Section

Rept. Bk. No. 66/156
G.S. 4016

DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY

ENGINEERING DIVISION

STURT HIGHWAY NO. 4 - KINGSTON-ON-MURRAY BRIDGE
GEOLOGICAL INVESTIGATIONS, PROGRESS REPORT NO. 1
DESIGN STAGE

Hd. Moorook

Client: Highways and Local Government Department

by

W.R.P. BOUCAUT
SENIOR GEOLOGIST

and

J.H. FRYAR
GEOLOGIST
ENGINEERING GEOLOGY SECTION

11th June, 1968

D.M. 949/65

DEPARTMENT OF MINES
SOUTH AUSTRALIA

RB 66/156

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FIGURES

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INTRODUCTION

The Commissioner of Highways in a letter dated 26th October, 1967, to the Director of Mines, requested the Department to drill two cable-tool holes at the site of the proposed Sturt Highway No. 4 crossing of the River Murray near Kingston.

A previous investigation has been carried out at the site by K.W.G. Smith, Schumann and Associates, Consulting Engineers (Ref. 1). This investigation was limited to a depth of about 60ft. (R.L. 40) below the river bed, and about 70ft. (R.L. 70) below the right bank.

The purpose of the present drilling (Holes CH1 and CH2) was to prove the nature of the materials present for a further 60ft. depth. It was requested that sampling be commenced at R.L. 85 (55ft. below pool level), but in hole CH1 sampling was not commenced until R.L. 52 which is 55ft. below river bed level.

Location details are in Fig. 1. The results of Holes CH1 and CH2 are shown in Fig. 2, together with general information obtained from the previous investigation. Detailed logs of Holes CH1 and CH2 are included in Appendix A.

Cores from Bore No. 5 drilled by K.W.G. Smith, Schumann and Associates were examined by the Palaeontology Section (Ref. 2).

Previous investigations in the area have included drilling for a proposed railway bridge 600ft. north of the Kingston-on-Murray punt (Ref. 3) and a proposed road bridge at Overland Corner about 6 miles northwest of Kingston. (Ref. 4).

OUTLINE OF REGIONAL GEOLOGY

The site lies within the Murray Basin. Sedimentation in this part of the basin began in Oligocene times and continued through most of the Tertiary. Eventually a thick sequence of horizontally bedded sandy limestones and marls (calcareous silts and clays), were deposited. (Ref. 5).

The geological succession in the area is as follows:-

AGE	FORMATION	MATERIAL
Upper Miocene	Loxton Sands (estuarine)	Sand, poorly graded.
Middle Miocene	Pata Limestone (marine)	Grey to white fossiliferous limestone.
Lower to Middle Miocene	Morgan Limestone (marine)	Yellow to grey fossiliferous limestone grading to marly limestone.

SITE GEOLOGY

Topography

The River Murray at the site is about 400ft. wide and flows in a northwesterly direction. The right bank of the river is formed by a flood plain 10 to 20ft. above pool level and about 1 mile wide.

The left bank is formed by a steep slope about 70ft. high (Fig. 2). The country within several miles of the cliff top is gently undulating.

Soil and Rock Types

The geological succession at the site as indicated by surface exposures and drilling is shown on Fig. 2.

Results of core drilling in holes CH1 and CH2 are shown in detail on the drill hole logs (Appendix A) and are summarized as follows:-

DEPTH (ft.) Hole CH1 From	To	Hole CH2 From	To	FORMATION	MATERIAL
-	-	53 (RL87)	71 (RL71)	Pata Limestone Equivalents	SAND, coarse silty fine, grey, with up to 10% fossil fragments to 10mm. diameter. Grades locally to SILTY SOIL, medium plasticity.
87 (RL52)	192 (RL-53)	71 (RL71)	130 (RL12)	Bongam Limestone Equivalents	SILT SOILS, SANDS and LIMESTONE in beds from ? to 40ft. thick, grey, fossiliferous.

Bedding was not observed in any of the samples but is assumed to be horizontal from knowledge of regional geology and their type of deposition.

Previous drilling indicates that the Pata Limestone equivalents are overlain by sands of the Lambert Sand Formation. These are exposed in the cliff face on the left bank, but have been removed by erosion in the river channel and in the right bank. The right bank is formed by sands and silts (Recent river deposits).

DISCUSSION

Both the Pata Limestone and Morgan Limestone at this site are soils in the engineering sense. They include clays, silts, sands and gravels, but the majority of soil grains of silt and larger sizes consist of irregularly shaped fragments of fossils, composed of calcite.

It is considered likely that these coarser soils gain some of their strength from interlocking of, and minor cementation between the fossil fragments, and are probably appreciably weakened by the tube-sampling operation. The Standard Penetration Test (N) values should not therefore be interpreted in terms of relative density, using published tables or graphs.

W.R.P. BOUCAUT
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Joanne H. Fryar.

J.H. FRYAR
GEOLOGIST
ENGINEERING GEOLOGY SECTION

WRPB:JHF:SMA
11.6.1968

REFERENCES

1. SMITH, G.W.G., SCHUMANN & ASSOCIATES, 1965. Foundation Investigation; Bridge and Embankments Kingston-on-Murray. (Includes Bore Sections). Smith, Schumann & Associates, Consulting Engineers. Ref. No. 3K.

2. LINDSAY, J.M. 1965. Kingston-on-Murray Bridge Site, Bore No. 5. Stratigraphy and Micropaleontology. Dept. of Mines. Rept. Bk. No. 61/113.

3. MILES, K.R. 1950. Geological Report on Railway Bridge Foundation Test Bores, Kingston-on-Murray. S.A. Dept. of Mines. Docket No. D.M.901/49.

4. STEEL, R.D. 1966. Bridge Proposals - Upper Murray Overland Corner Bridge. Geological Investigations. Progress Report No. 1. S.A. Dept. of Mines Rept. Bk. No. 62/26.

5. LUDBROOK, N.H., Stratigraphy of the Murray Basin in South Australia. Bulletin 36. Geol. Survey S. Aust.

APPENDIX A

LOGS OF CABLE TOOL HOLES

AND EXPLANATORY NOTES

APPENDIX A

LOGS OF CABLE TOOL HOLES AND EXPLANATORY NOTES

NOTES ON DRILLING PROCEDURES

Equipment

The drilling is carried out with a cable tool drilling plant using "s" series sampling tools. (Figs. 1 and 2).

Sampling Procedure

SA Samples

SA Samples are obtained by driving an "S" tube, fitted with a Mark A show, into the material to be sampled. The number of blows per foot of penetration of the sampling tube, are recorded by the driller. The sample, or core, is extruded from the sampling tube using an hydraulic ram. The extruded core is sealed in a plastic bag and stored in a core box with a label, showing depth of sample and number of blows per foot of penetration. The hole is reamed out after each sample with a Mark E show.

SAL Samples

Sealed tube samples, for laboratory testing, are taken at various intervals during drilling.

The drilling procedure is similar to that for obtaining SA Samples, but in order to completely fill the sampling tube, it is driven 1.5 ft. into the material to be sampled. On removal from the drill hole, both ends of the sampling tube are sealed with paraffin wax and screwed caps are fitted to the tube. The sealed tubes are labelled as in Fig. 3.

Standard Penetration Test

The Standard Penetration Test (Ref. 1) is used to test the in-situ density of sands and to give an indication of the consistency of clays, and compactness of silts.

The equipment is illustrated in Fig. 4 and consists of a 2in. diameter, sampling spoon (tube) and a hammer of standard weight (140 lbs.)

With the equipment assembled as in Fig. 4 the hammer is allowed to fall on to the drill rods until the sampling shoe has penetrated 6in. into the soil. The Standard Penetration Test is the number of blows (N) required to produce the next foot of penetration.

NOTES ON DRILL LOG SHEETS

The logs are plotted on a standard cable-tool log form.

Near the centre of the form a graphic log of the materials encountered is shown.

In the column to the right of the graphic log, the soils are classified and described according to the Unified Soil Classification (Ref. 2), (Fig. 5).

To the left of the graphic log is a geological description of the materials sampled. This includes:-

.....Geological age)
)
.....Soil unit name) printed vertically
)
.....Type of material)

.....Mineral composition

.....Grain shape

.....Cementation

.....Organic materials

Water levels are indicated by a small arrow with the date at which the observation was made.

In the blows per foot column, a continuous histogram is made of the number of blows required to drive the sampling tube through each foot of material. A hatching code is used to distinguish various types of sample. This code is reproduced at the bottom of each log sheet.

