

#60-F-274-C

W.P. 31-60

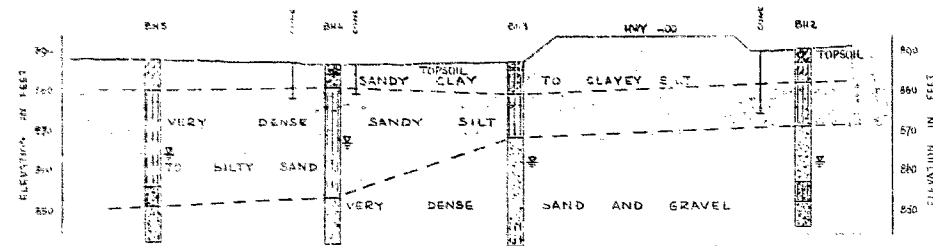
HWY. #400 -

NORTH OF

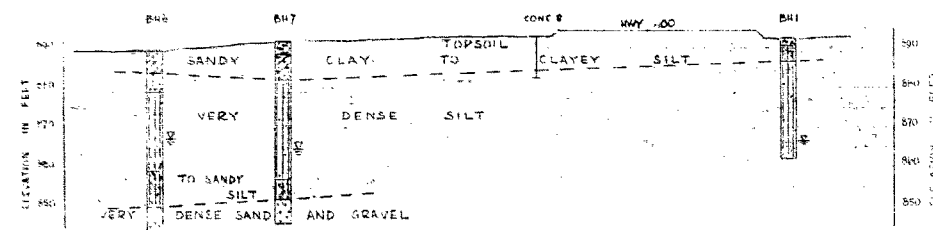
BARRIE

[illegible]

120(8) 1 + 20



VERTICAL & HORIZONTAL SCALE 1" = 20'



VERTICAL & HORIZONTAL SCALE 1" = 20'

WILLIAM A. TROW & ASSOCIATES LTD

DRAWING # 1

Mr. A. M. Teye,
Bridge Engineer.
Materials & Research Section.

May 26, 1960.

FOUNDATION INVESTIGATION --
William A. Trow and Associates
Ltd.

Attention: Mr. S. McCombie.

Re: Proposed Overpass Crossing County Road
& Highway No. 400, Vespra Township -
District No. 5 -- W.P. 31-60.

Sta 212±

Attached, we are sending you the above mentioned
report submitted by W. A. Trow and Associates, Ltd., for your
future use.

We are in agreement with the findings and recom-
mendations contained in the report.

Should there be any additional questions you would
like to discuss, please feel free to call on our Office.

AS/MdeF
Attach.

cc: Messrs. A. M. Teye (2)
H. A. Tregaskes
D. C. Ramsay
A. Gater
E. J. Orr
P. F. Weber
A. Watt
Foundations Office ✓
Gen. Files.

L. G. Soderman,
PRINCIPAL SOILS & FOUNDATIONS ENGR
Per:


(A. Stermac,
FOUNDATIONS OFFICE ENGR.)

W.P. 31-60

WILLIAM A. TROW AND ASSOCIATES LTD.

SITE INVESTIGATIONS
AND
SOIL MECHANICS CONSULTATION

W. A. TROW, M.A.S.C., M.E.I.C., P.ENG.

884 WILSON AVE.,
DOWNSVIEW, ONT.
ME. 5-5921

Project: J 507

May 11, 1960.

Mr. A. Rutka,
Acting Materials & Research Engineer,
Department of Highways of Ontario,
Parliament Buildings,
Toronto, Ont.

Attention: Mr. L. G. Soderman, P.Eng.,
Principal Soils and Foundation Engineer.

Foundation Investigation
Proposed Crossing County Road & Highway No. 400,
Vespra Twp., W.P. 31-60

Dear Sirs:

In accordance with your instructions of April 14th, we have carried out a soils investigation at the above site. This letter outlines the results of this work. The safe bearing capacity of the soils encountered is discussed in a subsequent paragraph. In view of the generally excellent soil conditions at this site, we take the liberty to report to you in brief letter form.

Soil Conditions

It is proposed to lower the grade of the county road at its intersection with Highway 400, from the present elevation of about 894 feet to elevation 875 feet. Highway 400 will be carried over the county road on a three span structure. Foundation conditions at the two central piers and the abutment locations had to be ascertained.

A total of seven sampled borings were put down at this site. They were made at the positions indicated on Dwg. 1. The soils encountered at each hole location are shown on the logs prepared for each boring - Dwg. 2 to 8. The subsoil stratigraphy of the site has been estimated in Dwg. 1.

Referring to the profiles of Dwg. 1, it can be seen that essentially three different soil strata were encountered at this site. A relatively shallow deposit of brown, soft to medium stiff, sandy clay to

clayey silt lies at the surface. This material probably represents the depth of soil that has been affected by weathering.

