

MEMORANDUM

FOUNDATION FILE COPY

70-235

TO: Mr. J. E. Gruspier,  
Regional Materials Engineer,  
Regional Office,  
KINGSTON, Ontario.

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

ATTENTION:

DATE: February 24, 1971

OUR FILE REF.

IN REPLY TO

MAR 2 1971

SUBJECT:

31G-36

FOUNDATION INVESTIGATION REPORT

For

Proposed Patrol Yard  
Carlsbad Springs  
Township of Cumberland  
Reg. Mun. of Ottawa -- Carleton  
District No. 9 (Ottawa)  
W.O. 70-11123 -- W.P. 100-70-01

CONT 70-235

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 feel free to contact our Office.

AGS/MdeF  
Attach.

cc: Messrs. S. J. Markiewicz (2)

-D. W. Farren  
F. G. Allen  
T. C. Muir  
W. Wigle  
J. E. Callaghan (2)  
R. Forrest

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

PRINCIPAL FOUNDATION ENGINEER

M. R. Ernesaks  
Z. L. Katona  
B. J. Giroux  
G. A. Wrong  
A. A. Aron  
C. Moase

Foundations Files  
Gen. Files

## TABLE OF CONTENTS

1. INTRODUCTION.
  2. DESCRIPTION OF SITE AND GEOLOGY.
  3. SUBSURFACE CONDITIONS:
    - 3.1) General.
    - 3.2) Sand to Silty Sand.
    - 3.3) Clay to Silty Clay.
    - 3.4) Glacial Till.
  4. GROUNDWATER CONDITIONS.
  5. DISCUSSION AND RECOMMENDATIONS:
    - 5.1) General.
    - 5.2) Patrol Garage.
    - 5.3) Domes and Stockpiles.
  6. MISCELLANEOUS.
-

FOUNDATION INVESTIGATION REPORT  
For  
Proposed Patrol Yard  
Carlsbad Springs  
Township of Cumberland  
Reg. Mun. of Ottawa -- Carleton  
District No. 9 (Ottawa)  
W.O. 70-11123    --    W.P. 100-70-01

1. INTRODUCTION:

The Foundation Section was requested to carry out an investigation to determine foundation conditions at a proposed patrol garage and two proposed stockpiles (domes) at the above site. The request was made in a memo from the Eastern Region Materials and Testing Office (Mr. A. M. Batten, Senior Soils Supervisor), dated December 10, 1970.

An investigation was subsequently carried out by the Foundation Section to determine subsoil and groundwater conditions at the site.

This report presents all the factual information obtained in the investigation, along with recommendations for the patrol garage foundations, as well as stability and settlement considerations associated with the stockpiles to be placed within D.H.O. standard domes.

2. DESCRIPTION OF SITE AND GEOLOGY:

The site is located on the east side of Boundary Road, 0.6 miles north of the proposed Hwy. #417, and 1.8 miles southeast of the Village of Carlsbad Springs.

The site is heavily wooded and is flat to slightly undulating, ranging from 256 to 264 in elevation.

Physiographically, the site is located within the "Russell and Prescott Sand Plains". In this area a sand mantle,

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

varying in thickness from 20 to 30 feet in the north to less than 10 feet in the south, overlies a considerable thickness of marine clay. The sand is of deltaic origin built up by the Ottawa River and its northern tributaries during the geologic period when the Champlain Sea inundated the area. The underlying silty clay, known as "Leda Clay", was deposited by the Champlain Sea. In this area the base of the clay extends down below an elevation of 150 feet. The clay stratum is underlain by a glacial till which, in turn, is underlain by grey to black shale bedrock of the Lorraine formation, Ordovician Period.

3. SUBSURFACE CONDITIONS:

3.1) General:

The field work consisted of putting down 5 sampled boreholes, one of which was accompanied by a dynamic cone penetration test. The boreholes were advanced by means of a conventional diamond drill rig adapted for soil sampling purposes.

Samples of the surficial sand and glacial till deposits were recovered in a 2" O.D. split-spoon sampler, which was driven in accordance with the specifications for the Standard Penetration Test. Samples of the cohesive stratum were recovered in 2" I.D. Shelby tubes which were pushed manually into the soil. Where practical, in situ field vane tests were carried out at various depths to determine the undrained shear strength and sensitivity of this stratum.

The groundwater conditions across the site, were determined by taking readings in the open boreholes during the course of the investigation.

The locations and elevations of all boreholes, surveyed by personnel from Eastern Region Engineering Surveys, are shown on Drawing No. 70-11123A, together with two estimated stratigraphical sections across the site.

3. SUBSURFACE CONDITIONS: (cont'd.) ...

3.1) General: (cont'd.) ...

All samples were subjected to careful visual examination both in the field and in the laboratory. Following this examination, laboratory testing was carried out on selected samples to determine Atterberg limits, unconfined shear strengths and consolidation characteristics.

The results of this investigation are summarized and are plotted on the Record of Borelog sheets and figures, all of which are contained in the Appendix of this report. A brief description of the deposits encountered at the site is presented in the following sub-sections.

3.2) Sand to Silty Sand:

The surficial material, sand to silty sand, was encountered across the site at all the boring locations. The thickness of this deposit ranges from 14 to 20 feet. The material is granular, uniformly graded and grey in colour.

Standard Penetration tests gave 'N' values of 4 to 33 blows/ft., indicating a relative density of loose to dense, being generally compact.