In the column on the far right of the log sheet, readings of unconfined compressive strength (qu) made with a Soiltest Penetrometer, are recorded. The readings are plotted as a histogram. The Soiltest Penetrometer only gives true values of qu when used in clays in which $\phi = 0$.

REFERENCE

1. TERZAGHI, K. and PECK, R.B. 1948. Soil Mechanics in Engineering Practice. John Wiley and Sons.

2. UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION, 1966. Earth Manual, 2nd Edition.

DESCRIPTIVE TERMS

1. CLAY SOILS

CONSISTENCY

CONSISTENCY	SYMBOL	UNCONFINED COMPRESSIVE STRENGTH (kg/sq. cm)	FIELD TEST	N
Very soft	V.S.	less than 0.25	Easily penetrated several inches by fist	2
Soft	S	0.25 to 0.5	Easily penetrated several inches by thumb	2 to 4
Firm	F	0.5 to.1.0	Can be penetrated several inches by thumb with moderate effort	4to 8
Stiff	St	10 to 2.0	Readily indented by t[illegible] thumb but penetrated only with great effort	8 to 15
Very Stiff	V.St.	2.0 to 4.0	Readily indented by thumb nail	15 to 30
Hard (Extremely stiff)	H	over 4.0	Indented with difficulty by thumb nail	30 and over

Based partly on Terzaghi, K. and Peck, R.B. 1966. Soil Mechanics in Engineering Practice, Wiley - New York

MOISTURE CONTENT

Abbreviation	Meaning
MC $\simeq$ LL	Moisture Content near liquid limit
MC < LL	" " less than liquid limit
MC > PL	" " greater than plastic limit
MC $\simeq$ PL	" " near " "
MC $\lesssim$ PL	" " less or equal to " "
MC < PL	" " less than " "
MC $\ll$ PL	" " much less than " "

2. SILT SOILS

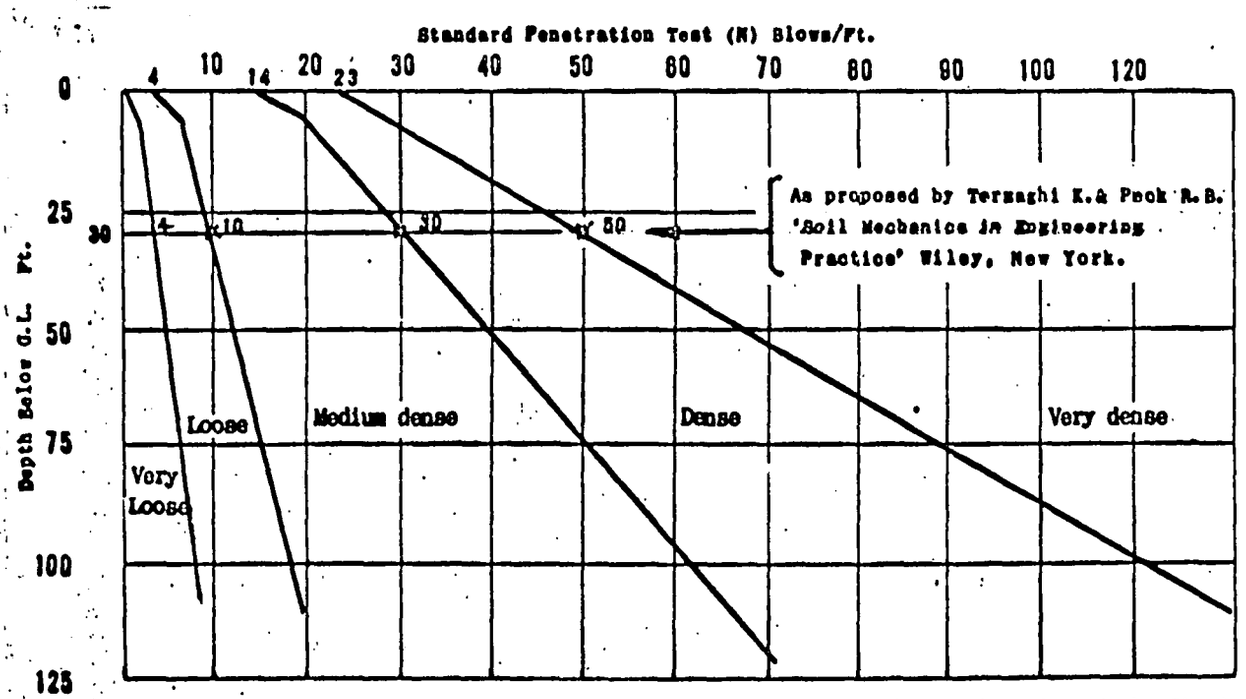
COMPACTNESS	SYMBOL	N
Loose	L	0 to 8
Moderately compact	MC	8 to 15
Compact	C	15 to 30
Very Compact	VC	greater than 30

3. SANDS

CLASSIFICATION OF SANDS BY STANDARD PENETRATION TEST

The relative density of granular soils has been judged from the results of Standard Penetration Tests carried out by the procedure described by Terzaghi and Peck (Ref. 1) bearing in mind the limitations of the method as discussed by Gibbs and Holtz (Ref. 2). At all times the water in the drill hole was kept at the level of surrounding groundwater.

EFFECT OF OVERBURDEN PRESSURE ON STANDARD PENETRATION TEST



Based on Gibbs H.J. & Holtz W.G.(1957) 'Research on Determining the Density of Sands by Standard Penetration Test' Vol.I. Proc. 4th. Int. Conf. S.M.& F.E. London.

REFERENCES

1. Terzaghi K, and Peck, R.B. 1948 "Soil Mechanics in Engineering Practice". Wiley, New York.

2. Gibbs, H.T. and Holtz W.G. 1957 Research on determining the density of sands by standard penetration tests. Proc. 4th Inter. Conf. SM & FE, London Vol. 9