Very dense silt or sandy silt underlies this surface deposit at depths of 6 to 10 feet. This soil varies in thickness from a maximum of about 30 feet at the west of the site, to a minimum thickness of about 10 feet at the north east side of the proposed structure. At most sampling intervals in this material, it was found impractical to attempt to drive the sampler to full penetration. The resistance of the soil was extremely high.

A deposit of very dense sand and gravel was intersected below the very dense silt described above. The extent of the sand and gravel was not proven deeper than elevation 842 feet.

Difficulty in measuring the groundwater level was experienced at a few of the hole locations. This was due in some cases to sloughing of the soft surface soils and in others to surface seepage. In those instances where it was impossible to measure the groundwater level in the uncased holes, the water level has been estimated from visual examination of the moisture conditions of the soil samples. The groundwater levels are indicated on the logs and in the profiles of Dwg. 1. This level is generally about elevation 867 feet, which represents a depth of about 10 feet below proposed county road grade.

Foundation Considerations

(1) Central Piers

Foundation elevation for the central piers of the bridge will be at some level below the proposed county road grade, elevation 875 feet. Adequate frost protection will have to be provided for these footings. In order to obtain this protection, the central piers should be carried down to about elevation 870 feet. Both the silt and the sand and gravel soil at, and below, this elevation are very dense. On the basis of empirical relationships with the standard penetration test, the safe bearing capacity of these soils is well in excess of 8000 p.s.f.*. Settlement associated with a pressure of this magnitude will be less than one inch, and will take place as the load is applied.

(2) Abutments

Probably the most practical method of foundation support for the abutments will be to place spread footings on the very dense silt. The lowest level of the top surface of this material was found to be about elevation 880 feet.

* Soil Mechanics in Engineering Practice, P. 423, Terzaghi and Peck.

The sides of the excavations for the county road could be benched to receive the abutments as indicated in Dwg. 10. After the abutments have been constructed, the slopes should be rebuilt with compacted soil. This surcharge is necessary for frost protection and to ensure that the full capacity of the foundation soil is developed.

The safe bearing capacity of the abutment footings benched into the hillside on the very dense silt, will be 8000 p.s.f. Settlement will be of a very low order and will occur simultaneously with application of load. This estimate is based upon the same empirical relationship referred to in an earlier paragraph.

As an alternative to using spread foundations to support the abutments, displacement piles could be driven to refusal to support a grade beam at each end of the bridge structure. Large diameter piles would encounter refusal conditions after only limited penetration of the very dense silt found about 8 feet below the surface at this site. The load carrying ability of the pile members will be equal to their structural capacity when acting as short columns.

(3) Approach Roadways

The natural soils found at shallow depth at this site appear subject to volume variations caused by moisture changes. The soil is also frost susceptible as indicated by its grading (see Dwg. 11). The amount of frost heaving that could occur would be limited, however, since the cutting for the county road will drain away much of the surplus groundwater. Spring thaws and prolonged rainy spells could alter the moisture content of the material somewhat, and affect the strength of these soils. This was the condition that existed at the time of this investigation.

The volume changes that would occur with moisture changes combined with the decreased subgrade strength during wet periods, could lead to differential movements between the approach pavements and the structure. Removal of this susceptible soil will prevent these movements from taking place.

It is recommended that a transition zone of coarse sand and gravel be formed back of the abutments. This transition should commence 50 feet away from each abutment. The thickness of coarse granular fill should increase until all of the soft silt-clay is removed by the time the abutment is reached. This will involve replacement of a maximum of about 8 feet of soil at the abutments. Dwg. 10 outlines this proposal.

This construction feature makes consideration of pile supported abutments less practical.

Excavation and Stability of Slopes

The moist surface deposits at this site should not present any construction difficulties. The natural groundwater table apparently exists at or close to elevation 865 feet. This elevation is lower than any contemplated excavation.

Ditches will have to be constructed on each side of the county road. These will carry surface run-off which presently passes under the existing lane of Highway 400 in two iron pipe culverts.

Side slopes of 2:1 are recommended for the deep cut. These slopes should be sodded to prevent erosion by rainwater.

Construction slopes approaching the vertical should be readily attainable in the dense silt. The weather conditions that exist at the time of construction will determine the maximum construction slopes that can be attained in the surface silt-clay. During summer months, this material will probably be dry and hard.

We trust that the information contained in this brief report will enable you to carry out the design of this structure. Thank you for the opportunity to serve you in this regard.

DHS/lt
Encls.



Yours very truly,

A handwritten signature in dark ink, appearing to read "D. H. Shields".

Donald H. Shields (P. Eng.)

APPENDIX A

Investigation Procedure

Continuous flight auger equipment was used to form the borings put down at this site. The holes were five inches in diameter and were uncased to full depth. Considerable resistance to augering was encountered in the soils found below 10 feet.

