71/153

SECTION

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DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY
ENGINEERING DIVISION

Plans filed in separate folder

SOUTH EAST WATER RESOURCES INVESTIGATION
TEST AREA I
PROGRESS REPORT NO. 5
to April, 1971

by

B.M. HARRIS
ASSISTANT SENIOR GEOLOGIST

and

M.A. COBB
GEOLOGIST
HYDROGEOLOGY SECTION

Rept.Bk.No. 71/153

71/153

24th September, 1971

DEPARTMENT OF MINES
SOUTH AUSTRALIA

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Rept.Bk.No. 71/153
G.S. No. 4728
D.M. No. 1060/69
Hyd. No. 2353

24th September, 1971

FIGURES

DEPARTMENT OF MINES
SOUTH AUSTRALIA

Rept.Bk.No.71/153
G.S. No. 4728
D.M. No. 1060/69
Hyd. No. 2353

SOUTHEAST WATER RESOURCES INVESTIGATION
TEST AREA 1

PROGRESS REPORT NO.5
APRIL, 1971

SUMMARY AND CONCLUSIONS

Additional investigations in Test Area 1 during 1970 have confirmed the hydrogeological model for this area. Deep underflow through the Gambier Limestone is practically non-existent. Instead groundwater circulation is localised within geologic/physiographic sub-areas. It is believed that groundwater recharge is received fairly uniformly over the entire area. However, groundwater is discharged as vapour in the low lying swampy areas where the water table occurs at shallow depth. These evaporation areas are correlated with the occurrence of salt groundwater.

Water levels show a regular seasonal fluctuation. They commence to rise in April - May at the onset of the wet season reaching a peak in the September - October period. Levels then start declining due to the increased evaporation and lower rainfall.

Determinations of Transmissivity have been made from four pump tests but these need to be treated with caution. This is because of the effects of partial penetration. Therefore it is recommended that an additional bore be drilled and pump tested in Sub Area A. (Appendix D).

Changes in water quality within the area both laterally and at depth are discussed and explanations for seasonal variations proposed.

INTRODUCTION

In 1969, a program of hydrogeological investigation was carried out in Test Area 1 as part of the South East Water Resources Investigation. The results were described in a report by Harris (1969).

Since that time there has been:-

(a) a monitoring program which includes
    (i) monthly measurements of water levels and
    (ii) sampling from selected bores for salinity measurements at regular time intervals and in some cases at several depths within a particular bore.

(b) further drilling in 1970 to complete the observation bore network and examine groundwater salinity at depth in salt water areas.

This report describes the results of monitoring and additional drilling and discusses the hydrologic model of the area.

The location of the Test Area is shown in Figure 1.

DRILLING

Table 1 below summarises the drilling program of 1970. Bore locations are shown on Figure 1, and the geologic logs are presented in Appendix A.

Table 1

Bore No.	Depth (ft.)	Objective
P9	200	Test salinity at depth in salt groundwater area.
A36-44	20ft.-30ft.	Water level observation bores.

HYDROGEOLOGY

Harris (1969) describes the general hydrogeology of the area. A summary of pumping tests is given in Appendix C.

The Test Area can be subdivided hydrogeologically into three main sub-areas as indicated in Figure 1.

SUB AREA 1

Geology

The near surface geological sequence is illustrated in Section A-B (Fig.3). The Bridgewater Formation forms the dune ranges, where it consists mainly of aeolian deposits of quartz and shell sand, poorly consolidated and cemented in part to a calcarenitic sandstone. It continues beneath the flats adjoining the western side of the dune as mainly beach deposits. This development thins in a westerly direction and is replaced laterally by reworked Gambier Limestone.

The approximate western limit of the Bridgewater Formation adjoining the Reedy Creek Range is indicated in Figure 1. The boundary was determined from drilling results and groundwater salinity values.

Groundwater Movement

Water table contours are shown in Figures 4 to 10. Gradients of 7 to 12ft. per mile occur in the Reedy Creek Range and the adjoining flats to the west. Further west the gradients decrease considerably ranging from 1 to 6 ft. per mile. Groundwater movements in a westerly to north-westerly direction are indicated.