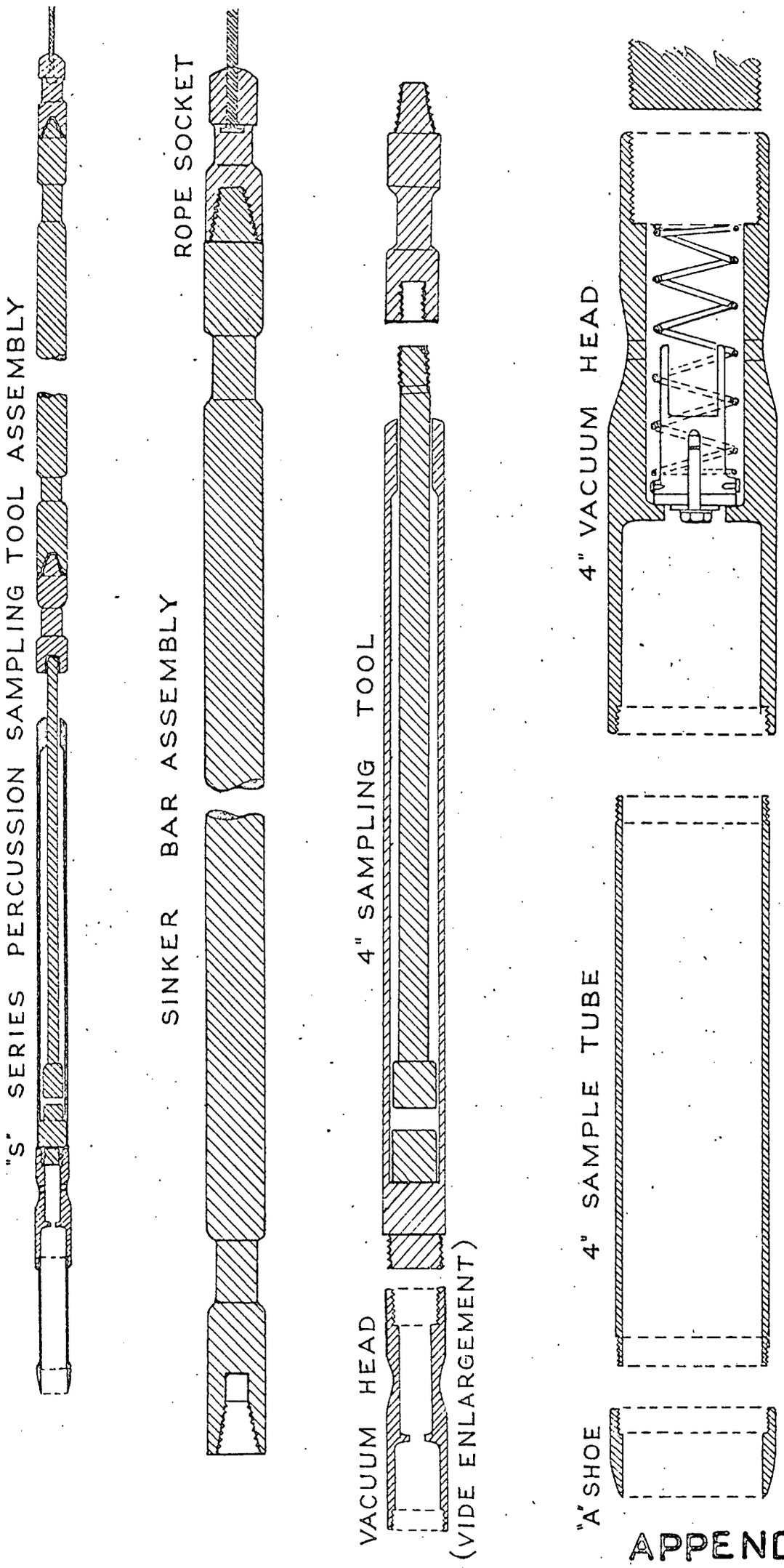
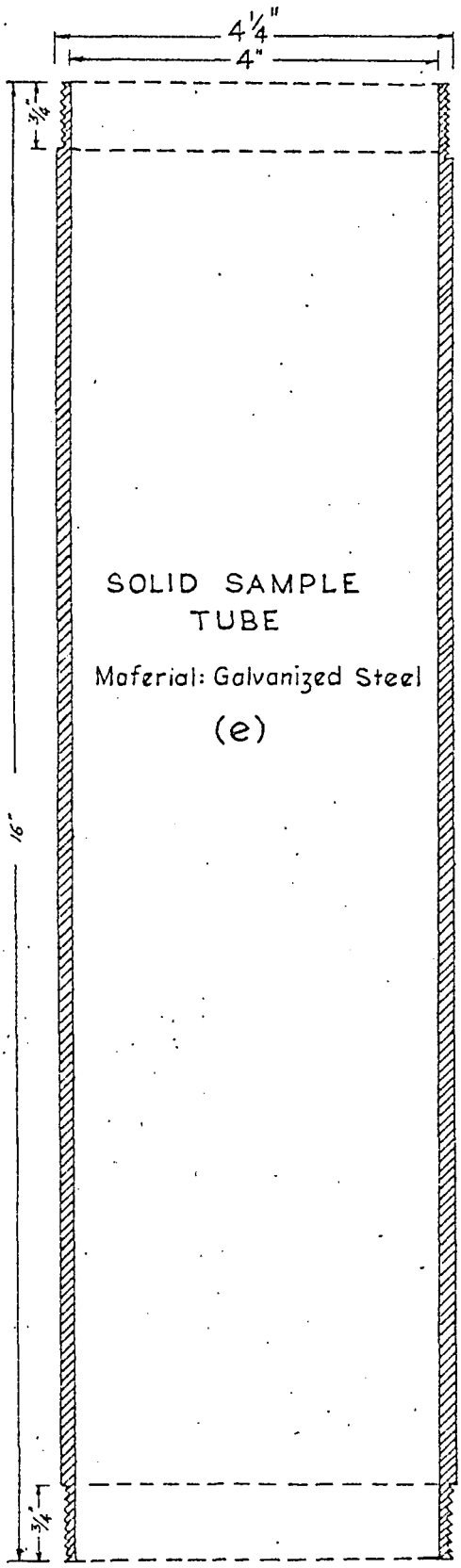


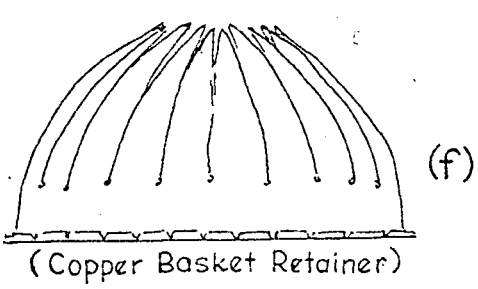
FIG. 1.

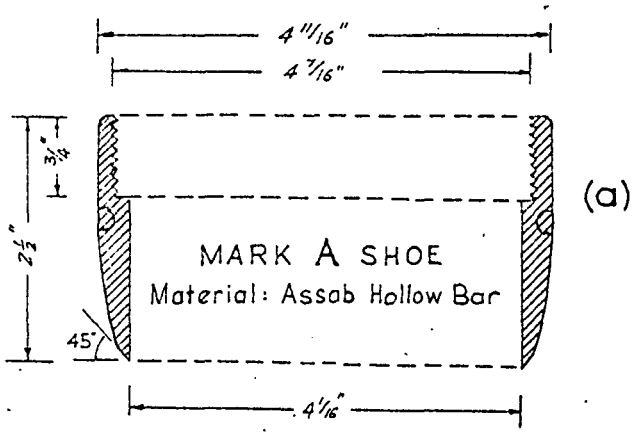
APPENDIX A

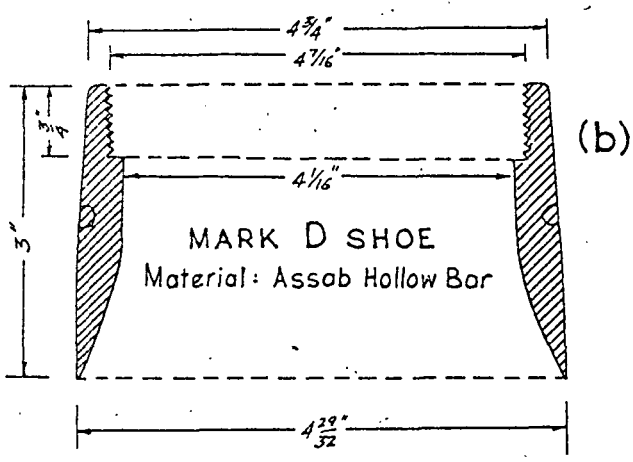
DEPARTMENT OF MINES — SOUTH AUSTRALIA

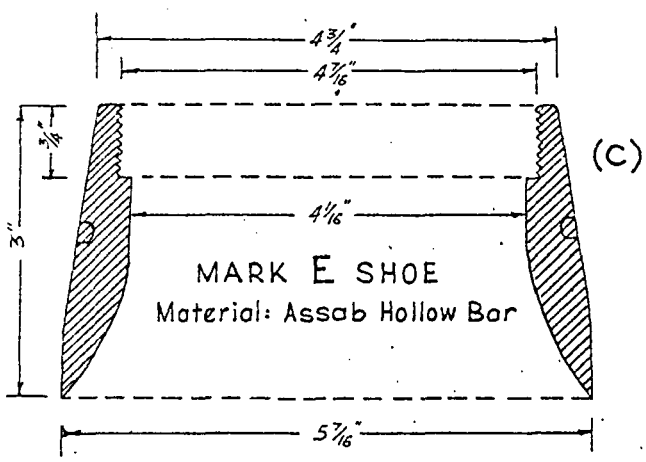
ENGINEERING GEOLOGY SECTION	Drn. R.D.S.	CABLE-TOOL DRILLING SAMPLING TOOL ASSEMBLY WITH "S" SERIES SHOES	SCALE: NOT TO SCALE
	Tcd. R.D.S.		S4416 MB
DIRECTOR OF MINES	Ckd. D.H.S.		DATE: 29 June 65
	Exd.		

