

*Memo to* Mr. A. M. Toye, *Date* September 16, 1959.  
Bridge Engineer. *Subject* FOUNDATION REPORT by  
*From* Materials & Research Section. Dominion Soil Investigation, Ltd.

Attention: Mr. S. McCombie.

Re: Foundation Investigation,  
Little Mississippi River Crossing,  
Secondary Rd. #500 at McArthur's Mills,  
W.P. 232-59.

Enclosed herewith is a foundation report recently completed at the above site by Dominion Soil Investigation, Ltd. Reference to the contents of this report shows that the subsoil of this structure location consists of a stratum of loose to medium coarse sands and silts with varying percentages of gravel. This stratum extends from ground surface which is at an average elevation of 940', to a depth of approximately 30 ft. - i.e., elevation 910'. This upper layer of essentially granular material is underlain by a medium dense to dense coarse sand and gravel. Borings were terminated in this layer of competent stratum. No artesian conditions were encountered in any of the borings.

Spread footings at this site are not recommended because of the variation in relative densities of the upper stratum, and also because of the reported high percent of mica evidenced in the samples recovered. In addition, this upper layer is particularly susceptible to scour action.

It is recommended that abutments and piers be supported on end-bearing piles founded upon the underlying dense layer of coarse sand and gravel. Either timber piles with a design capacity of 20 tons, or steel monotube sections with capacities of the order of 35 to 40 tons, are recommended at this site. Steel 'H' piles should not be used because of the indeterminate depth of penetration.

cont'd. /2 ...

## SOIL EXPLORATION AND TESTING

DRILLER 1 McL ENGINEER McL JOB No. 9-153

DRILLING RIG Unit No 3 HAMMER WT. 140 DROP 309

CLIENT \_\_\_\_\_

D. K. O.

BOREHOLE No. 1 SHEET 2 OF 2

PROJECT Little Mississippi River Bridge

LOCATION McArthur Mills

LOCATION \_\_\_\_\_ SURFACE ELEV. \_\_\_\_\_

BORING DATE 20-9-57 TO \_\_\_\_\_

WATER LEVEL

[illegible]

# DOMINION SOIL INVESTIGATION LTD.

SOIL EXPLORATION AND TESTING

88 Eglinton Ave. East Toronto 12, Ontario Phone HU. 7-3633

DRILLER J. Mack ENGINEER AK JOB No. 51-158  
 DRILLING RIG Unit No 3 HAMMER WT. 140 DROP 30"

CLIENT D.H.O.  
 PROJECT Little Mississippi River Bridge  
 LOCATION \_\_\_\_\_

BOREHOLE No. 1 SHEET \_\_\_\_\_ OF \_\_\_\_\_  
 LOCATION 20'E of 4 SURFACE ELEV. \_\_\_\_\_  
 BORING DATE Aug 19, 1959 TO \_\_\_\_\_  
 WATER LEVEL 0.0.

Depth	SOIL PROFILE SAMPLE DESCRIPTION	SAMPLES					CODE PENETRATION		INSITU VANE SHEAR TESTS			REMARKS
		Depth Ft.	Sample No.	Sample Type	Recovery Ft.	Std. Pen. Resistance Blows/Ft.	Cone Dia.	Hydraulic Pressure or Blows/Ft.	Vane Size	Insitu Torque	Remoulded Torque	
0.0	Ground Surface - river water level						0-1	9				Drove 5 ft casing
	Loose coarse sand & gravel						1-2	3				
3.0	Soft loose med to coarse gray silt - base of river						2-3	2				
		5.0	1	SS.	14'	3	3-4	6				added 5 ft casing before 15 ft sample
		6'-6"				5	4-5	10				
						6	5-6	17				
	Loose dark gray silt	9'-6"	2	SS.		4	6-7	19				
	Homogeneous.					5	7-8	17				
		11'-0"				5	8-9	23				
							9-10	19				
	Loose dark gray silt - layers	15'-0"	3	SS		4	10-11	17				
	Occasional thin clay layers 15'-4"	16'-6"				5	11-12	23				
						6	12-13	23				
	Med dense dark gray silt layers	20'-6"	4	SS		8	13-14	28				
	Some clay layers -	22'-0"				9	14-15	22				
	flight action pressure at 24'-0" - 25'-0"					8	15-16	17				Water rose 200 mm 9" above ground level
							16-17	22				
							17-18	17				
	Med dense dark gray silt	25'-0"	5	SS		5	18-19	20				
	Brittle soft clay (fissured)	26'-6"				7	19-20	30				
	25'-3" to 25'-10"					7	20-21	33				
	Denser at 27'-0"						21-22	38				



ONTARIO  
DEPARTMENT OF HIGHWAYS

Toronto 5,  
Aug. 7, 1959.

MEMORANDUM TO:

Mr. L. G. Soderman,  
Principal Soils &  
Foundation Engineer,  
Downsview, Ontario.

*Kellie*

Attention: Mr. K. Peaker.

Re: W.P. 232-59, Little Mississippi R.,  
Sec. Rd. 500, District 10.  
W.P. 67-58, Bonnechere River @  
Tramore, Hwy. 62, Dist. 10.

Attached are plans and profiles for the above crossings which may require a soil investigation.

The crossing of the Little Mississippi River will probably be two spans of 50' each and test holes could be planned accordingly..

As yet no information is available on the size of the opening required at the Bonnechere River, however, it would be appreciated if some test holes were put down at intervals along the centre line and further holes put down if required when preliminary design is ready.

*J. C. McAllister*

JCMcA/gs

J. C. McAllister,  
for S. McCombie,  
Bridge Planning Engineer.

In order to assist you in choosing the required pile length, the following pile tip elevations for timber piles are tabulated:-

<u>Hole No.</u>	<u>Estimated Pile Tip Elevation For Timber Piles</u>
1	908'
2	905'
3	910'
4	906'
5	906'
6	908'

We do not have any available information on stream velocities and recommend that the Hydrology Section be consulted with respect to the design on scour protection at the piers. It would appear that sheet piling, driven to elevation 925' is necessary.

