

#58-F-204 C

TALFORD CREEK

BRIDGE-SARNIA

The Department of Highways of Ontario
280 Davenport Road,
Toronto - Ontario

58 F 204c

FOUNDATION INVESTIGATION FOR
THE PROPOSED TALFORD CREEK
BRIDGE NEAR SARNIA - ONTARIO

Reference 105/F86

Dominion Soil Investigation Ltd.

December 5th 1958

December 5th 1958

FOUNDATION INVESTIGATION FOR
THE PROPOSED TALFORD CREEK
BRIDGE NEAR SARNIA, ONTARIO

PURPOSE OF THE INVESTIGATION AND SCOPE OF THE REPORT

1. The investigation was undertaken to determine the foundation conditions at the above-mentioned site. The report covers the field work undertaken, and the results of laboratory tests on selected samples together with an analysis of the methods of support for the proposed structure.

LOCATION OF THE SITE AND BOREHOLES

2. The proposed Talford Creek Bridge replacement is on Highway No. 40 approximately 5 miles south of Sarnia. A sketch plan of the area illustrating the location of the site is shown on Enclosure No. 1. The borehole locations are shown on the plan on Enclosure No. 2.

FIELD INVESTIGATION AND DESCRIPTION OF THE SUBSOIL

3. Field work was commenced on October 19th and completed on October 24th 1958. Four holes were drilled, one to a depth of 81 ft and the remainder to a depth of 50 ft. One cone penetration test was undertaken. Drilling was carried out using a conventional diamond drill adapted for soil sampling. Samples were obtained by means of a 2 in. O.D. standard split spoon or using a 2 in. I.D. thin walled Shelby tube. 'In situ' vane shear tests including both undisturbed and disturbed readings were taken at depths intermediate between the 5 ft sampling intervals. Penetration of the standard split spoon and the 2 in diameter cone was achieved by

means of a 140 lb hammer falling freely through a height of 30 ins.

The subsoil conditions over the site are uniform and consist of an upper layer of up to 10 ft of loose sand and gravel clayey sand overlying soft to medium stiff silty clay containing some fine gravel to a proven depth of 81.5 ft. Between depths of 47 ft and 57 ft the soil becomes more silty and has a Plasticity Index of approximately 12.

RESULTS OF LABORATORY TESTS

4. The results of laboratory tests on selected samples are shown in the Appendix. These tests indicate that the silty clay has a Plasticity Index of between 17 and 23 between depths of 10 ft and 47 ft below ground surface. Between depths of 47 ft and 57 ft below ground surface in Borehole No. 1. the Plasticity Index is approximately 12 increasing to 17 to 19 from a depth of 57 ft to 80ft.

The 'in situ' vane tests indicate an undisturbed shear strength of 750 to 1200 p.s.f. and an average sensitivity of 1.3 to 1.4 (a sensitivity of 1.7 was noted at a depth of 27.5 ft in borehole No.2.)

The shear strengths as determined by the unconfined tests are lower than the values obtained by means of the 'in situ' vane. This is possibly due to the disturbing effect of the fine gravel in the soil.

Two consolidation tests are shown on Enclosures 9 and 10. The Compression Indices for the two samples are about identical at .265 and this checks closely with the Cassagrande value for insensitive clays obtained from their Liquid Limits. The two results suggest that the clay is normally consolidated, and that the material has a c/p ratio of about 0.25. However the only borehole where any trend towards a conventional c/p ratio was observable in the 'in situ' vane tests, was in borehole No.1.

DISCUSSION OF THE RESULTS

5. The disturbed shear strength as determined by the 'in situ' vane appears to be lower in borehole No.1. than in the remaining holes and is approximately 500 p.s.f. In the remaining boreholes the average value is approximately 700 p.s.f.

The average value of cohesion in borehole No.1. as determined by the unconfined compression test is also 500 p.s.f. In borehole No.2. the unconfined strength is lower, but this is thought to be due to the disturbing effect of the gravel. Based on a c/p ratio of 0.25 the average value of cohesion between depths of 10 ft and 50 ft is approximately 500 p.s.f.

Assuming an average value of cohesive shear strength of 500 p.s.f., a factor of safety of 3, and that the abutment loads are 500 kips then the following is an illustrative estimate of the probable settlement.

Assume pile diameter is 1 ft.

Assume effective length of pile in clay is 50ft.

Then the allowable load per pile is $\frac{500 \times 11 \times 50}{3}$ or approximately 26 kips per pile.

If the abutment load is 500 kips then 20 piles are required.

For safety against group failure the group perimeter should be at least $\frac{500k \times 3}{50 \times 500}$ or 60 ft.

This could be achieved by placing the piles in two rows of 7 and one of 6 piles in a square pattern at 3.5 ft centres.

Taking the settlement horizon to be 2/3 the effective embedded length down the pile, the depth below ground surface of the settlement horizon is 43 ft (i.e. below elevation 585).

The settlement S of a strip of soil H thick is given by the expression

$$S = \frac{C_c}{1 + e_o} \cdot \frac{H}{10} \log \frac{P_o + \Delta p}{P_o}$$

Where

C_c is the Compression Index

e_o is the Initial voids ratio of the soil under P_o

H is the depth of the strata under compression

P_o is the initial pressure

Δp is the increase in pressure

Assume that the soil is normally consolidated and has an average Compression Index of 0.27.

The probable settlement as determined from the above expression is then approximately 4 ins.

Since at least a portion of the soil below the assumed settlement horizon is more silty than that represented by the consolidation tests it will have a lower Compression Index than 0.27. It seems probable therefore that actual settlements are more likely to be of the order of 2 - 3 ins. These settlements will be long term.

CONCLUSIONS

1. The subsoil consists of a normally consolidated silty clay overlain by a 5 to 10 ft upper layer of sand or clayey sand.
2. The average value of cohesive shear strength may be taken to be 500 p.s.f. between elevations 575 and 525 ft.
3. Assuming the pile loads and grouping used in the illustrative calculations in this report the probable settlement of the abutments is of the order of 2 - 3 ins and should be long term. If other

lengths of piles and other group dimensions are used the probable settlement should be rechecked, though it is not thought that any major change in the magnitude will result.

P. E. M. Monk

P.E.M. Monk. P. Eng.



