Rept.Bk.No. 74/68

SOUTH EAST WATER RESOURCES

ROBE TOWN WATER SUPPLY
BORE NOS. 2, 2A and 3
AQUIFER TESTS

O. J.W. BOWERING

Department of Mines
South Australia —

DEPARTMENT OF MINES
SOUTH AUSTRALIA

SOUTH EAST WATER RESOURCES

ROBE TOWN WATER SUPPLY
BORES NOS. 2, 2A and 3
AQUIFER TESTS

by

O.J.W. Bowering
Assistant Senior Geologist
South East Regional Office

Rept.Bk.No. 74/68
G.S. No. 5387
Hyd. No. 2630
D.M. No. 1194/66

23rd May, 1974

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DEPARTMENT OF MINES SOUTH AUSTRALIA

HYDROGEOLOGY SECTION

BORE LOG

HIRER E & W S Dept.

Drill type Cable tool
Circulation Water
Driller W.H.James
Start 24-9-73
Finish 11-10-73

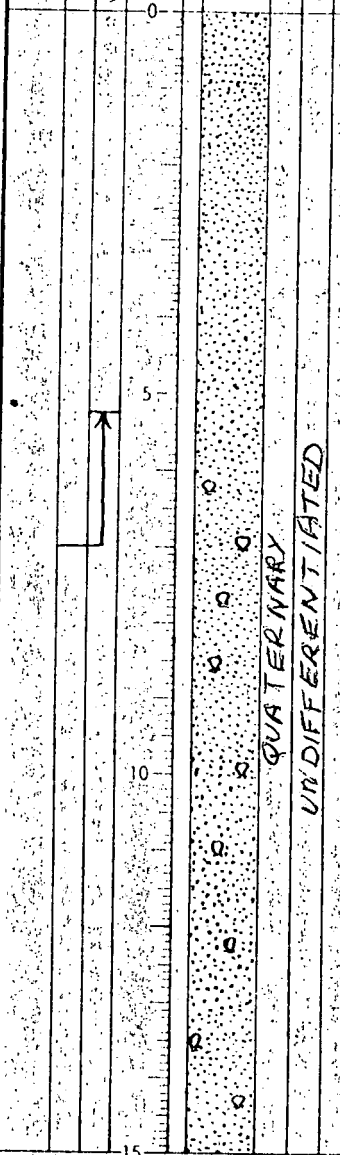
Logged by R.Read
Date logged 11-10-73
Bore Diameter 10"
DEPTH 40·0

A.M.G. Zone
Coords: E
N
Datum Elev.
(m) Ref. Pt. Elev.
Surface Elev.

HUNDRED Waterhouse
SECTION Adj 193
STATE No. 687019303
Project No. 2
Docket No. 1436/57
Bore Serial No. 19/74

Depth to Water cut. (m)	Depth to standing water (m)	SUPPLY litres/sec.	SUPPLY Method of test	TOTAL DISSOLVED SOLIDS Milligrammes/litre	TOTAL DISSOLVED SOLIDS Analysis W No.
7·0	5·22	20	12 hr pump test 24 hr recovery test	830	

REMARKS Permit Nº A 252 Robe bore Nº 2



DEPTH (m) From	To	DESCRIPTION
0	15	SAND, well sorted, fine to medium grained, 0·25 to 0·5mm, av. 0·3mm. Slightly calcareous, yellow-brown.
		6-8m much coarser, 1 to 1·5mm, with large bivalve fragments, grey.
		8-15m as 6-8m with echinoid spines and some shell fragments. 1 to 1·5mm

Drn: J.M.B. Sheet 1 of 2
Date: 11.4.74 Bore Folder No.

PF Nº S10537 MH

DEPARTMENT OF MINES
SOUTH AUSTRALIA

Rept.Bk.No. 74/68
G.S. No. 5387
Hyd. No. 2630
D.M. No. 1194/66

Robe Town Water Supply
Bore Nos. 2, 2A, and 3

Aquifer Tests

Client: Engineering & Water Supply Department

LOCATION: GENERAL Northeastern part of town of Robe.

REGION 1

COUNTY Robe

HUNDRED Waterhouse

SECTION Adjacent 193

Permit Nos. A252, A454, A455

ABSTRACT

Three bores were drilled at Robe to develop an additional town water supply and to investigate salinity and the extent of hydrogen sulphide contamination. An aquifer test of 12 hours duration gave a value of transmissivity of 2,424 metres 3/day/metre and a storage coefficient of 0.256 in the Gambier Limestone at Robe. Little variation in salinity was noted during the course of the test. The results of salinity sampling with depth are also presented.

INTRODUCTION

Due to a greatly increased demand for water in the town of Robe during the tourist season, it has become necessary to provide an additional supply of groundwater to overcome the shortage.

Previous investigations by the Department of Mines to examine fresh-salt interface phenomena have located good quality water in the Gambier Limestone in a general area to the northeast of the town.

It was decided to further investigate this area of good quality water with a view to its possible development for an additional supply during the tourist season.

A salinity survey carried out in 1973 (Bowering & Edwards 1973) delineated the area of good quality groundwater near Long Beach to the northeast of the town, within which a site for an aquifer test was selected.

This report summarises the results of the aquifer test to determine yield and aquifer parameters. A further objective of the test was to determine whether or not any change in groundwater salinity would occur during the test and whether or not hydrogen sulphide gas contamination would be dispelled after a period of pumping.

A further exploratory bore hole, now designated the Robe town water supply bore No. 3, was drilled to examine the possibility of obtaining a good supply of low salinity groundwater free of hydrogen sulphide. Drilling continued below a zone of salt water intrusion detected by resistivity depth probing near the coast in Test area I during the hydrogeological investigations of that area (Harris, 1969). Bore No.3 is located approximately 250 metres north of borehole No.2. A locality plan is shown in Figure 1.

CONSTRUCTION DETAILS

Drilling commenced on 24th September, 1973 using a cable tool rig.

Bore No.2 was completed at a depth of 40 metres, with 10 inch (254mm) casing installed to a depth of 18 metres. The bore was pumped for seven hours to develop the aquifer and to establish flow rates and drawdown. This was completed on 2nd September, 1973.

The rig was then moved and the second bore, Robe T.W.S. bore No.2A, was drilled 10 metres south of Bore No.2 as a pump test observation bore.

This hole was completed at a depth of 40 metres and lined with 3 inch (76 mm) P.V.C. casing which was perforated between 34 and 40 metres. Some difficulty was experienced in this bore with unconsolidated sandy limestone continually collapsing into the borehole during drilling.

On completion of bore No. 2A, the plant was moved to the site of bore No. 3. This bore which was commenced on 12.10.73 was completed at a depth of 80 metres, the 6 inch (152 mm) casing being driven closely behind the bit all the way. When all sampling had been completed, the bore was backfilled and a cement plug placed at 40 metres to prevent contamination of the good quality water in the upper aquifer by saline water below. The casing was pulled back to 29 metres and pressure cemented to the surface.

A sketch of bores 2A and 3 is shown in figure 2.

BOREHOLE GEOLOGY AND HYDROGEOLOGY

Sludge samples were collected during drilling at 2 metre intervals or at a change in lithology noted by the driller. Bit and tube samples were obtained where possible. Water samples were obtained every ten metres from bore No. 2A and at intervals varying from 1 to 6 metres in bore No. 3.

The sedimentary section encountered in all three bores consists of the Gambier Limestone overlain by Bridgewater Formation.

The bore logs of Robe T.W.S. bore No. 2 and bore No. 3 are shown in Appendix A. The log of bore No. 2A is not included, being identical to that of bore No. 2. In Robe T.W.S. bore No.3, the section is as follows:-

Bridgewater Formation 0-23 metres

The upper part of this unit (0-9 m) consists of yellow-brown aeolianite which is underlain by a dark grey unconsolidated sand, silty in part and containing abundant organic matter and coarse shell fragments.

Gambier Limestone 23-80 metres

From 23 to 40 metres, the lithology consists of bryozoal limestone and calcarenite, cream to yellow in colour. From 40 to 80 metres the section becomes generally lighter and consists of pale grey and cream marl and calcilutite. Flinty bands appear below a depth of approximately 50 metres, and the section becomes a little more porous towards the bottom of the hole.

The Gambier Limestone in this area is an unconfined aquifer. In bores 2 and 2A, water was first cut at a depth of 7 metres and rose to 5.22 metres and 5.24 metres respectively.

In the Robe T.W.S. bore No. 3, water was cut at 16 metres and rose to 6.50 metres. Salinity of the groundwater is approximately 050 milligrams/litre but only long term pumping will determine whether or not salinity is likely to change. However, if the bore is used only during periods of peak demand, no problems should arise with increasing salinity of the groundwater in the Robe T.W.S. bore No. 2.