Fills for this structure are understood to be of the order of 8 ft. in height above existing ground level - i.e., to elevation approx. 948'. The granular, free-draining character of the upper stratum of sand has sufficient strength to adequately support this embankment height, using a 2:1 side slope.

If you have any queries with respect to the contents of this report, or our comments on this report, please do not hesitate to contact our office.

LGS/MdeF  
Encl.

*L. G. Soderman*  
for - L. G. Soderman,  
PRINCIPAL SOILS & FOUNDATIONS ENGR.

cc: Messrs. A. M. Toye  
H. A. Tregaskes  
D. G. Ramsay  
I. Campbell  
C. R. Robertson  
J. E. Gruspier  
Foundation Section  
Gen. Files

BA 943

Department of Highways  
Materials and Research Section  
Downsview Ave. - Toronto, Ont.

59-F-243

REPORT ON  
FOUNDATION INVESTIGATION  
LITTLE MISSISSIPPI RIVER CROSSING  
SECONDARY HWY 500 AT  
McARTHUR'S MILLS, ONTARIO  
W.P. 232-59

Submitted by:  
Dominion Soil Investigation Ltd.  
38 Eglinton Avenue East,  
Toronto 12, Ontario

August 28, 1959.

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## ENGINEERING DATA SHEETS

Location of Boreholes and Subsurface Sections .....	Encl. 1
Borehole Logs .....	Encl. 2-7 incl.

# DOMINION SOIL INVESTIGATION LTD.

SOIL MECHANICS • FOUNDATION ENGINEERING

TORONTO 12, ONTARIO

FOUNDATION INVESTIGATION FOR BRIDGE  
OVER LITTLE MISSISSIPPI RIVER AT McARTHUR'S MILLS  
SECONDARY ROAD NO. 500 DISTRICT NO. 10  
W.P. 232-59

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## 1. INTRODUCTION:

A foundation investigation for a proposed crossing of the Little Mississippi River at McArthur's Mills, Ontario was requested by the Materials and Research Section of D.H.O. Six boreholes were drilled to determine the foundation conditions at the site. The site is located on the recommended new line immediately south of the existing bridge. It is situated on Lot 22, Concession XII in the Township of Mayo, Hastings County.

This report presents the results of the field investigation, a description of the soil encountered and provides recommendations on foundations for the proposed structure.

## 2. SUMMARY OF CONCLUSIONS

The borings revealed that the soil is primarily loose granular glacial and post glacial sand. A layer of loose silt found on the south side of centreline does not extend to the North side.

River level during the investigation was at elev. 938.3. It is possible to support the proposed bridge on spread footings at elev. 928-929. At that depth the safe bearing capacity is 2000 psf. Settlement may exceed 1" due to the loose underlying sand. If the bearing capacity is too low for economical foundation design, a pile foundation is an alternative choice.

Extensive scour protection is required because of the nature of the silt on the upstream side of the bridge.

Construction problems with excavation for foundations and with the ingress of water may be anticipated. A steel sheet piling cofferdam is considered essential for effective construction of deep foundations at this site.



### 3. LOCATION AND DESCRIPTION OF SITE:

The site is located in the Village of McArthur's Mills (about 17 miles east of Bankroft) along Secondary Highway 500. A new line is proposed about 45 ft south of the existing centre-line of road at the river crossing.

The area is rugged irregular terrain that is heavily wooded. At the site bedrock (Precambrian) outcrops 150 ft upstream from the crossing. A small water fall (3 ft) in the river is created by outcropping rock. From the west bank for a distance of about 200 ft the proposed line follows along a marshy depression which was once a small lagoon. This area was filled with waste wood and shavings, a transported sand and organic matter. Some of the waste lumber, timbers and logs were encountered in the middle of the river below the coarse sand.

North of the bridge the site is heavily wooded.

The existing bridge is a 16 ft roadway 2 span steel girder with concrete deck. Overall length is 75 ft. Spread footing foundations at a shallow depth support the pier and abutments. A small island on the upstream side of the bridge and near the east bank diverts the river flow towards the west bank.

The Little Mississippi River flows northerly from Weslemkoon Lake some 8 miles from the site. A recently constructed control dam near the waters source regulates the flow. At the site the river bed is lined with rocks, stones and coarse sand. During the period of investigation the water level was at elev. 938.3. There was about 1.5 to 2.0 ft of water.

Local residents stated that there is some flow of water all winter. The waterfall, 75 yards upstream from the site, and the "stilling basin" below it are responsible for keeping the ice relatively thin. There is no flow of ice but a gradual disintegration within the "stilling basin".

### 4. DRILLING PROGRAMME:

Six boreholes were drilled in the order numbered as shown on Enclosure No. 1. Field work was started on August 19, and was completed on August 24, 1959. Cone penetration tests were made at all but borehole 3.

It was not possible to locate survey stakes or pins to reconstruct the proposed line. The chainages shown to the boreholes are therefore an approximation based on the plans provided.

Boreholes 3 and 5 were located within the water at the edge of the banks. Borehole 6, located on the west bank, also serves as an indication of the soil conditions for the bridge approach embankment.

Split spoon samples were taken plus one shelby tube sample in the silt stratum. The disturbed samples are stored in air-tight glass jars. All samples will be stored for a period of three months.

From elevation 915-920, within the coarse sand and silty sand strata, the water was not returning the surface when washing inside the casing or rotating the casing. The wash pump was delivering 12 gallons per minute. Also, split spoon samples could not be recovered in the loose strata even when a spring type sample retainer was used. In several instances a 2" cone was driven from the bottom of the cased borehole to practical refusal when this condition was encountered.

#### 5. SOIL DESCRIPTION:

The soil encountered at the site is predominantly granular. There is a varying thickness of dark grey silt found only on the south side of the proposed centreline. Two subsurface sections shown on Enclosure No. 1 indicate the variation in soil.