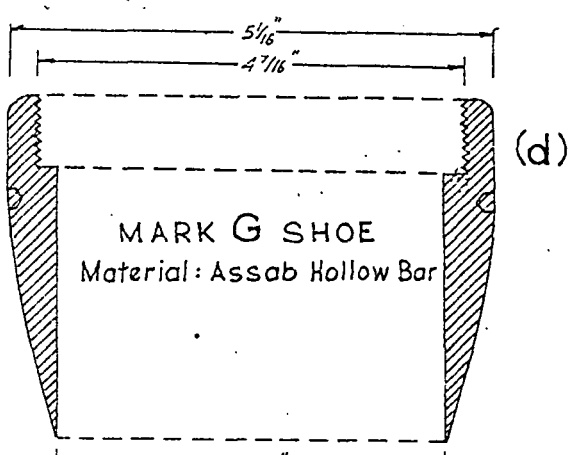








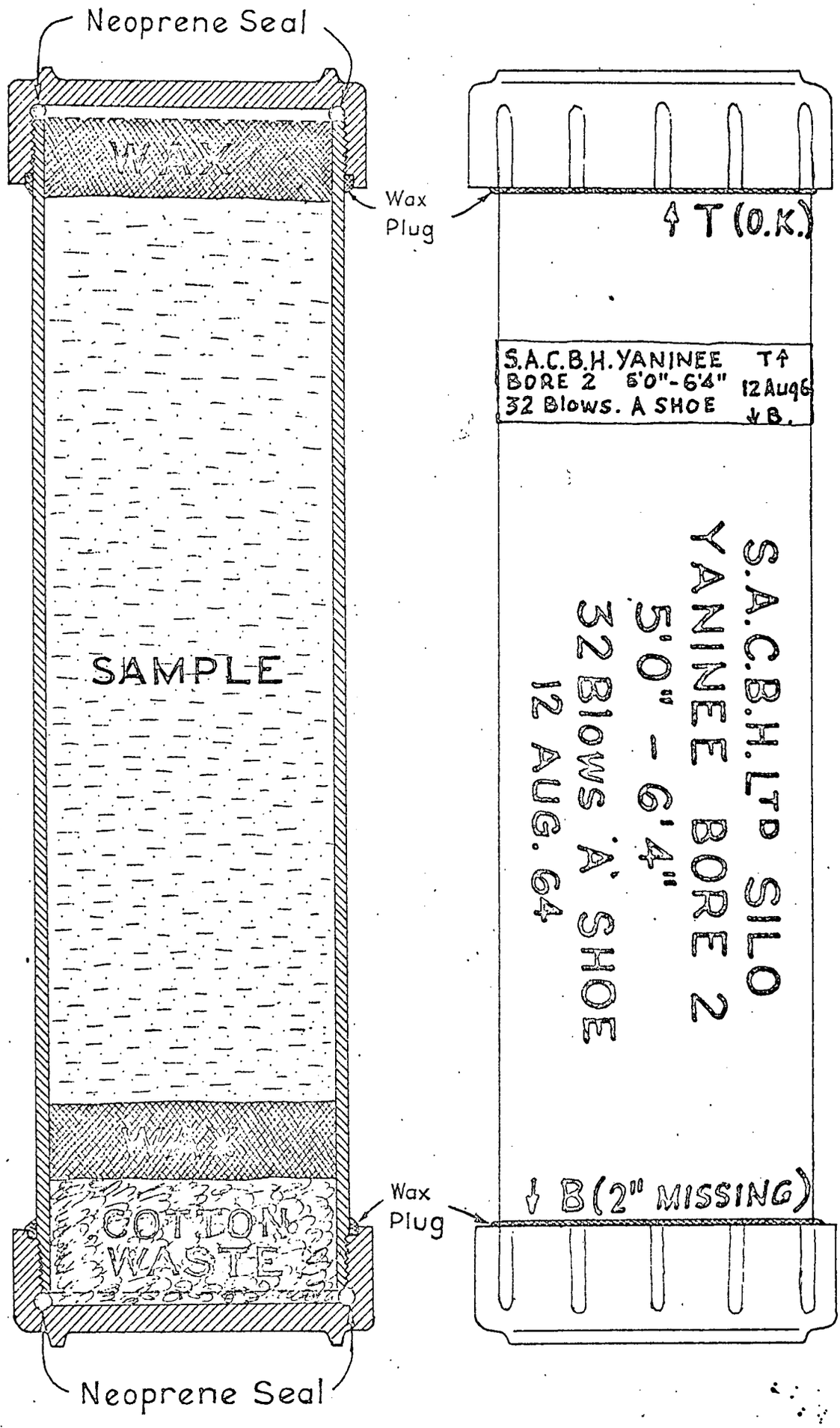




APPENDIX A FIG. 2

DEPARTMENT OF MINES — SOUTH AUSTRALIA

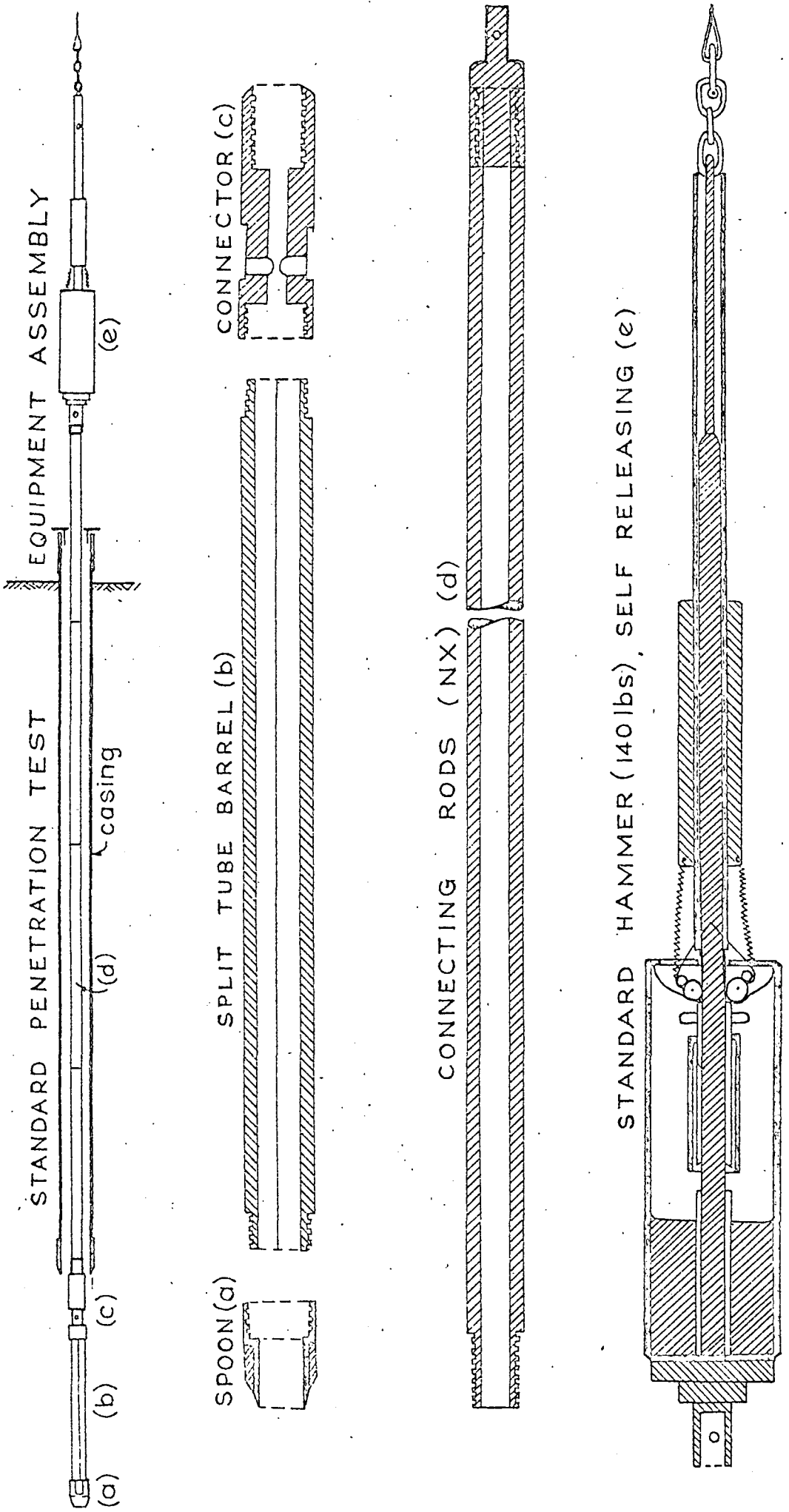
ENGINEERING GEOLOGY SECTION	Dm. R.D.S.	CABLE-TOOL DRILLING S SERIES SAMPLING TUBE AND SHOES	SCALE: NOT TO SCALE
	Tcd. R.D.S.		S 4418 MB.
	Ckd. D.H.S.		DATE: 29 June 65
	Exd.		



APPENDIX A FIG. 3

DEPARTMENT OF MINES — SOUTH AUSTRALIA

ENGINEERING GEOLOGY SECTION	Drn. R.D.S	CABLE-TOOL DRILLING SEALED TUBE SAMPLE	SCALE: NOT TO SCALE
	Tcd. R.D.S.		S4419 MB
DIRECTOR OF MINES	Ckd. D.H.S		DATE: 29 JUNE 65
	Exd.		