In all three bores, the groundwater in the upper part of the Gambier Limestone smelled strongly of hydrogen sulphide gas. The source of the hydrogen sulphide is obscure but there are possibilities:

(a) Traces of pyrite were noted in the sludge samples of Robe T.W.S. bore No. 3. If significant quantities of pyrite occur

within the Gambier Limestone in the general area, this may account for the hydrogen sulphide contamination.

(b) Landowners in the Mt. Benson area have reported groundwater contaminated with hydrogen sulphide being associated with semi-decomposed seaweed material occurring within sediments of Recent age.

WATER SAMPLING AND QUALITY

A sample of groundwater was taken where cut in Robe T.W.S. Bore No. 2. In the No. 2A bore, water samples were taken every ten metres during drilling. During the aquifer test on the No. 2 bore, water samples were taken at two hourly intervals to examine the variation in salinity with time. Samples were also taken for the E. & W.S. Department for bacterial analysis.

The samples taken during the pump test show a slight increase in salinity over a period of 12 hours. This may suggest that more saline water is being drawn to the bore by pumping but the result of the salinity survey carried out in 1973 (Bowering & Edwards 1973) suggest that Groundwater salinity should not increase markedly as long as the bore is used for standby purposes only.

During the drilling of the Robe T.W.S. bore No. 3, water samples were obtained after short periods of pumping by means of the Mines Department's mobile submersible pumping unit at selected depths down to 43 metres. At this depth the pumping unit broke down and water samples were therafter obtained at one metre intervals by bailing. The objectives of this sampling programme were:-

(a) To examine the variation in salinity with depth to determine the availability or otherwise of a supply of fresh water

below the zone of salt water as recorded in S.E.B. 1 and,

(b) To determine the extent of hydrogen sulphide contamination of groundwater with increasing depth in the Gambier Limestone and to determine whether or not water free from such contamination was obtainable by deeper drilling.

A resume of the results of the water sampling programme is given in Appendix C and the salinity profile is shown in Figure 5 which is a plot of salinity against depth. The salinity profile shows a gradual increase in salinity to 36 metres. From 36 to 49 metres salinity increases markedly from 440 to 2430 mg/l. This interval corresponds to a decrease in permeability of the Gambier Limestone. From 61 metres to the bottom of the bore, salinities up to 15,800 mg/l. were encountered. The profile shows that no suitable groundwater is obtainable below the zone contaminated with hydrogen sulphide gas.

AQUIFER TEST, BORE NO.2

At the completion of the observation bore, the aquifer comprising the Gambier Limestone and the overlying Bridgewater Formation, was tested by pumping from the Robe T.W.S. bore No. 2 using the Deutz test unit No. 2. The 15.2 cm 12 stage pump was set at a depth of 31 metres. The bore was pumped at an average rate of 23 litres per second (1976 m^3/day) and deviation from this figure did not exceed 5%. Water level readings were taken with an electric probe at the following time intervals:-

start to 10 minutes	:	1 minute intervals
10 to 20 minutes	:	2 minute intervals
20 to 100 minutes	:	5 minute intervals
100 to 180 minutes	:	10 minute intervals
180 to 240 minutes	:	30 minute intervals
240 to end	:	60 minute intervals

A graph showing the variation in drawdown plotted against the logarithm of time to the base 10 is shown in Figure 3. The pumping test was followed by a recovery test of 8 hours duration.

The drawdown plot shows a steep slope until approximately 30 minutes after pumping commenced. The drawdown per log cycle of time ($\triangle s$) has been calculated from the slope of that part of the graph beyond 50 minutes after which time it is considered that the modified Thies equation applies. The slope of this part of the graph ($\triangle s$) is 0.15 m per log cycle. A good approximation of the value of transmissivity (T) of the aquifer can be determined by the Jacob method.

Using the equation:-

$$T = \frac{0.183 \times Q}{\triangle s}$$

Where T = transmissivity (metres^3/day/metre)

Q = pumping rate (metres^3/day)

$\triangle s$ = drawdown per log cycle of time (metre)

substituting the measured values into the above equation gives:-

$$T = \frac{0.183 \times 1987}{0.150}$$

$$= 2424 \text{ metres}^3\text{/day/metre}$$

One possible source of error in this calculation lies in the fact that full penetration of the aquifer was not achieved. However in the Robe T.W.S. bore No. 3, it was found that below 40 metres, the section becomes marly and fairly tight and behaves partially as an impermeable base to the limestone aquifer from which groundwater was withdrawn during the test. The error involved by partial penetration is therefore not as great as would be the case had the aquifer been homogeneous throughout its total thickness.

Because of the shallow slope of the straight line section of the drawdown curve, it is difficult to determine a satisfactory value of t_o.* It is therefore necessary to use an equation independent of t_o to obtain a value of storage coefficient (S). The equation:-

$$S = \frac{2.25T\ t/r^2}{\log^{-1} 10\ (Ts/2.30Q)}$$ is used

On substitution this becomes

$$S = \frac{2.25 \times 28.1 \times 10^{-3} \times \frac{100}{10}\ 2 \times 60}{\log^{-1} 10\ (\frac{12.58 \times 28.1 \times 10^{-3} \times 1.57}{2.30 \times 23.0 \times 10^{-3}}}$$

$$= 0.256$$

This value appears quite reasonable for the Gambier Limestone at Robe.

The specific capacity of the bore is the discharge rate available per unit of drawdown and is obtained by dividing the discharge rate (Q) used during the aquifer test by the total drawdown. In this case, the value of specific capacity is:

$$Q/S \text{ final} = \frac{23 \text{ litres/sec}}{5.0\ T \text{ metres}}.$$

$$= 4.55 \text{ litres/sec/metre}$$

---

*t_o is a theoretical figure and represents the time at which drawdown is zero. It is obtained by extrapolating the drawdown curve back to where it intersects the line representing s = o. This method cannot be used when high transmissivities occur.

From the known value of transmissivity, approximate drawdown curves for the pumping bore can be constructed for different pumping rates. The maximum drawdown in the pumped bore was 5.07 metres after 12 hours of pumping at 23 litres/second.

The equation:-

$$\Delta s = \frac{0.183 \times Q}{T}$$

$= 6.52 \times 10^{-3} Q$ This can be used to predict values of drawdown (s) for various pumping rates.

(a) when Q = 10 litres/second (870m^3 day)

$\Delta s = 0.065$ m

(b) when Q = 15 litres/second (1300 m^3 day)

$\Delta s = 0.98$ m

(c) when Q = 20 litres/second (1700 m^3 day)

$\Delta s = 0.13$ m

The theoretical drawdown curves for the pumping rates given above are shown in Figure 4.

CONCLUSIONS

The calculated transmissivity of the upper part of the Gambier Limestone and the overlying sands of the Bridgewater Formation at the Robe T.W.S. bore No. 2 is 2,424 m^3/day/m, and the storage coefficient of this aquifer is 0.258 or 25.6%.

The specific capacity of the pumped bore is 4.55 litres/second/metre of drawdown.

The hydrogen sulphide contamination was not dispelled during the aquifer test and it appears unlikely that it would be dispelled by prolonged periods of pumping.

There is no viable source of water suitable for town water supply purposes below the aquifer tested.

RECOMMENDATION

It is recommended that salinity sampling be carried out on six bores within the general area of the Robe T.W.S. bore No.2 at regular intervals during heavy pumping in the tourist season. It would be advisable to carry out the sampling at monthly intervals initially, to detect the possibility of any increase on groundwater salinity in the area.

O.J.W. Bowering
Assistant Senior Geologist
South East Regional Office

OJW:JL
23rd May 1974

REFERENCES

Bowering, O.J.W. and Edwards, D.R., 1973. Report on a Salinity Survey Northeast of the Township of Robe for the E. & W.S. Department. S.A. Dept. Mines unpublished report. 73/121.

Harris, B.M., 1969. Southeast Water Resources Hydrogeology Progress Report No. 4 Test Area I. Results of Geological and Geophysical Investigation July 1969. S.A. Dept. Mines unpublished Report 69/63.

APPENDIX A

LOGS BORE NOS.2 and 3

DEPARTMENT OF MINES SOUTH AUSTRALIA

HYDROGEOLOGY SECTION

BORE LOG

HIRER E. & W.S. Dept.

Drill type Cable tool
Circulation Water
Driller W.H.James
Start 24-9-73
Finish 11-10-73

Logged by R.Read
Date logged 11-10-73
Bore Diameter 10"
DEPTH 40·0 (m)

A.M.G. Zone
Coords. E
" N
Datum Elev.
Rel. Pt. Elev.
Surface Elev.