North of the centreline (boreholes 2, 4 and 5) a loose coarse sand extended from the ground surface to elev. 928-933. This is followed by a layer of organic matter, timber etc. on the west bank. Below the coarse sand is a 2½ ft dense layer of gravel and sand with some silt. A loose to medium dense grey sand with some gravel followed to the end of borings at elev. 912. Mica particles, estimated up to 10% by volume, are evident in this formation. Wash water was not returning to the surface from this porous strata. Cones were driven to practical refusal below the end of boreholes. Practical refusal was met at elev. 905 and 895 at the west bank.

South of the centreline (boreholes 1, 3 and 6) a loose brown sand was encountered from the surface to elevations 935.5-929.5-927.5 respectively in the boreholes mentioned. About a foot thickness of wood shavings, boards etc. was encountered in boreholes 3 and 6 at elev. 935 and 932 respectively. A thin coarse sand and gravel layer underlies the brown sand below elev. 927.5 at borehole 6. This is the same formation as found in the boreholes on the north side of centreline.

Loose to medium dense dark grey silt was encountered across the river below the sand strata. It is 7.7 ft thick at the west bank, 10 ft at the centre of the river and 24 ft at the east bank. Below elev. 920 occasional ½" to 1" thick fissured clay layers are present in the silt formation. A 6-7 ft thickness of medium dense grey silty sand underlies the silt. It was only about 2 ft thick at the east bank. Following the silty sand is a medium dense to dense coarse sand and gravel strata. This was generally met at elev. 910-913. The depth of this strata is not known although the resistance to a cone penetration increased sharply several feet below the depths penetrated by the boreholes.

Bedrock, considered to be not far below the coarse glacial till formation, is a veined pink and grey Precambrian rock as found at the nearby rock outcrops.

A detailed description of the soil is given in the borehole logs found at the back of the report on the Engineering Data sheets.

## 6. FOUNDATION CONDITIONS:

The proposed bridge is a two 50 ft span structure with one river pier. From the subsurface sections shown on Enclosure No. 1 it may be seen that there is considerable variation in the soil at the abutments and pier in a direction perpendicular to the bridge centreline. This is most pronounced, from the viewpoint of foundation conditions, at the east bank.

To allow an unobstructed passage of water, the island should be removed. This would permit the water to flow adjacent to the east bank and abutment. The loose grey silt encountered in borehole 1 is very susceptible to erosion by water with the river velocity likely attained during normal spring flow. Foundations placed within the silt require adequate scour protection, particularly on the upstream side. This also holds true for the pier footing.

The safe bearing capacity for spread footing foundations is only 2000 psf. This is based on placing the foundations for the abutments at elev. 928-929 and the pier foundations at or below elev. 929. It is assumed that the least width of the footings will be between 8 and 10 ft. Settlement under the design loads will take place soon after full dead load is applied. In view of the uncertainty of the magnitude of settlement due to variation in the soil a simply supported structure should be considered.

Based on the relative densities of the granular soils determined (approximated) from the standard penetration tests and from laboratory determinations settlement of foundations under the design pressure may exceed 1" for a 10 ft footing. The presence of mica in the sand is a contributing factor for the high elastic deformation.

If the low bearing capacity and the predicted magnitude of settlement is not desirable, a pile supported foundation is an alternative choice. Bearing piles for a safe carrying capacity of 30-40 tons will drive to elev. 898 $\frac{1}{2}$  - 904 $\frac{1}{2}$ . The base of footings may be established 5-6 ft below the ground surface or river bed. Scour protection is also required.

Borehole 6 on the west bank provides an indication of the soil conditions for the west approach. From a cursory analysis of the stability of an 8 ft embankment height there appears to be no danger of a slide into the river. The reduced height of fill required on the east approach will not create stability problems.

Excavation for foundations will require a sheet piling cofferdam. The penetration of sheet piles below the footing level in all probability should be more than 5 ft to effectively reduce the amount of water entering the cofferdam and prevent "boiling" in the silt. Water level during construction will be a determining factor in depth of sheet pile penetration required and excavation procedure and technique used.

## 7. CONCLUSIONS:

There is a variation between the type of soil encountered, North and south of the proposed centreline. A loose to medium dense silt formation was encountered south of centreline but not on the north side. The soil is predominantly granular.

The proposed bridge may be supported on spread footing foundations established at elev. 928-929. At that level an 8-10 ft width of footing may be designed for a safe bearing capacity of 2000 psf.

Entire settlement will occur shortly after full dead load is applied. A total vertical displacement of about 1" is predicted. An alternative means of supporting the bridge is on pile foundations. Bearing piles are expected to drive to elev. 898-904.

Scour protection around the abutments and piers is required primarily at the upstream side where loose silt was encountered.

Construction problems with the excavation for foundations and with the ingress of water may be anticipated. Asheet piling cofferdam is essential for deep foundation work at this site. With the numerous waste timbers, and coarse gravel encountered during drilling, steel sheet piling is recommended for penetration and watertightness.

DOMINION SOIL INVESTIGATION LTD.



*A. Kobelak*  
A. Kobelak, P. Eng.  
Manager.

ENGINEERING DATA SHEETS

Location of Boreholes and Subsurface

Sections ..... Encl. 1

Borehole Logs ..... Encl. 2-7 incl.

## Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole: 1

W.P.232-59

Date: 19-8-59

Project: Little Mississippi River  
 Location: McArthur's Mills, Ont.  
 Hole Location: See No.1 495+23 20'E  
 Hole Elevation and Datum: 938.6  
 Field Supervisor: AK Prep.: AK  
 Driller: J Mac Checked: GR

## LEGEND

## Shear Strength (C)

Unconfined compression  
 Vane test and sensitivity (S)

## Penetration Resistance (P)

2" Split tube  
 2" Dia. Cone  
 Casing

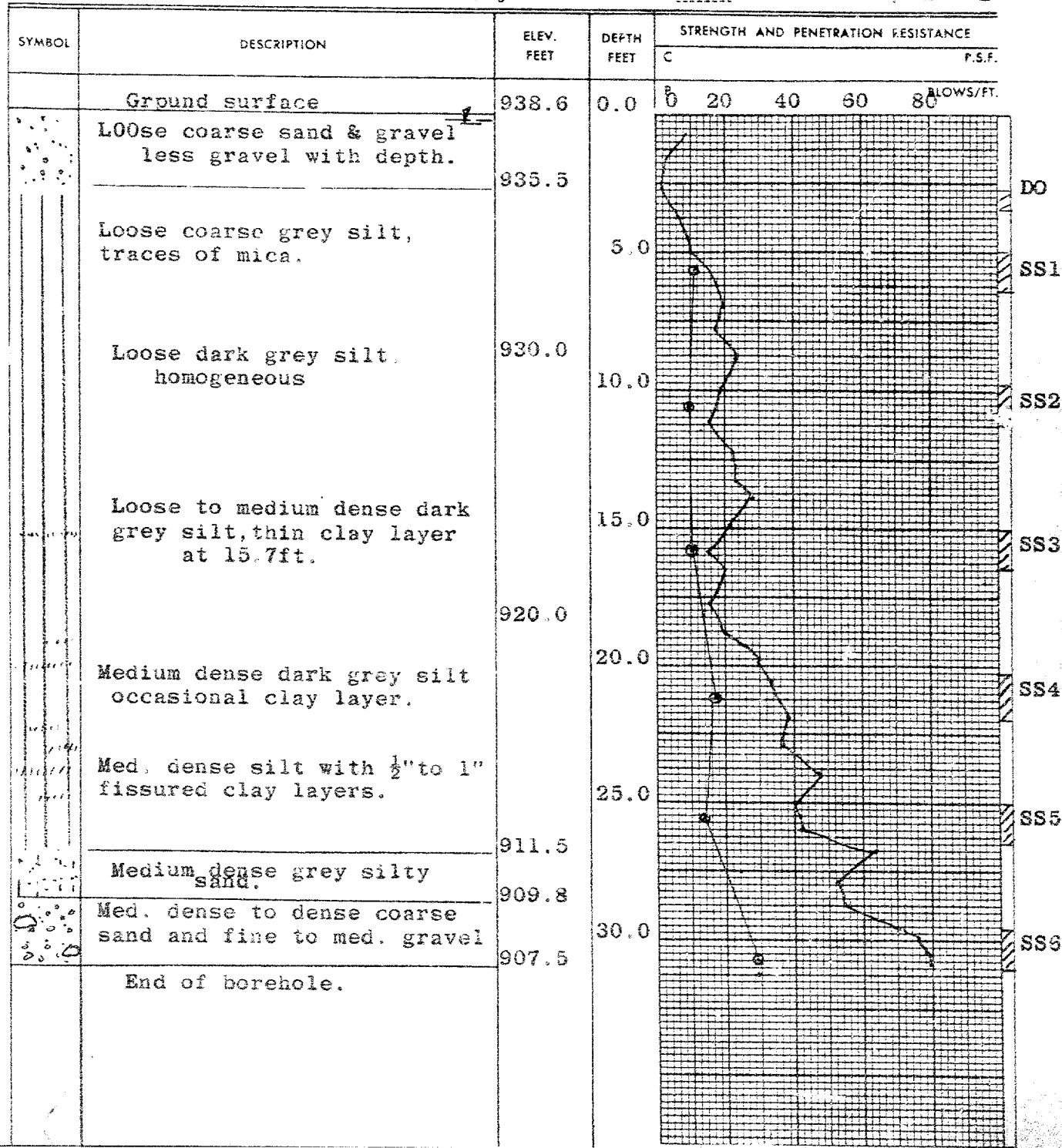
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⊕  
 ⊕

## Sampling Method

2" Dia. split tube

2" Shelby tube



## Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole: 2

W.P. 232-59

Date: 20-8-59

Project: Little Mississippi River

## LEGEND

Location: McArthur's Mills, Ontario

Shear Strength (C)

Hole Location: Sta. 495+25 20' South

Unconfined compression

Hole Elevation and Datum: 5

Vane test and sensitivity (S)

Field Supervisor: AK

AK

Penetration Resistance (P)