3.3) Clay to Silty Clay:

The granular deposit is underlain by the predominant stratum, a sensitive marine clay to silty clay (Leda clay). The total thickness of this deposit was proved only at B.H. #1 and found to extend to elevation 143.8 (a thickness of 98 feet). The stratum was proven to exist to a depth of 54 feet below ground surface in each of the remaining boreholes. Layers of silt and sand up to 4 inches thick are found in the upper 7 feet of this stratum. Occasional inclusions of organic material are found throughout.

3. SUBSURFACE CONDITIONS: (cont'd.) ...

3.3) Clay to Silty Clay: (cont'd.) ...

Atterberg limits performed on selected samples, yielded the following average values:

Bulk Density	:	102	p.c.f.
Liquid Limit	:	48.0	%
Plastic Limit	:	24.0	%
Natural Water Content	:	64.0	%

These results are plotted on Figure 1, and indicate that the clay is inorganic and of medium to high plasticity. The natural water content is generally considerably higher than the liquid limit - a characteristic of Leda clay.

Undrained shear strengths were obtained by performing in situ vane tests. The top 30 feet of this stratum is generally firm, changing gradually below this level to stiff, and near the bottom very stiff. This progression can be seen on the Record of Borelog sheets in the Appendix. Unconfined shear strengths performed in the lab, yielded considerably lower values - an indication that the samples are sensitive and had been disturbed slightly during handling.

The consolidation characteristics of the stratum were obtained by carrying out two laboratory consolidation tests, the results of which are shown on Void Ratio vs. Pressure plots on Figure 2. The results of this testing indicate that the clay is preconsolidated by approximately 500 to 800 p.s.f. with respect to the existing overburden pressure. The relatively high values given for the initial void ratio ( $e_0$ ) and the compression index ( $C_c$ ) are within the normal range for such values obtained from laboratory consolidation testing on Leda clay.

3. SUBSURFACE CONDITIONS: (cont'd.) ...

3.4) Glacial Till:

The cohesive stratum is underlain by a competent granular glacial till, proven to extend for 3 feet in B.H. #1. The glacial till is composed of a heterogeneous mixture of silt, sand and gravel with a trace of clay. This material has a very high relative density as indicated by 'N' values of 79 and 135 blows/ft.

4. GROUNDWATER CONDITIONS:

Observations of water levels in open boreholes were made during the course of the investigation. These are shown on the borelog sheets as well as on Drawing No. 70-11123A. The groundwater level was found to be at elevation 257.6 at the proposed patrol garage and at elevation 255.7 at the proposed domes. These elevations correspond to depths ranging from 0 to 4 feet below ground surface.

5. DISCUSSION AND RECOMMENDATIONS:

5.1) General:

It is proposed to construct a patrol garage as well as stockpiles (domes) in the vicinity of Boundary Road and Hwy. #417, more precisely, at a location 1.8 miles southeast of the Village of Carlsbad Springs.

It is proposed to grade the site with 2 feet of granular material prior to the construction of the aforementioned.

5.2) Patrol Garage:

The garage will be a steel frame, single storey, 40 feet by 180 feet structure. An 3-inch concrete floor slab is to be placed directly on the granular pad. Ten-inch thick, 3 feet wide key strip footings are to extend below the floor slab; the footings will be placed on 16-foot centres.

The subsoil is such that a safe allowable load of 3,000 p.s.f. may be used for the design of footings. Total settlement on the footings will be less than one inch and will occur

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

5.2) Patrol Garage: (cont'd.) ...

during or immediately following construction. The differential settlement between exterior and interior footings should be less than 1/2 inch.

The exterior footings should be protected with a minimum of four feet of earth cover for frost protection purposes.

5.3) Domes and Stockpiles:

The domes which are of light frame construction, are 100 feet in diameter at the base and 51 feet high. The structures will be carried on a ring footing, 23 inches wide and 16 inches deep. Each footing will be placed on top of an asphalt mat which is supported by the previously mentioned 2 feet of granular fill. The domes will house stockpiles of sand and salt for winter maintenance of Hwy. #417.

The stockpiles placed within the domes will be carried on an 18-foot thick layer of sand to silty sand which is underlain by a cohesive stratum of clay to silty clay about 90 feet thick. Stability computations were carried out to determine the safe height to which these stockpiles may be built. The following assumptions were made for computational purposes:



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

5.3) Domes and Stockpiles: (cont'd.) ...

1) Soil Properties:

<u>Depth</u>	<u>Soil</u>	<u>Density</u> (p.c.f.)	<u>Strength Parameters</u>	
			$C_u$ (p.s.f.)	$\phi$ (°)
	Material in Dome	120	0	30
O.G.S. - 16'	Sand to Silty Sand	110	0	35
16' - 22'	Clay to Silty Clay	96	650	0
22' - 37'	" " " "	96	600	0
37' - 47'	" " " "	96	740	0
47' - 57'	" " " "	96	1040	0
57' -	" " " "	96	1500	0

2) Side Slopes (Stockpiles) - 1-1/2:1

Computations indicate that, in order to ensure stability of the subsoil, the height of the stockpiles should not exceed 18 feet. Further computations reveal that, if the 18 feet high fills are placed, the subsoil can be expected to settle 24 to 28 inches. 20% of this settlement will occur after 2-1/2 years of continuous loading and 50% will occur after 13 years of continuous loading. However, in view of the fact that the loads will be placed and removed on an annual basis, the times given above for settlement may be doubled.

6. MISCELLANEOUS:

The field work, performed between January 12 and 21, 1971, was supervised by Mr. W. Hutton, Project Foundation Engineer. This report was written by Mr. J. D. Wiebe, Student Technician (Field).