HUNDRED Waterhouse
SECTION Adj 193
STATE No. 687019303
Project No. 2
Docket No. 1436/57
Bore Serial No. 19/74

Depth to Water cut (m)	Depth to standing water (m)	SUPPLY		TOTAL DISSOLVED SOLIDS	
		litres/sec.	Method of test	Milligrammes/litre	Analysis W. No.
7·0	5·22	20	12 hr pump test 24 hr recovery test	830	

REMARKS Permit Nº A 252 Robe bore Nº 2

CASING	WATERS CUT	WATER LEVEL	DEPTH (m)	CORE	GRAPHIC LOG	AGE	UNIT	DEPTH (m) from	DEPTH (m) to	DESCRIPTION
			0			QUATERNARY	Undifferentiated	0	15	SAND, well sorted, fine to medium grained, 0·25 to 0·5mm, av. 0·3mm. Slightly calcareous, yellow-brown.
										6-8m much coarser, 1 to 1·5mm, with large bivalve fragments, grey.
										8-15m as 6-8m with echinoid spines and some shell fragments. 1 to 1·5mm
			5							
			10							
			15							

Drn: J.M.B. | Sheet 1 of 2
Date: 11·4·74 | Bore Folder No.

DEPARTMENT OF MINES — SOUTH AUSTRALIA

CASING	WATERS CUT	WATER LEVEL	DEPTH (m)	CORE	GRAPHIC LOG	AGE	UNIT	DEPTH (m) from	to	DESCRIPTION
			15–40			OLIGO - MIOCENE	GAMBIER LIMESTONE	15	40	CALCARENITE, 0·25 – 0·5 mm, av. 0·3mm with some fragments to 0·7mm. Abundant echinoid spines. Some fine sand grains present, light grey. 21 - 29 m off white. 29 - 40m occasional shell fragments END OF HOLE 40m.

Depth scale: 15, 20, 25, 30, 35, 40

Borehole State No. 687019303

Drn: J.M.B

Date: 11.4.74

Sheet 2 of 2

Bore Folder No.

PF Nº 910837u MH

DEPARTMENT OF MINES SOUTH AUSTRALIA

HYDROGEOLOGY SECTION

BORE LOG

HIRER E&WS Dept.

Drill type Percussion
Circulation Water
Driller
Start
Finish

Logged by D. Edwards
Date logged 16-11-73
Bore Diameter
DEPTH 80m.

A.M.G. Zone
Coords. E
" N
Datum Elev.
(m) Ref. Pt. Elev.
Surface Elev.

HUNDRED Waterhouse
SECTION 193
STATE No. 687019305
Project No. EWS Bore No3
Docket No.
Bore Serial, No.

Depth to Water cut (m)	Depth to standing water (m)	SUPPLY		TOTAL DISSOLVED SOLIDS	
		litres/sec.	Method of test	Milligrammes/litre	Analysis W. No.

REMARKS (Bore No 3) Permit No. A486

CASING | WATERS CUT | WATER LEVEL | DEPTH (m) | CORE | GRAPHIC LOG | AGE | UNIT

DEPTH (m) from	to	DESCRIPTION
0	0.5	QUARTZ - ARENITE; 90-100% dark & light quartz particles (0.1 - 0.5mm) Average size = 0.25 m.m. subangular to subrounded particles 5-10% Calcareous particles (white). 5-10% dark organic matter
0.5	18	ARENITE - CALCARENITE; 50% quartz arenite (description as above) 50% yellow and white calcareous fragments. (0.1 to 0.50mm) average grain size = 0.40 m.m. Some fresh & dull coloured shell chips up to 3m.m. diam. Sponge spicules also present 16 - 18m: - Almost wholly composed of shell chips and shells (molluscs) Some subrounded quartz particles to 1.5m.m. diam. Brown to grey.

0 5 10 15

QUATERNARY UNDIFFERENTIATED

Drn: D.R.E. Sheet 1 of 4
Date 21-12-73 Bore Folder No.

PF No S10537 MH

DEPARTMENT OF MINES — SOUTH AUSTRALIA

CASING | WATERS CUT | WATER LEVEL | DEPTH (m) | CORE | GRAPHIC LOG | AGE | UNIT

DEPTH m from to

DESCRIPTION

18 - 23

CALCARENITE - ARENITE - 50% yellow & white calcareous grains (0.1 - 0.5 m.m.) Average size = 0.40mm Sponge spicules, coral fragments & bryozoal sticks abundant. 50% dull & clean quartz grains, 0.1 - 0.40 m.m. average size = 0.25 m.m. Grey.

23 - 80

CALCARENITE; 90 - 100% white to off-white calcareous grains 0.1 to 2.00 m.m. Average size = 0.30 m.m. Coral chips, bryozoa sticks & foraminifer discernable Echinoderm spines and rounded glauconite pellets (0.1 to 0.3 mm.) also present. 10% Arenite. quartz grains - average size 0.20 m.m.
57-80; abundant black flint fragments up to 2.50 cm. Also calcrete fragments to 2.00 cm. Calciciltite (grey) comprises 30 - 40% Off-white to grey.

20 25 30 35 40

Borehole State No.

Drn.

Date

Sheet 2 of 4

Bore Folder No.

PF Nº S10537a MH

DEPARTMENT OF MINES — SOUTH AUSTRALIA

CASING	WATERS CUT	WATER LEVEL	DEPTH (m)	CORE	GRAPHIC LOG	AGE	UNIT	DEPTH (m) from	DEPTH (m) to	DESCRIPTION
			45							
			50							
			55							
			60							
			70							

Borehole State No.

Drn:

Date:

Sheet 3 of 4

Bore Folder No.

PF Nº S10537a MH

DEPARTMENT OF MINES — SOUTH AUSTRALIA

CASING | WATER CUT | WATER LEVEL | DEPTH (m) | CORE | GRAPHIC LOG | AGE | UNIT | DEPTH (m) from to | DESCRIPTION

END HOLE 80 M.

Borehole State No.

Drn.

Date:

Sheet 4 of 4

Bore Folder No.

PF Nº S10537a MH

APPENDIX B

WATER ANALYSIS

Robe

WATER ANALYSIS REPORT

AMDEL COMPUTER SERVICES

SAMPLE NO. W2856/73 JOB NO. 125/74

CHEMICAL COMPOSITION

		MILLIGRAMS PER LITRE MG/L	MILLIEQUIVS. PER LITRE ME/L
CATIONS			
CALCIUM	(CA)	56.	2.8
MAGNESIUM	(MG)	43.	3.5
SODIUM	(NA)	155.	6.7
POTASSIUM	(K)	6.	.2
ANIONS			
BICARBONATE	(HCO3)	327.	5.4
SULPHATE	(SO4)	29.	.6
CHLORIDE	(CL)	255.	7.2
NITRATE	(NO3)	<1	.0

TOTALS AND BALANCE

CATIONS (ME/L)	13.2	DIFF =	.0
ANIONS (ME/L)	13.1	SUM =	26.4

DIFF*100. / SUM = .3 %

DERIVED AND OTHER DATA

CONDUCTIVITY (E.C.)
MICRO-S/CM AT 25 DEG. C 1330.

	MILLIGRAMS PER LITRE MG/L
TOTAL DISSOLVED SOLIDS	
A. BASED ON E.C.	
B. CALCULATED (HCO3=CO3)	705.
C. RESIDUE ON EVAP. AT 180 DEG. C	
TOTAL HARDNESS AS CACO3	317.
CARBONATE HARDNESS AS CACO3	268.
NON-CARBONATE HARDNESS AS CACO3	49.
TOTAL ALKALINITY AS CACO3	268.
FREE CARBON DIOXIDE (CO2)	
SUSPENDED SOLIDS	
SILICA (SIO2)	
BORON (B)	

	UNITS
REACTION - PH	8.0
TURBIDITY (JACKSON)	
COLOUR (HAZEN)	
SODIUM TO TOTAL CATION RATIO (ME/L)	51.0 %

REMARKS

NAME-E.W.S. DEPT. Case 3
ADDRESS-ROBE

DATE COLLECTED-22- 6-73
DATE RECEIVED-

HUNDRED-WATERHOUSE
SECTION-ADJ 193
HOLE NO-
SUPPLY-
SAMPLE COLLECTED BY-W.D. WILSON

WATER CUT-3.47M SWL
WATER LEVEL-
DEPTH HOLE-68.58M

WATER ANALYSIS REPORT — AMDEL COMPUTER SERVICES

SAMPLE NO. W3812/76 — JOB NO. 536-77

CHEMICAL COMPOSITION

		MILLIGRAMS PER LITRE MG/L	MILLIEQUIVS. PER LITRE ME/L
CATIONS			
CALCIUM	(CA)	59	2.9
MAGNESIUM	(MG)	25	2.1
SODIUM	(NA)	93	4.0
POTASSIUM	(K)	4	.1
IRON	(FE)	.62	.0
ANIONS			
HYDROXIDE	(OH)		
CARBONATE	(CO3)		
BICARBONATE	(HCO3)	263	4.3
SULPHATE	(SO4)	23	.5
CHLORIDE	(CL)	166	4.7
BROMIDE	(BR)		
FLUORIDE	(F)	0.75	.0
NITRATE	(NO3)	<1	.0
PHOSPHATE	(PO4)		

TOTALS AND BALANCE

CATIONS (ME/L)	9.1	DIFF =	.4
ANIONS (ME/L)	9.5	SUM =	18.7

DIFF*100. / SUM = 1.9 %

DERIVED AND OTHER DATA

CONDUCTIVITY (E.C.) MICRO-S/CM AT 25 DEG. C 940.