In most instances, a standard 2-inch diameter split sampler was used to obtain samples of the soil. The sampler was driven with a hammer energy of 350 ft.lbs. The number of blows required to cause the sampler to penetrate from 6 inches to 18 inches into the undisturbed soil ahead of the boring was recorded as the penetration resistance of the soil. At many sampling intervals, however, the resistance of the soil was so great that it was found impractical to attempt to obtain full penetration of the sampler. On these occasions, the penetration for a nominal number of blows was recorded.

A few relatively undisturbed samples of the soils found at shallow depth were recovered in thin-walled 2" I.D. shelly tubes. These samples were subsequently ejected in the laboratory and identified.

Three mechanical grain size determinations were carried out on soils representative of the shallow deposits. The results of this work are presented in Dwg. 11.

WILLIAM A. TROW & ASSOCIATES LTD.

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT Overpass WP 31-60

LOCATION Highway 400 N. of Barrie

HOLE LOCATION See Dwg. 1

HOLE ELEVATION AND DATUM 892.5 B.M. see Dwg. No. 1

BOREHOLE NO. 1

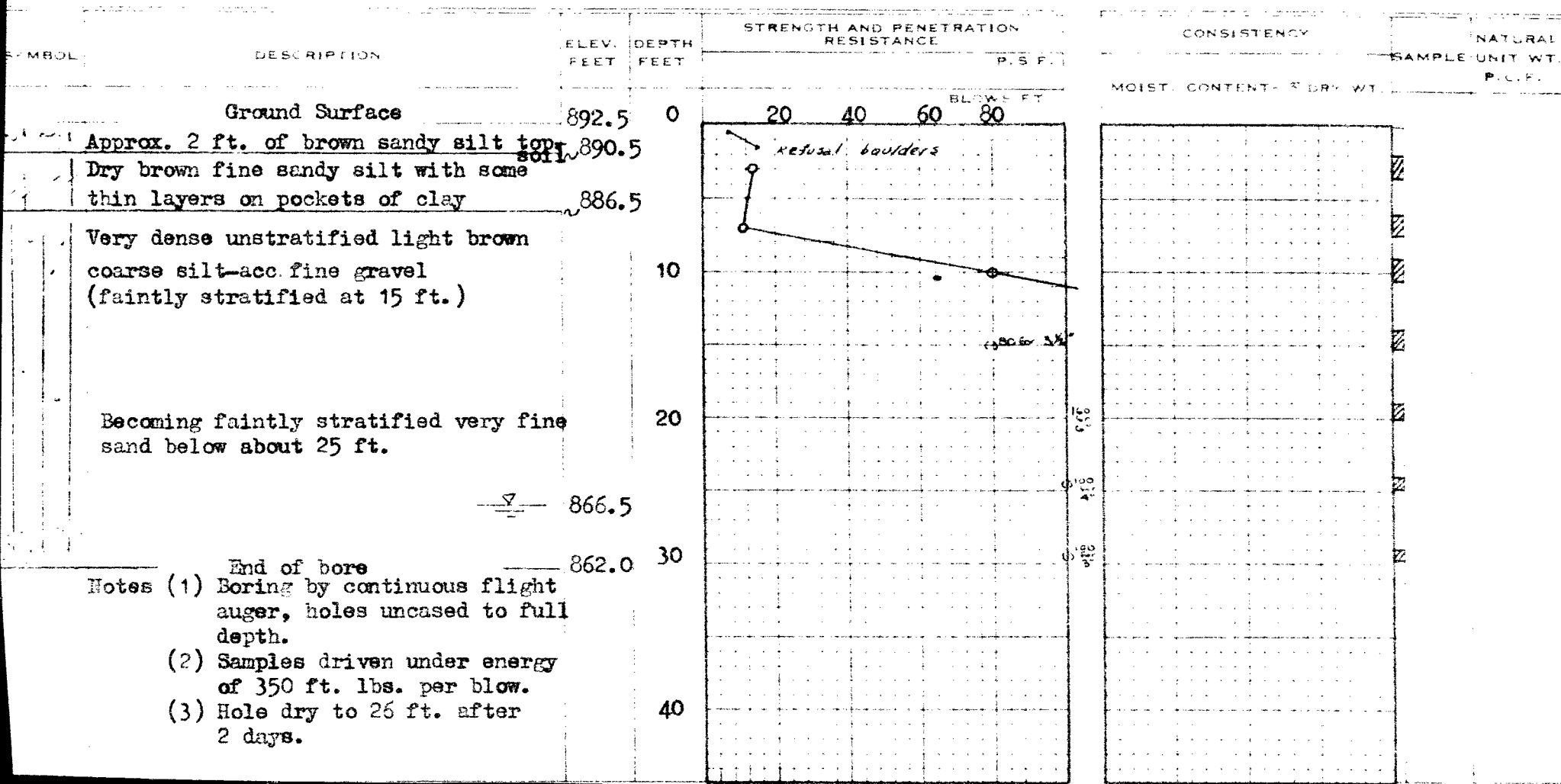
FIELD SUPERVISOR

DRILLER

PREP.

