

#

58-F-253C

W.P. 183-58

HORNER CREEK.

BLENHEIM TWP.

B4864.

58-F-253 C

RACEY, MacCALLUM AND ASSOCIATES
LIMITED

A COMPANY OWNED, DIRECTED AND OPERATED BY

Consulting Engineers
AND ASSOCIATED STAFF

MONTREAL  VANCOUVER

TORONTO

RONALD C. MACCALLUM, B.ENG., M.E.I.C., P.ENG.

JOHN RACEY, B.SC., M.E.I.C., P.ENG.

ERIC RANKINE, B.SC., M.E.I.C., A.M.I.ELEC.E., P.ENG.

TORONTO DIVISION
27 CARLTON STREET
Toronto 2.

Reference: S-500/T-1102.

30 September, 1958.

Bridge Office,
Department of Highways of Ontario,
280, Davenport Road,
TORONTO - Ontario.

Attention: Mr. J. McAllister.

RE: FOUNDATION INVESTIGATION FOR A WP 183-58
BRIDGE ACROSS HORNER CREEK, AT
HWY. NO 401, BLENHEIM TOWNSHIP
NO 11 - ONTARIO.

Dear Sir,

The enclosed report presents the results of our
soil investigation at the above location.

We hope the report is satisfactory to you; if you
have any questions about it do not hesitate to get in touch
with us.

Thank you for this opportunity of being of service to
you.

Yours sincerely,
RACEY, MacCALLUM AND ASSOCIATES LIMITED,

Ronald F. Scott

Ronald F. Scott, P.Eng.,
Divisional Soil Engineer.

RFS:YDP

Copy to Philip Benn and Associates,
C/o 5902, McDonald Avenue, Montreal.
Attention: Mr. A. P. Benn.

Bridge Office,
Department of Highways of Ontario,
280, Davenport Road,
Toronto.

FOUNDATION INVESTIGATION FOR A
BRIDGE ACROSS HORNER CREEK, AT
HWY. NO 101, SLENNHEIM TOWNSHIP
NO 11 - ONTARIO.

Reference: 3-500/T-1102

Racey, MacCallum and Associates
Limited.

30 September, 1958.

RACEY, MacCALLUM AND ASSOCIATES LIMITED

A COMPANY OWNED, DIRECTED AND OPERATED BY

Consulting Engineers
AND ASSOCIATED STAFF

MONTREAL



VANCOUVER

TORONTO

DONALD C. MACCALLUM, B.ENG., M.E.I.C., PENG

H. JOHN RACEY, B.SC., M.E.I.C., PENG

A. ERIC RANKINE, B.SC., M.E.I.C., A.M.I.ELEC.E., PENG

TORONTO DIVISION
27 CECIL STREET
TORONTO 2, ONT.

Reference: S-500/T-1102.

30 September, 1958.

FOUNDATION INVESTIGATION FOR A BRIDGE ACROSS HORNER CREEK AT HIGHWAY NO 401, BLANCKIN TOWNSHIP NO 11, ONTARIO.

This investigation was carried out between 11 and 25 September, 1958, and consisted of four borings with adjacent cone penetration tests and two separate cone penetration tests, to a maximum depth of 75 feet. This report presents the results of the investigation, a summary of the engineering properties of the soil and recommendations regarding the foundations of the proposed structure.

SITE INVESTIGATION :

The site is located in a relatively low-lying area bounded to the West by a swamp and to the East by higher land. The Horner Creek meanders through this land which has been utilised mainly as pasture. At periods of high water the site is flooded by the creek.

The location of the bridge site, borings and probings is indicated on a sketch, Enclosure No 1. The Horner Creek will be diverted by cutting off one of its loops, and the Highway will cross the new channel at right angles. Originally, it was planned to carry out four borings, or two borings and two probings if the soil conditions proved to be fairly uniform. At the request of the structural consultant, however, all four borings were completed and two additional probings at the proposed centreline of the bridge were carried out.

A standard lightweight diamond drill was used, equipped with 3 inch diameter casing. Samples of the mainly granular soil were taken using a standard 2 inch outside diameter split spoon sampler, which is driven into the ground by a 140 lb hammer falling a distance of 30 inches. The number of blows required to drive the sampler one foot is recorded as the standard penetration resistance, which bears an empirically established relationship to the relative density of the soil. Three times an undisturbed thin-walled sample was taken of

Reference: S-500/T-1102.

30 September, 1958.

- Continued -

what seemed at the time to be a layer of cohesive soil, but in each case this turned out to be a small pocket of clay within the granular layer, and no further attempts at undisturbed sampling were made.

The cone penetration tests were carried out by driving a 2 inch diameter 60 degree point angle cone into the ground, using the same driving energy as for the split spoon sampler. This method gives a continuous picture of the changes in density with depth.