Driller: J. MacL

AK

GR

2" Split tube

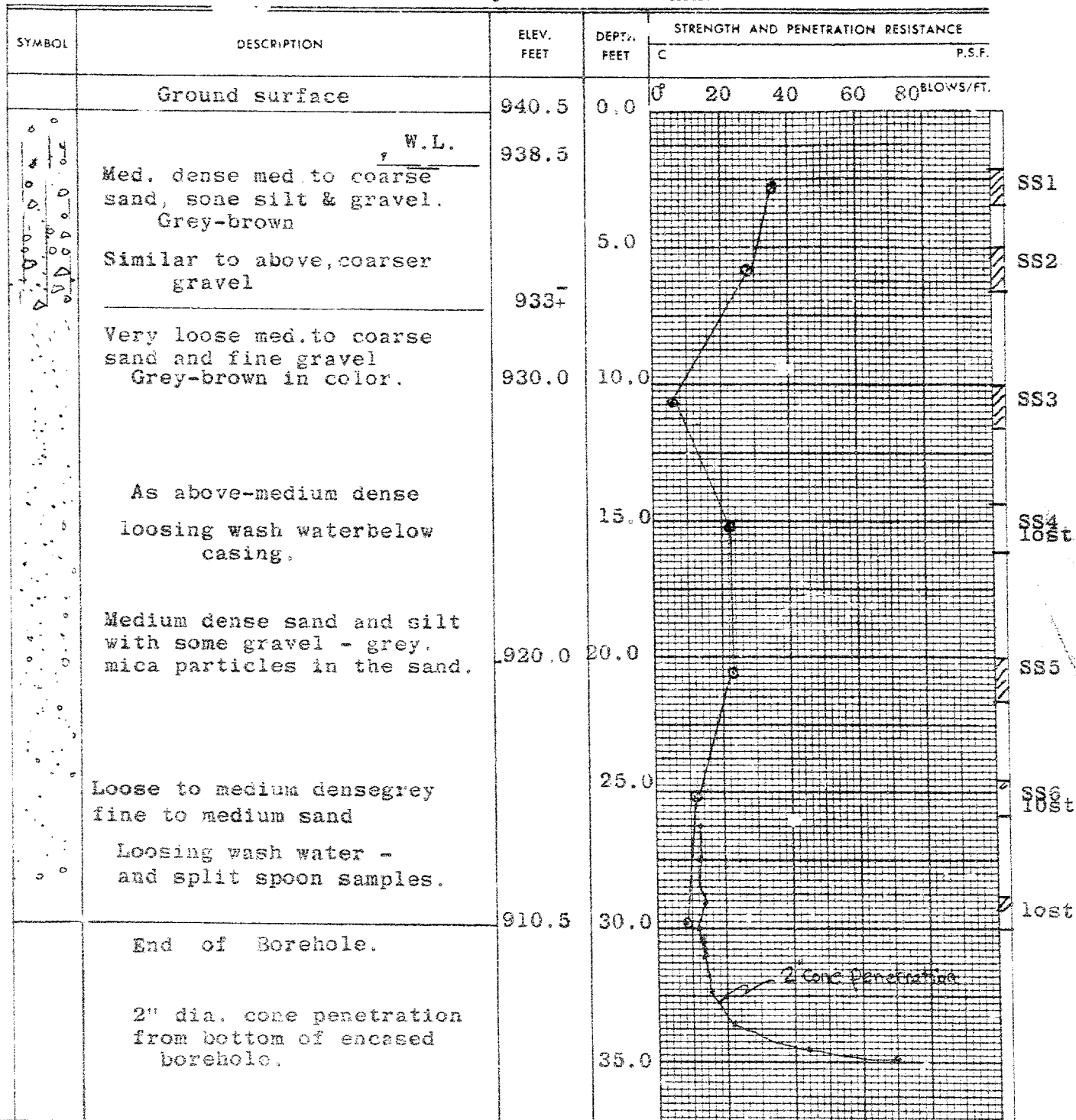
2" Dia. Cone

Casing

Sampling Method

2" Dia. split tube

2" Shelby tube



## Dominion Sell Investigation Ltd.

Engineering Data Sheet for Borehole: 3

W.P. 232-59

Date: 21-8-59

Project: Little Mississippi River

Location: McArthur's Mills, Ont.

Hole Location: Sta. 494+67 12' South

Hole Elevation and Datum: 988.3

Field Supervisor: AK Prep.: AK

Driller: J MacL Checked: GR

## LEGEND

Shear Strength (C)