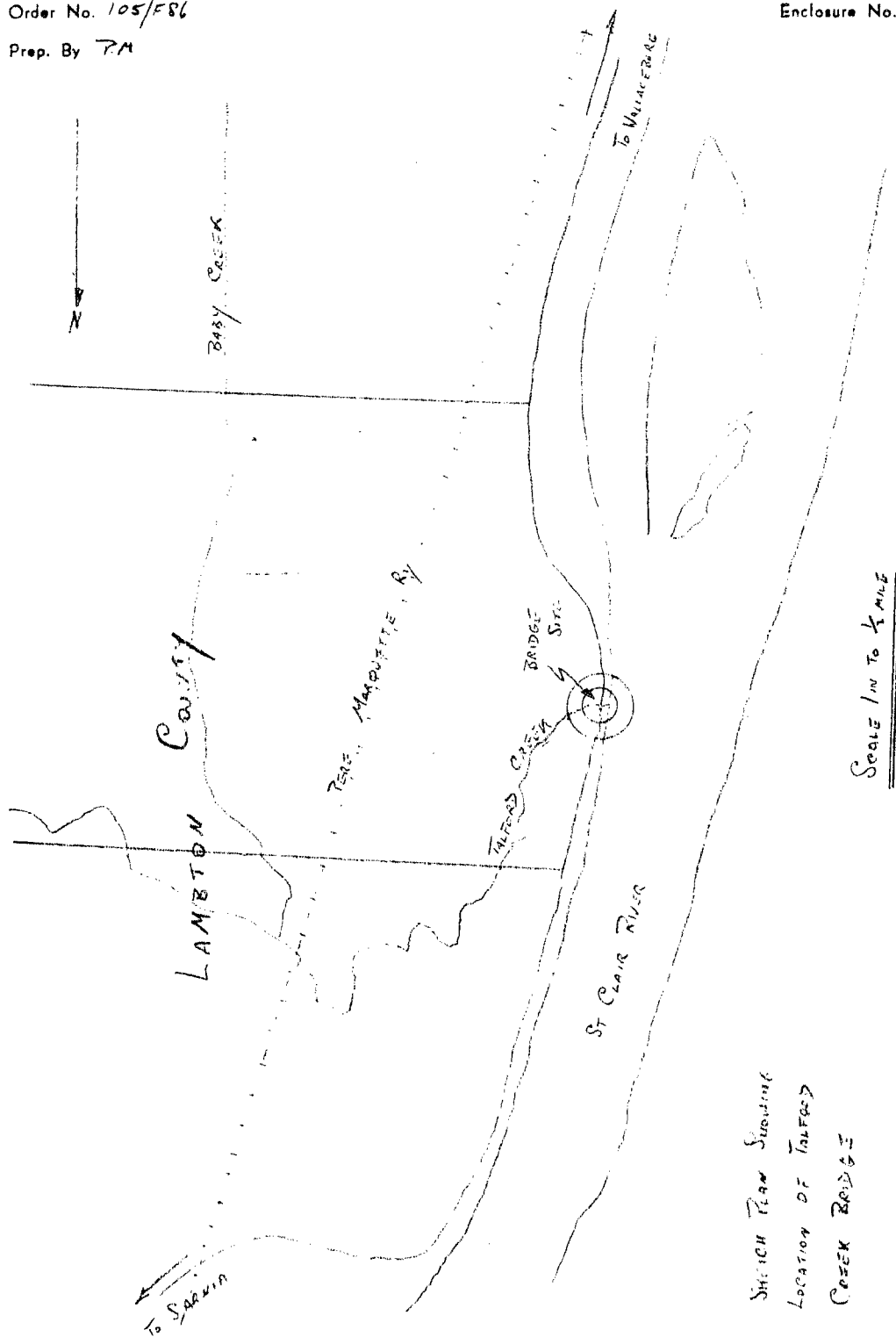
Borehole No.	Sample	Depth in ft.	Unconfined Cohesive Shear Strength p.s.f.	Moisture Content Percent	Liquid Limit	Plastic Limit	Plasticity Index	Unit Weight p.c.f.	Description
1	SS 4	15			40.2	21.8	18.4		Soft gray silty clay with some fine gravel
1	TW 5	20	775	31.9	42.8	22.1	20.7	119.5	Soft to medium stiff gray silty clay with some fine gravel
1	TW 6	25	583	41.3	46.9	24.0	22.9	112.5	-ditto-
1	TW 7	30	470	37.5	43.9	24.8	19.1	115.5	-ditto-
1	SS 8	35			44.2	22.9	21.3		-ditto-
1	TW 9	40	720	39.5	45.0	24.7	20.3	115.5	-ditto-
1	SS 10	45			41.0	23.6	17.4		-ditto-
1	SS 11	50			31.2	18.8	12.4		-ditto- increased silt content
1	SS 12	55			30.7	18.6	12.1		-ditto-
1	SS 13	60			40.2	21.8	18.4		Soft to medium stiff silty clay with some fine gravel
1	SS 14	65			41.7	22.0	19.7		-ditto-
1	SS 15	70			39.2	21.7	17.5		-ditto-
1	SS 16	75			35.5	22.1	13.4		-ditto-
1	SS 17	80			42.5	23.3	19.2		-ditto-

Borehole No.	Sample	Depth in ft.	Unconfined Cohesive Shear Strength p.s.f.	Moisture Content Percent	Liquid Limit	Plastic Limit	Plasticity Index	Unit Weight p.c.f.	Description
2	TW 7	30	332	32.5	39.8	23.0	16.8	121.0	Soft grey silty clay with fine gravel
2	TW 9	40	332	33.2	39.6	22.8	16.8	119.5	-ditto-
2	TW 11	43-50	443	35.4	41.3	24.1	17.2	115.5	-ditto-