6. MISCELLANEOUS: (cont'd.) ...

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

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

February, 1971

APPENDIX I

---

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING OFFICE

# RECORD OF BOREHOLE No. 1

FOUNDATION SECTION

JOB 70-11123

LOCATION North West Corner of Garage

ORIGINATED BY WH

W.P. 100-70-01

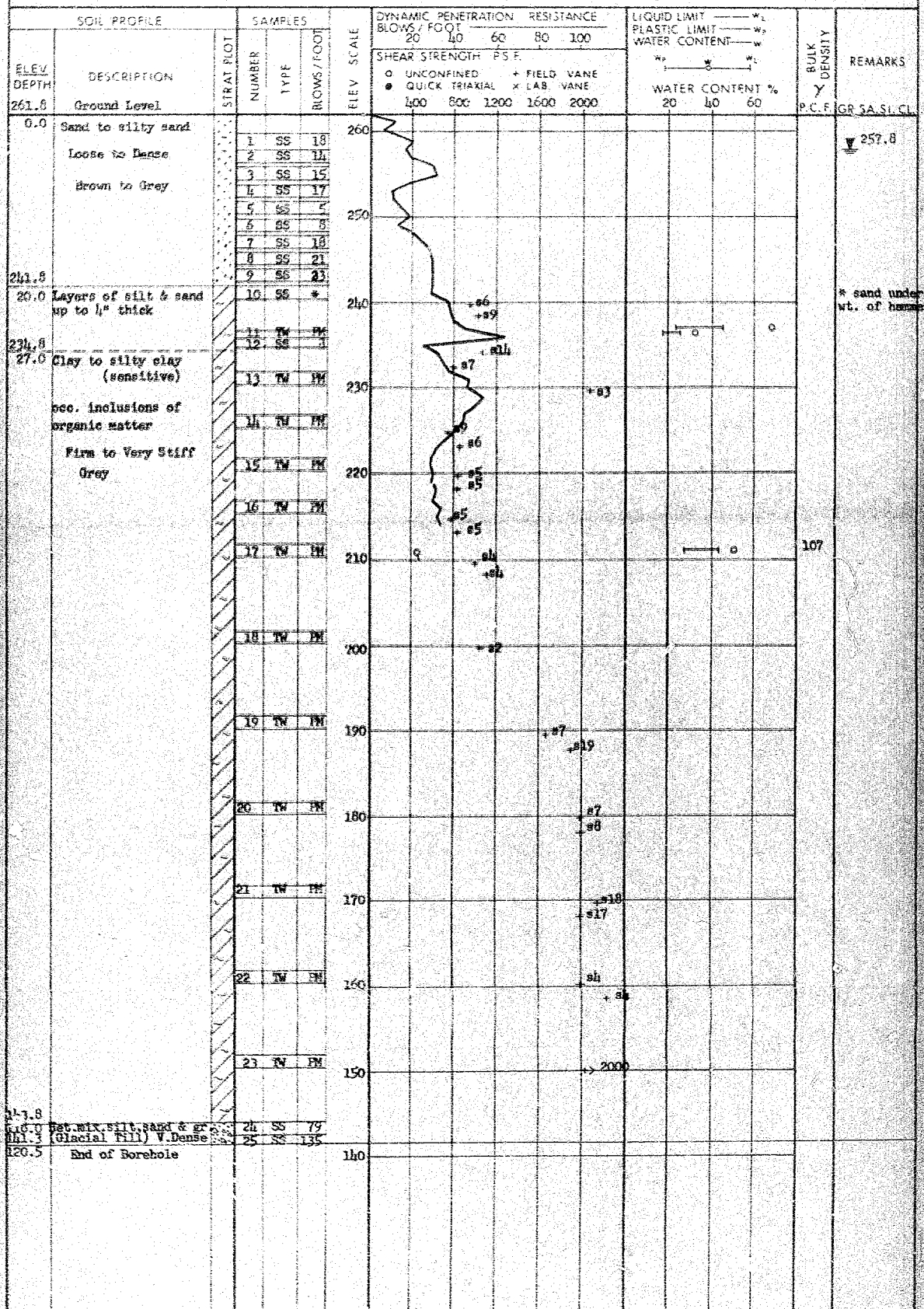
BORING DATE Jan. 13 - 15, 1971

COMPILED BY WH

DATUM Geodetic

BOREHOLE TYPE Diamond Drill - Washboring

CHECKED BY



DEPARTMENT OF HIGHWAYS - ONTARIO		<b>RECORD OF BOREHOLE No. 2</b>		FOUNDATION SECTION
MATERIALS & TESTING OFFICE				
JOB 70-11123	LOCATION South Wall of Garage	ORIGINATED BY WH		
W.P. 100-70-01	BORING DATE Jan. 18 - 19, 1971	COMPILED BY WH		
DATUM Geodetic	BOREHOLE TYPE Diamond Drill - Washboring	CHECKED BY		

SOIL PROFILE		STRAT. PLOT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			BULK DENSITY $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION		NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUIKA TRIAXIAL x LAB. VANE 400 800 1200 1600 2000				WATER CONTENT % $w_p$ — $w$ — $w_L$				
260.5	Ground Level													P.C.F.	GR. SA. SI. CL.
0.0	Sand to silty sand Loose to Compact  Brown to Grey		1	SS	4	260									257.5 $\gamma$
			2	SS	12										
			3	SS	9										
			4	SS	9	250									
			5	SS	10										
243.0			6	SS	18										
17.5	Clay to silty clay (sensitive)  occ. inclusions of organic matter  Firm to Stiff  Grey		7	SS	4	240									
			8	TW	PM										
			9	TW	PM										
			10	TW	PM	230									
			11	TW	PM										
			12	TW	PM	220									
			13	TW	PM										
			14	TW	PM	210									
206.5															
54.0	End of Borehole														