APPENDIX A FIG. 4

DEPARTMENT OF MINES — SOUTH AUSTRALIA

ENGINEERING GEOLOGY SECTION	Drn. R.D.S.	CABLE TOOL DRILLING STANDARD PENETRATION TEST EQUIPMENT	SCALE: NOT TO SCALE
	Tcd. R.D.S.		S 4420 M.B.
DIRECTOR OF MINES	Ckd. D.H.S.		DATE: 29 June 65
	Exd.		

DEPARTMENT OF MINES SOUTH AUSTRALIA
SOILS CLASSIFICATION CHART

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 0.25 ft. and basing fractions on estimated weights)				GROUP SYMBOL	GROUP NAME and typical materials
COARSE GRAINED SOILS More than 50% of material is larger than No. 200 B.S. Sieve size.	GRAVELS More than 50% of the coarse fraction is larger than 2mm.	CLEAN GRAVELS Little or no fines	Wide range in grain size and substantial amounts of all intermediate particle sizes	GW	GRAVEL, well graded; gravel sand mixtures, little or no fines
			Predominantly one size, or a range of sizes, with some intermediate sizes missing.	GP	GRAVEL, poorly graded; gravel sand mixtures, little or no fines.
		DIRTY GRAVELS Appreciable amount of fines	Non-plastic fines – for identification see ML below.	GM	GRAVEL, excess silty fines; poorly graded gravel-sand-silt mixtures
			Plastic fines – for identification see C L below	GC	GRAVEL, excess clayey fines; poorly graded gravel-sand-clay mixtures
	SANDS More than 50% of the coarse fraction is smaller than 2mm.	CLEAN SANDS Little or no fines.	Wide range in grain sizes, and substantial amounts of all intermediate particle sizes	SW	SAND, well graded; well graded sands, gravelly sands, little or no fines.
			Predominantly one size or a range of sizes, with some intermediate sizes missing.	SP	SAND, poorly graded; poorly graded sands gravelly sands, little or no fines
		DIRTY SANDS Appreciable amount of fines	Non plastic fines - for identification see M L below	SM	SAND, excess silty fines; poorly graded sand-silt mixtures
			Plastic fines - for identification see CL below	SC	SAND excess clayey fines; poorly graded sand-clay mixtures.

FIELD INVESTIGATION PROCEDURES (on fraction smaller than B.S. No.7 sieve)							GROUP SYMBOL	GROUP NAME (and typical materials)
	SOIL CAST (wet soil)	SOIL THREAD	SHINE	DILATANCY	ODOUR	DRY STRENGTH		
FINE GRAINED SOILS More than 50% of material is smaller than No. 200 B.S. sieve size. SILTS AND CLAYS Liquid limit less than 50	Forms fragile cast Cracks form when kneaded while moist	Thick crumbly thread; easily broken	None to very dull	Distinct	Not significant	None to slight	ML	SILT SOIL, low plasticity; inorganic silts and very fine silty or clayey sands, rock flour.
	Cast maybe handled freely without breaking. Can be kneaded moist without cracking. Material adheres to the hand.	Thread can be pointed as fine as a lead pencil, but is fragile.	Moderate	None to slight	Not significant	Moderate	CL	CLAY SOIL, low plasticity; inorganic clays of low to medium plasticity, gravelly clays, sandy clays silty clays, lean clays
	Cast fragile to cohesive material will adhere somewhat to the hand.	Soft, weak thread.	None to very dull	Slight to distinct	Decayed organic matter	Low	OL	ORGANIC SOIL low plasticity; organic silts and silt clays of low plasticity
SILTS AND CLAYS Liquid limit more than 50	Moderately plastic and cohesive. Material adheres somewhat to the hand	Weak to medium thread. May be crumbly.	Dull	None to slight	Not significant	Moderate Powdered soil feels floury	MH	SILT SOIL, high plasticity; inorganic silts, micaceous or diatomaceous fine sandy or silty soils elastic silts.
	Very plastic and cohesive. Material very sticky to the hand. Greasy to to touch.	Very tough thread Can be rolled to a pin point.	Very glossy	None	Strong earthy.	High to very high. Cannot be powdered by finger pressure.	CH	CLAY SOIL, high plasticity; inorganic clays of high plasticity, fat clays
	Plastic and cohesive. Feels slightly spongy Greasy to touch.	Weak to medium thread. Often soft and fibrous	Moderate to very glossy	None	Decayed organic matter	Moderate to high. Powdered soil may be fibrous.	OH	ORGANIC SOIL, high plasticity; organic clays of medium to high plasticity.
HIGHLY ORGANIC SOILS	Readily identified by colour, odour, spongy feel and frequently by fibrous texture.						Pt	PEATY SOIL; Peat and other highly organic soils.

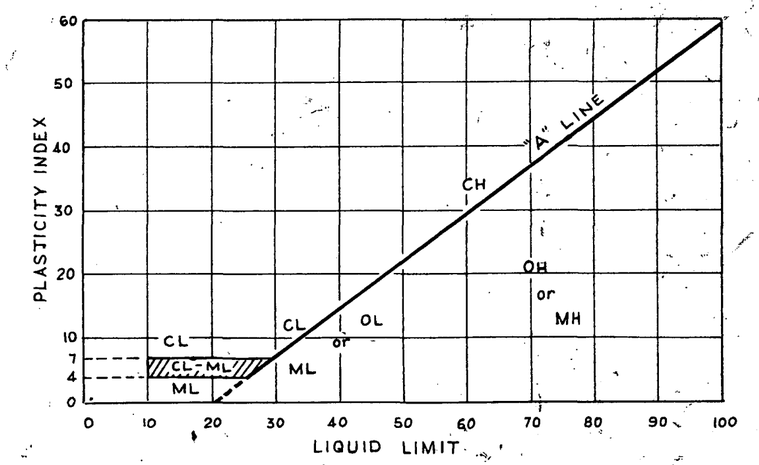
LABORATORY CLASSIFICATION CRITERIA

GRAIN SIZE CURVE to be used to identify soil fractions.

Coarse grained soils classified on basis of percentage of fines, as follows

PERCENT OF FINES		
Less than 5	GRAVELS GW, GP	SANDS SW, SP
More than 12	GM, GC	SM, SC
5 to 12	Borderline cases, use 2 symbols	

$Cu = \frac{D60}{D10}$ Greater than 4 $Cc = \frac{(D30)^2}{D10 \times D60}$ Between one and 3		
Not meeting all gradation requirements for GW		
Atterberg limits below "A" line or PI less than 4		Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
Atterberg limits above "A" line with PI greater than 7		
$Cu = \frac{D60}{D10}$ Greater than 6 $Cc = \frac{(D30)^2}{D10 \times D60}$ Between one and 3		
Not meeting all gradation requirements for SW		
Atterberg limits below "A" line or PI less than 4		Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
Atterberg limits above "A" line with PI greater than 7		



PLASTICITY CHART
FOR LABORATORY CLASSIFICATION OF FINE GRAINED SOILS

NOTE : BOUNDARY CLASSIFICATIONS : Soils possessing characteristics of two groups are shown as a combination of two group symbols, e.g. GW - GC, well graded gravel with clay binder.

Based on "The Unified Soil Classification System" United States Department of the Interior, Bureau of Reclamation "Earth Manual" First Edition, Denver COLORADO 1960

FIG. 5.

64-246
MG

64-246

DEPARTMENT OF MINES SOUTH AUSTRALIA

PROJECT . KINGSTON ON-MURRAY BRIDGE CROSSING.

LOG OF CABLE TOOL HOLE

HOLE NO CH.1(A)

SERIAL No. 362/63

SECTION .

FEATURE . FOUNDATIONS.

HUNDRED. MOORROOK.

R.L. Surface. 139.00 . FT.

LOCATION. In Channel 1,650 ft. South of Punt.

CO-ORDS

R.L. Collar . . FT.

Datum R.Murray Level

SOIL TYPE GEOLOGICAL DESCRIPTION	R.L. (FEET) DEPTH	GRAPHIC LOG	GROUP SYMBOL	SOIL DESCRIPTION GROUP NAME Unified Soil Classification, U.S.B.R. Earth Manual 1st Edition 1963.	WATER LEVEL	MOISTURE CONTENT	Consistency Compct. Dens'y	FIELD TEST DATA: BLOWS PER FOOT 20 40 60 80	FIELD TEST DATA: SOILTEST P'TR METER UNITS * 1 2 3 4
	139			RIVER MURRAY WATER	6 inch				* These values refer to clay soils only and provide an indication of their consistency.
	130 10								
	120 20								
	110 30			River bottom					
	100 40			NOT SAMPLED.					
	90 50								
	80 60								
	70 70								
	60 80								
LOWER TO MIDDLE MIOCENE MORGAN LIMESTONE EQUIVALENTS	50 90		MH	SILT SOIL; medium plasticity. Slightly sandy, calcareous. Grey, becoming bluish grey and somewhat clayey in pockets. 5% gravel (fossil) fragments up to 10 mm. size.	W			30 blows	NOT APPLICABLE.
Calcareous clayey silt. Sand grains mainly calcareous fossil fragments, occasionally sub rounded quartz and sub angular ilmenite.	40 100							32 blows.	

