obtaining up to 7 feet of BX size rock core samples. Over the site the bedrock surface was found to vary between elevations 204 and 195, which corresponds to depths below ground surface of from 11 to 16 feet. The boring programme appears to indicate that the surface of the bedrock increases in elevation in a westerly direction.

The bedrock is composed of a grey calcareous shale which is in a sound condition as evidenced by the high percentage of core recovery (See also geologist's report in Appendix II).

5. GROUNDWATER CONDITIONS:

Groundwater level observations were carried out during the period of the investigation, in open boreholes. The observations are presented on the individual borelog sheets, as well as on Drawing No. 71-11127 A. The results indicate that the groundwater level, in the overburden, varies between elevations 203 and 206. These water levels correspond to depths below ground surface

of from 6.5 to 9.5 feet.

## 6. DISCUSSIONS AND RECOMMENDATIONS:

### 6.1) General:

It is proposed to construct a two span (140' - 140') 95 feet wide, underpass structure at the crossings of the north and southbound lanes of Hwy. #417 and the proposed Innes Rd. realignment, in the Township of Gloucester, Regional Municipality of Ottawa-Carleton.

It is understood that the profile grade of the north and southbound lanes of Hwy. #417, in the vicinity of the crossings, will be about elevation 207.5. The proposed profile grade of the Innes Rd. realignment in the proximity of the structure, is to range between elevations 230 and 232. The associated approaches will, therefore, be approximately 23 ft. in height in the longitudinal direction, and a maximum of 21 ft. in the transverse direction (along the east approach).

The predominant stratum across the site is composed of a brownish grey, loose to very dense silty sand, with a trace of gravel, the thickness of which varies from 11 to 16 feet. This granular deposit is followed by grey, sound calcareous shale.

### 6.2) Structure Foundations:

#### 6.2.1) Centre Pier (Refer to B.H.'s #2 and 3):

As mentioned elsewhere the profile grade of the new Innes Rd. realignment is 232, and the proposed profile grade of Hwy. #417 is about elevation 207.5, which is 6 ft. below existing ground surface. At least 4 feet of earth cover should be provided to the underside of the footing in order to satisfy the frost protection requirements. Taking this into account the base of the pier foundation could be located as high as elevation 203.5. The presence of loose to compact silty sand at the footing formation level, raises the problem of low bearing capacity and excessive settlements. For these reasons it is recommended that the pier be carried down to support directly or within the shale bedrock (base of footing ranging from elevation 196.5 south end stepping up to 198.5 north end). A spread footing founded on

bedrock could be designed using an allowable bearing value of up to 15 t.s.f.

If, during construction, any localized areas of weathered shale are encountered, they should be excavated to their full depth. The excavation should be brought up to footing level by placing mass concrete.

Since the excavation of the pier footing will extend below the existing groundwater level, in a granular material, some measures will be required during construction to prevent the inflow of groundwater seepage from the sides. Such groundwater flow or any uncontrolled surface runoff could be handled by pumping from sumps.

As an alternative the pier columns can be founded directly on or within sound shale bedrock utilizing bored-in concrete caissons. In order to provide adequate lateral stability these caissons should be keyed in to a minimum depth of 3 feet into shale bedrock. The allowable loads would depend on the size of 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 abutments, 'perched' within the fill, can be supported on end-bearing piles driven to bedrock. From the boring data it is estimated that the pile tip elevations for the east and west abutments are 196 and 201 respectively.

The allowable pile loads would be dependent on the section chosen - for example, 12 HP 74 steel H piles may be designed for 100 tons/pile.

The bottom of the pile caps should have a minimum earth cover of 4 feet for frost protection purposes. No bouldery or rock fill should be placed in areas where piles are to be driven.

#### 6.3) Approach Fills - Stability and Settlement Considerations:

As mentioned elsewhere, the proposed grades of the Innes Rd. realignment and Hwy. #417, in the vicinity of the structure, are

at elevations 232 and 207.5 respectively. This indicates that cuts up to 6 feet and fills up to 20.5 feet are anticipated in the longitudinal direction. Based on this it is estimated that the maximum height of fill will be 23 feet in the longitudinal direction and 21 feet in the transverse direction.