DEPARTMENT OF HIGHWAYS - ONTARIO

## RECORD OF BOREHOLE No. 3

FOUNDATION SECTION

MATERIALS &amp; TESTING OFFICE

JOB 70-11123

LOCATION

South East Corner of Garage

ORIGINATED BY

WH

W.P. 100-70-01

BORING DATE

Jan. 14 - 15, 1971

COMPILED BY

WH

DATUM Geodetic

BOREHOLE TYPE

Diamond Drill - Washboring

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 $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.					WATER CONTENT %				
257.6	Ground Level														P.C.F. 100	
0.0	Sand to Silty Sand	•••	1	SS	13											
	Loose to Compact	•••	2	SS	13											
		•••	3	SS	9											
	Greyish-Brown to Grey	•••	4	SS	10	250										
		•••	5	SS	16											
		•••	6	SS	11											
243.6																
14.0	Clay to silty clay (Very sensitive)	~	7	SS	2											
		~	8	TW	PM	240										
	occ. inclusions of organic matter	~	9	TW	PM											
		~	10	TW	PM	230										
	Soft to Very Stiff	~														
	Grey	~	11	TW	PM											
		~	12	SS	*	220										
		~														
		~	13	SS	*											
		~														
		~	14	SS	*	210										
		~														
		~	15	TW	PM											
203.6																
54.0	End of Borehole					200										

\* split spoon  
taken after  
taking  
shelby  
sample

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 4

FOUNDATION SECTION

JOB 70-11123 LOCATION West Dome ORIGINATED BY WH  
 W.P. 100-70-01 BORING DATE Jan. 18 - 19, 1971 COMPILED BY WH  
 DATUM Geodetic BOREHOLE TYPE Diamond Drill - Washboring CHECKED BY *WLC*

SOIL PROFILE		STRAT. PLOT	SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			BULK DENSITY $\gamma$	REMARKS	
ELEV. DEPTH	DESCRIPTION		NUMBER	TYPE		BLOWS / FOOT	SHEAR STRENGTH P.S.F.					$w_p$ — $w$ — $w_L$ WATER CONTENT % 20 40 60				
257.6	Ground Level					○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE 400 800 1200 1600 2000								P.C.F.	GR. SA. SI. CL.	
0.0	Sand to silty sand		1	SS	19	250										
	Loose to compact		2	SS	9											
	Brown to Grey		3	SS	15											
			4	SS	19											
240.6			5	SS	29		240									
17.0	Clay to silty clay		6	TW	PM	230								105		
	occ. inclusions of organic material		7	TW	PM											
	Firm to Stiff		8	TW	PM											
	Grey		9	TW	PM											
			10	TW	PM		220									
			11	TW	PM											
			12	TW	PM		210									
			13	TW	PM											
203.6																
54.0	End of Borehole				200											