Unconfined compression  
Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

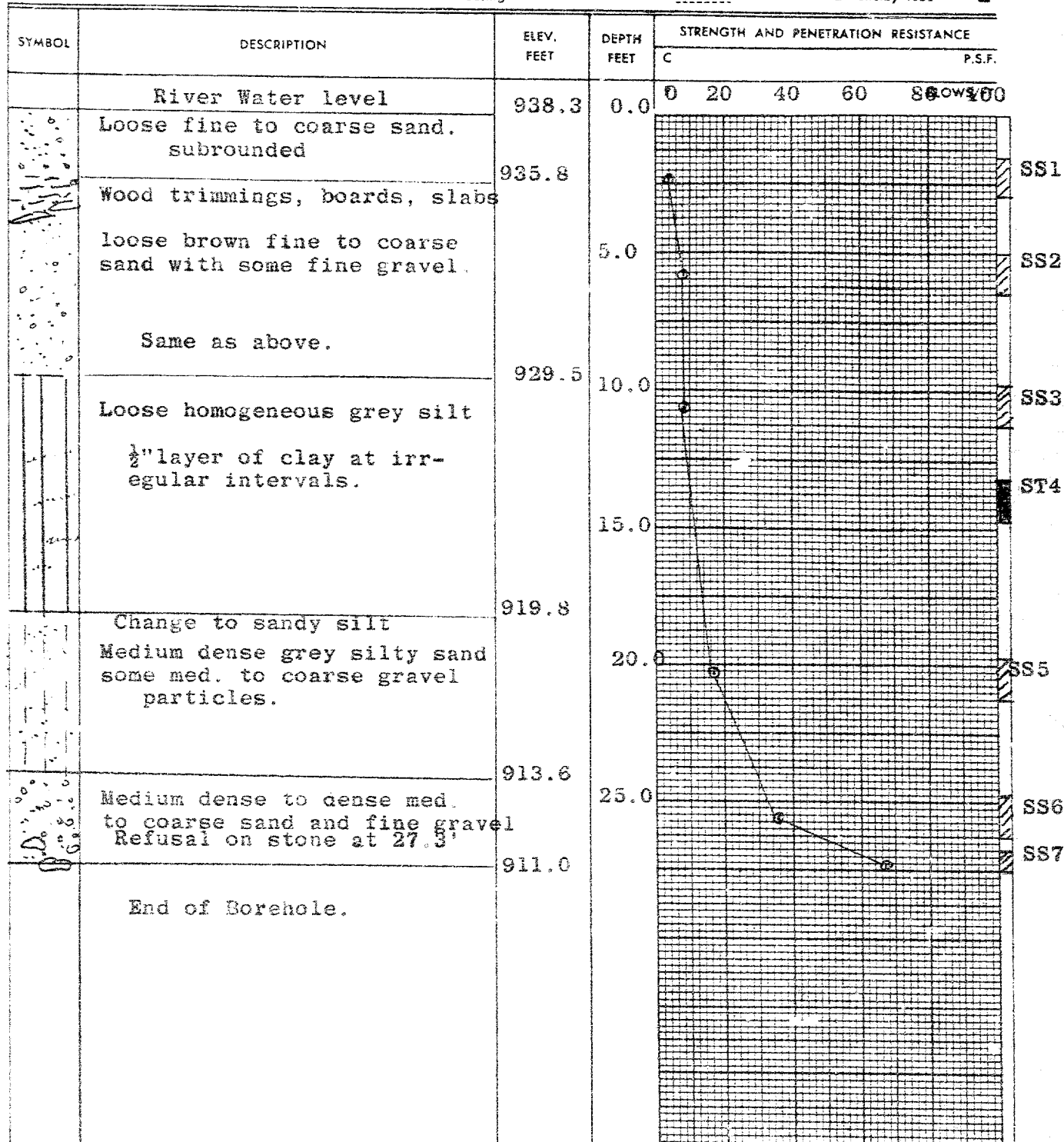
2" Dia. Cone

Casing

Sampling Method

2" Dia. split tube

2" Shelby tube





## Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole: 4

W.P. 232-59

Date: 22-8-59

Project: Little Mississippi River

Location: McArthur's Mills, Ontario

Hole Location: Sta. 494+73 18' North

Hole Elevation and Datum: 938.5

Field Supervisor: AK Prep.: AK

Driller: J. MacL Checked: GR

## LEGEND

Shear Strength (C)

Unconfined compression  
Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

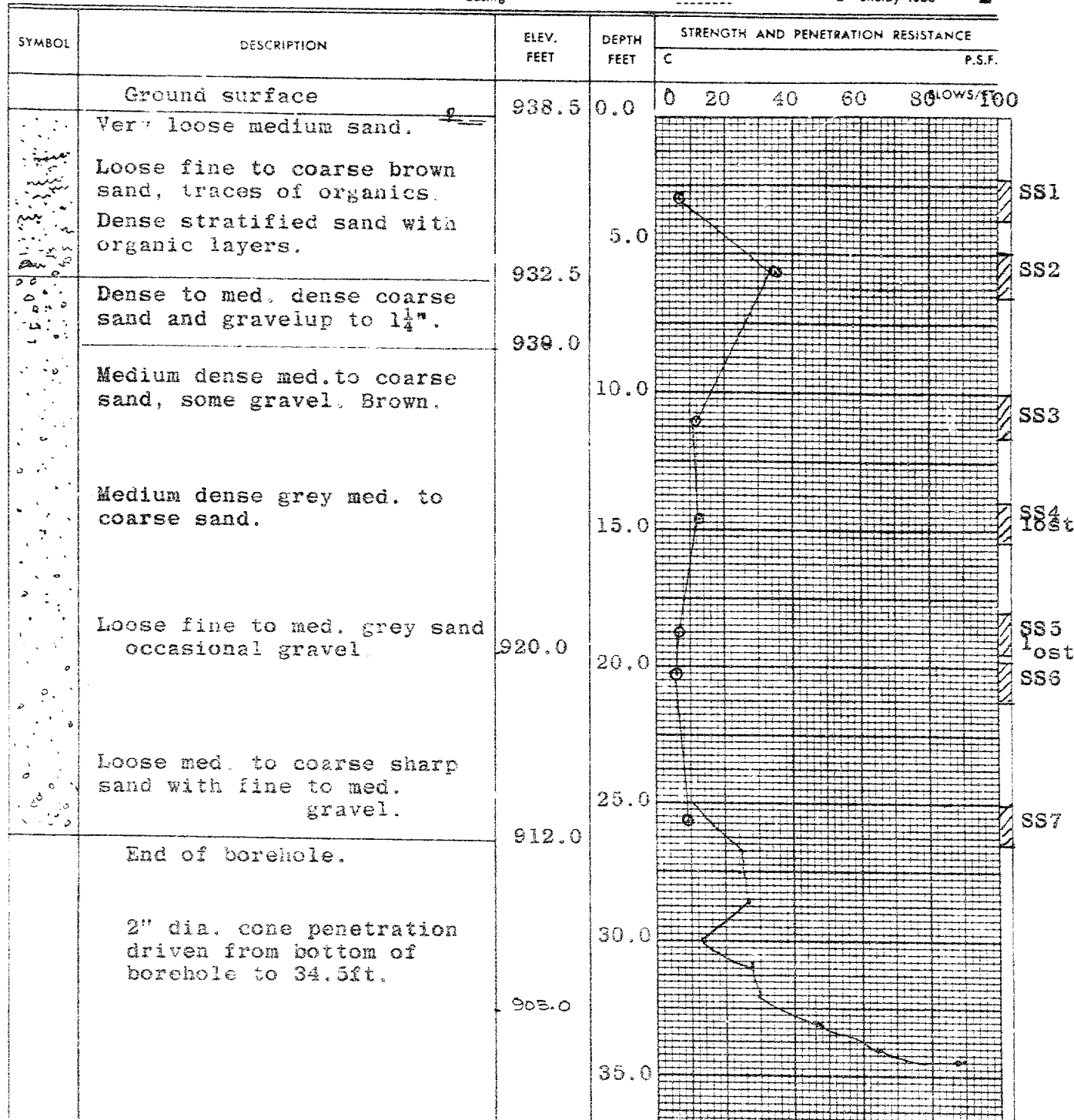
2" Dia. Cone

Casing

Sampling Method

2" Dia. split tube

2" Shelby tube



## Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole: 5

W.P. 232-59

Date: 22-8-59

Project: Little Mississippi River

Location: MaArthur's Mills. Pnt.

Hole Location: Sta. 494+02 217t. N.