The stability of the approach embankments was determined in terms of total stresses. Fills of the maximum height contemplated (about 23 ft.) will be inherently stable with respect to a deep-seated rotational type of failure within the granular foundation subsoil, provided standard 2:1 slopes are adopted.

The basically granular foundation subsoil will settle due to the loading of the approach fills. The magnitude of this settlement should not exceed  $1\frac{1}{2}$  inches. Further, it will be elastic in nature; i.e., take place during or immediately following the construction period.

#### 7. MISCELLANEOUS:

The field work, performed during the period of November 29, to December 2, 1971, was carried out under the supervision of Mr. S. A. Ahmad, Project Foundation Engineer, who also prepared this report.

The equipment was owned and operated by Johnston Drilling Co., Ltd., Ottawa.

This project was carried out under the general supervision of Mr. M. Devata, Supervising Foundation Engineer, who also reviewed this report.

*Shaheen Ahmad*

Shaheen Ahmad, P. Eng.



*M. Devata*

M. Devata, P. Eng.

SA/ao  
Feb. 7, 1972.

## APPENDIX I

FOUNDATION SECTION

CHECKED BY                     

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION . RESISTANCE BLOWS / FOOT	LIQUID LIMIT ———— W <sub>L</sub> PLASTIC LIMIT ———— W <sub>P</sub> WATER CONTENT ———— W				BULK DENSITY $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F.	W <sub>p</sub> ———— W ———— W <sub>L</sub> WATER CONTENT %					
209.6	GROUND LEVEL Topsoil						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE						
0.8	Sandy Silt with trace of gravel seams of clayey silt Compact to V. Dense Brown-Grey		1	SS	41	200							
			2	SS	17								
			3	SS	14								
196.3	Calcareous Shale		4	SS	66/10"								
13.3	Sound - Grey		5	RC	99.5%								7 26 64 3
191.0													
18.6	End Of Borehole					190							

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 1A

FOUNDATION SECTION

JOB 71-11127

LOCATION Co-Ord's. 16,504,689 N; 1,228,612 E

ORIGINATED BY S.A.A.

W.P. 13-68-05

BORING DATE November 30, 1971.

COMPILED BY S.A.A.

DATUM Geodetic

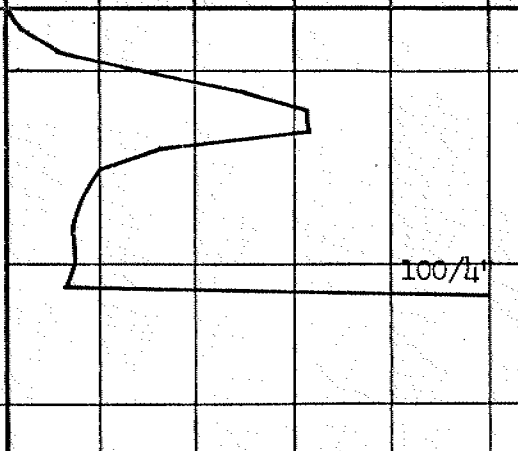
BOREHOLE TYPE Cone Test Only

CHECKED BY *SK*

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	SHEAR STRENGTH P.S.F.		$w_p$ — $w$ — $w_L$ WATER CONTENT %			
209.5	Ground Level						20 40 60 80 100	○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB. VANE				
						200							
195.4	Probable Bedrock												
114.1	End of Cone Test					190							
				</									

FOUNDATION SECTION

CHECKED BY *AK*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION BLOWS / FOOT	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		20	40	60	80	100			$w_p$ ——— $w$ ——— $w_L$
213.0	Ground Level													
199.1	Silty Sand with some Gravel- Occ. Silt to clayey Silt Seams Compact to Dense Brown - Grey	.....	1	SS	39	210								24 58 18 ▼ W.L. Elev. 204.4
			2	SS	50									
			3	SS	13									
			4	SS	23									
			5	RC	20%									
13.9	Calcareous Shale	[Hatched Pattern]	6	RC	91.5%									
192.7	Sound - Grey													
20.3	End of Borehole					190								

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 3

FOUNDATION SECTION

JOB 71-11127

LOCATION Co-Ord's. 16,504, 625 N; 1,228,484 E

ORIGINATED BY S.A.A.