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING OFFICE

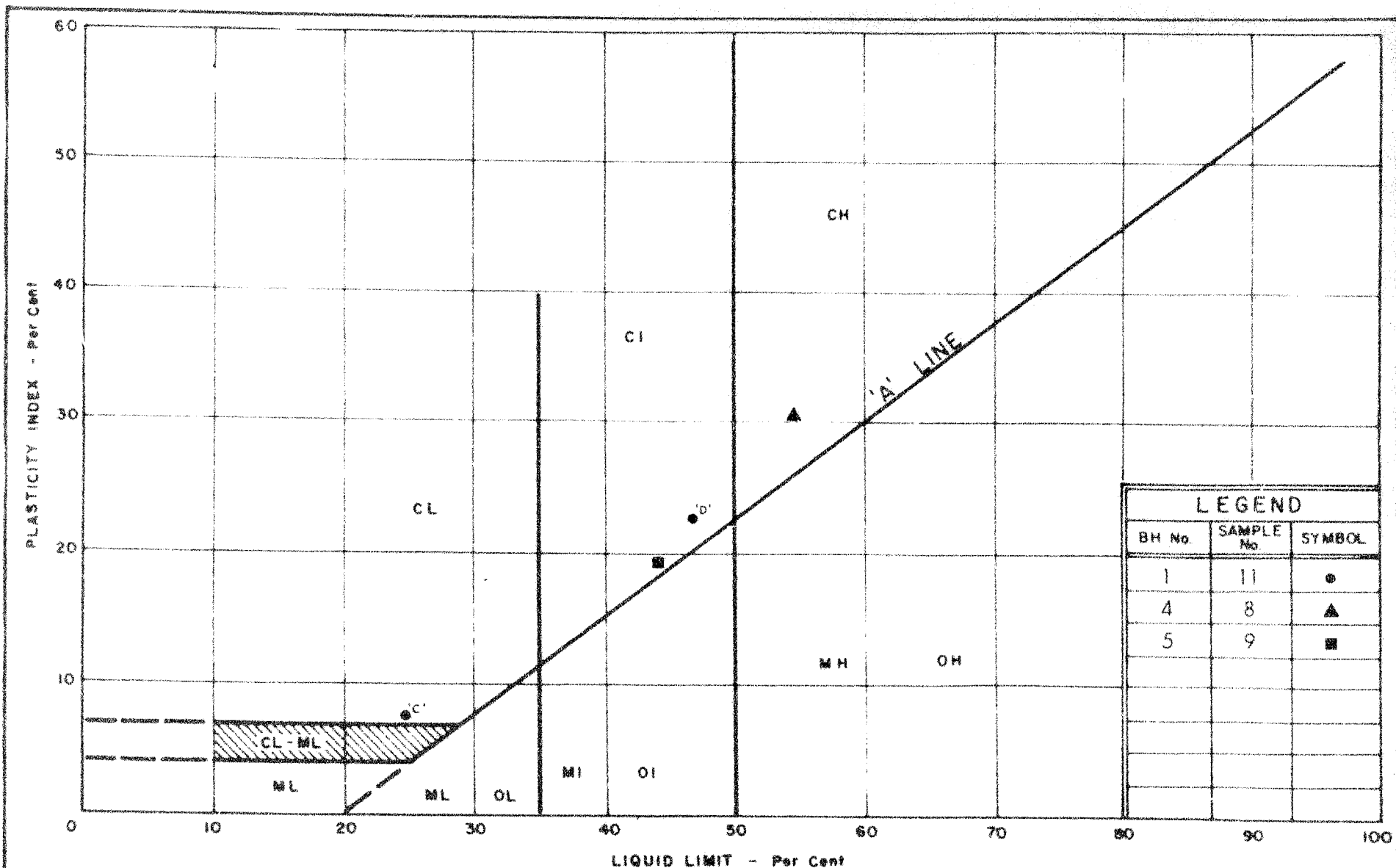
## RECORD OF BOREHOLE No. 5

FOUNDATION SECTION

JOB 70-11123 LOCATION East Dome ORIGINATED BY WH  
 W.P. 100-70-01 BORING DATE Jan. 20 - 21, 1971 COMPILED BY WH  
 DATUM Geodetic BOREHOLE TYPE Diamond Drill - Washboring 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 Y P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.					WATER CONTENT % 20 40 60				
257.3	Ground Level						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE 400 800 1200 1600 2000									
0.0	Fine sand to silty sand	•••••	1	SS	10	250										▼ 255.8
	Compact		2	SS	11											
	Brown to Grey		3	SS	10											
242.3			4	SS	28											
15.0	Clay to silty clay (sensitive)		5	SS	1	240										99
	Soft to Stiff		6	TW	PM											
	Grey to Reddish-Grey)		7	TW	PM	230										
			8	TW	PM											
			9	TW	PM	220										
			10	TW	PM											
			11	TW	PM	210										
			12	TW	PM											
203.3																
54.0	End of Borehole					200										