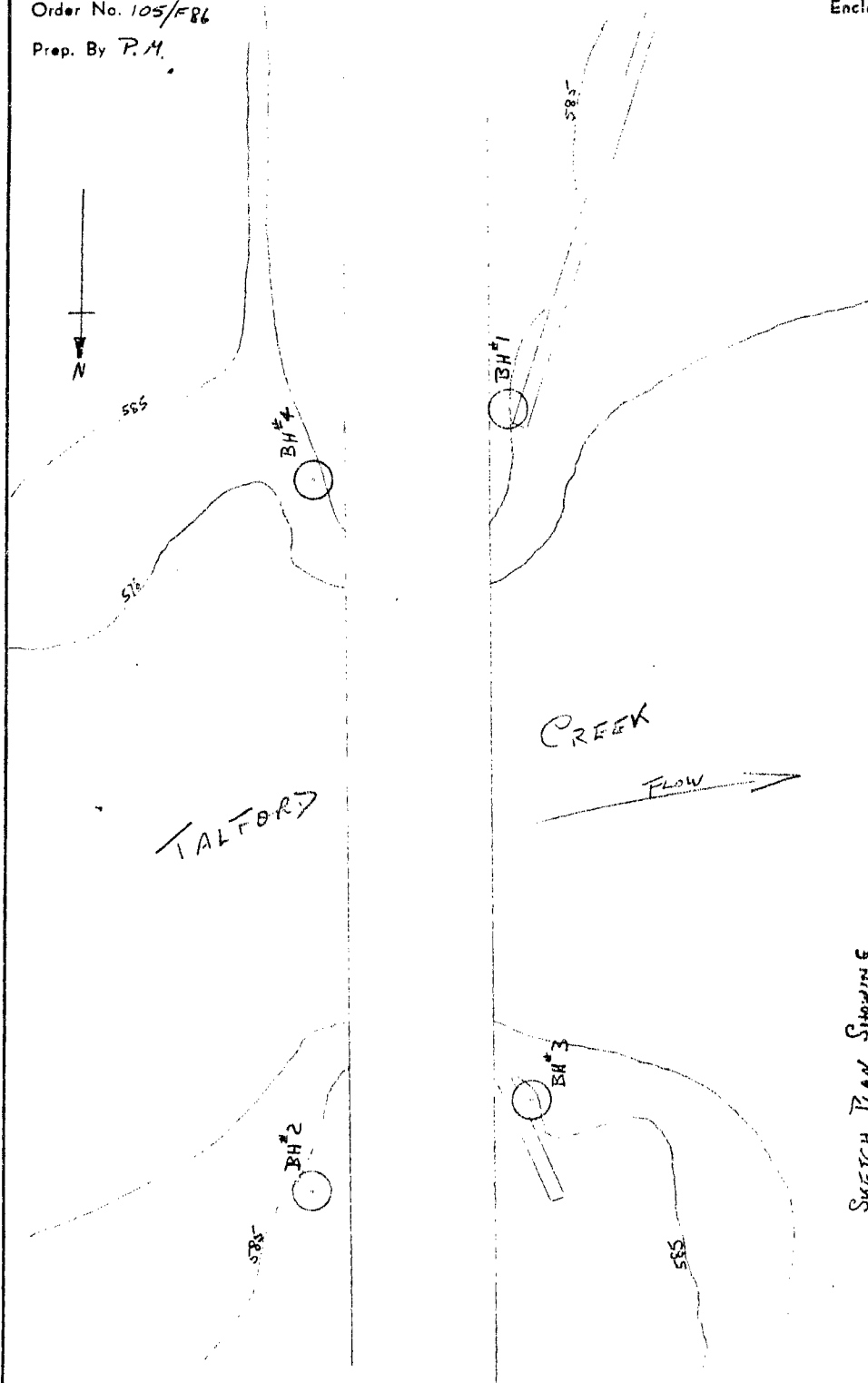
Order No. 105/F86

Enclosure No. 1

Prep. By RM



Prep. By P.M.



SCALE 1 IN TO 20 FT

SKETCH PLAN SHOWING
TALFORD CREEK BOREHOLE
LOCATIONS

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole: I

Date: 23/10/58

Project: Proposed Telford Creek Bridge

Location: Nr. Sarnia on Hwy No. 40

Hole Location: See Enclosure No 2

Hole Elevation and Datum: 584 Geo.

Field Supervisor: H.P. Prep.: P.M.

Driller: A.B. Checked:

LEGEND

Shear Strength (C)

Unconfined compression

Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

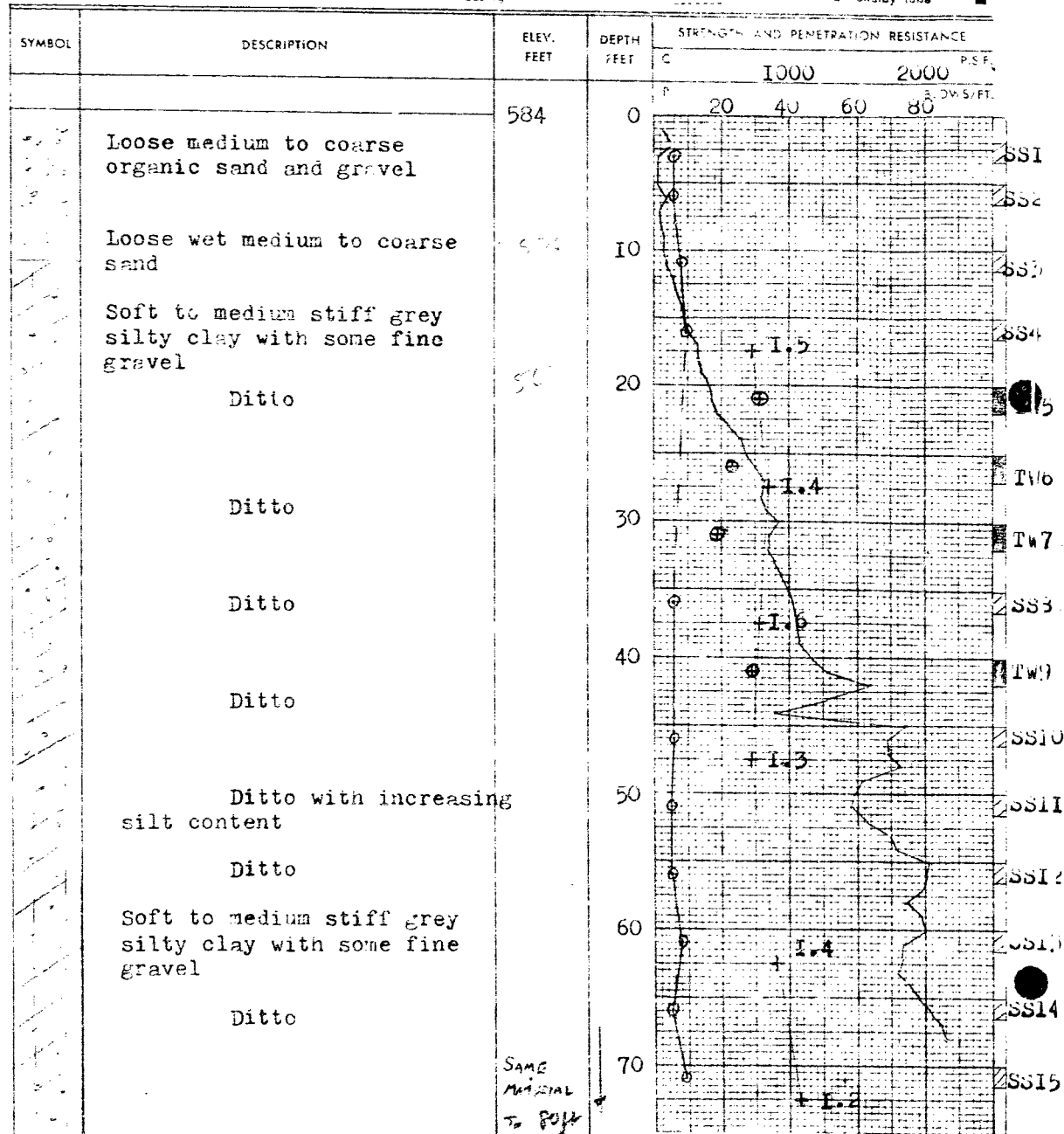
2" Dia. Cone

Casing

Sampling Method

2" Dia. split tube

2" Shelby tube



Dominion Soil Investigation Ltd.