Due to the great depth of exploration which was required to obtain conclusive evidence of safe foundation support, and to the difficult access to the site, the field operations took a total of two weeks. Fences had to be taken down and re-erected, and a small bridge had to be reassembled for crossing a ditch. The present tenant of the property on which the site was located, Mr. Miller, was most co-operative in allowing the use of his right of way and by keeping his cattle away from the site.

BORING RESULTS :

The results of the borings and preborings are plotted on the Engineering Data Sheets, Enclosures 2 to 7. Although there are some local differences in the sand and silt content of the soil, the general soil profile is quite consistent. The top layer of 11 - 15 feet of very loose sand and organic silt probably originates from relatively recent creek deposits. At Boring No 1, close to the creek bed, some of the fine silt and organic matter may have been eroded at a later time and replaced by sand. Below the creek deposits the soil is more sandy and contains no organic material, while the density increases somewhat with depth, reaching a maximum at about 40 feet depth. At greater depths there is a decrease in the standard penetration resistance, but the cone resistance continues to increase. This can be explained by the fact that in a boring in granular soil below the ground water table and below a depth which depends on the grain size and the presence of finer material, the soil tends to come up inside the casing, thus decreasing in density.

At about 70 feet a very compact mixture of sand, gravel and silt was found, generally described as a glacial till. Further penetration in order to find bedrock did not appear to be of much use, and drilling was terminated at that depth.

The ground water table at each of the borings was found to be at or near the level of the creek. The week prior to the investigation there was considerable rainfall, and the level of the creek rose about 2 feet. It remained relatively constant, however, during the time of the borings.

Reference: S-500/T-1102.

30 September, 1958.

- Continued -

RECOMMENDATIONS :

From the above results it is evident that the site conditions offer several serious difficulties to the proposed project. In the first place, the excavation of a new channel for the creek in the loose granular organic soil would require very gentle slopes in order to be stable. In view of the depth of the present creek the channel depth would only be about 6 feet, however, and the width of the channel would still be kept within reasonable limits. Some slope protection in the form of sodding and bad protection against scour by means of rip rap may be advisable.

The second problem inherent to the proposed project is the extent of settlements and soil displacement which will be caused by the proposed 6 feet height of highway embankment fill. If sufficient time were available, the highway embankments could be built up to approximately their final level a year prior to further construction. The presence of coarse sand layers between the organic material would stimulate rapid drainage, and consequently relatively quick consolidation would take place. Some displacement might also occur, particularly towards the creek bed. However, any deformations in the embankment could be remedied at the end of the settlement period. If settlement readings were taken at frequent intervals, this period might be ended when no more settlements are observed. If no time is available for this settlement programme, it would seem necessary to replace the top 10 - 15 feet of organic soil by a better quality fill. The underlying loose sandy soil will settle somewhat, but these settlements should take place during erection of the embankment.

The foundation for the bridge structure will have to be carried down to a considerable depth. Even if the subsoil were of a reasonable density at, say 5 - 10 feet, below the surface, the danger of scour damage would make extensive protection measures a necessity. In view of the loose soil extending to relatively great depths, however, a foundation on piles would appear to be advisable, while at the same time it eliminates the possibility of scour damage.

Because of the increase in cone penetration resistance from about 45 feet down, it would not appear feasible to drive piles beyond this depth to refusal at approximately 75 feet depth. It would be easier to use shorter piles down into the denser material encountered at each boring at elevations varying from 908 feet to 903 feet. In this layer the standard penetration resistance is equal to or exceeds 20 blows per foot.

The safe bearing capacity of a pile driven into this layer can be determined by the empirical formula :

$$Q = \frac{45 A_p}{FS} + \text{Friction}^*$$

* G.O. Meyerhof "Penetration Tests and Bearing Capacity of Cohesionless Soils", Proceedings of American Society of Civil Engineers, January, 1956.

Reference: E-500/T-1102.

30 September, 1958.

- Continued -

where Q = safe bearing capacity of pile in tons
 N = standard penetration resistance
 A_p = cross-sectional area of pile tip in square feet
 FS = factor of safety, generally taken as 3.0

Friction is at least equal to 10% of safe point resistance in granular soils.

For $N = 20$ and for a cross-sectional area of one square foot, Q would be about 30 tons. The required pile length might vary as much as 10 feet over the area of the site, and it might be considered advisable to use piles that can easily be cut to required length, such as concrete capped timber piles or steel manutube piles.

As it is essential for the designer to know the exact safe bearing capacity of the piles, the above value of 30 tons per square foot of cross-sectional area should be adhered to. When the type of pile and its diameter are chosen, the required refusal can be determined by means of one or two test piles with the help of one of the prevailing pile driving formulas, and the piles can be driven to this refusal and cut off. The maximum depth of pile penetration can probably be safely taken at Elevation 900 feet.