DEPARTMENT OF HIGHWAYS  
 MATERIALS and  
 TESTING  
 DIVISION

# PLASTICITY CHART CLAY TO SILTY CLAY

WP. No. 100 - 70 - 01  
 JOB No. 70 - 11123  
 FIG. 1

# VOID RATIO - PRESSURE CURVES

JOB NO. 70 - 11123

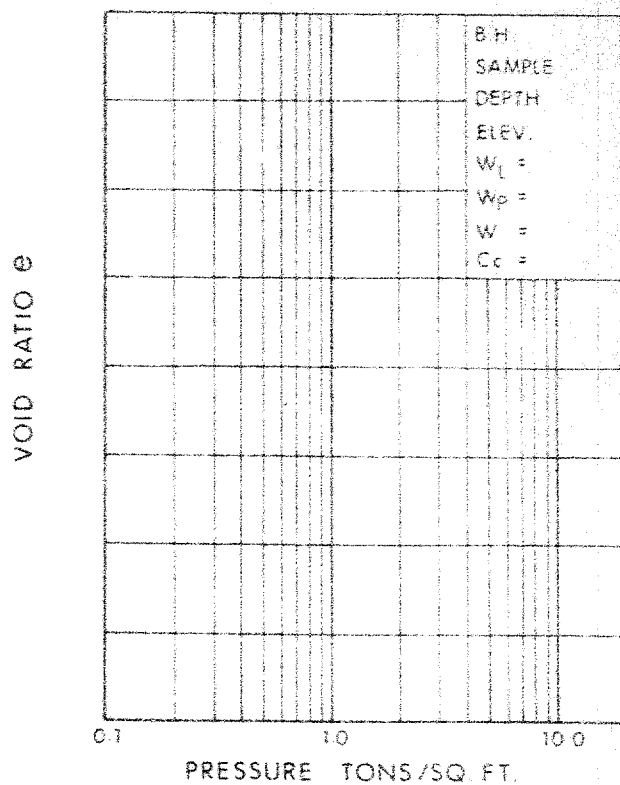
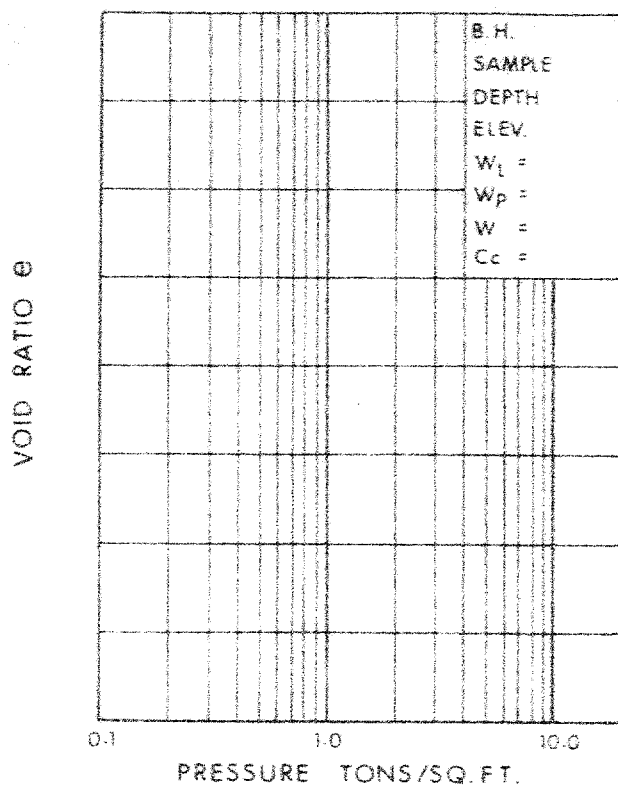
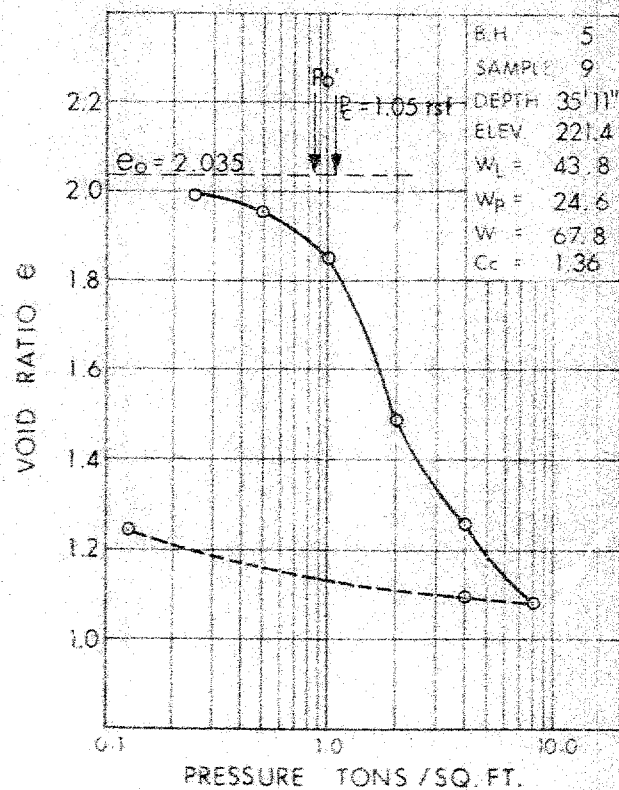
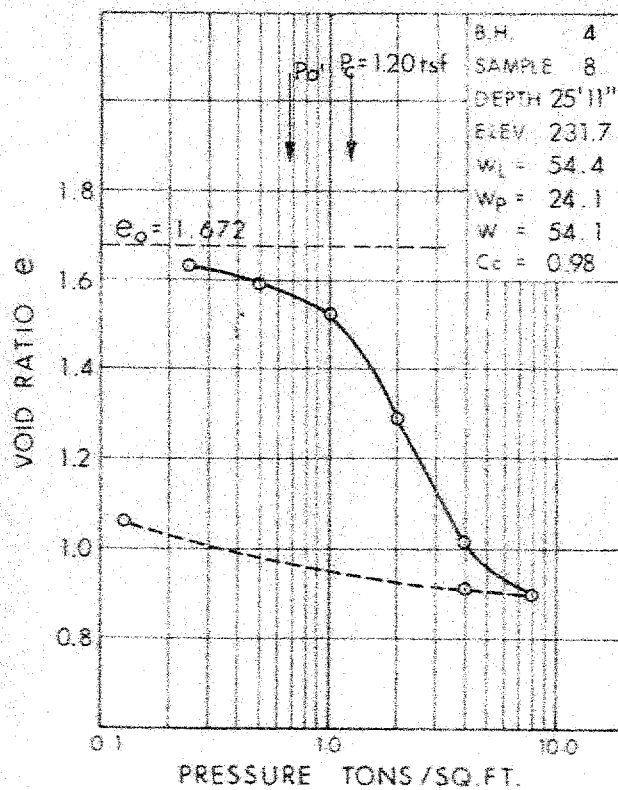
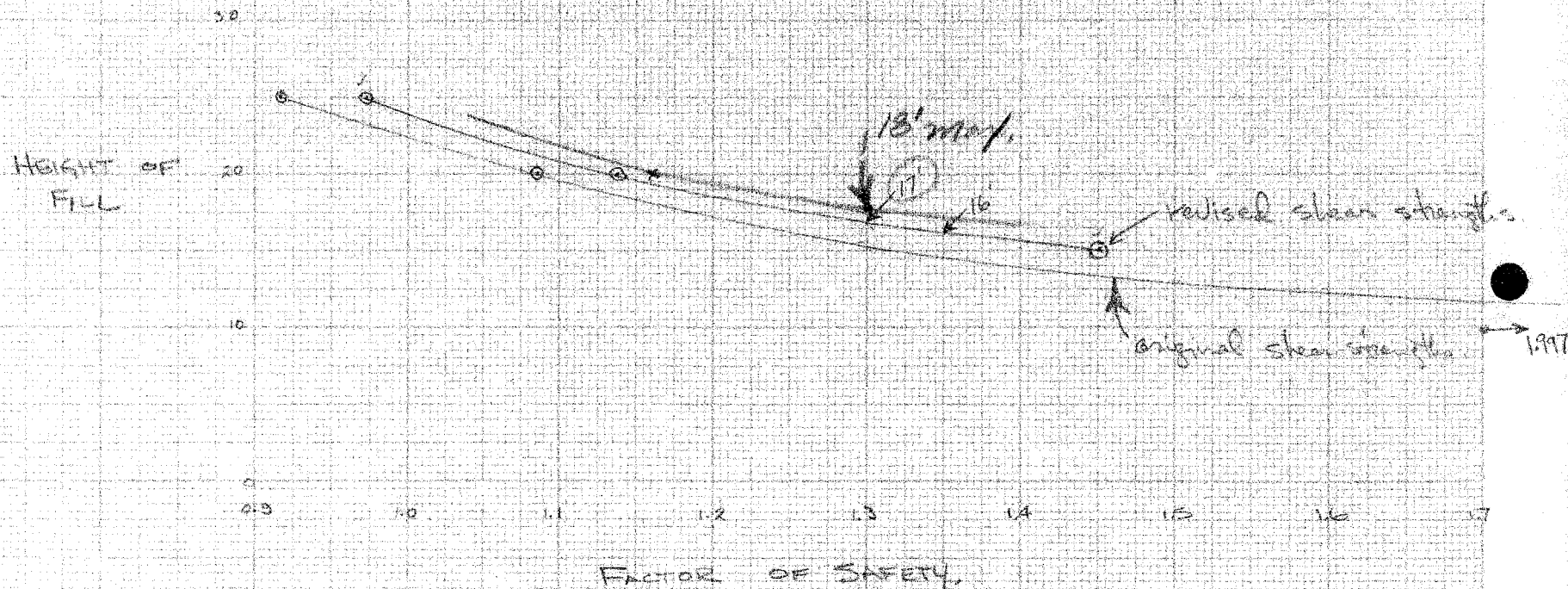