Foundation Engineering Division

Engineering Data Sheet for Borehole: I

Date: 28/10/58

105/F86

Consulting

Right of way

Coulter test

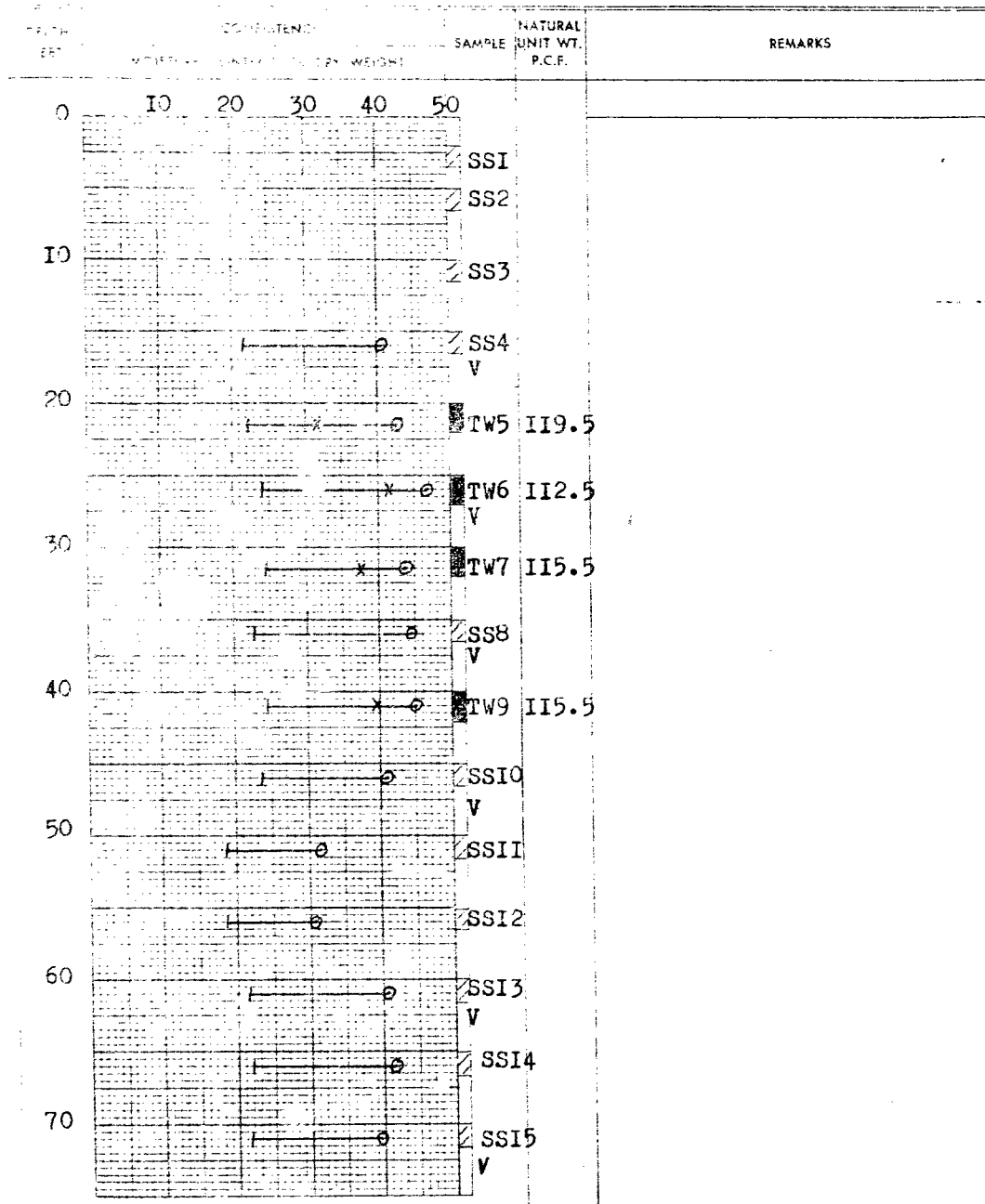
Penetration

Penetration

Sampling Method

2" Dia. split tube

2" Shelby tube



Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole: 2

Project: Proposed Talford Creek Bridge

LEGEND

Location: Nr Sarnia on Hwy No 40

Shear Strength (C)

Hole Location: See Enclosure No 2

Unconfined compression
Vane test and sensitivity (S)

Hole Elevation and Datum: 535 Geo.

Penetration Resistance (P)

Field Supervisor: H.P. Prep: P.M.

Driller: C.S.

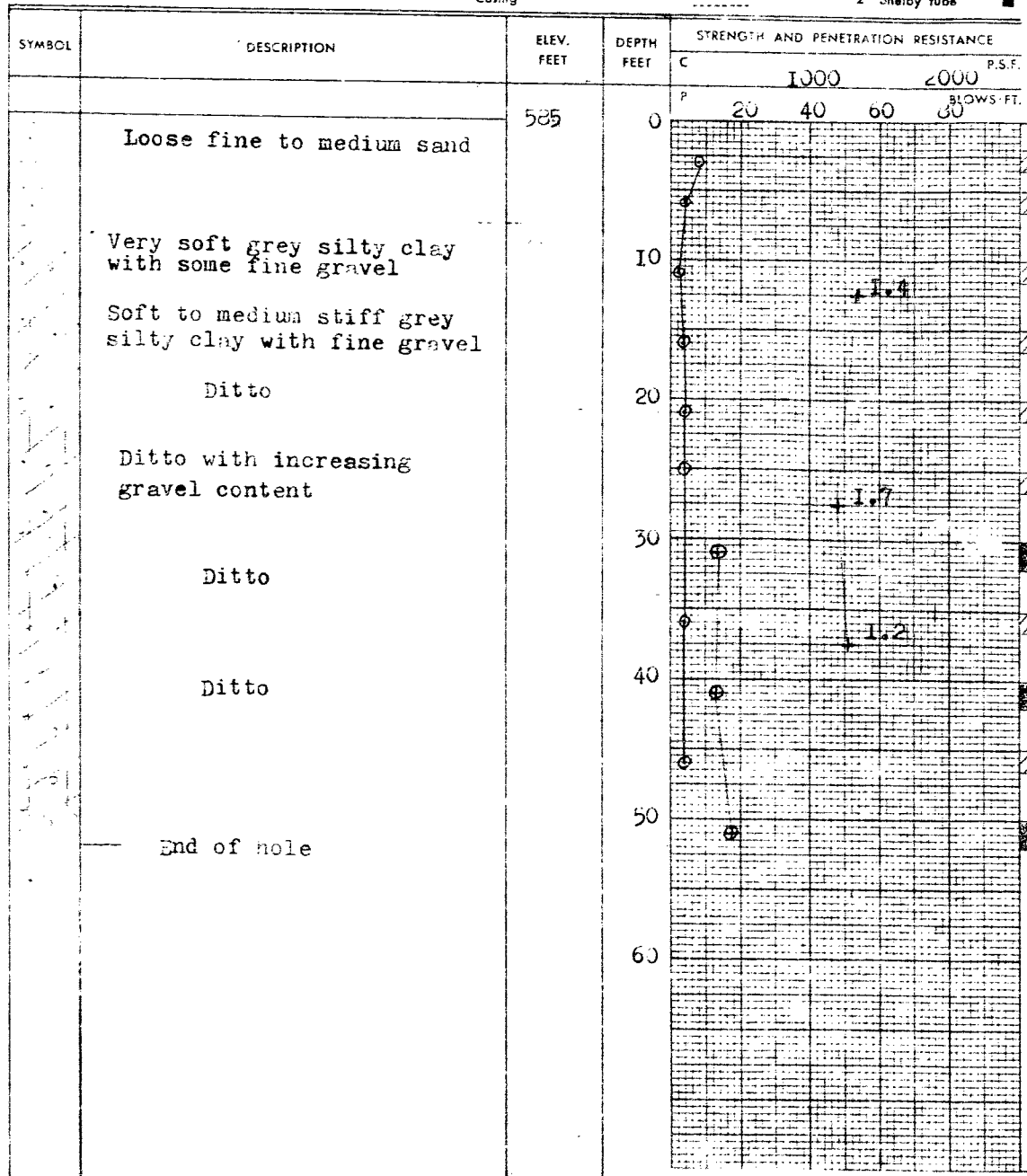
Checked:

Date: 28/11/58

Sampling Method

2" Dia. split tube

2" Shelby tube



Heminien Soil Investigation Ltd.

Foundation Engineering Division

Engineering Data Sheet for Borehole: 2

Date: 26/11/58

APPROX.

Consistency

Non-cohesive soils

Sandy soils

Clayey soils

Rocky soils

Sampling Method

2" Dia. split tube

2" Shelby tube



DEPTH FEET	CONSISTENCY	SAMPLE	NATURAL UNIT WT. P.C.F.	REMARKS
0	10 20 30 40 50			
		SS1		
		SS2		
10		SS3		
		V		
		SS4		
20		SS5		
		SS6		
30		TW7	121	
		SS8		
40		TW9	119.5	
		SS10		
50		TW11	115.5	
60				

Dominion Soil Investigation Ltd.**Engineering Data Sheet for Borehole: 3**

Date: 29/11/58

Project: Proposed Telford Creek Bridge

Location: Nr Sarnia on Hwy No 40

Hole Location: See Enclosure No 2

Hole Elevation and Datum: 535 Geo.

Field Supervisor: H.P. Prep.: P.M.

Driller: C.S.

Checked:

LEGEND

Shear Strength (C)

Unconfined compression
Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing

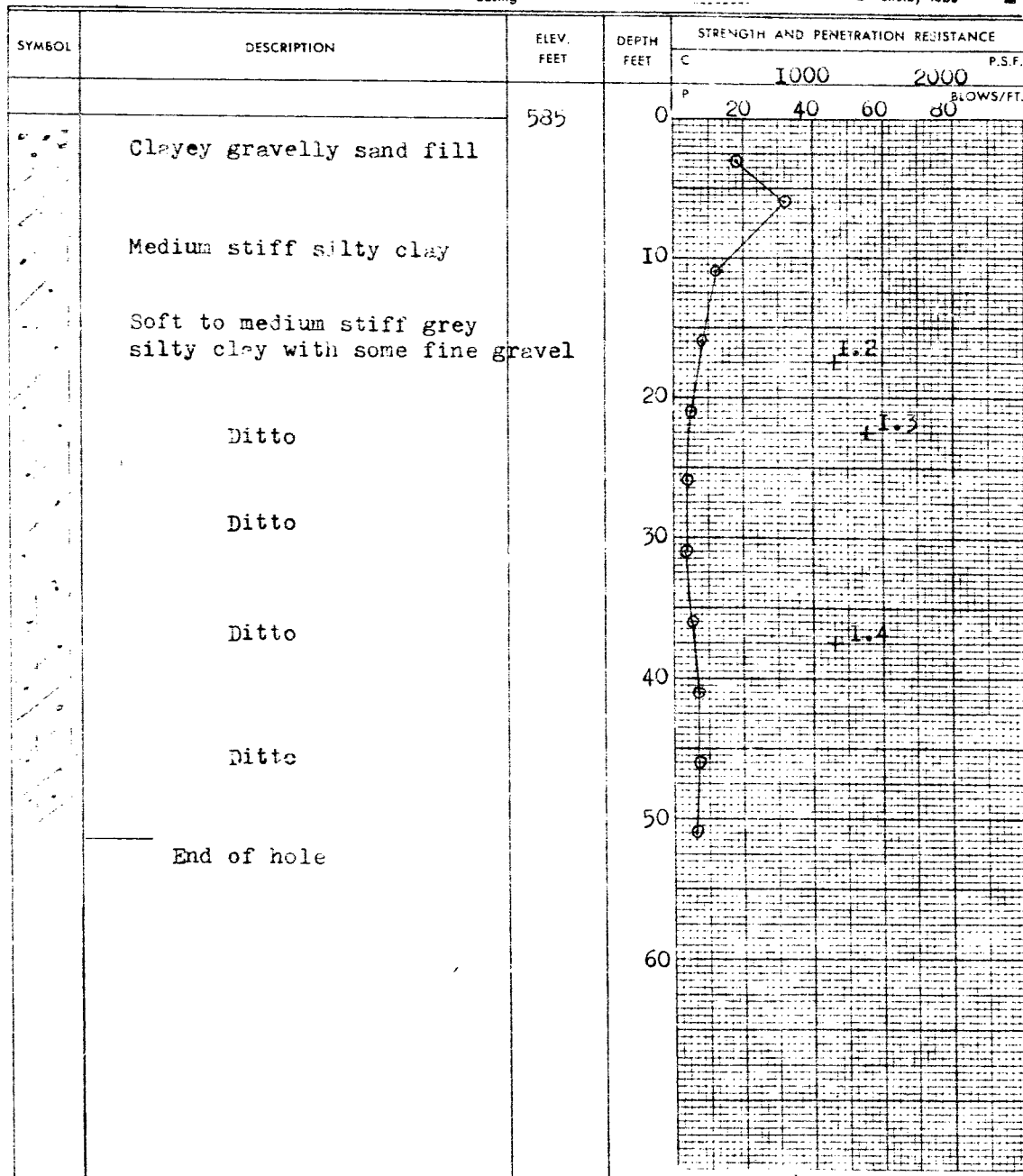
⊕
+5

⊕ ⊕

Sampling Method

2" Dia. split tube

2" Shelby tube



Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole: 4

Date: 29/II/58

Project: Proposed Telford Creek Bridge

Location: Nr Sarnia on Hwy No 40

Hole Location: See Enclosure No 2

Hole Elevation and Datum: 584 Geo.

Field Supervisor: H.P. Prep.: P.M.