The relatively high embankments will cause considerable lateral thrust on the bridge abutment, the extent of which will depend on the type of construction and the properties of the embankment fill. These thrusts should be accommodated by batter piles.

CONCLUSIONS :

Summarising the results of this investigation the following conclusions may be drawn :

1. The soil at the site consists of approximately 15 feet of loose organic sand and silt, changing to sandy soil of gradually increasing density.
2. The top layer of soil will be subject to appreciable settlements and displacements by the weight of the embankments, and one of the two remedial measures mentioned in this report will have to be taken.
3. The excavation for the creek diversion will require gentle slopes, probably with some additional protection, in order to assure stability.
4. The bridge should be founded on piles, which would find safe support at depths from 40 to 45 feet.

- 5 -

Reference: E-500/T-1402.

30 September, 1958.

- Continued -

CONCLUSIONS : (Continued)

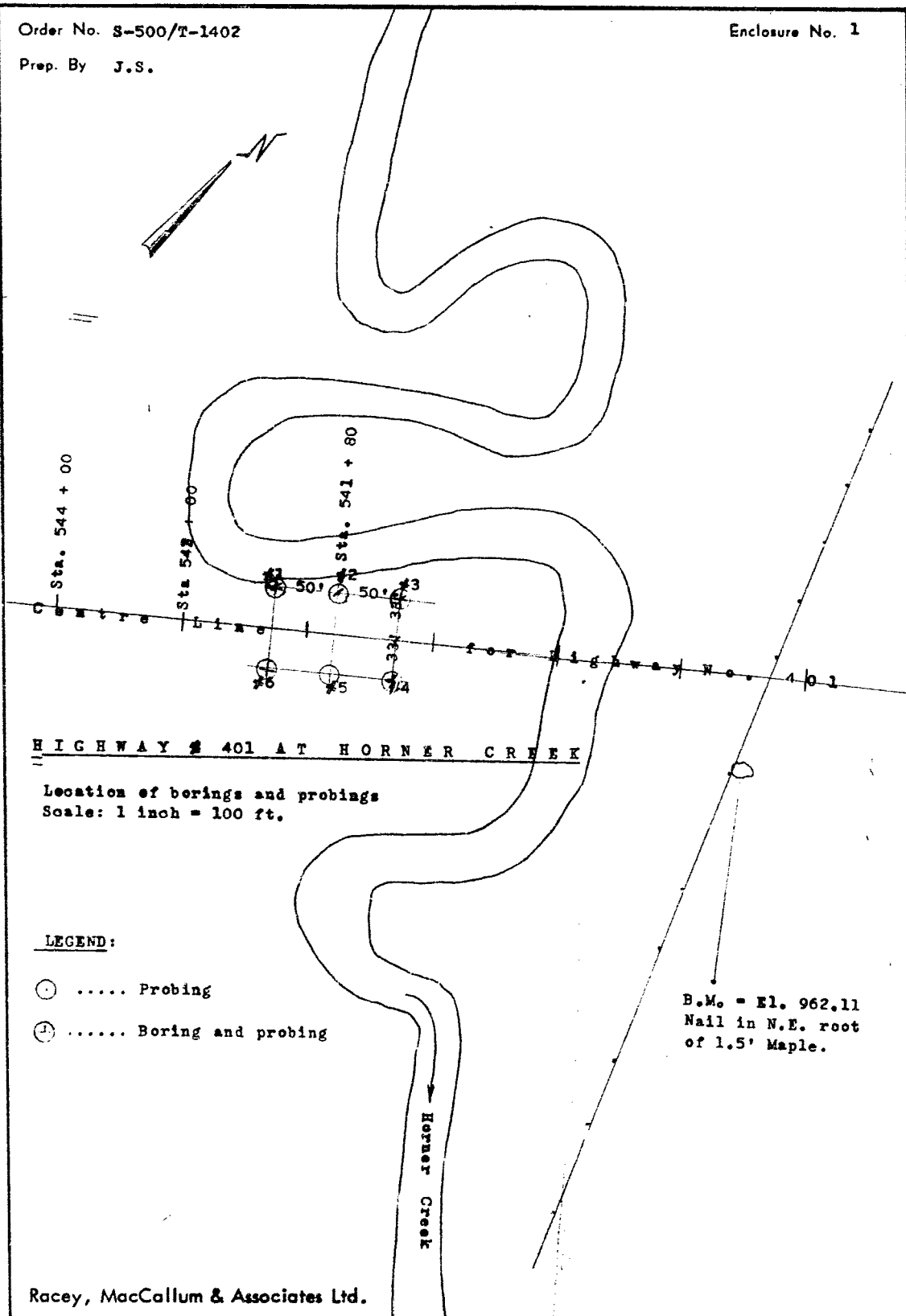
5. Recommended safe pile bearing capacity is 30 tons per square foot of cross-sectional area.
6. The lateral thrust caused by the embankment fill will have to be accommodated by better piles.