TOTAL DISSOLVED SOLIDS	MILLIGRAMS PER LITRE MG/L
A. BASED ON E.C.	
B. CALCULATED (HCO3=CO3)	500.
C. RESIDUE ON EVAP. AT 180 DEG. C	538

TOTAL HARDNESS AS CACO3	250.
CARBONATE HARDNESS AS CACO3	215.
NON-CARBONATE HARDNESS AS CACO3	35.
TOTAL ALKILINITY AS CACO3	215.
FREE CARBON DIOXIDE (CO2)	
SUSPENDED SOLIDS	
SILICA (SIO2)	9
BORON (B)	0.10

	UNITS
REACTION - PH	7.3
TURBIDITY (JACKSON)	0.38
COLOUR (HAZEN)	2.5

SODIUM TO TOTAL CATION RATIO (ME/L) 44.2 %

REMARKS

NAME- DEPT MINES
ADDRESS-ROBE TWS NO 2

State No. ~~NUMBER~~ 1-687019303
SECTION-
HOLE NO-TCWD 151
SUPPLY-
SAMPLE COLLECTED BY-

WATER CUT-
WATER LEVEL-
DEPTH HOLE-

DATE COLLECTED
DATE RECEIVED

HD. WATERHOUSE F 76/-

COPY - RECORDS SECTION

WATER ANALYSIS REPORT

AMDEL COMPUTER SERVICES

SAMPLE NO. W4533/73 JOB NO. 1725/74

CHEMICAL COMPOSITION

		MILLIGRAMS PER LITRE MG/L	MILLIEQUIVS. PER LITRE ME/L
CATIONS			
CALCIUM	(CA)	62.	3.1
MAGNESIUM	(MG)	46.	3.8
SODIUM	(NA)	200.	8.7
POTASSIUM	(K)	10.	.3
ANIONS			
BICARBONATE	(HCO3)	280.	4.6
SULPHATE	(SO4)	29.	.6
CHLORIDE	(CL)	369.	10.4
NITRATE	(NO3)	<1	.0

TOTALS AND BALANCE

CATIONS (ME/L)	15.8	DIFF =	.2
ANIONS (ME/L)	15.6	SUM =	31.4

DIFF*100. / SUM = .7 %

DERIVED AND OTHER DATA

CONDUCTIVITY (E.C.) MICRO-S/CM AT 25 DEG. C 1758.

	MILLIGRAMS PER LITRE MG/L
TOTAL DISSOLVED SOLIDS	
A. BASED ON E.C.	
B. CALCULATED (HCO3=CO3)	854.
C. RESIDUE ON EVAP. AT 180 DEG. C	
TOTAL HARDNESS AS CACO3	344.
CARBONATE HARDNESS AS CACO3	230.
NON-CARBONATE HARDNESS AS CACO3	114.
TOTAL ALKALINITY AS CACO3	230.
FREE CARBON DIOXIDE (CO2)	
SUSPENDED SOLIDS	
SILICA (SIO2)	
BORON (B)	

	UNITS
REACTION - PH	8.1
TURBIDITY (JACKSON)	
COLOUR (HAZEN)	
SODIUM TO TOTAL CATION RATIO (ME/L)	54.9 %

REMARKS

NAME-E.W.S.
ADDRESS-ROBE

HUNDRED-WATERHOUSE
SECTION-ADJ 193
HOLE NO-2
SUPPLY-
SAMPLE COLLECTED BY-W H JAMES

WATER CUT-
WATER LEVEL-
DEPTH HOLE-40.00M

DATE COLLECTED-11-10-73
DATE RECEIVED-

F: 74/1

68701930 3
WEM

APPENDIX C

RESULTS OF SALINITY SAMPLING WITH DEPTH AT ROBE T.W.S. BORE NO. 3

APPENDIX C

RESULTS OF SALINITY SAMPLING WITH DEPTH AT ROBE T.W.S. BORE NO. 3

Samples were obtained by means of the mobile submersible pumping unit down to a depth of 43 metres at which stage, the unit broke down.

Sampling was continued thereafter by means of bailing, The results of the sampling are tabulated below.

(METRES)	ppm	REMARKS
16	-	Water smelling of H_2S in shelly sand.
17	310	Hydrogen sulphide present.
18	335	" " " "
20	355	" " " "
22	355	" " " "
24	425	" " " "
24		Sampled after 10 minutes pumping with casing at 23 m. H_2S present.
30	425	Sampled after 15 minutes pumping with casing at 25 m. H_2S present.
36	440	Sampled after 15 minutes pumping H_2S present.
43	1040	" "
44	1300	Bailed H_2S present.
45	1340	" "
46	1440	" "
47	1990	" H_2S present but diminishing.
48	2430	" H_2S present.
49-53		Samples contaminated by upper water.
54	1300	No H_2S.
55-60		Samples not reliable-little water present.
61	7000	No. H_2S.
62	13600	" "
63	10200	" "
64	10800	" "
65	10600	No H_2S.
66	3300	Samples appear to be diluted by water.
67	5600	higher in section.
68	15800	
69	12500	
70	12600	

71	7900	
72	9300	
73	9800	
74	3800	
75	15000	
76	3540	
77	3010	
78	1990	
79	2670	
80	5100	Casing driven to 79 metres.

RESULTS OF SALINITY SAMPLING WITH TIME ROBE T.W.S. BORE NO.2

Samples were taken at 2 hourly intervals during the aquifer test and analysed for A.T.S. The results are tabulated below.

At start of test	740 ppm.
2 hours	750 ppm.
4 hours	800 ppm.
6 hours	800 ppm.
8 hours	860 ppm.
10 hours	860 ppm.
12 hours	830 ppm.