Driller: C.S.

Checked:

LEGEND

Shear Strength (C)

Unconfined compression
Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

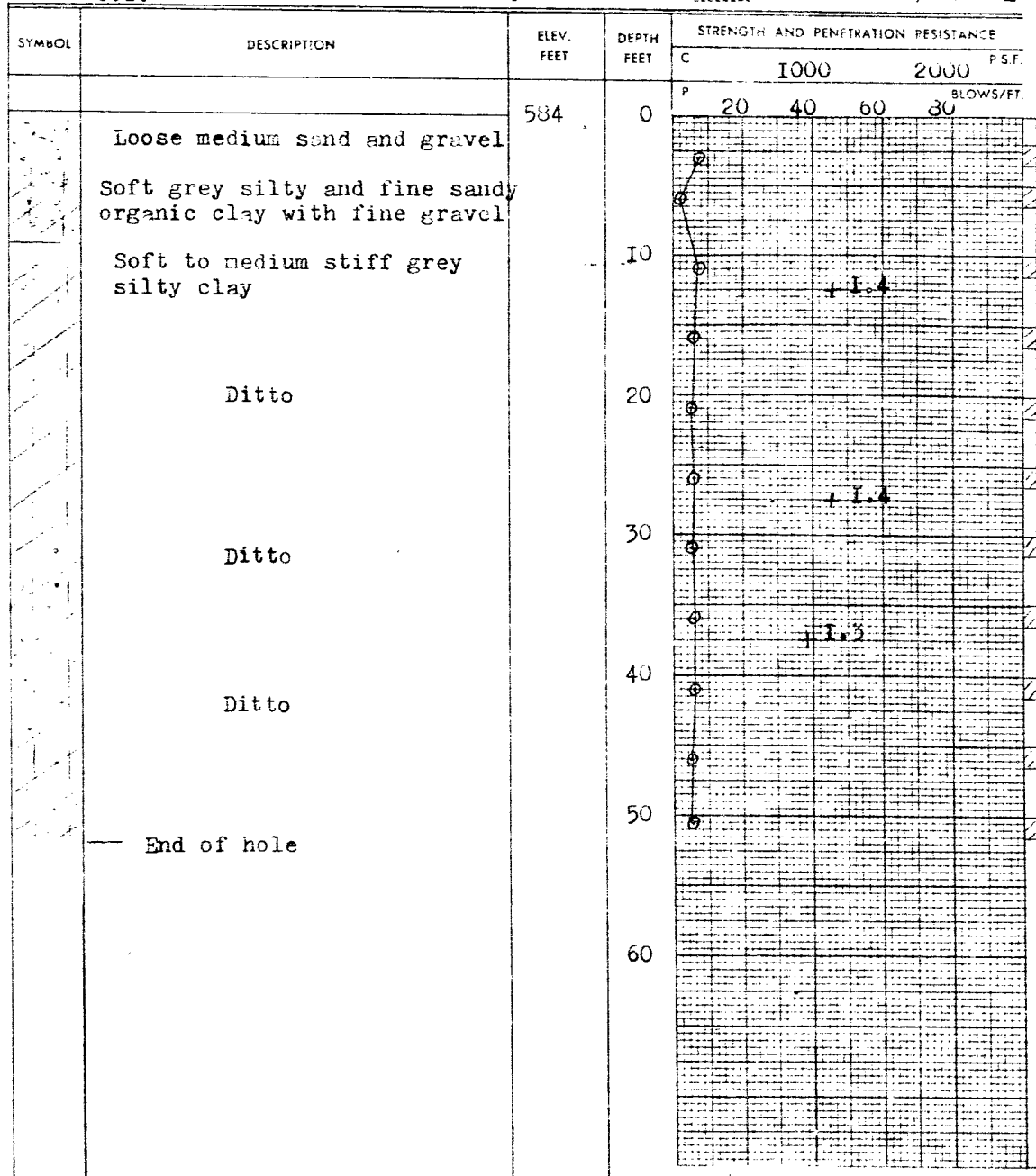
2" Dia. Cone

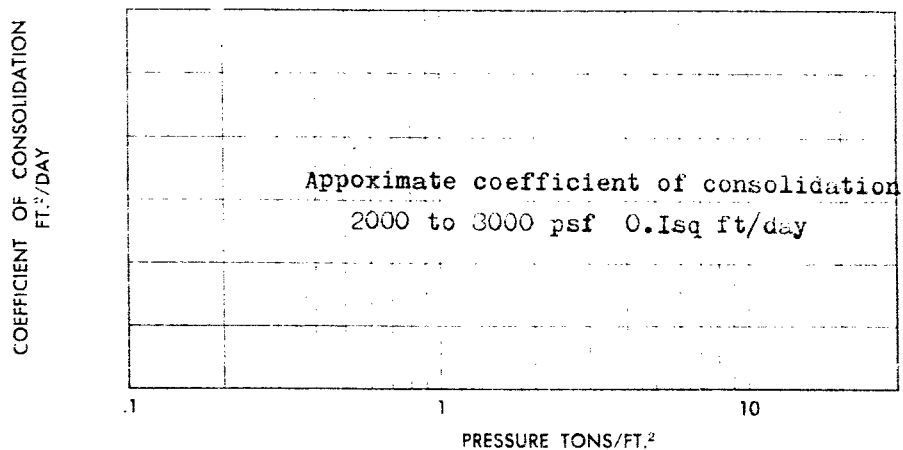
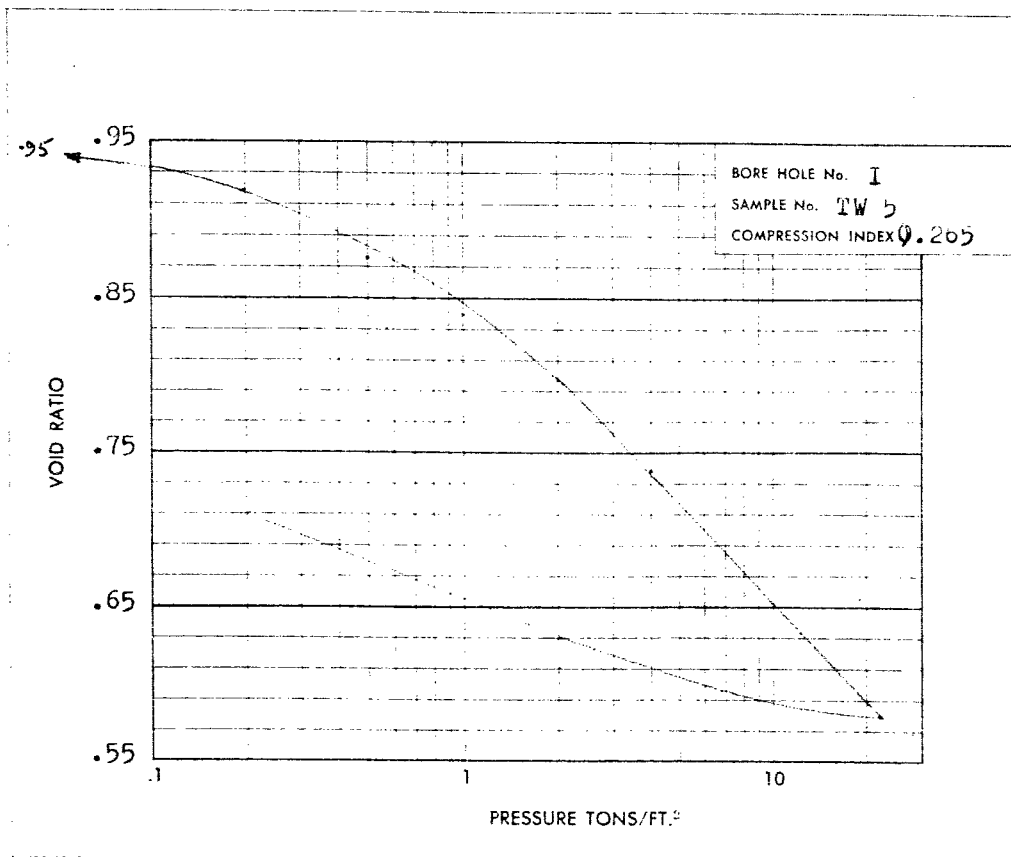
Casing