J. J. Schoustra, P.Eng.,

JJS:YDP

Prep. By J.S.



RACEY MacCALLUM AND ASSOCIATES LTD.

Foundation Engineering Division

Engineering Data Sheet for Borehole: 1

Project: Highway No. 401, Bridge No. 11.
Location: Blenheim Township, Con. V, Lot 24.

Hole Location: See Enclosure No. 1.

Hole Elevation and Datum: 948.0 Ft.

Field Supervisor: A.H. Prep.: J.S.

Driller: F.B. Checked: J.S.

Date: 26.9.58

LEGEND

Shear Strength (C)

Unconfined compression

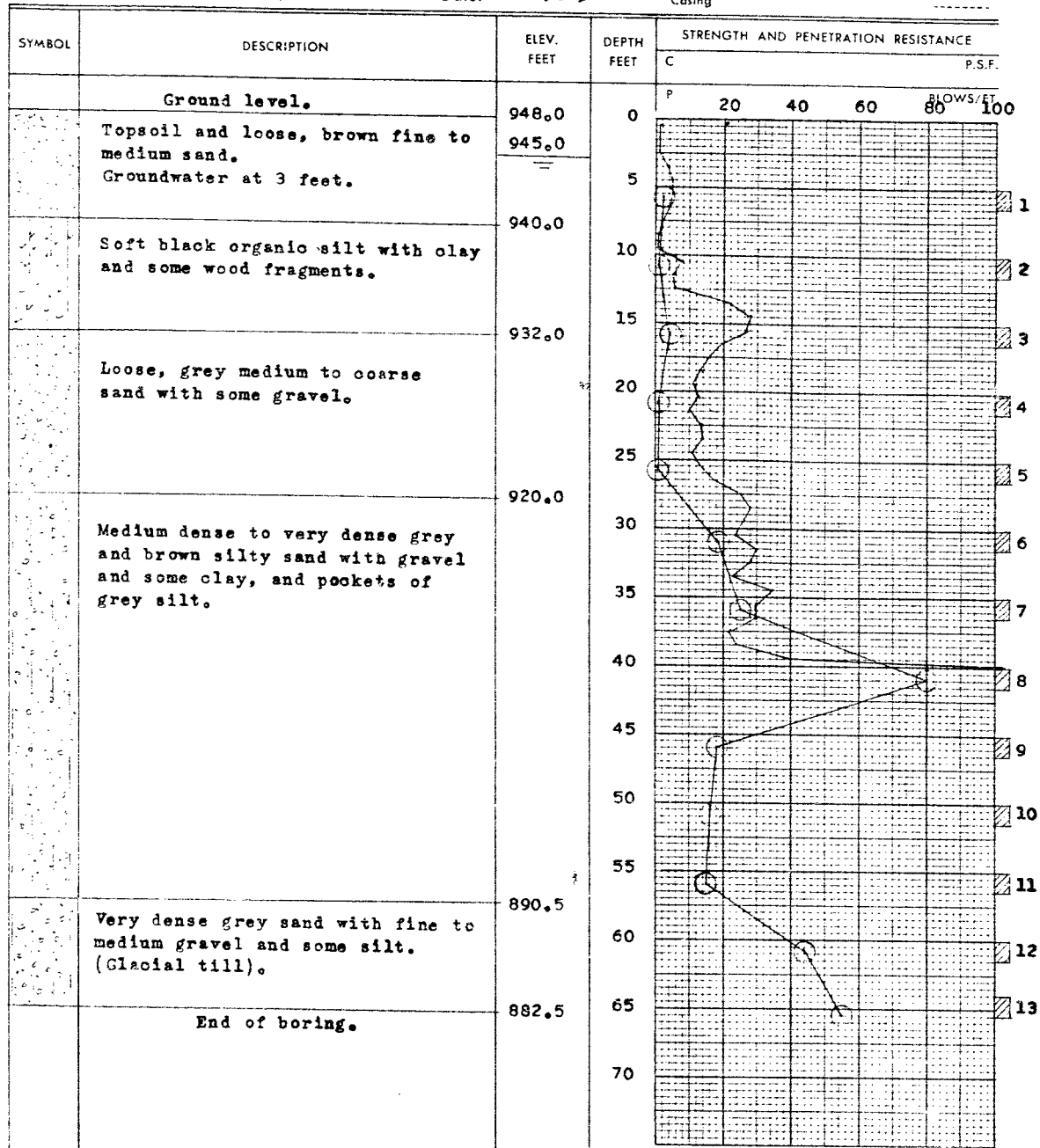
Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing

⊕
+5

RACEY MacCALLUM AND ASSOCIATES LTD.