LEGEND

2" DIA. SPLIT TUBE
 2" SHELBY TUBE
 2" SPLIT TUBE
 2" DIA. CONE
 CASING
 2" SHELBY
 1/2 UNCONFINED COMPRESSION (QU)
 VANE TEST (C) AND SENSITIVITY (S)
 NATURAL MOISTURE AND
 LIQUIDITY INDEX
 LIQUID LIMIT
 PLASTIC LIMIT



PROJECT NO. J 507

DRAWING NO. 3

WILLIAM A. TROW & ASSOCIATES LTD.

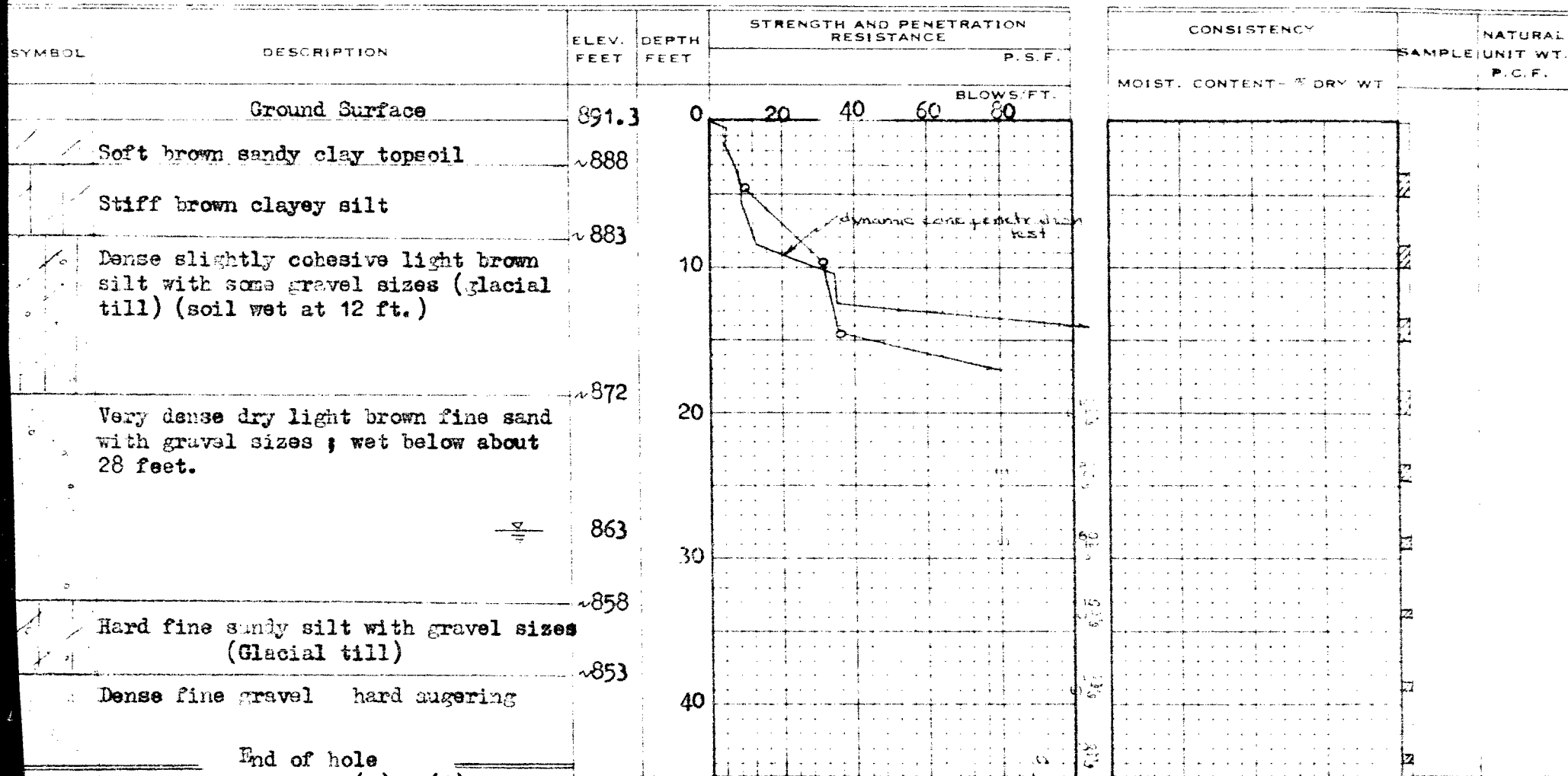
SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT Overpass WP 31-60
 LOCATION Highway 400 N. of Barrie
 HOLE LOCATION See Dwg. 1
 HOLE ELEVATION AND DATUM 891.3

BOREHOLE NO. 2
 FIELD SUPERVISOR
 DRILLER
 PREP.