FIG.2

70-11123  
 PATROL YARD  
 - STOCKPILES.



## MEMORANDUM

70-11123

TO: Mr. A. Stermac,  
Principal Foundations Engineer,  
Materials & Testing Office,  
Downsview, Ontario.

FROM: Materials & Testing Office,  
Kingston, Ontario.

ATTENTION:

DATE: December 10, 1970.

OUR FILE REF.

IN REPLY TO

SUBJECT:

Re: W.P. 100-70-01,  
Proposed Carlsbad Springs Patrol Yard,  
District 9, Ottawa.

Enclosed please find a plan for the proposed patrol yard for Highway #417 which is to be located approximately 1½ miles north east of Carlsbad Springs.

Borehole data from our pre-engineering investigation is included on the plan.

We would appreciate it if you would carry out a field investigation to determine if any foundation problems are anticipated with the proposed garage construction and to indicate the maximum allowable stockpile heights at the proposed dome locations.

A print of this plan will be left at the Ottawa District Office on December 10, 1970, for Mr. Wm. Hutton, Field Engineer from your section presently working in the area.



A. M. Batten,  
Senior Soils Supervisor.

AMB/jtk

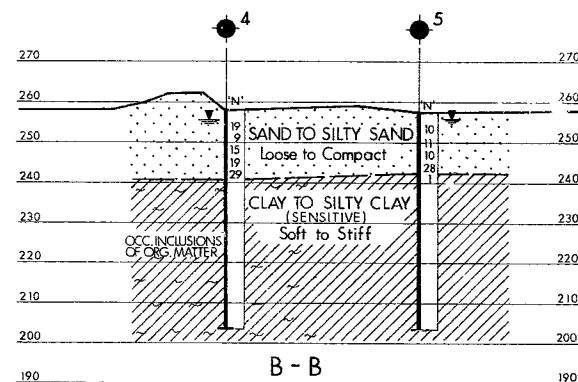
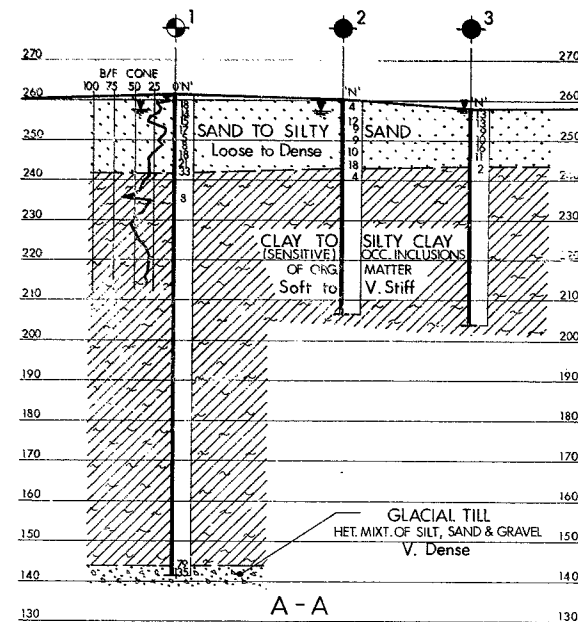
c.c. J. E. Callaghan  
L. M. Fraser