Foundation Engineering Division

Engineering Data Sheet for ~~Borehole~~ **Probing : 2**

Project: **Highway No. 401, Bridge No. 11.**
 Location: **Blenheim Township, Con. V, Lot 24.**
 Hole Location: **See Enclosure No. 1.**
 Hole Elevation and Datum: **948.8 Ft.**
 Field Supervisor: **H.G. Prep.: J.S.**
 Driller: **F.B. Checked: J.S. Date: 26.9.158**

LEGEND

Shear Strength (C)

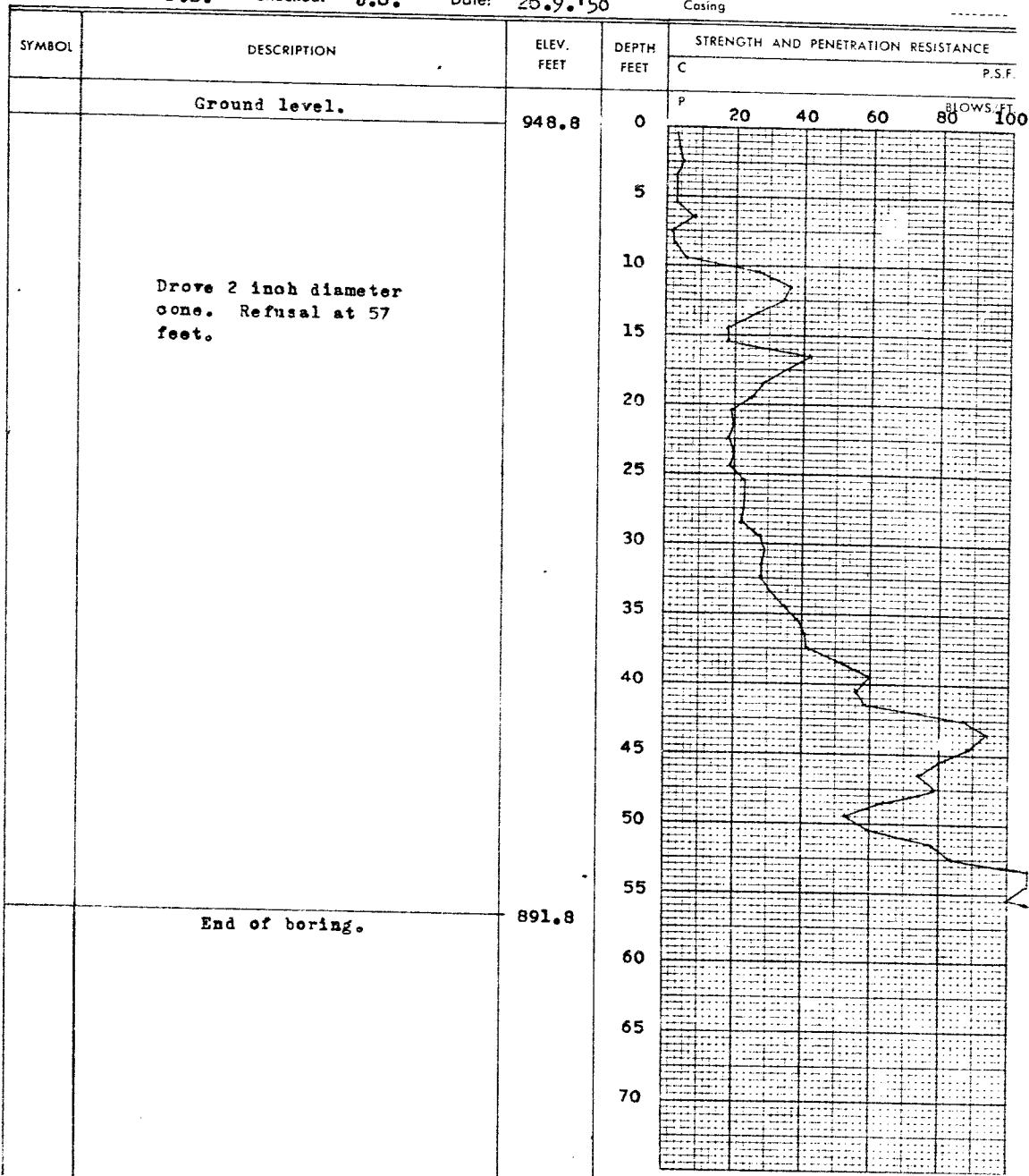
 Unconfined compression
 Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing

 \oplus
 $+s$
 \oplus \oplus


RACEY MacCALLUM AND ASSOCIATES LTD.