LEGEND

2" DIA. SPLIT TUBE
 2" SHELBY TUBE
 2" SPLIT TUBE
 2" DIA. CONE
 CASING
 2" SHELBY
 1/2 UNCONFINED COMPRESSION (Qu)
 VANE TEST (C) AND SENSITIVITY (S)
 NATURAL MOISTURE AND
 LIQUIDITY INDEX
 LIQUID LIMIT
 PLASTIC LIMIT



End of bore Notes (1) & (2) as in hole 1

(3) hole caved and wet to 10.3' after 6 days

Source of this water probably from 12 feet; estimated water table at El. 863

PROJECT NO. J 507

WILLIAM A. TROW & ASSOCIATES LTD.

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

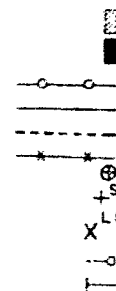
PROJECT Overpass WP 31-60
LOCATION Highway 400 N. of Barrie
HOLE LOCATION See Dwg. 1
HOLE ELEVATION AND DATUM 888.2

BOREHOLE NO. 3
FIELD SUPERVISOR
DRILLER
PREP.

DRAWING NO. 4

LEGEND

2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
CASING
2" SHELBY
1/2 UNCONFINED COMPRESSION (Qu)
VANE TEST (C) AND SENSITIVITY (S)
NATURAL MOISTURE AND
LIQUIDITY INDEX
LIQUID LIMIT
PLASTIC LIMIT



SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE				CONSISTENCY				SAMPLE	NATURAL UNIT WT P.C.F.
				P.S.F.				MOIST. CONTENT- % DRY WT.					
	Ground Surface	888.2	0	20	40	60	80	BLOWS/FT.					
2	Soft brown clayey topsoil	886											
	Soft to medium stiff dark brown clayey silt with some pebbles	880											
	Very dense unstratified slightly cohesive light brown silt-some gravel. Some sand seams noted at 11 ft.		10										
		869	20										
	Very dense light brown fine to med. sand with some gravel sizes.	863											
	Wet below about 30 feet		30										
	Silty below about 40 feet												
	(Could not sample at 45 feet, hole caved 5 feet.)		40										

Notes (1) & (2) As on hole 1.
(3) Estimated water table at approx. El. 863

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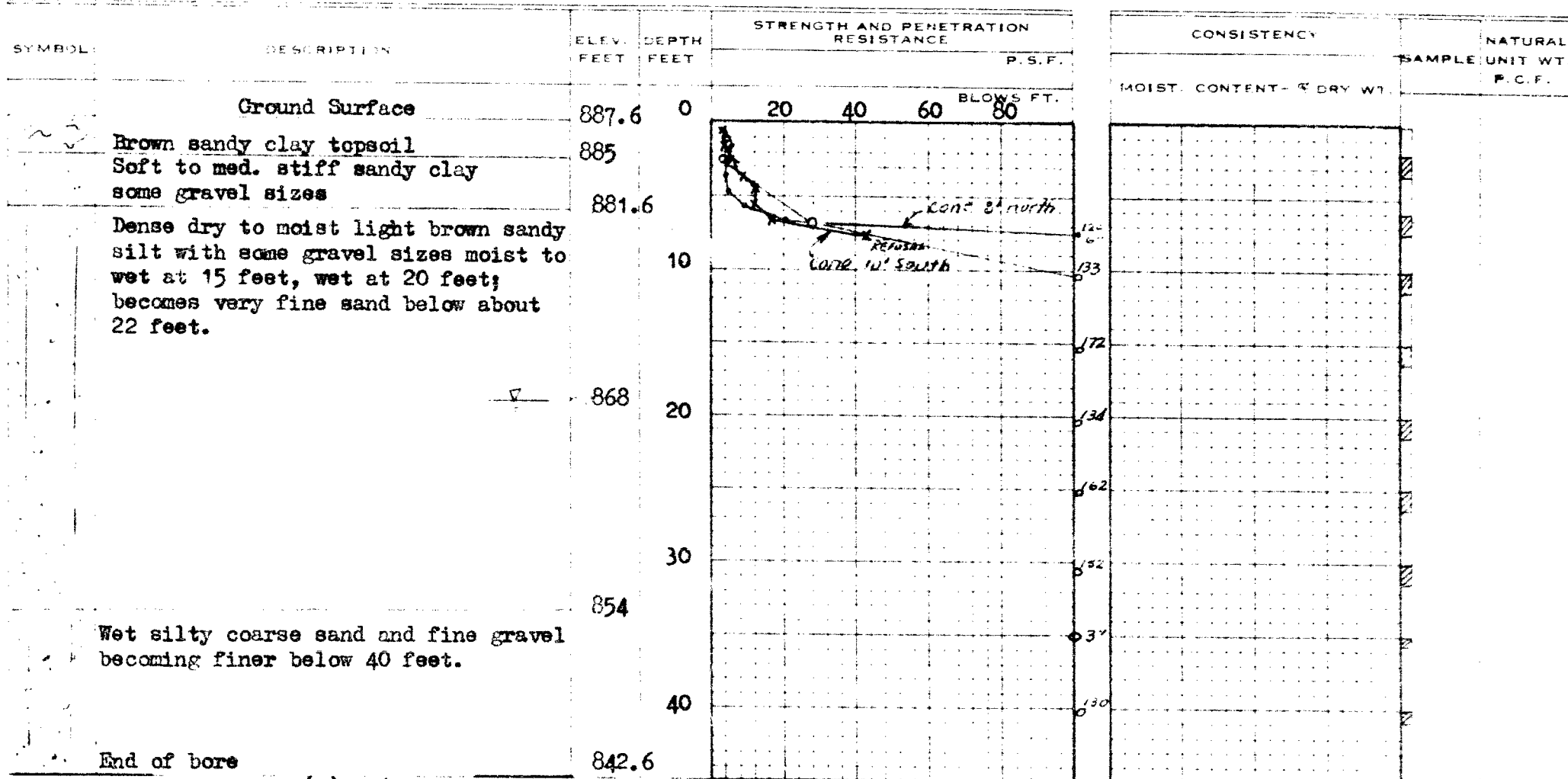
SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT Overpass WP 31-60
 LOCATION Highway 400 N. of Barrie
 HOLE LOCATION See Dwg. 1
 HOLE ELEVATION AND DATUM 887.6