Hole Elevation and Datum: 938.3

Field Supervisor: AK

Prep.: AK

Driller: J. MacL

Checked: GR

## LEGEND

Shear Strength (C)

Unconfined compression

Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

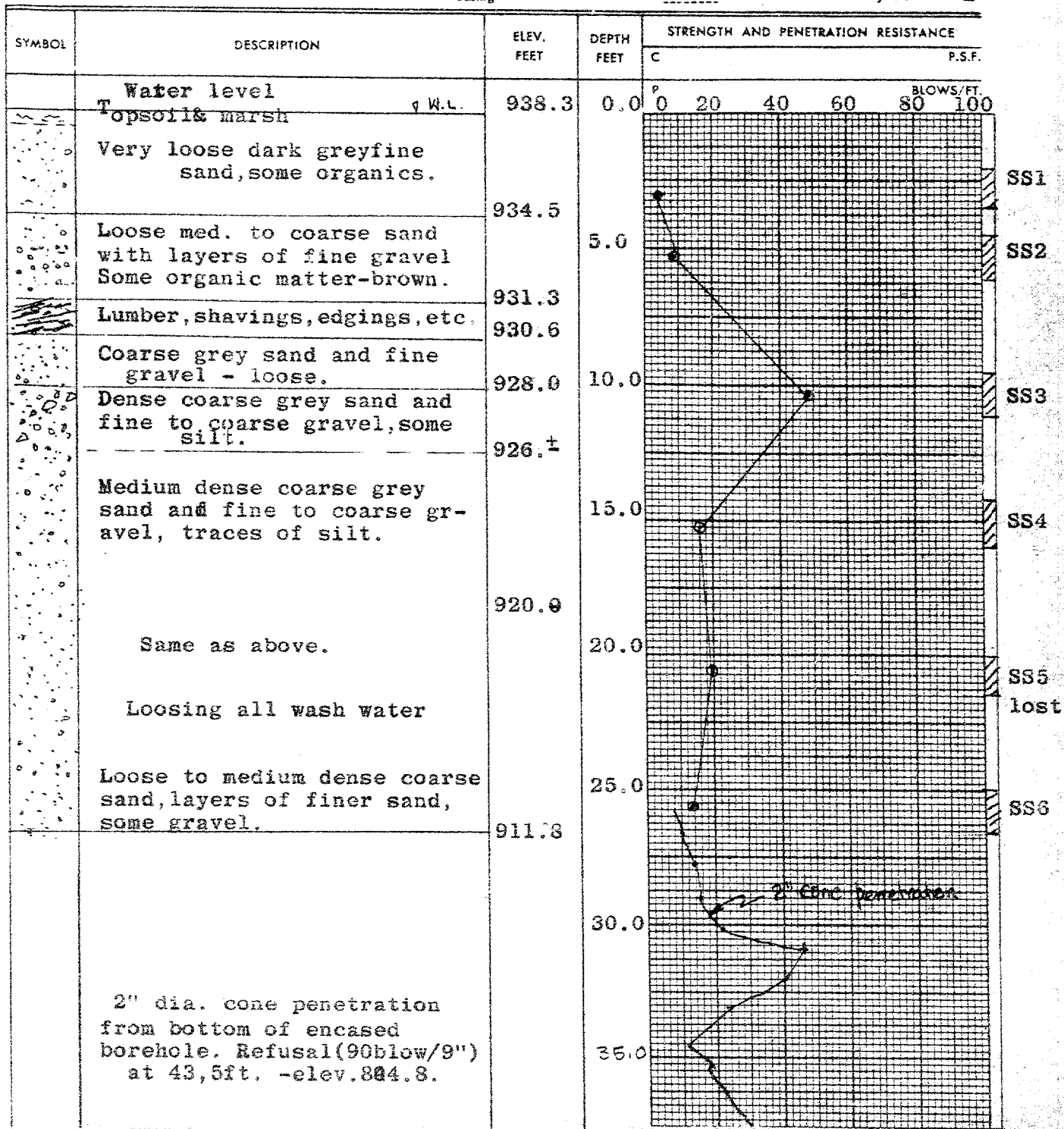
Casing

⊕  
+<sup>5</sup>⊕  
⊕

Sampling Method

2" Dia. split tube

2" Shelby tube



## Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole: 6

W.P. 232-59

Date: 24-8-59

Project: Little Mississippi River

Location: McArthur's Mills, Ont.

Hole Location: Sta. 493+75 20' South

Hole Elevation and Datum: 940.0

Field Supervisor: AK Prep.: AK

Driller: J MacL Checked: GR

## LEGEND

## Shear Strength (C)

Unconfined compression  
Vane test and sensitivity (S)