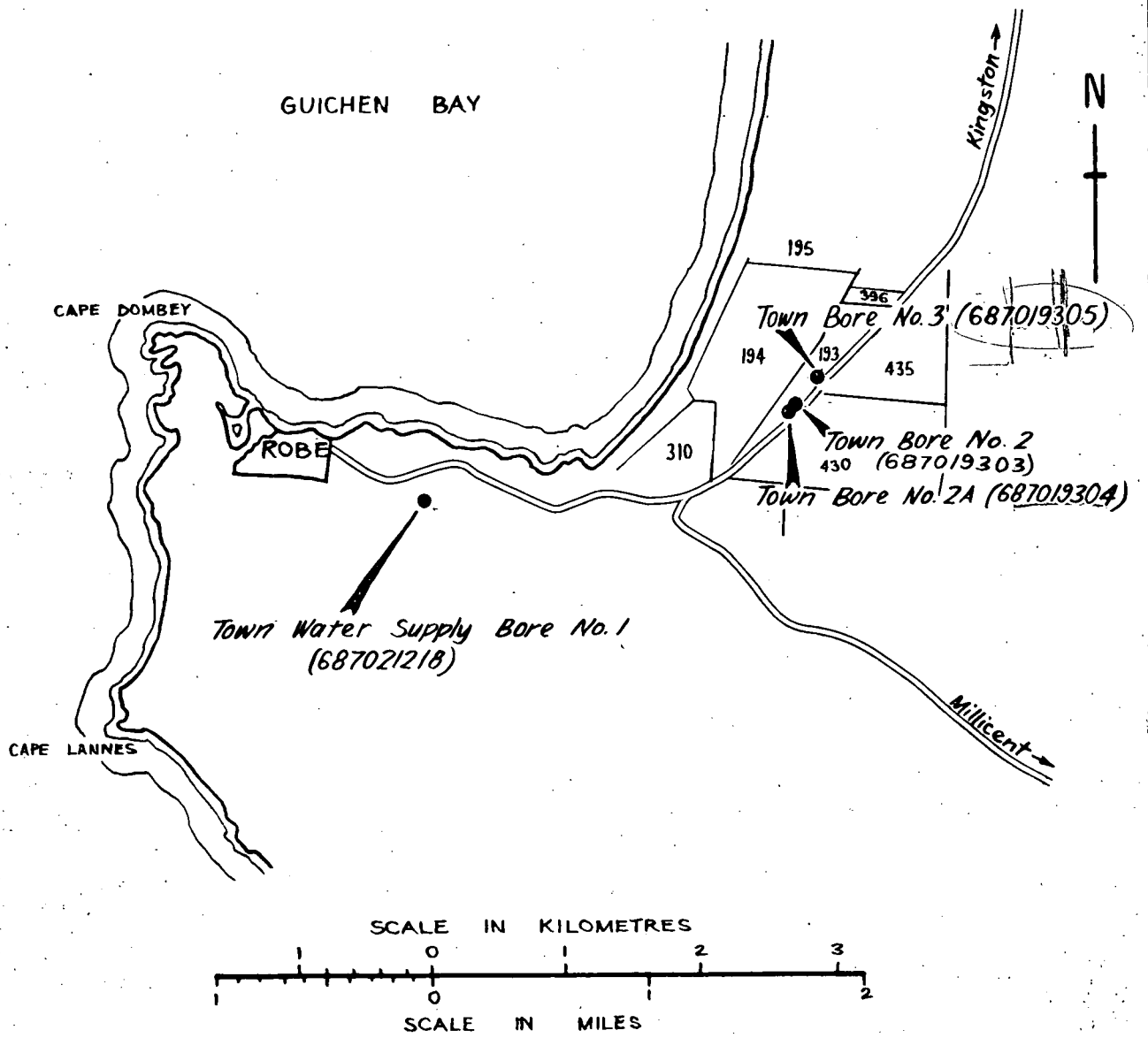


FIG. 1

DEPARTMENT OF MINES — SOUTH AUSTRALIA

HYDROGEOLOGY SECTION	Drn. RJM	ROBE TOWNSHIP WATER SUPPLY — LOCATION OF BORES 1, 2, 2A, & 3	SCALE: 1:50 000 (orig.)
	Tcd.		S10733 Ke10
	Ckd.		DATE: 27-2-74
	Exd.		

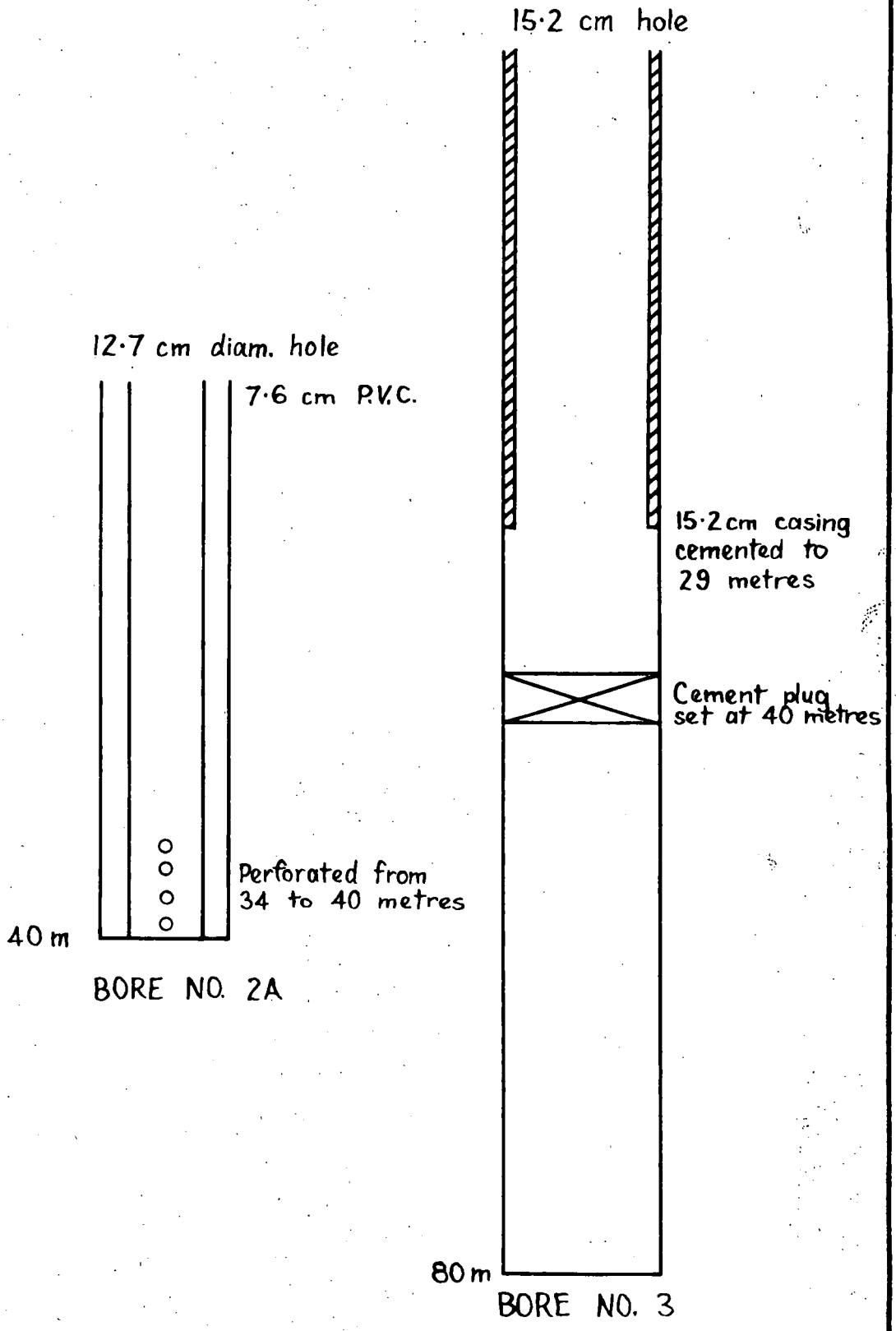
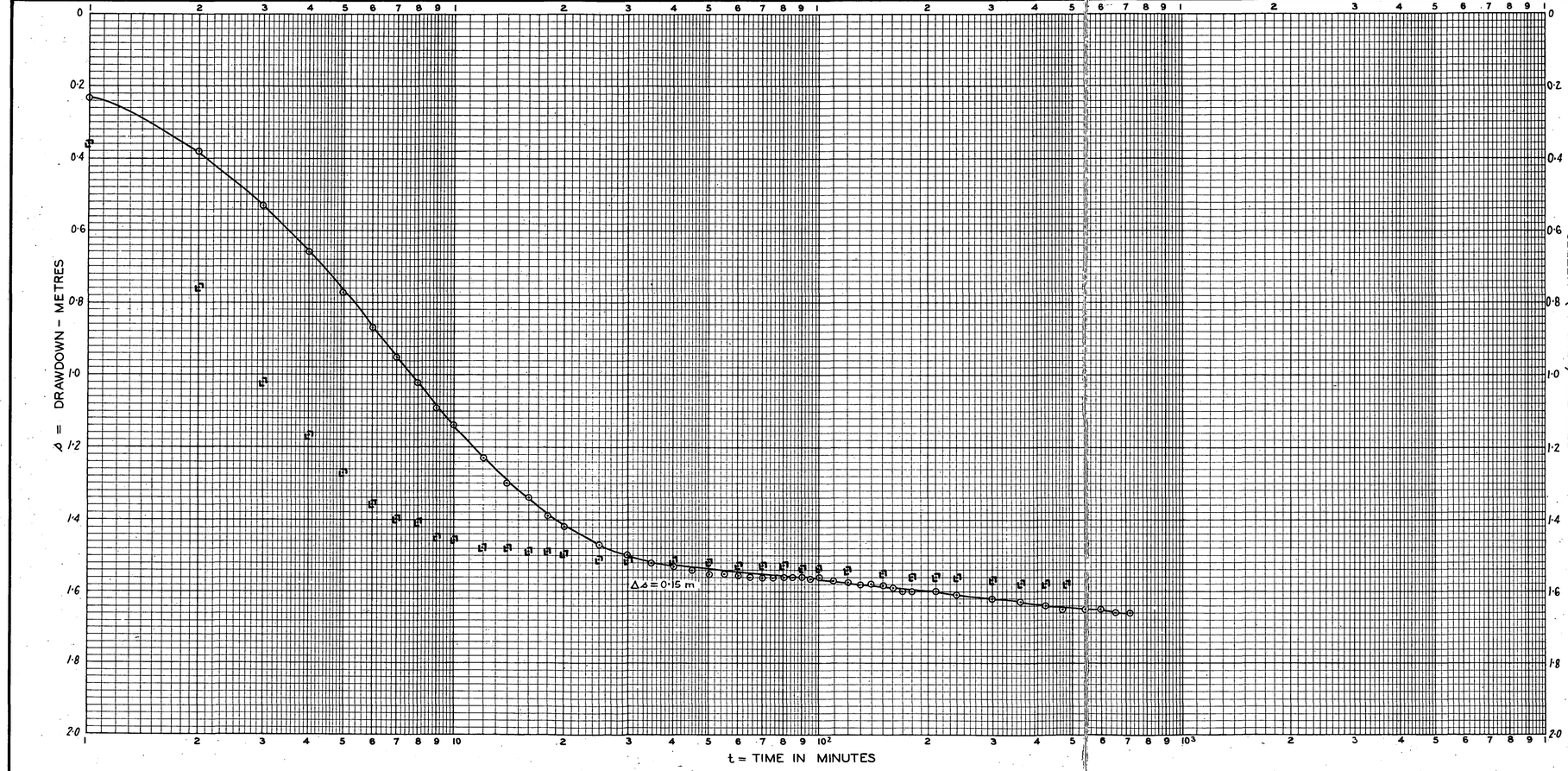