BORHOLE NO. 4
 FIELD SUPERVISOR
 DRILLER
 PREP.

LEGEND

2" DIA. SPLIT TUBE
 2" SHELBY TUBE
 2" SPLIT TUBE
 2" DIA. CONE
 CASING
 2" SHELBY
 1/2 UNCONFINED COMPRESSION [Q_u]
 VANE TEST [C] AND SENSITIVITY [S]
 NATURAL MOISTURE AND
 LIQUIDITY INDEX
 LIQUID LIMIT
 PLASTIC LIMIT



Notes (1) & (2) as in hole 1.

(3) Estimated water level at about 19½ Ft.

WILLIAM A. TROW & ASSOCIATES LTD.

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT Overpass WP 31-60

LOCATION Highway 400 N. of Barrie

HOLE LOCATION See Dwg. 1

HOLE ELEVATION AND DATUM 888.8

HOLE NO. 5

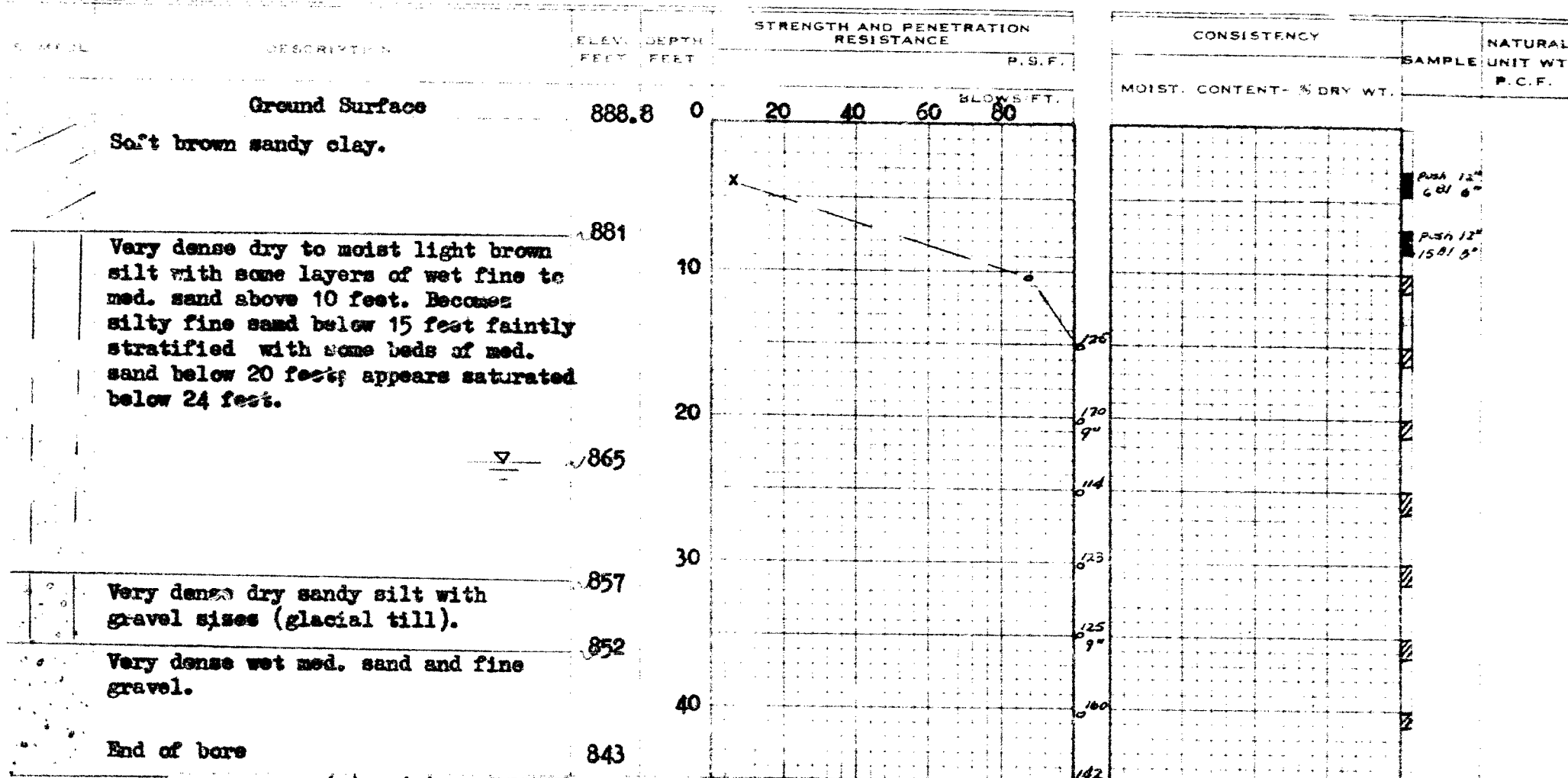
FIELD SUPERVISOR

DRILLER

PREP.

LEGEND

- 2" DIA. SPLIT TUBE
- 2" SHELBY TUBE
- 2" SPLIT TUBE
- 2" DIA. CONE
- CASING
- 2" SHELBY
- 1/2 UNCONFINED COMPRESSION [QU]
- VANE TEST [C] AND SENSITIVITY [S]
- NATURAL MOISTURE AND LIQUIDITY INDEX
- LIQUID LIMIT
- PLASTIC LIMIT



Notes (1) & (2) as in hole 1.

(3) Estimated water table about 23 feet below surface.

PROJECT NO. J 507

DRAWING NO. 7

WILLIAM A. TROW & ASSOCIATES LTD.

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT Overpass WP 31-60

LOCATION Highway 400 N. of Barrie

HOLE LOCATION See Dwg. 1

HOLE ELEVATION AND DATUM 889.8