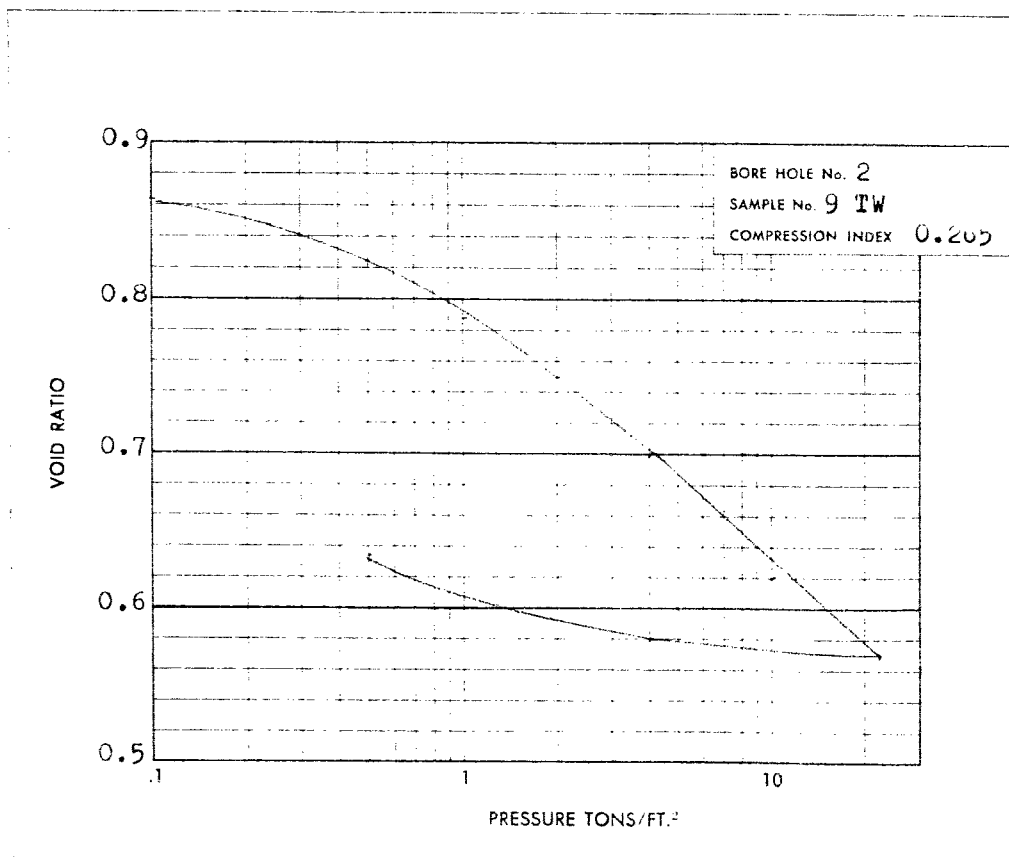
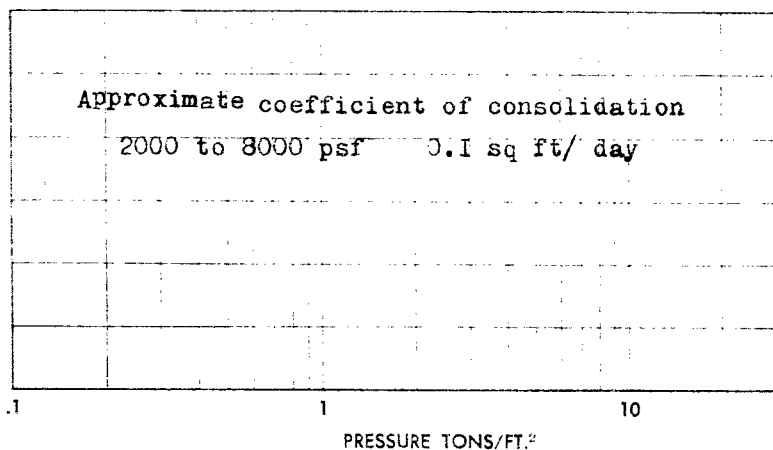
Sampling Method