APPENDIX A

TYPE OF SAMPLE	CONSISTENCY	COMPACTNESS	RELATIVE DENSITY	MOISTURE CONTENT
A shoe (SA)	VS. — Very Soft	Ls — Loose	VL — Very Loose	H — Humid
D " (SD)	S — Soft	MC — Moderately Compact	L — Loose	D — Damp
E " (SE)	SF — Soft to Firm	C — Compact	MD — Medium Dense	M — Moist
G " (SG)	F — Firm	VC — Very Compact	D — Dense	W — Wet
Sealed Tube - A Shoe - SAL	F St. — Firm to Stiff		VD — Very Dense	S — Saturated
Standard Penetration Test - SPT	St. — Stiff			LL — Liquid Limit
	V.St. — Very Stiff			PL — Plastic Limit
	H — Hard			

Water level, (date) 7 Dec. '66

WC Water cut

Casing

ENGINEERING GEOLOGY SECTION

DRILL No. 23

TYPE 500

DRILLER A. Sturak.

START 12th. Dec. '67

FINISH 15th. Dec. '67

LOGGED BY J.H.F.

DATE 23rd. Jan. '68

TRACED R.A.J.

CHECKED R.D.S.

SHEET 1 OF 2

DRG No. S 6440 Ja5

PF No. S 6026A

DEPARTMENT OF MINES SOUTH AUSTRALIA

PROJECT KINGSTON-ON-MURRAY BRIDGE CROSSING

LOG OF CABLE TOOL HOLE

HOLE NO CH.1 (A)

SERIAL No. 362/68

FEATURE FOUNDATIONS

SECTION

HUNDRED. Moorook

R.L. Surface. 139 FT.

R.L. Collar FT.

LOCATION. In Channel 1,650 ft. South of Punt.

CO-ORDS

Datum R. Murray level

SOIL TYPE GEOLOGICAL DESCRIPTION	R.L. (FEET) DEPTH	GRAPHIC LOG	GROUP SYMBOL	SOIL DESCRIPTION GROUP NAME Unified Soil Classification, U.S.B.R. Earth Manual 1st Edition 1963.	WATER LEVEL	CASING	MOISTURE CONTENT	Consistency Consist. Dens'y.	FIELD TEST DATA: BLOWS PER FOOT 20 40 60 80	SOILTEST P'TR'METER UNITS * 1 2 3 4
Calcareous clay containing fossil fragments and numerous silt filled worm burrows.	110		MH	See Sheet 1.		6 inch.				
	30		CH	CLAY SOIL, high plasticity slightly silty. Dark blue-grey. Contains 10% GRAVEL fragments up to 30 mm. size.			PL	VI	32 blows	
Contains fossil fragments of sand and gravel size. Fine grained sand, mainly lime. Contains variable strong and rubbly zones.	120		ML/MH	SILT SOIL medium plasticity, sandy. Brown grey, sandy. Contains 10% GRAVEL fragments up to 50mm. size. Grades to					27 blows	
	20		SM-SC	SAND with variable clay and silt fines. Light grey. Contains 30% GRAVEL (fossil) fragments up to 30 mm.					26 blows	
	130		ML	SILT SOIL; low plasticity, slightly sandy in part. Light grey. Contains 10% GRAVEL (fossil) fragments up to 40 mm.			Moist		24 blows	
	10								22 blows	
Rubbly limestone	140		GM	GRAVEL; poorly graded, sandy, excess silty fines.					15 blows	
Silt and gravels almost entirely fossil fragments.	0		ML	SILT SOIL; Low plasticity, sandy. Light grey. Contains 15% GRAVEL (fossil) fragments up to 30 mm.					22 blows	
	150								22 blows	
	-10								22 blows	
	160								20 blows	
	-20						Damp		35 blows	
Green glauconitic mottling	170								20 blows	
	-30									
Rubbly, with angular gravel fragments up to 40 mm.	180		GM	GRAVEL, excess silty fines, sandy. Light grey.					24 blows	
	-40		SC/SM	SAND, with variable clay and silt fines. Light grey. Contains 10% GRAVEL (fossil) fragments up to 30 mm. size.						
Sand, silt and gravel fragments are mainly fossil remains.	190									
	-50			END OF HOLE 192 ft.						
	200									

LOWER TO MIDDLE MIOCENE
MORGAN LIMESTONE EQUIVALENTS
Mainly grey calcarenitic fossil silts, sands, and rubbly limestone in part. Uncemented.

* These values refer to clayey soils only and provide an indication of their consistency. Generally not applicable.

APPENDIX A.

TYPE OF SAMPLE	CONSISTENCY	COMPACTNESS	RELATIVE DENSITY	MOISTURE CONTENT	ENGINEERING GEOLOGY SECTION
A shoe (SA) D " (SD) E " (SE) G " (SG) Sealed Tube - A Shoe - SAL Standard Penetration Test - SPT	VS. — Very Soft S — Soft SF — Soft to Firm F — Firm F St. — Firm to Stiff St. — Stiff V St. — Very Stiff H — Hard	Ls — Loose MC — Moderately Compact C — Compact V C — Very Compact	VL — Very Loose L — Loose MD — Medium Dense D — Dense VD — Very Dense	H — Humid D — Damp M — Moist W — Wet S — Saturated LL — Liquid Limit PL — Plastic Limit	DRILL No. 23. TYPE 500. DRILLER A. Sturak. START 12th. Dec. '67 FINISH 15th. Dec. '67 LOGGED BY J.H.F. DATE 23rd. Jan. '68 TRACED R.A.J. CHECKED R.D.S.

Water level, (date) 7 Dec. '66 — Casing — WCP Water cut

SHEET 2 OF 2. DRG No. S6440a · Ja5

PF No. 35026A

DEPARTMENT OF MINES SOUTH AUSTRALIA

LOG OF CABLE TOOL HOLE

HOLE NO C.H.2 (B)

SERIAL No. 366/68

PROJECT KINGSTON ON MURRAY BRIDGE CROSSING.

SECTION

FEATURE FOUNDATIONS

HUNDRED. MOOROOK

LOCATION. N.E. Bank 1,650 ft South of Punt.

CO-ORDS

R.L. Surface. 142 FT.

R.L. Collar FT.

Datum R.Murray level

SOIL TYPE GEOLOGICAL DESCRIPTION	R.L. (FEET) DEPTH	GRAPHIC LOG	GROUP SYMBOL	SOIL DESCRIPTION GROUP NAME Unified Soil Classification, U.S.B.R. Earth Manual 1st Edition 1963.	WATER LEVEL CASING	MOISTURE CONTENT	Consistency Compct. Dens'y	FIELD TEST DATA: BLOWS PER FOOT 20 40 60 80	FIELD TEST DATA: SOILTEST P'TR METER UNITS 1 2 3 4
	142			NOT SAMPLED	6 INCH.				* These values refer to clay soils only and provide an indication of their consistency.
	140								
	130								
	120								
	110								
	100								
	90								
MIDDLE MIOCENE PATA LIMESTONE EQUIVALENTS — Fine sand is lime, angular to sub-angular, with minor subrounded quartz, and subangular ilmenite (<2%) Weakly cemented.	70		SM to MH	SAND, excess silty fines, grey. Contains 10% GRAVEL fossil fragments up to 10 mm. Grades into SILT SOIL, medium plasticity, clayey, light grey.	W			8 blows; 10 blows	
LOWER TO MIDDLE MIOCENE MORGAN LIMESTONE EQUIVALENT — Fine calcareous clayey silt, fossiliferous. Sand grains are mainly lime, occasionally subrounded quartz.	70		MH	SILT SOIL high plasticity, excess clayey fines, sandy. Blue-grey, lighter grey mottled in places. Contains 5% GRAVEL (fossil) fragments up to 10 mm.	DAMP			9 blows; 9 blows; 8 blows; 8 blows; 7 blows	NOT APPLICABLE
	50								
	100								