BOREHOLE NO. 6

FIELD SUPERVISOR

DRILL: 7

PREP.

LEGEND

- 2" DIA. SPLIT TUBE *
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
CASING
2" SHELBY
1.2 UNCONFINED COMPRESSION [QU]
VANE TEST [C] AND SENSITIVITY [S]
NATURAL MOISTURE AND
LIQUIDITY INDEX
LIQUID LIMIT
PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE	
				P.S.F.	
	Ground Surface	889.8	0	20	40 60 80
	Soft to med. stiff sandy clay.				
		883.8			
	Dense med. sand and fine gravel. (Thin layer of clayey silt 10 feet).	879	10		
	Very dense faintly stratified light brown silt becoming very fine sand and wet between about 23 feet.				
		867	20		
		859	30		
	Very dense sandy silt with fine gravel sizes (glacial till).				
		850	40		
	Very dense medium sand some fine gravel.				
	End of bore.	843			

[illegible]

Notes (1) & (2) as in hole 1.

WILLIAM A. TROW & ASSOCIATES LTD

SITE INVESTIGATIONS AND SOIL CONSULTATION

PROJECT Overpass WP 31-60

LOCATION Highway 400 N. of Barrie

HOLE LOCATION See Dwg. 1

HOLE ELEVATION AND DATUM 891.9

BORE HOLE NO. 7

FIELD SUPERVISOR

DRILLER

OPER

LEGEND

2" DIA. SPLIT TUBE

2" SHELBY TUBE

2" SPLIT TUBE

2" DIA. CONE

CASING

2" SHELBY

1/2 UNCONFINED COMPRESSION (QU)