W.P. 13-68-05

BORING DATE November 29, 1971

COMPILED BY S.A.A.

DATUM Geodetic

BOREHOLE TYPE Washboring - NX Casing

CHECKED BY *AK*

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.					$w_p$ ——— $w$ ——— $w_L$				
213.7	Ground Level															
0.8	Topsoil															
	Silty Sand with some Gravel		1	SS	29	210										
	Occ.Silt to Clayey Silt Seams		2	SS	10											
	Loose to V. Dense		3	SS	17											
	Brown to Grey		4	SS	7	200										
			5	SS	79											
			6	RC	50%											
196.9																
16.8	Calcareous Shale															
191.7	Sound - Grey		7	RC	97.5%											
22.0	End of Borehole					190										

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 4

FOUNDATION SECTION

JOB 71-11127

LOCATION Co-Ord's. 16,504,572 N; 1,228,341 E

ORIGINATED BY S.A.A.

W.P. 13-68-05

BORING DATE Nov. 30, 1971

COMPILED BY S.A.A.

DATUM Geodetic

BOREHOLE TYPE Washboring - NX Casing

CHECKED BY *SK*

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		20	40	60	80	100	$w_p$	$w$	$w_L$		
214.7	Ground Level Topsoil															
201.4	Silty Sand with Trace of Gravel Seams of Clayey Silt Loose to V. Dense Brown - Grey		1	SS	9	210										
			2	SS	9											
			3	SS	29											
			4	SS	70/10"											
			5	RC	23%											
13.3	Calcareous Shale					200										
195.4	Sound - Grey		6	RC	96.5%											
19.3	End of Borehole					190										

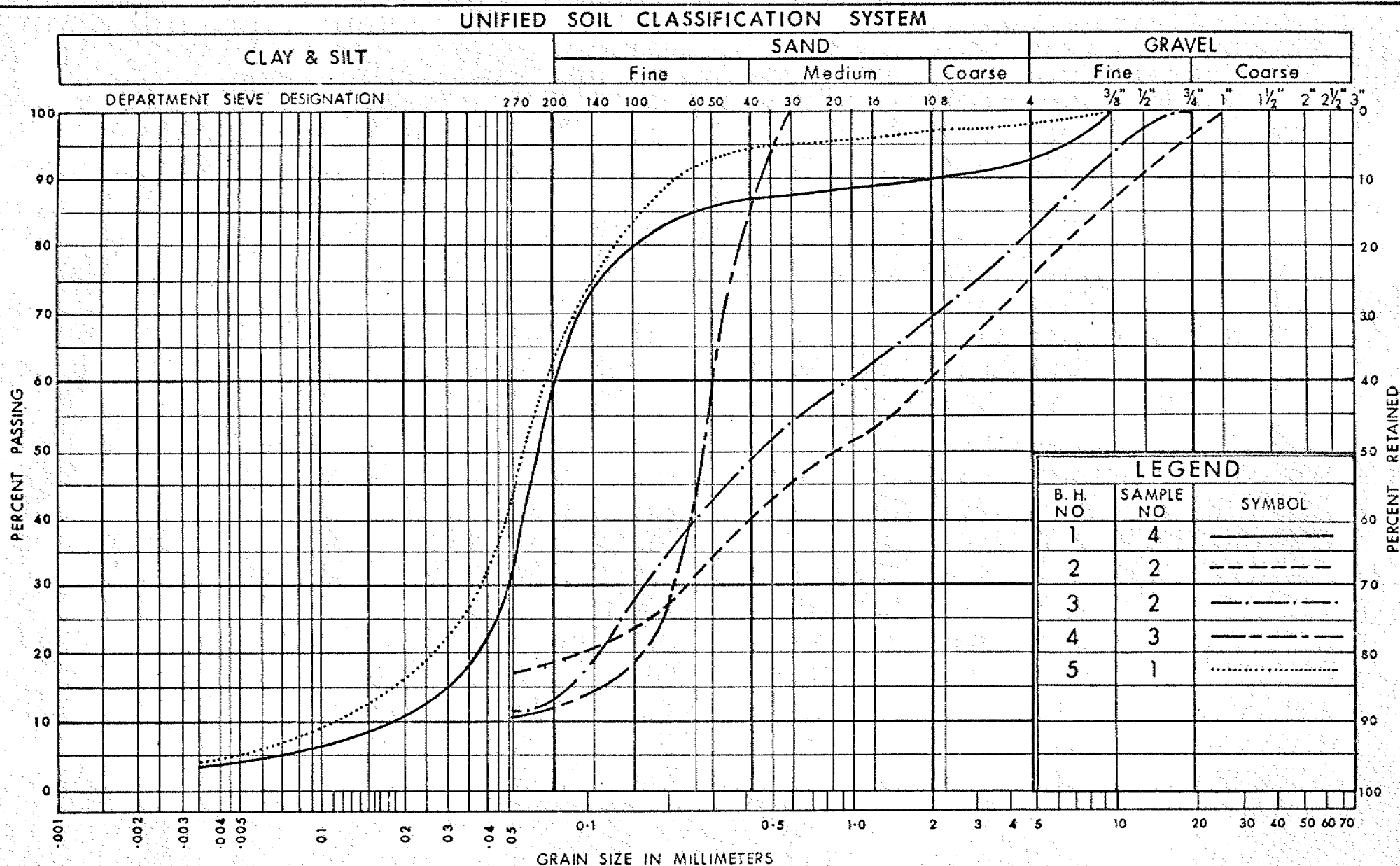
Elev.  
206.2  
In Open BH  
Nov. 30/71  
0 - 87.13