**CONT. 70-235**

**CARLSBAD SPRINGS**

**TWP. OF CUMBERLAND**

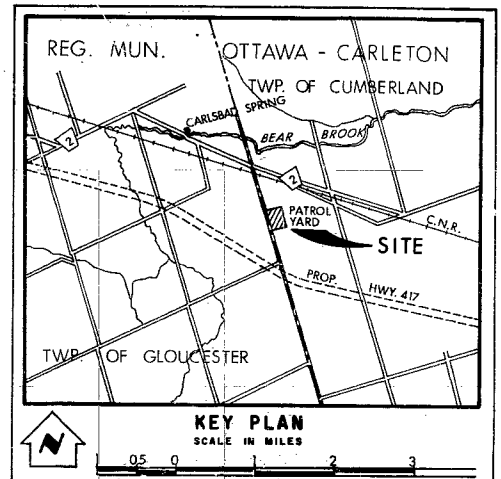
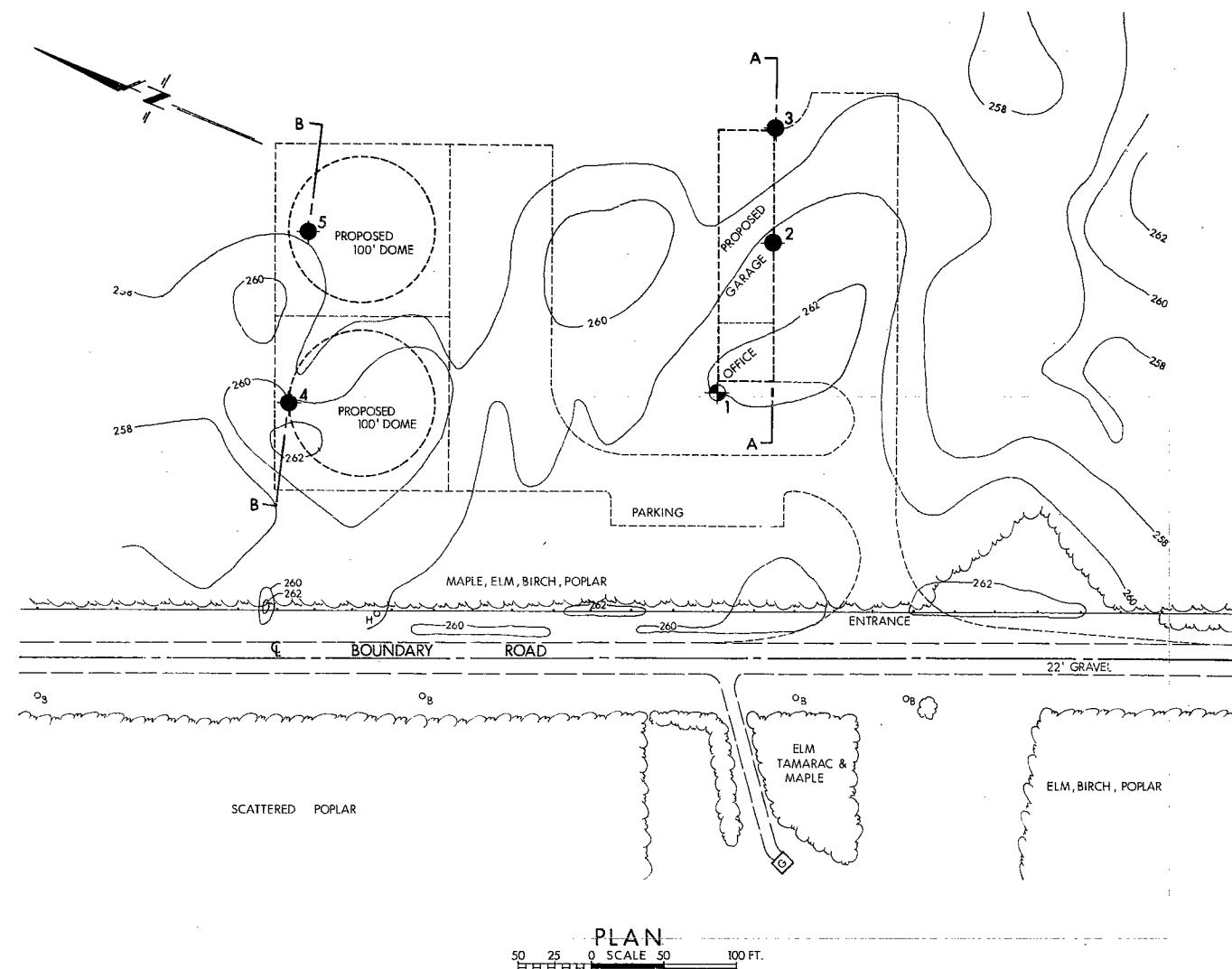
**316-36**



**SECTIONS**

HORIZ. 50 25 0 SCALE 50 100 FT.

VERT. 20 10 0 20 40 FT.



LEGEND			
	Bore Hole		
	Cone Penetration Hole		
	Bore & Cone Penetration Hole		
	Water Levels established at time of field investigation, JANUARY 1971.		
NO.	ELEVATION	STATION	OFFSET
1	261.8		
2	260.5		
3	257.6		
4	257.6		
5	257.3		

**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

GEOCRES NO. 31G-36

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING OFFICE - FOUNDATION SECTION

**PATROL YARD**

KING'S HIGHWAY NO. DIST. NO. 9

CO. REGIONAL MUNICIPALITY OTTAWA - CARLETON

TWP. CUMBERLAND LOT 20 CCN. 11

**BORE HOLE LOCATIONS & SOIL STRATA**

SUBM'D. W.H. CHECKED	W.P. NO. 100-70-01	M.B.T. DRAWING NO.
DRAWN S.R. CHECKED	JOB NO. 70-11123	70-11123 A
DATE FEBRUARY 24, 1971	SITE NO.	BRIDGE DRAWING NO.
APPROVED <i>A. J. Thomas</i>	CONT. NO.	

REF. No: H-57-3