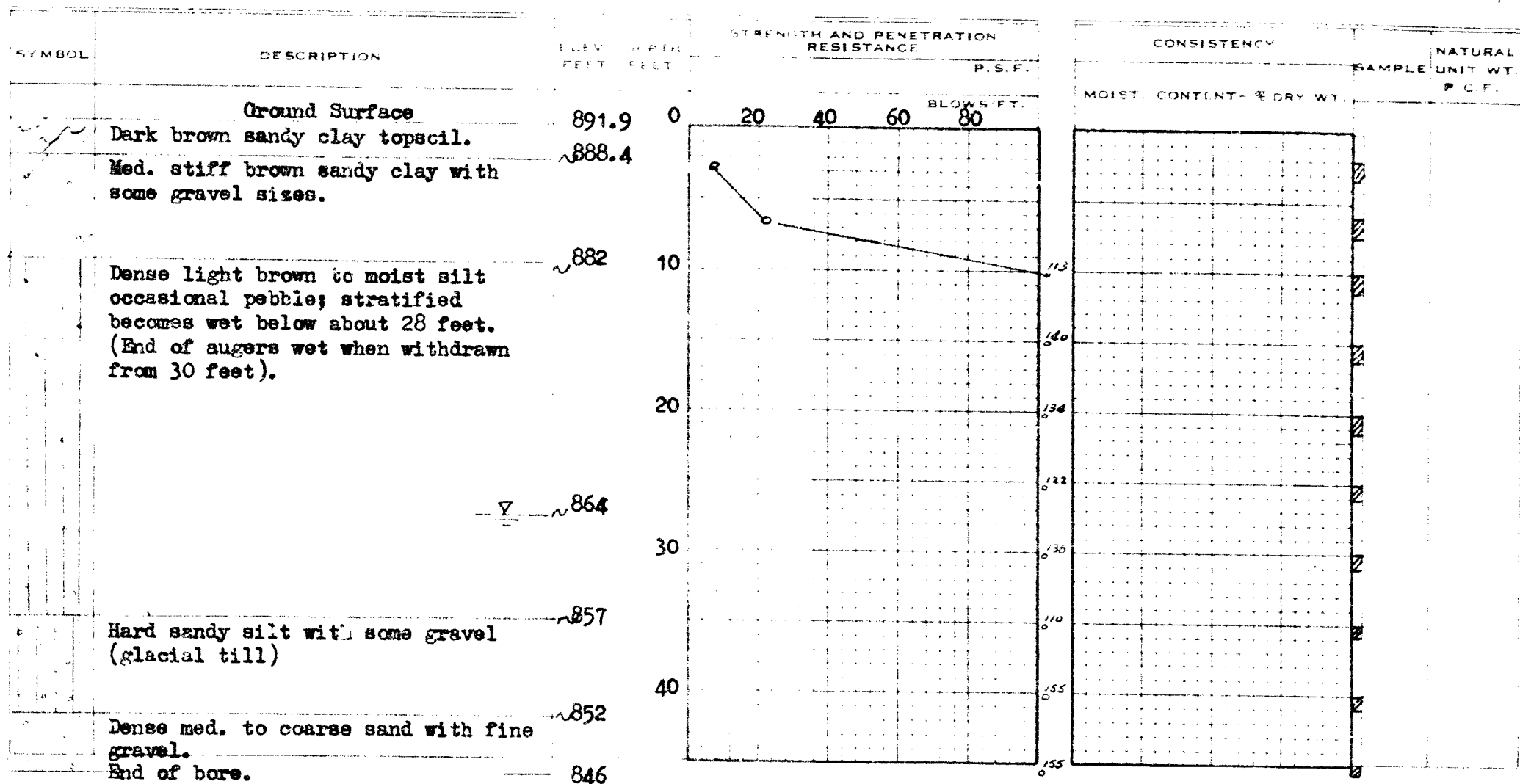
VANE TEST (C) AND SENSITIVITY (S)

NATURAL MOISTURE AND

LIQUIDITY INDEX

LIQUID LIMIT

PLASTIC LIMIT



Notes (1) & (2) as in hole 1

(3) Water level 29 feet after 15 minutes; 28.5 ft. after 3 hrs.

PROJECT NO J 507

DRAWING NO.. 9

WILLIAM A. TROW & ASSOCIATES LTD.

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT **Overpass WP 31-60**

LOCATION Highway 400 N. of Barrie

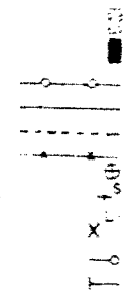
HOLE LOCATION ~~See~~ Dwg. 1

HOLE ELEVATION AND DATUM 892.9

Cone 8
~~XXXXXXXXXX~~ NO.
FIELD SUPERVISOR
DRILLER
PREP.

LEGEND

- 2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
CASING
2" SHELBY
1/2 UNCONFINED COMPRESSION (QU)
VANE TEST (C) AND SENSITIVITY (S)
NATURAL MOISTURE AND
LIQUIDITY INDEX
LIQUID LIMIT
PLASTIC LIMIT



SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE	
				P.S.F.	
		892.9	0	BLOWS/FT.	
	Cone Penetration Test Only				
	Cone refusal Depth	882.4	10		
			20		
			30		

[illegible]

County Road

To Barrie

To Coldwater

50'

50'

Remove

Elev. 880

Elev. 870

890

880

870

860

2:1

Elev. 880

Elev. 870

Remove soil in these areas
where necessary and
compact when replaced

Scale 1 in. = 20 ft

Remove natural soils in
these areas and replace
with compacted coarse
granular material

RECOMMENDED FOOTING ELEVATIONS, SIDE SLOPES
AND REPLACEMENT OF INFERIOR SOILS

MECHANICAL ANALYSIS