FOUNDATION SECTION

CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION BLOWS / FOOT	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		SHEAR STRENGTH P.S.F.						
215.4	Ground Level												
0.8	Topsoil												
204.1	Sandy Silt with Trace of Gravel Occ. Silt Seams Dense to V. Dense Brown - Grey		1	SS	40	210							2-37-58-3
			2	SS	152/9"				100/3"				Elev. 206.2 Dec. 27/71
11.3	Probable Bedrock					200							



## 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
$\sigma'$	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: January 19, 1972

OUR FILE REF.

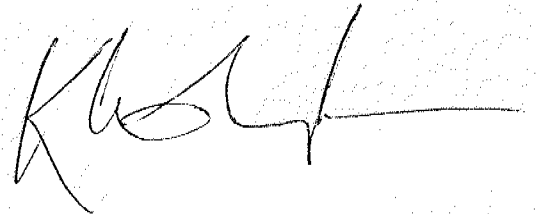
IN REPLY TO

SUBJECT:

Formation Investigation 71-11127;  
Highway 417; Ottawa

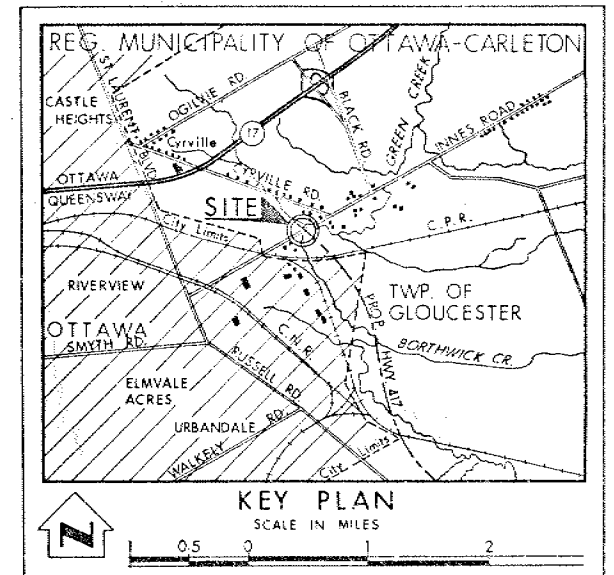
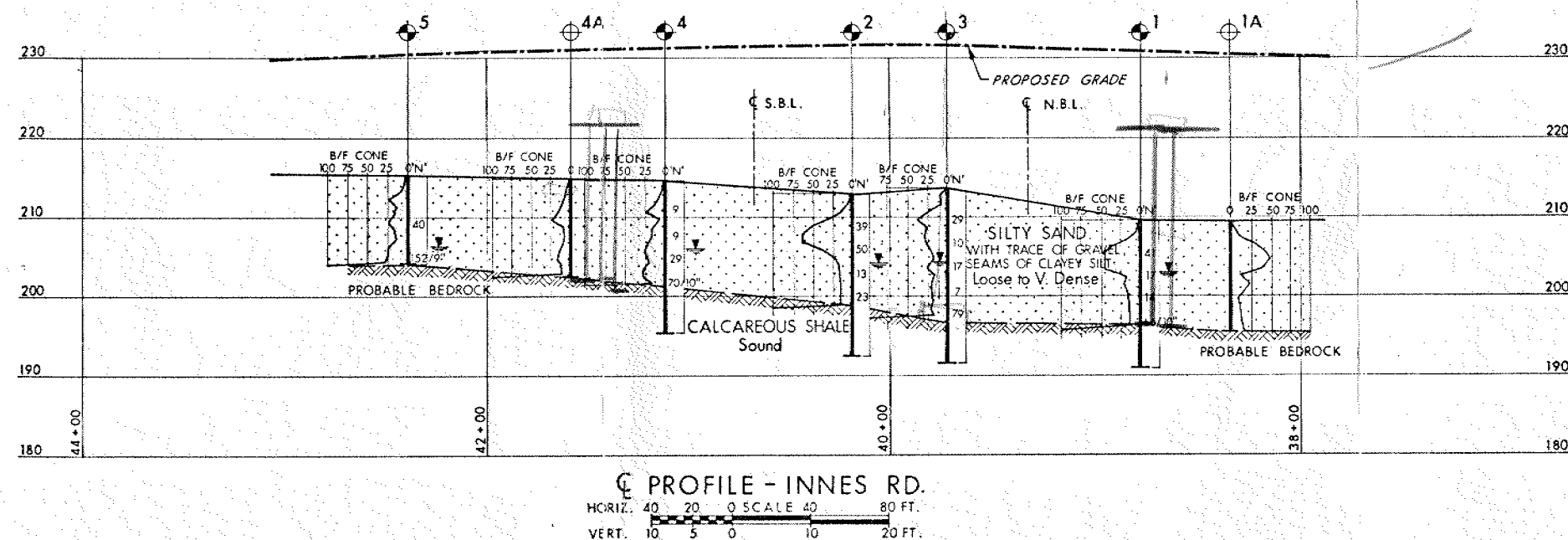
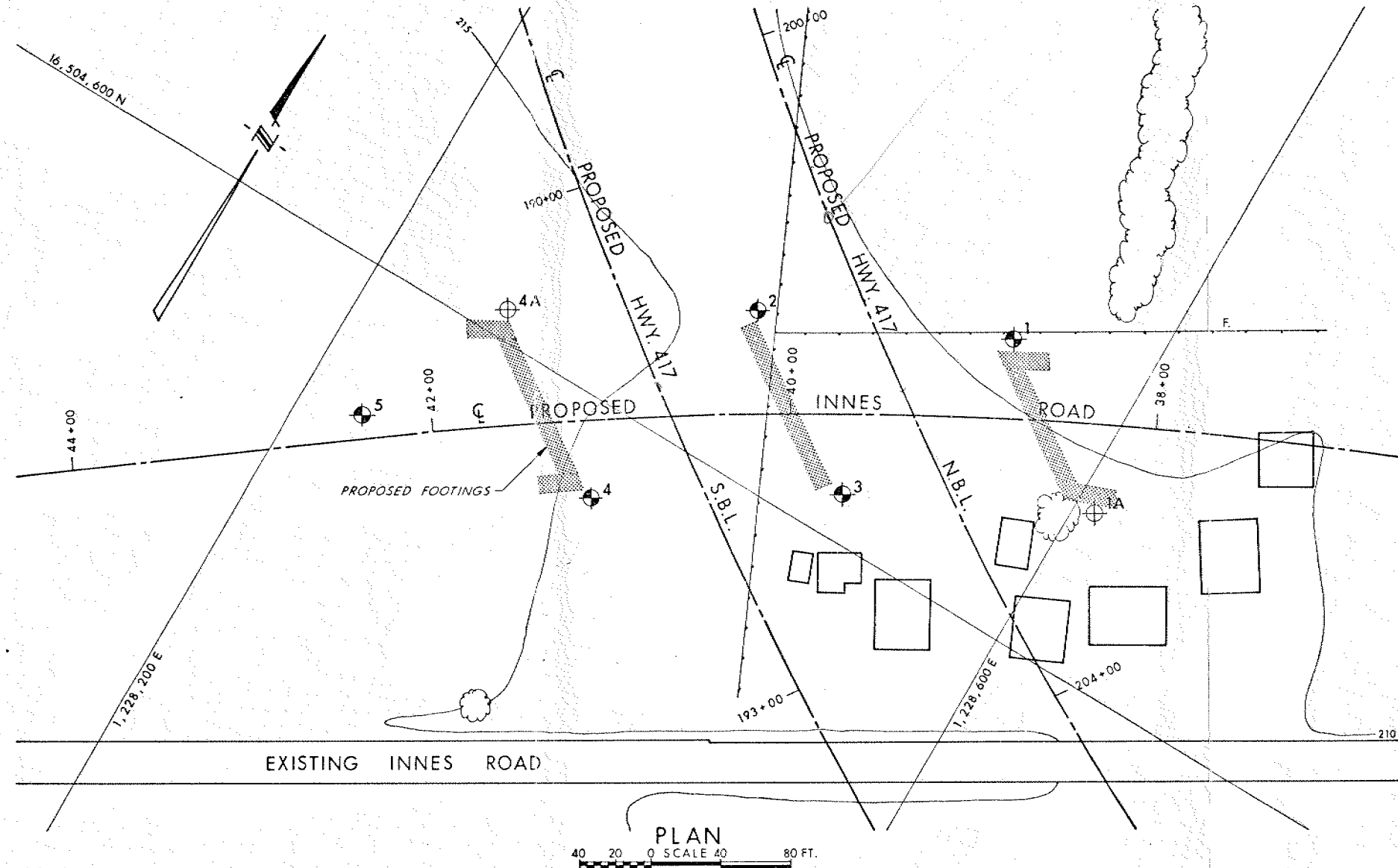
Four boreholes drilled to bedrock indicate uniform rock conditions underlying the site. The bedrock is a sound dark grey calcareous shale with minor bands of shaly limestone. The bedrock elevation in each of the four holes is given below.