2" Dia. split tube

2" Shelby tube



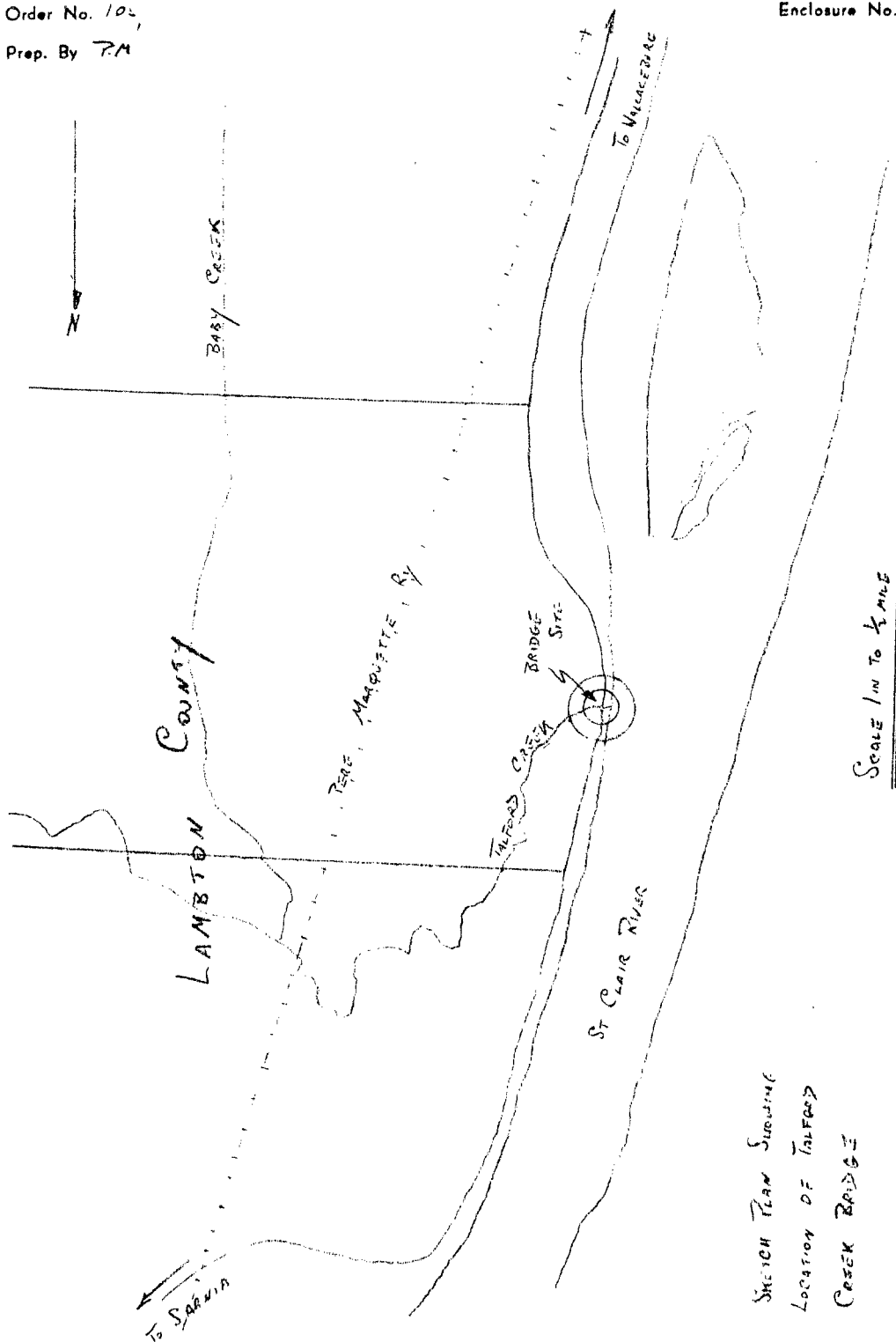
Dominion Soil Investigation Ltd.**CONSOLIDATION TEST**

Dominion Soil Investigation Ltd.**CONSOLIDATION TEST**COEFFICIENT OF CONSOLIDATION
FT.²/DAY

Order No. 102,

Prep. By RM

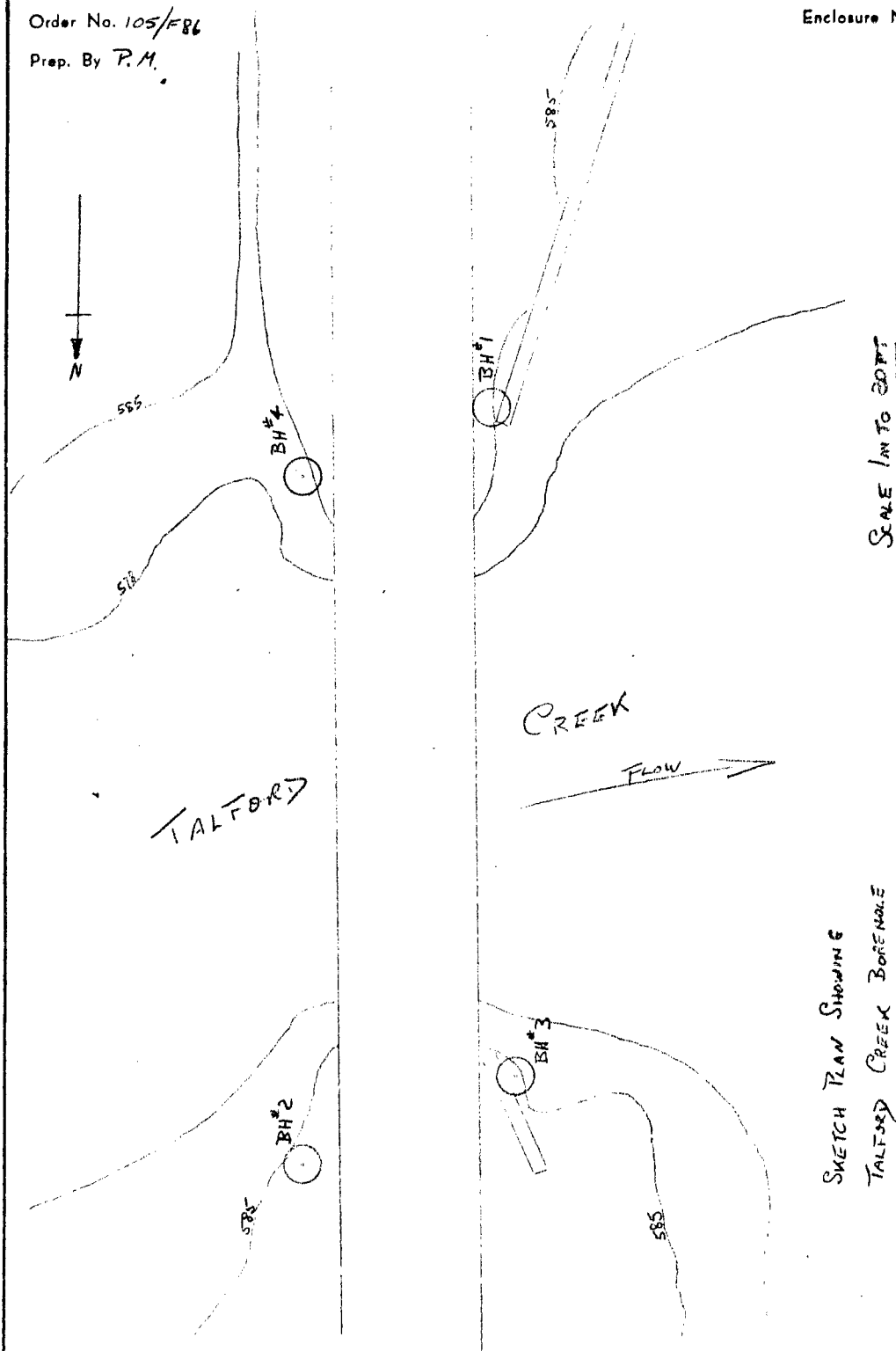
Enclosure No. 1



Order No. 105/F86

Prep. By P.M.

Enclosure No. 2



SKETCH PLAN SHOWING
TALFORD CREEK BOREHOLE
LOCATIONS