Foundation Engineering Division

Engineering Data Sheet for Borehole: 3

Project: Highway No. 401, Bridge No. 11.
 Location: Blenheim Township, Con. V, Lot 24.
 Hole Location: See Enclosure No. 1.
 Hole Elevation and Datum: 948.7 Ft.
 Field Supervisor: H.C. Prep.: J.S.
 Driller: F.B. Checked: J.S. Date: 26.9.58

LEGEND

Shear Strength (C)

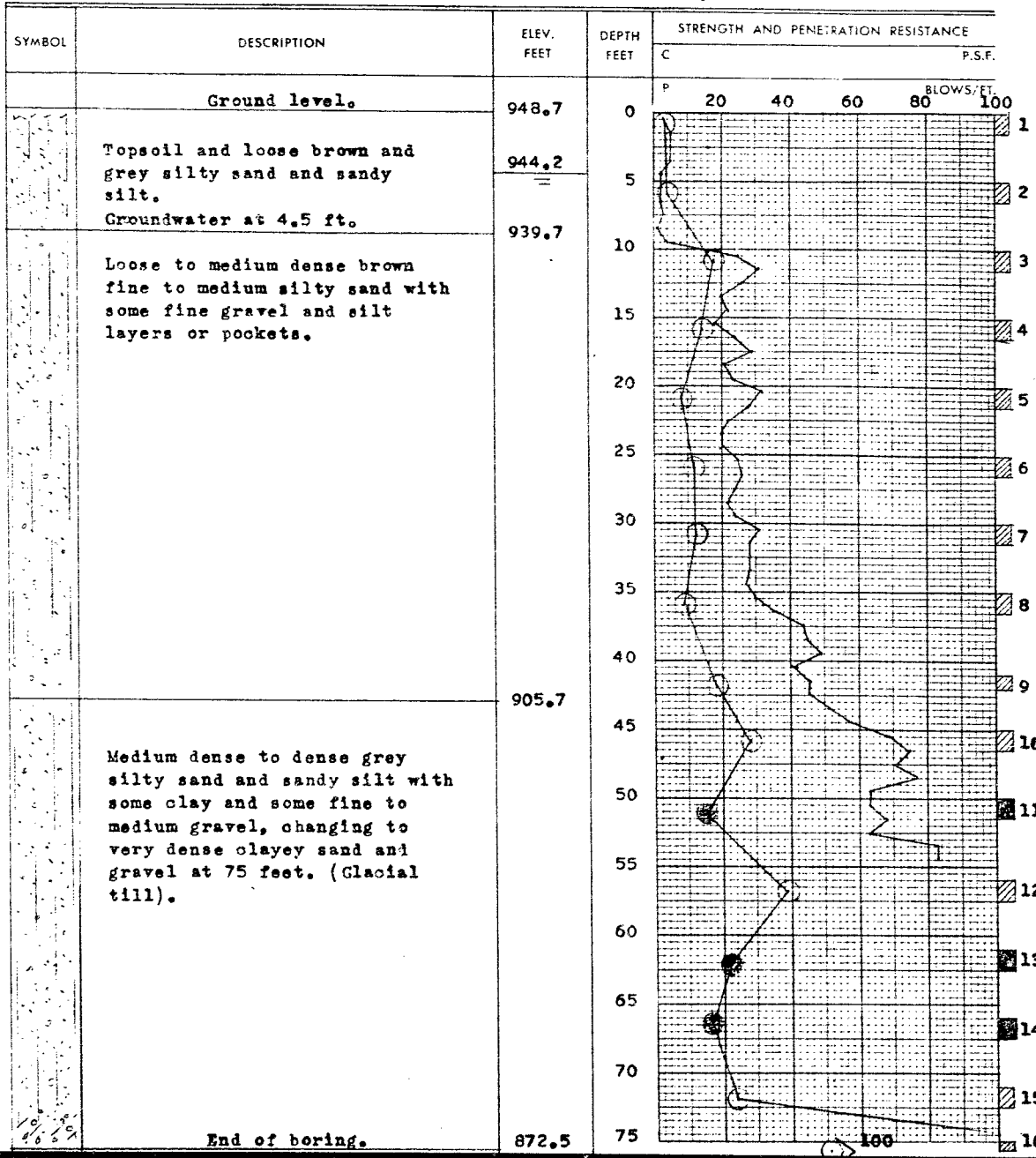
 Unconfined compression
 Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing



RACEY MacCALLUM AND ASSOCIATES LTD.

Foundation Engineering Division

Engineering Data Sheet for Borehole: 4

Project: Highway No. 401, Bridge No. 11.

Location: Blenheim Township, Con. V, Lot 24.