Hole No. 1	Bedrock at	196.3
Hole No. 2	"	199.1
Hole No. 3	"	196.9
Hole No. 4	"	201.4



KWI:mv

K. W. Ingham,  
Geologist.



LEGEND				
	Bore Hole			
	Cone Penetration Test			
	Bore Hole & Cone Test			
	Water Levels established at time of field investigation, Nov. & Dec. 1971			
NO.	ELEVATION	CO - ORDINATES		
		NORTH	EAST	
1	209.6	16,504,750	1,228,523	
1A	209.5	16,504,689	1,228,612	
2	213.0	16,504,690	1,228,400	
3	213.7	16,504,625	1,228,484	
4	214.7	16,504,572	1,228,341	
4A	215.0	16,504,616	1,228,277	
5	215.4	16,504,523	1,228,236	

— 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

**INNES ROAD**

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

**BORE HOLE LOCATIONS & SOIL STRATA**

SUBMD. S.A.	CHECKED <u> </u>	WP. NO. 13-68-05	DRAWING NO.
DRAWN S.R.	CHECKED <u> </u>	JOB NO. 71-11127	<b>71-11127 A</b>
DATE JANUARY 5, 1972	SITE NO.	BRIDGE DRAWING NO.	
APPROVED <u> </u>	CONT. NO.		

PRINCIPAL FOUNDATION ENGINEER