APPENDIX A

TYPE OF SAMPLE
- A shoe (SA)
- D " (SD)
- E " (SE)
- G " (SG)
- Sealed Tube - A Shoe - SAL
- Standard Penetration Test - SPT

Water level, (date) 7 Dec. '66; WCP Water cut; Casing

CONSISTENCY
- VS. — Very Soft
- S — Soft
- SF — Soft to Firm
- F — Firm
- F St. — Firm to Stiff
- St. — Stiff
- V.St. — Very Stiff
- H — Hard

COMPACTNESS
- Ls — Loose
- MC — Moderately Compact
- C — Compact
- VC — Very Compact

RELATIVE DENSITY
- VL — Very Loose
- L — Loose
- MD - Medium Dense
- D — Dense
- VD — Very Dense

MOISTURE CONTENT
- H — Humid
- D — Damp
- M — Moist
- W — Wet
- S — Saturated
- LL — Liquid Limit
- PL — Plastic Limit

ENGINEERING GEOLOGY SECTION

DRILL No. 23
TYPE 500
DRILLER A. Sturiak.
START 1st. Jan. '68
FINISH 10th Jan. '68

LOGGED BY J.H.F.
DATE 23rd. Jan. '68
TRACED R.A.J.
CHECKED R.D.S

SHEET 1 OF 2. DRG No. S6441 Ja5

PF No. S5026A

DEPARTMENT OF MINES SOUTH AUSTRALIA

LOG OF CABLE TOOL HOLE

PROJECT KINGSTON ON-MURRAY BRIDGE CROSSING

FEATURE FOUNDATIONS.

LOCATION N.E. Bank, 1,650ft South of Punt.

SECTION

HUNDRED MOOROOK

CO-ORDS

HOLE NO C.H.2(B)

SERIAL No. 366/68

R.L. Surface 142 FT.

R.L. Collar FT.

Datum R. Murray Level.

SOIL TYPE GEOLOGICAL DESCRIPTION	R.L. (FEET) DEPTH	GRAPHIC LOG	GROUP SYMBOL	SOIL DESCRIPTION GROUP NAME Unified Soil Classification, U.S.B.R. Earth Manual 1st Edition 1963.	WATER LEVEL COLOUR	MOISTURE CONTENT	Consistency Compct. Dens'y.	FIELD TEST DATA: BLOWS PER FOOT 20 40 60 80	SOILTEST P'TR'METER UNITS* 1 2 3 4
LOWER TO MIDDLE MIOCENE MORGAN LIMESTONE EQUIVALENTS. Calcareous clay containing fossil fragments and numerous worm burrows filled with silt.	40		MH	See Sheet 1		DAMP		7 blows	
	110		CH	CLAY SOIL, high plasticity, slightly silty and sandy. Blue grey and contains 5% GRAVEL (fossil) fragments up to 20 mm. size.		≈ PL		17 blows	
Grey, calcarenitic fossil silts, sands and rubbly limestone. Uncemented.	30		ML/MH	SILT SOIL; medium plasticity, sandy. Light brown-grey Contains 5% gravel up to 40 m.m.				17 blows	
	120		SM/SC	SAND with variable clay and silt fines. Light brown-grey, contains 20% gravel (fossil) fragments.		DAMP		18 blows	GENERALLY N.A.
	26		ML	SILT SOIL low plasticity, sandy. Light grey. Est. 10% gravel (fossil) fragments up to 40mm.				17 blows.	
	130			End of hole 130 ft.					

* These values refer to clay soils only and provide an indication of their consistency.

APPENDIX A.

TYPE OF SAMPLE	CONSISTENCY	COMPACTNESS	RELATIVE DENSITY	MOISTURE CONTENT
A shoe (SA)	VS. — Very Soft	Ls — Loose	VL — Very Loose	H — Humid
D " (SD)	S — Soft	MC — Moderately Compact	L — Loose	D — Damp
E " (SE)	SF — Soft to Firm	C — Compact	MD — Medium Dense	M — Moist
C " (SC)	F — Firm	VC — Very Compact.	D — Dense	W — Wet
Sealed Tube - A Shoe - SAL	St. — Stiff		VD — Very Dense	S — Saturated
	V St. — Very Stiff			LL — Liquid Limit
	H — Hard			PL — Plastic Limit

Water level, (date) 7 Dec. '66 Casing

WCO Water cut

ENGINEERING GEOLOGY SECTION

DRILL No. 23

TYPE 5.00

DRILLER A. Sturak.

START 1st. Jan. '68

FINISH 10th. Jan. '68

LOGGED BY J. H. F.

DATE 23rd Jan '68

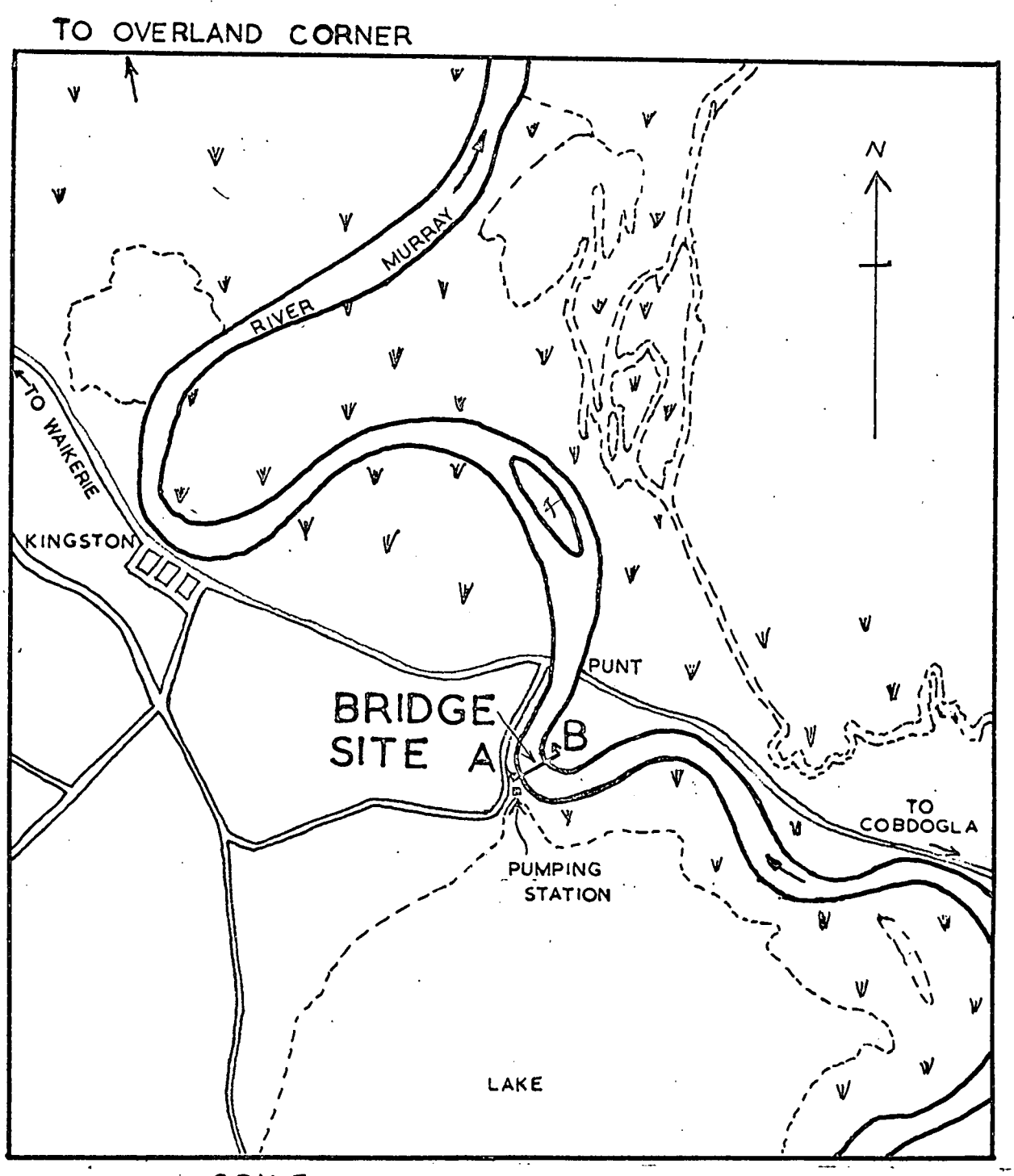
TRACED R.A.J.