Hole Location: See Enclosure No. 1.

Hole Elevation and Datum: 947.9 Ft.

Field Supervisor: H.G. Prep.: J.S.

Driller: F.B. Checked: J.S. Date: 26.9. '58

LEGEND

Shear Strength (C)

Unconfined compression

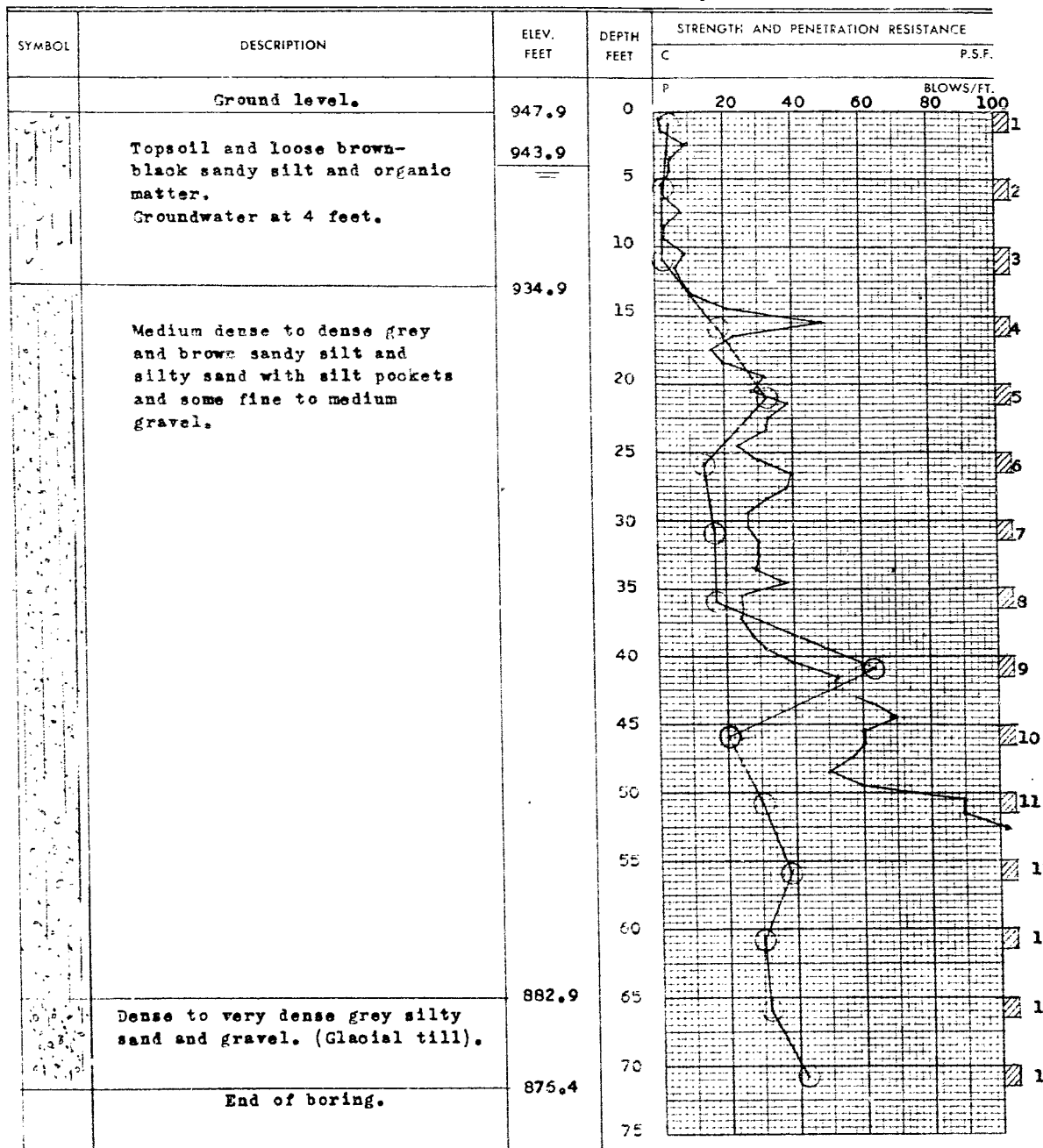
Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing

⊕
+s⊕
⊕

RACEY MacCALLUM AND ASSOCIATES LTD.