FIG. 2

HYDROGEOLOGY SECTION	**DEPARTMENT OF MINES — SOUTH AUSTRALIA**	Scale:
Compiled: O. J. W. B.	ROBE TOWN WATER SUPPLY—BORES 2A, 3	Date: 25 Feb. '74
Drn. D.J.M. Ckd.	CONSTRUCTION DETAILS	Drg. No. S10729 Ke10



BOREHOLE STATE Nº_____ TYPE OF PUMP_____

DEPTH TO WATER LEVEL DISCHARGE STARTED AT____ON_____

AT TEST START (ℓ_2)_____(L) ** " STOPPED AT____ON_____

PUMP INTAKE DEPTH (ℓ_1)_____(L) AQUIFER FROM_____TO_____(L)

*AVAILABLE DRAWDOWN_____(L) HOLE DEPTH_____(L)

EQUATIONS

$$T = \frac{0.183 \times Q}{\Delta s} \qquad S = \frac{2.25 \times T t_o}{r^2}$$

In which

T= Transmissivity ($L^3/t/L$)

Q= Pumping Rate . (L^3/t)

Δs= Drawdown per log cycle. (L)

S= Storage Coefficient

t_o= Zero drawdown time- (t)

r = Distance to Observation Bore- (L)

1 day = 8.64×10^4 secs.

DATA

Q	Δs	t_o
1987 m^3/day	0·15 m	

CALCULATIONS

$$T = \frac{0.183 \times 1987}{0.15} = 2424 \text{ m}^3\text{/day/m}$$

$$S = \frac{2.25 \times T \times t/r^2}{\log_{10}^{-1}\left[\frac{4\pi r^2}{2.30Q}\right]} = 0.256$$

⊙ Drawdown

Recovery

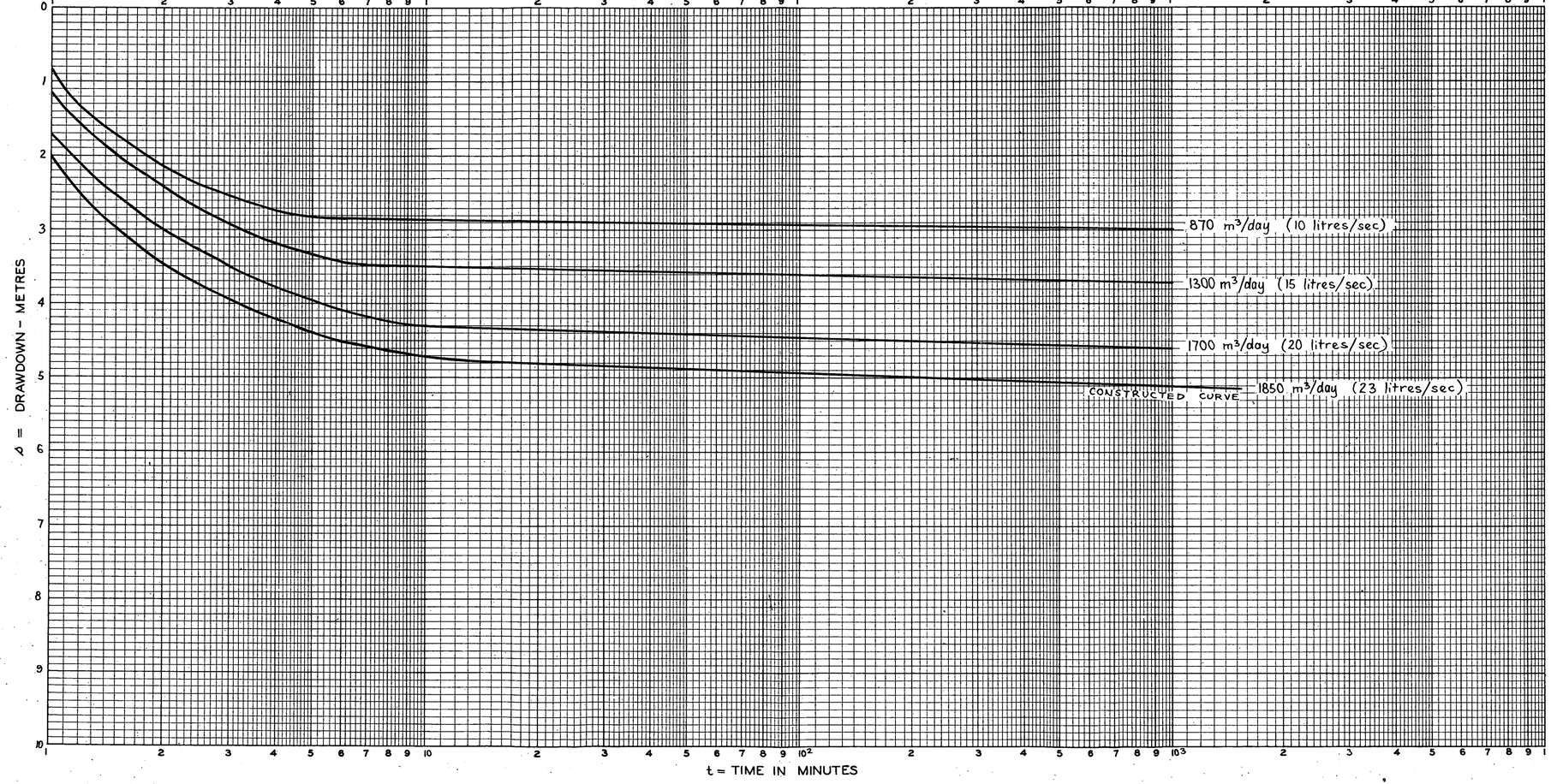
** L = unit of length.
t = time unit.

*Available drawdown = $\ell_1 - (\ell_2 +$ _____) (OBSERVATION BORE)

FIG. 3

HYDROGEOLOGY SECTION	DEPARTMENT OF MINES—SOUTH AUSTRALIA	D.M. /
COMPILED: D. J. W. B.	AQUIFER TEST - ROBE TOWN WATER SUPPLY BORE NO. 2A GAMBIER LIMESTONE	DATE: 25 Feb. 1974
DRN. D.J.M. CHD.		DRG. No. 74-134 Ke10

P.F. No. 69—953 MH



Δ = RECOVERY (RESIDUAL) - METRES

BOREHOLE STATE Nº_____ TYPE OF PUMP_____

DEPTH TO WATER LEVEL DISCHARGE STARTED AT____ON_____

AT TEST START (ℓ_2)_____(L) ** " STOPPED AT____ON_____

PUMP INTAKE DEPTH (ℓ_1)_____(L) AQUIFER FROM_____TO_____(L)

*AVAILABLE DRAWDOWN_____(L) HOLE DEPTH_____(L)

EQUATIONS

$$T = \frac{0.183 \times Q}{\Delta_o} \qquad S = \frac{2.25 \times T t_o}{r^2}$$

In which

T = Transmissivity ($L^3/t/L$)

Q = Pumping Rate . (L^3/t)

Δ_o = Drawdown per log cycle. (L)

S = Storage Coefficient

t_o = Zero drawdown time- (t)

r = Distance to Observation Bore- (L)

1 day = 8.64×10^4 secs.