## Penetration Resistance (P)

2" Split tube

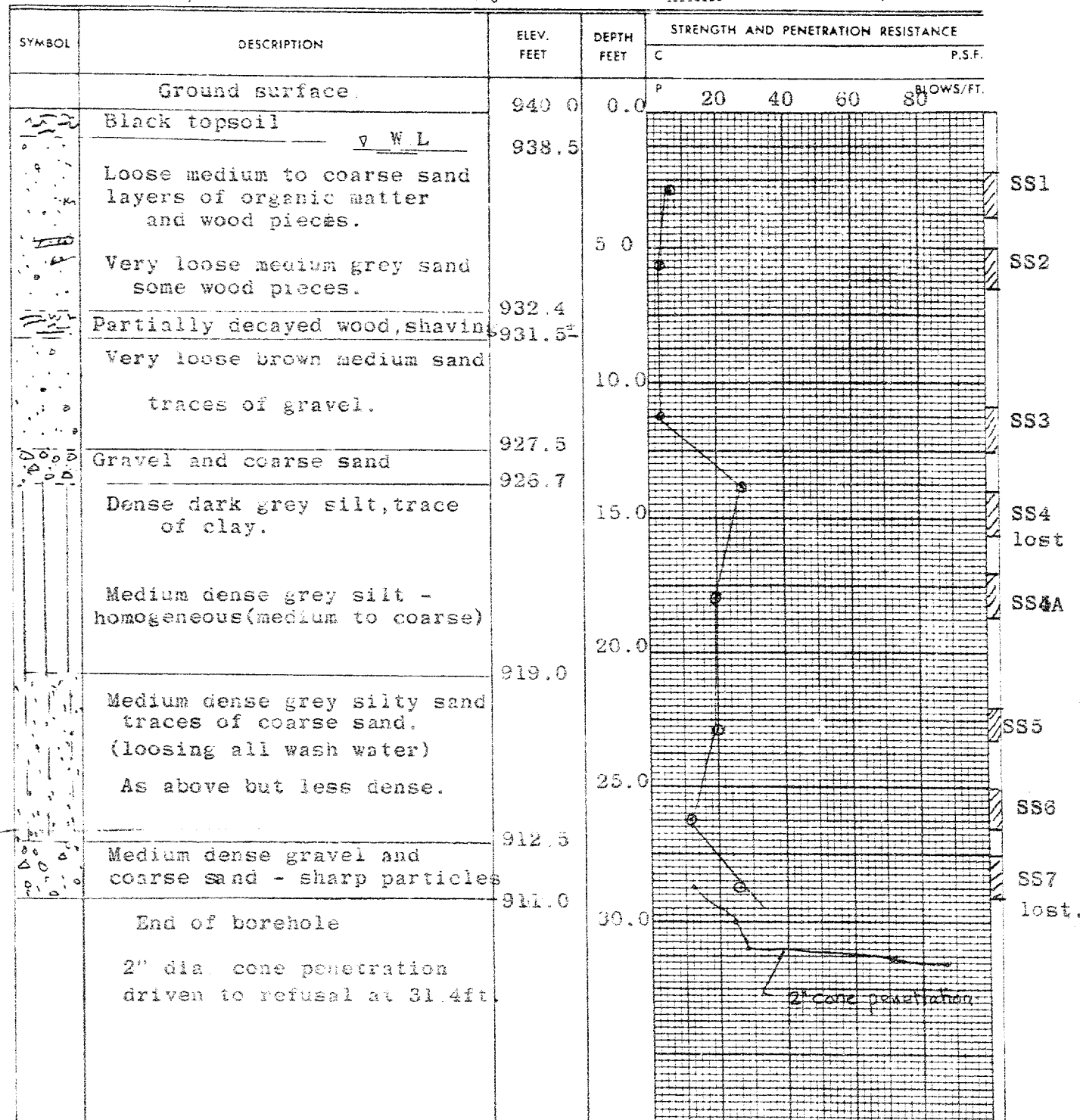
2" Dia. Cone

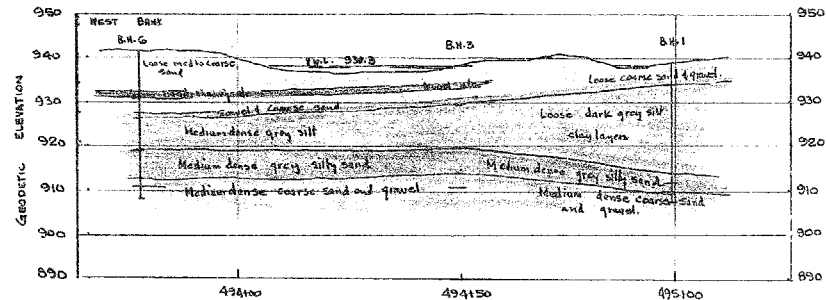
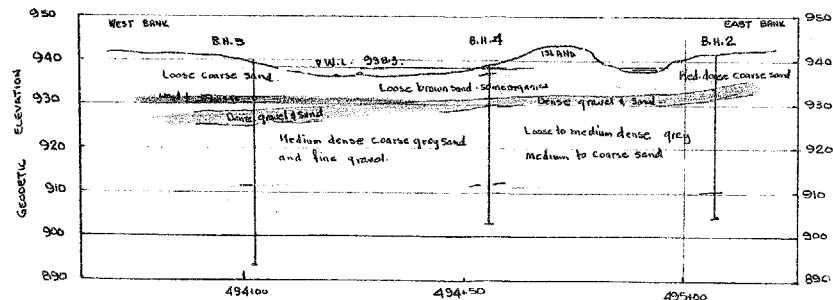
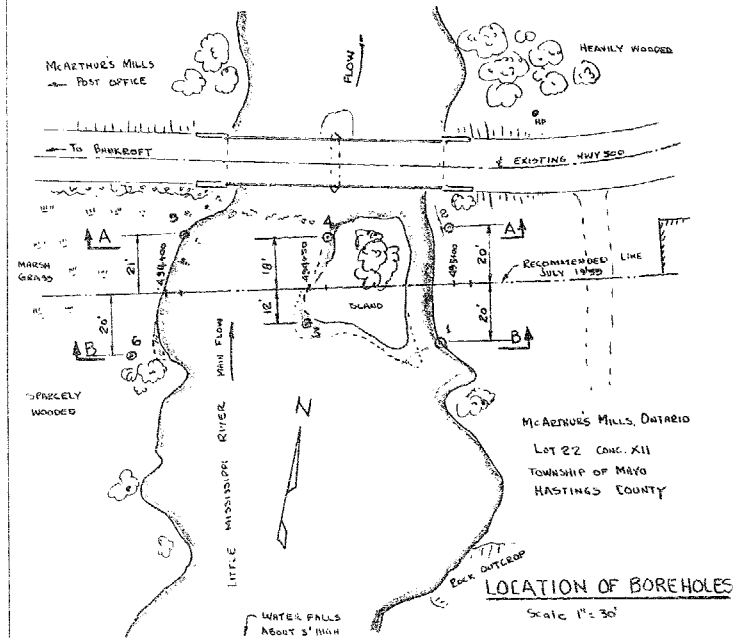
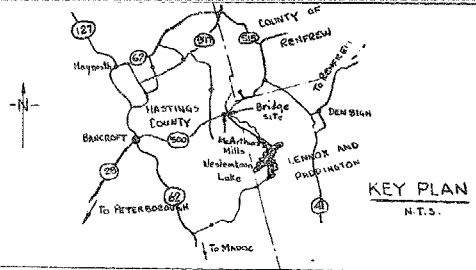
Casing

## Sampling Method

2" Dia. split tube

2" Shelby tube





DOMINION SOIL INVESTIGATION

LITTLE MISSISSIPPI RIVER BRIDGE

AUG 26, 1959.

ENCLOSURE NO.