Foundation Engineering Division

Engineering Data Sheet for ~~Soils~~ **Probing : 5**

Project: Highway No.101, Bridge No.11.
 Location: Blenheim Township, Con.V, Lot 24.
 Hole Location: See Enclosure No.1.
 Hole Elevation and Datum: 948.2 Ft.
 Field Supervisor: H.G. Prep.: J.S.
 Driller: F.B. Checked: J.S. Date: 26.9.'58

LEGEND

Shear Strength C

 Unconfined compression
 Vane test and sensitivity (S)

Penetration Resistance P

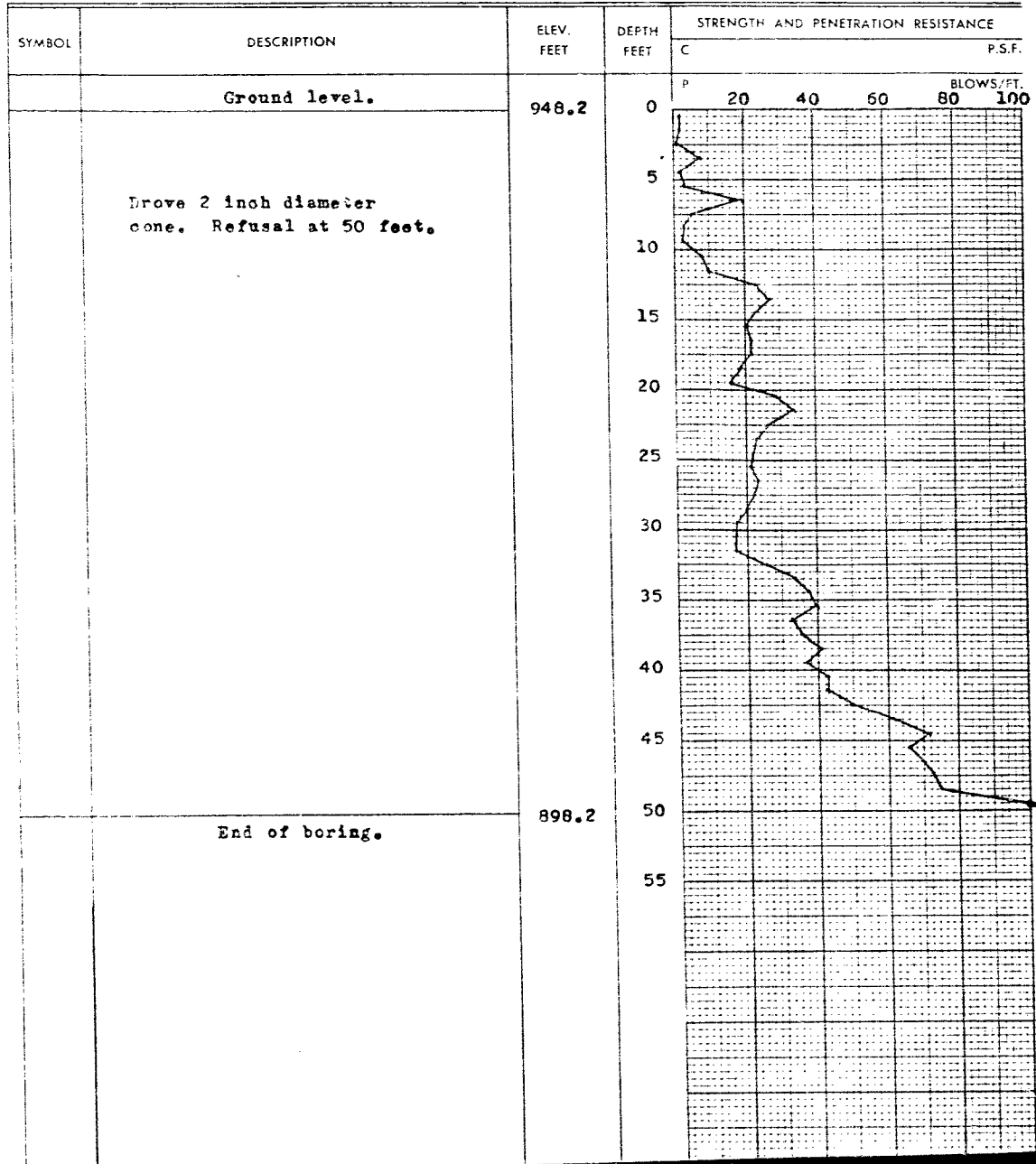
2" Split tube

2" Dia. Cone

Casing

⊕
+3

⊕ ⊕



RACEY MacCALLUM AND ASSOCIATES LTD.

Foundation Engineering Division

Engineering Data Sheet for Borehole: 6

Project: Highway No. 401, Bridge No. 11.
 Location: Blenheim Township, Con. V, Lot 24.
 Hole Location: See Enclosure No. 1.
 Hole Elevation and Datum: 948.4 Ft.
 Field Supervisor: H.G. Prep.: J.S.
 Driller: F.B. Checked: J.S. Date: 26.9.'58

LEGEND

Shear Strength (C)

Unconfined compression

Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing

⊕
15