DATA

Q Δ_o t_o

CALCULATIONS

$T = \frac{0.183 \times}{\quad} = 2424\ m^3/day/m$

$S = \frac{2.25 \times}{\quad} =$

** L = unit of length.
t = time unit.

*Available drawdown = $\ell_1 - (\ell_2 + \text{-----})$

FIG. 4

HYDROGEOLOGY SECTION	DEPARTMENT OF MINES—SOUTH AUSTRALIA	DM. /
COMPILED: O.J. W.B.	ROBE TOWN WATER SUPPLY BORE 2 PUMP BORE - EXPECTED DRAWDOWN CURVES FOR VARYING PUMPING RATES	DATE: 26 Feb. 1974
DRN. D.J.M CHD.		DRG. No. 74-135 Ke10

P.F. No. 69—953 MH

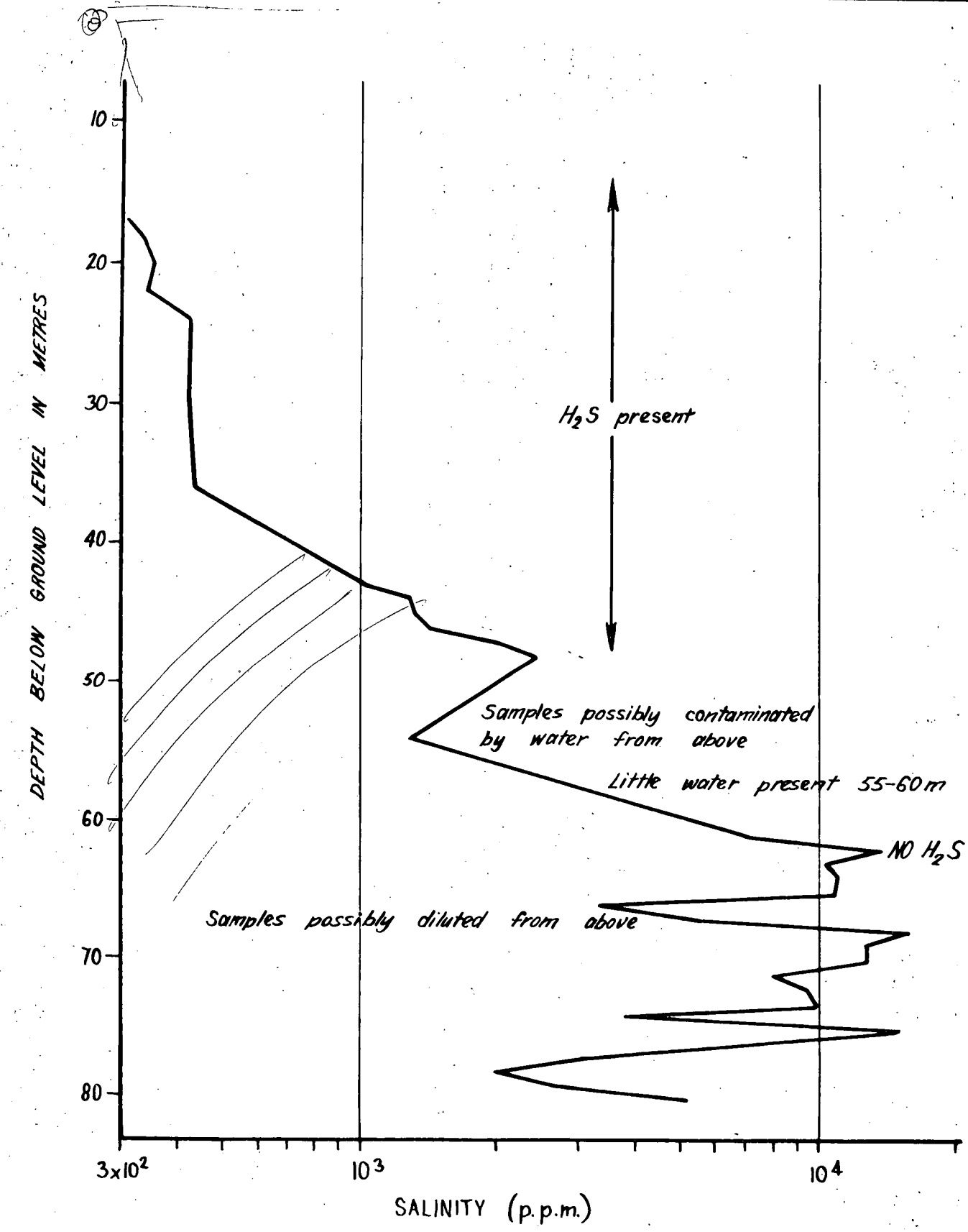
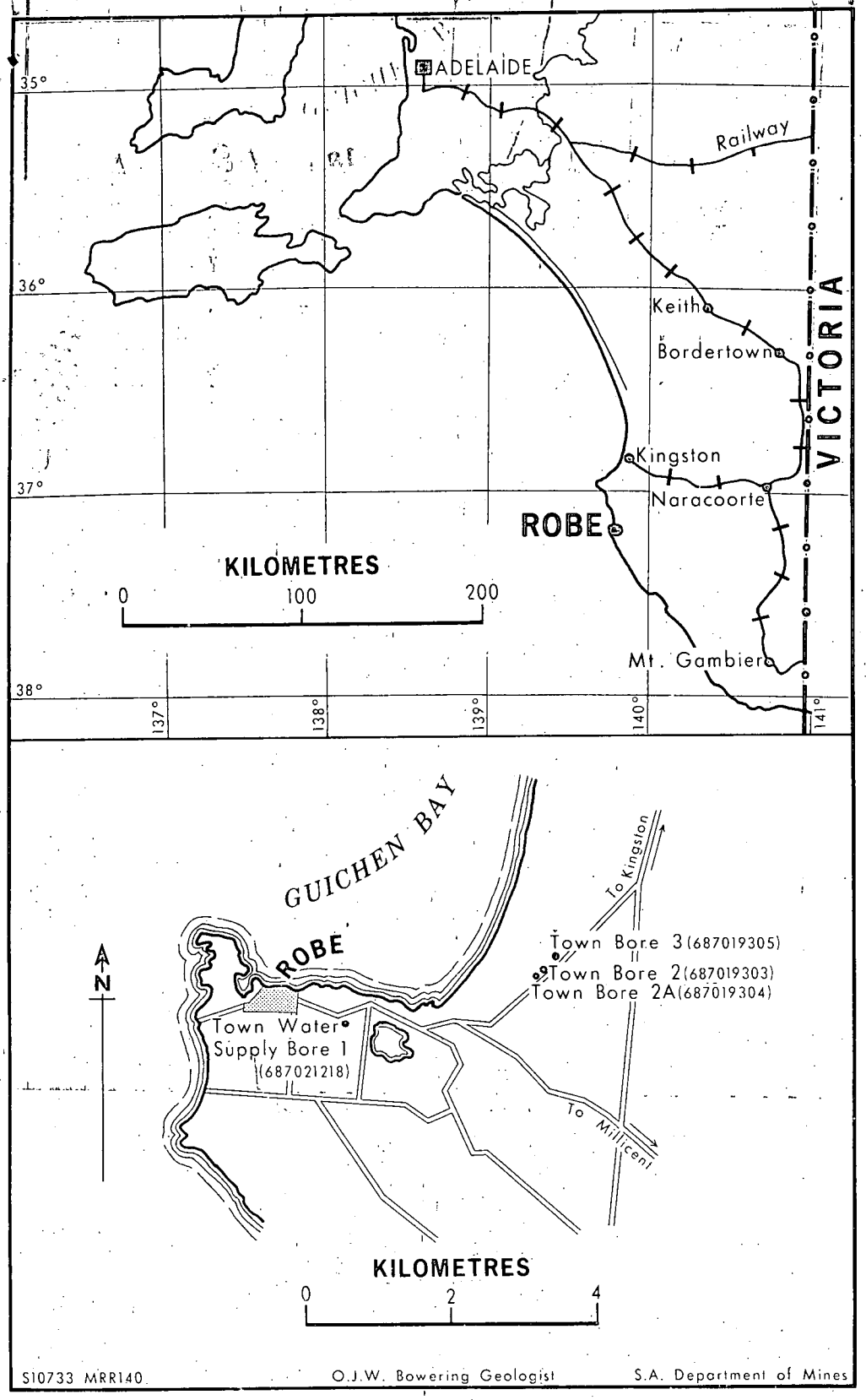