CHECKED R.D.S.

SHEET 2 OF 2

DRG. No. S6441a Ja5

S6426A



SCALE
CHAINS

40 30 20 10 0 40 80

2,640 1000 0 2,000 4,000

FEET

FIG 1

DEPARTMENT OF MINES — SOUTH AUSTRALIA

ENGINEERING GEOLOGY SECTION	Drn.	KINGSTON-ON-MURRAY BRIDGE STURT HIGHWAY NO. 4 LOCALITY PLAN	SCALE: AS SHOWN
	Tcd.		S 6421 Ja 5
	Ckd.		
	Exd.		DATE: 6 JUNE 68

A

B

BH 1A

Kingston

BH 1C

LOXTON SANDS

Fine to coarse grained quartz sand.

BH 2

Talus

Pool Level (R.L. 139.00 ft.)

CH 1 (A)

BH 3

BH 4 & 4A

BH 5A

BH 5

BH 6A

BH 6

CH 2 (B)

Cobdogla

RIVER MURRAY DEPOSITS

Silts sands etc.

Erosion Surface

PATA LIMESTONE EQUIVALENTS

Calcarenitic silts and rubbly limestone, with sandy intercalations

Transitional Boundary

MORGAN LIMESTONE EQUIVALENTS

Grey fossiliferous silts sands and rubbly limestone.

87 ft. MH CH ML-MH SM-SC ML GM ML GM SC-SM 192 ft.

55 ft. SM-MH MH CH ML-MH SM-SC ML 30 ft.

ELEVATION IN FEET.

240 220 200 180 160 140 120 100 80 60 40 20 0

STRATIGRAPHIC SUCCESSION

QUATERNARY	RECENT TO PLEISTOCENE	RIVER DEPOSITS
TERTIARY	PLIOCENE	LOXTON SANDS
	MIDDLE ? MIOCENE	PATA LIMESTONE EQUIVALENT
	LOWER TO MIDDLE ? MIOCENE	MORGAN LIMESTONE EQUIVALENT

NOTE: Stratigraphy determined initially from paleontological examination of core from BH 5.

EXPLANATORY DIAGRAM

CH1(A) — Cable Tool Drill Hole showing depth & materials present. Constructed by Dept. of Mines.

BH 4 — Auger Drill Hole. Constructed by Schumann & K.W.G. Smith, Associates.

Natural Surface.

NO CORE

GROUP SYMBOL FOR TYPE OF MATERIAL PENETRATED. (BASED ON UNIFIED SOIL CLASSIFICATION.)

GRAPHIC SYMBOL

MH CH ML-MH SM-SC ML

60 ft. (DEPTH OF HOLE)

SCALE

20 0 20 40 60

FEET.

FIG 2.

FOR LOCATION OF SECTION SEE DWG NO. 56421

DEPARTMENT OF MINES — SOUTH AUSTRALIA

STURT HIGHWAY NO. 4.
KINGSTON-ON-MURRAY BRIDGE
GEOLOGICAL SECTION

ENGINEERING GEOLOGY SECTION.	Joanne H. Fryar. GEOLOGIST	Drn. J.H.F	SCALE As shown.
		Tcd. G.M.	68-195 Ja 5
		Ckd. W.R.B.	
Director of Mines	SENIOR GEOLOGIST	Exd.	DATE: 13 June '68

G+J.

2 HD. MOOROOK S: T/S

LOG OF BORE 6929-58

Depth From	Depth To	Nature of Strata
0'	9'6"	Water. 2.90
9'6"	15'	Coarse yellow sand some boulders.
15'	22'	Fine yellow silty sands.
22'	25'	Fine grey silty sands some bands coarse yello & shell fragments.
25'	30'	Grey silty traces blue clay & shell fragments
30'	41'	Grey green silts & shell fragments some hard
41'	57'	Fine grey silty sands hard bands cemented she & sand.
57'	60'	Fine grey silts shell fragments, hard bands t bleu clay.
60'	70'6"	Fine grey sandy silts some blue clay & shell fragments.

END OF BORE: 70'6"
DRILLER LOG

21.49.

Micro Film No. .....

2 0M—5.65 4244

RE: ROCKCOR B: 1,3

3 LOG OF BORE 6929-59

Depth From	Depth To	Nature of Strata
0'	32'	Water. 9.75
32'	40'6"	Green grey silty lime sand shell fragments, s hard bands.
40'6"	64'	Fine grey silts, shell fragments traces blue some hard bands.
64'	72'	Fine grey silty sand.
72'	73'10"	As above, some grey clay & shell fragments.
73'10"	74'4"	Blue clay fine sand & shell fragments.
74'4"	80'	Fine grey silty sands & grey clay, shell fragments.
80'	95'	Blue grey clay fine sand & shell fragments.
		END OF HOLE: 95'
		DRILLER'S LOG

28.96

Micro Film No. .....

2 0M—5.65 4244

4

LOG OF BORE 6929-60

Depth From	Depth To	Nature of Strata
0'	35'	Water. 10.67
35'	42'	Green to grey silt with shell fragments.
42'	44'	Grey silt with some shell fragments.
44'	48'	Grey silt.
		END OF HOLE: 48'
		DRILLER'S LOG
		14.6.60.

Micro Film No. .....

2 014—5.65 4244

4A 6929-61

LOG OF BORE

Depth From	Depth To	Nature of Strata
0'	34'	Water. 10.36
34'	43'6"	Green to grey marl.
43'6"	46'6"	Grey silts.
46'6"	64'	Cemented grey silts.
64'	72'	Grey silts with clay traces.
72'	75'	Grey silts with clay traces.
75'	93'	Blue to grey clayish silts with shell fragm
		END OF HOLE: 93'
		DRILLER'S LOG.
		28.35

Micro Film No. .....

2 0M—3.65 4244

Depth From	Depth To	Nature of Strata
0'	15'6"	To River Bottom. 4.72
15'6"	16'6"	Brown, fine to med. SAND. Scattered mica flak Thin layers of bluish grey silty fine sand wit lignitic fragments in top few inches.
16'6"	21'6"	Light brown, med. to coarse SAND. Rounded qua grains. H igh uniformity coeff.
21'6"	25'	Grey, med. to coarse SAND. Rounded quartz gra High uniformity coeff with a thin layer of v. fine SANDSILT.
25'	33'	Light greyish brown to light brown, Fine SAND. Scattered mica.
33'	34'	Grey, fine to med. SAND Scattered mica.
34'	35'	As above.
35'	42'	Olive grey, sl. clayey v. fine SAND-SILT with numerous small shell fragments. Scattered smal silty clay (CLO) patches. Dominantly sand Bottom foot. Turritella are present. General v. low plas. Medium low in patches. Num. small dark rounded grains. Greenish in part glauconitic.
42'	46'	No sample for description.
46'	47'	Light grey, v. fine sand-silt. Calcareous. Scatt. shell frags. including Turitella Murrayana.
47'	51'	Light grey, v. fine sand-silt. As above but wi lime cemented hard patches. (Numulities at 47'-48').
51'	54'	Light grey, v. fine sand-silt. As above but g generally weakly lithified by lime cement. Sa shattered in sampling.
54'	58'6"	Light grey. Interbedded medium grained SAND & silty v. fine SAND which has hard partly cemen lime patches. Spartse shell fragments. The m sand has high uniformity. The cemented patche are brittle.
58'6"	68'	Light grey. v. fine SAND-SILT. Calcareous. Patches of hard lime cemented patches. Sparse shell fragments.

Micro Film No. .....

2 OM—5.65 4644

RD. MOOROOK S. 43

5

LOG OF BORE

Depth From	Depth To	Nature of Strata
68'	74'0"	Light grey, silty fine SAND with med. grained clean sand layer 73'-73'4". Limey sparse shell fragments.
74'	78'	Olive grey streaky clayey. v. fine SAND-SILT. Very calcareous low plasticity.
78'	95'6"	Light grey, v. fine SAND-SILT Very calcareous. Scattered small shell fragments. Small scattered sl. clayey darker grey patches.

29.11

Micro Film No. .....

2 0/A—5.65 4244

5A? 6. **LOG OF BORE** 6929-63

Depth From	Depth To	Nature of Strata
0'	8'	Water. 2.44
8'	20'	Grey sand & clay.
20'	34'6"	Coarse sand.
34'6"	41'6"	Fine grey silty clay sand & shell fragments.
		END OF BORE: 41'6"
		DRILLER LOG
		12.61' (10.21)

Micro Film No. .....

2 0M—6.65 4244