FIG. 5

HYDROGEOLOGY SECTION	**DEPARTMENT OF MINES — SOUTH AUSTRALIA**	Scale: Logarithmic
Compiled: O. J. W. B.	ROBE TOWN WATER SUPPLY BORE NO. 3 SALINITY AGAINST DEPTH	Date: 25 Feb. '74
Drn. D.J.M. | Ckd.		Drg. No. S10730 Ke10



REDUCE TO 10 ENS

R.F. S10733
Ke 10
30/6/75

FIG.1 ROBE-TOWN WATER SUPPLY.
LOCATION OF BORES 1,2,2A&3

MRR 140

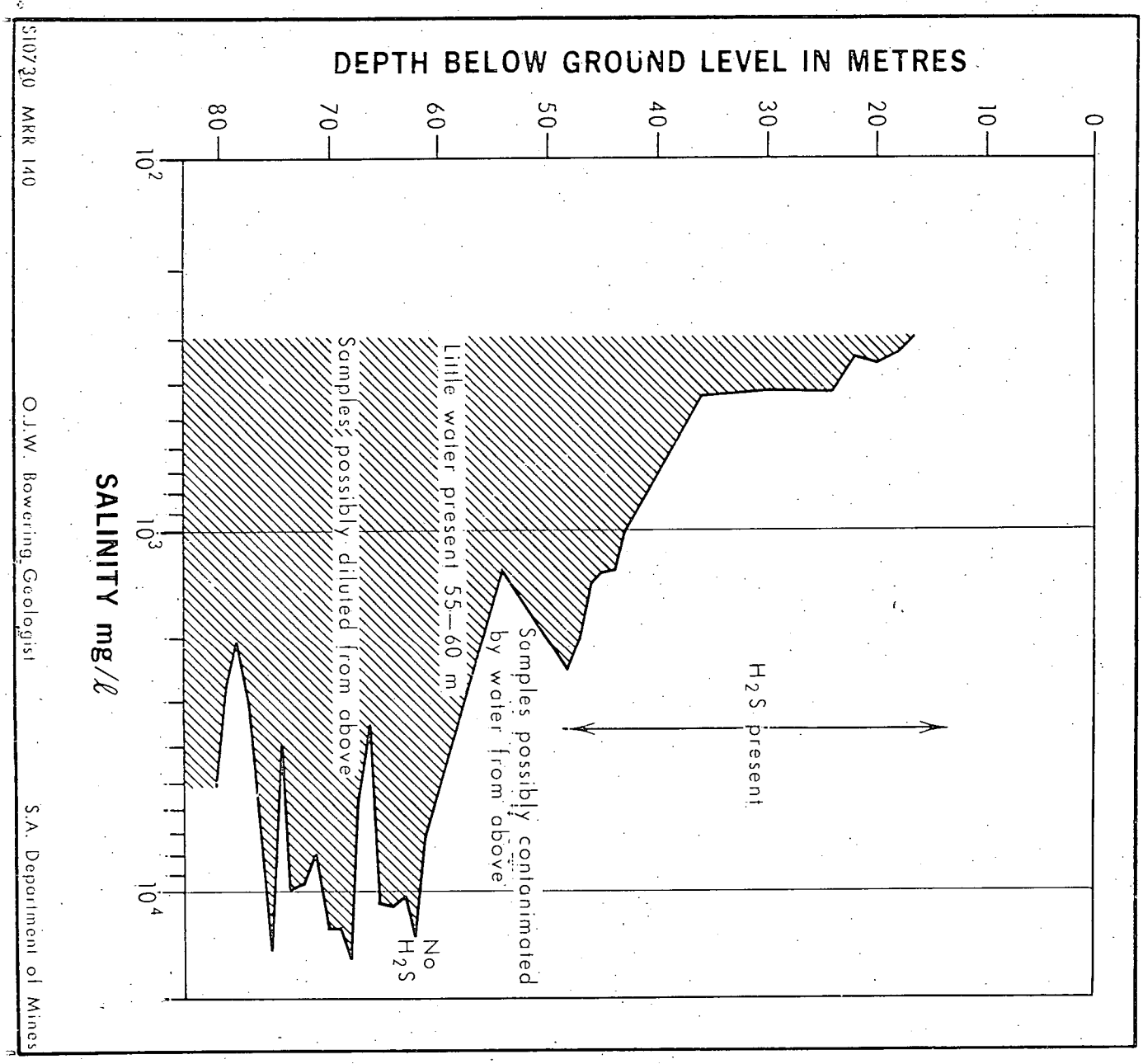
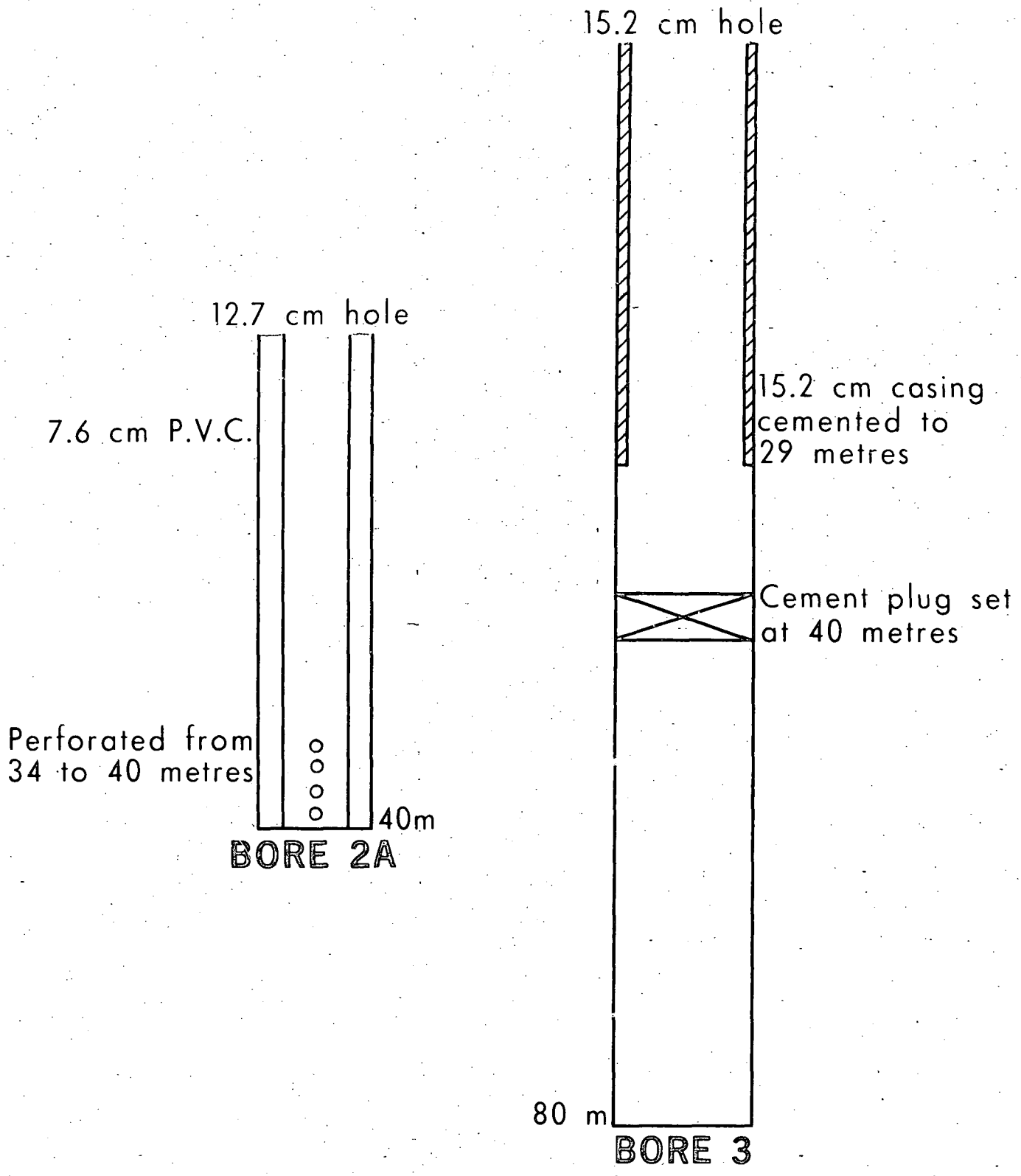


Fig. 3 ROBE WATER SUPPLY
BORE 3
SALINITY AGAINST DEPTH
MRR 140

R.F. S10730
Kelo
2/7/75



S10729 MRR140 O.J.W. Bowering Geologist S.A. Department of Mines

REDUCE TO 2 ½ INCHES