The contours show a marked similarity in form to the topographic contours (Fig.2). Steeper water table gradients have developed where topographic gradients are greater, i.e. where the Bridgewater Formation occurs, for example, the Reedy Creek Ranges and its western flanks. Very gentle groundwater gradients occur where the ground surface is very flat, i.e. where the Bridgewater Formation is absent. Apart from Reedy Creek Range the flat topography results in a low groundwater gradient and consequently slow groundwater movement.

There is a marked difference in the transmissive properties of the Bridgewater Formation and Gambier Limestone aquifers as indicated by the pumping tests (Appendix C). The transmissivity of a combined Bridgewater Formation and Gambier Limestone aquifer is almost 30 times greater than the Gambier Limestone alone. Groundwater movement in the latter is virtually static because of the low transmissivity combined with moderate to low groundwater gradients (Appendix B). As the Bridgewater Formation occurs where water table gradients are greater it follows that this aquifer is probably transmitting an appreciable flow from the Reedy Creek Range to the flats.

Beyond the western limit of the Bridgewater Formation, groundwater movement becomes restricted because of the lower water table gradients. The water table is close to the ground surface here and evaporation losses become an important form of groundwater discharge. This point is discussed in the following section.

Groundwater Salinity

Investigations in 1969 showed the presence of fresh and salt groundwater occurring in characteristic physiographic positions (Figures 12 to 16). Fresh groundwater occurs in the dune ranges and eastern areas of the interdune flats.

In 1970 bore P9 was drilled to determine whether groundwater quality improved with depth in saline areas. The results are given in Table 2 below.

Table 2

Chemical Analyses of Groundwater from Bore P9

DEPTH (FT.)	TOTAL DISSOLVED SALTS (P.P.M.)	ANALYSIS NO.
10 - 15	10,486	W.2771/70
40 - 45	11,177	W.2775/70
70 - 75	14,827	W.2781/70
90 - 95	16,048	W.2785/70
100 -105	18,392	W.2787/70
120 -125	17,123	W.2791/70
140 -145	18,179	W.2795/70
160 -165	18,114	W.2799/70
175 -180	18,842	W.2802/70
195 -200	19,732	W.2806/70

It can be seen that groundwater salinity progressively increases with depth. Obviously deep underflow does not occur in these areas.

It is believed that saline groundwater occurs because there is virtually no groundwater circulation. As a result, before drains were constructed, the water table rose close to or above the ground surface during the wet season from May to August. The water was lowered by evaporation in the following months from about September to April. Direct evaporation from the water table may continue for several feet below the ground surface. This process has concentrated the dissolved salts and a saline groundwater body formed as a result.

It is also possible that the saline groundwater body is connate sea water which has never been completely flushed from the aquifer.

Drains now remove most of the water that would have evaporated together with varying amounts of dissolved salts. This will ultimately lower the salinity. To date no study of the effect of drains on groundwater salinity has been made.

Hydraulic Model

Figure 3 illustrates the general hydraulic model which is representative of the area. Artificial drains constructed in recent years have modified this model locally. Recharge is not concentrated in specific localities but occurs over all the region. However, appreciable movements are probably found only in the Bridgewater Formation. At the limits of this formation groundwater circulation becomes restricted.

The water table beyond the western limits of the Bridgewater Formation is commonly 4ft. or less in the dry season and rises to near or above the ground surface during the wet season. Because circulation is restricted groundwater is discharged as vapour.

Artificial drainage has altered this model to the extent that vapour discharge is now considerably reduced.

SUB AREA "B"

This is the area from Dairy Range to Woakwine Range (Fig.1).

The geological sequence here is similar to Sub Area A.

The Dairy Range is a stranded coastal dune that has been truncated by a return of the sea during the Pleistocene Period. It is formed of calcarenitic sands and sandstones of the Bridgewater Formation, and is slightly higher than the surrounding flats. The Bridgewater Formation here appears to be an excellent aquifer as there are a number of bores capable of yielding 100,000 gallons per hour or more.

The hydrogeologic model for Sub Area B is identical to Sub Area A. Groundwater moves in a north-westerly direction towards Lake Hawdon or westwards into Reedy Swamp, both of which are evaporative areas. It is believed that no deep underflow exists for the reasons outlined in the previous section.

SUB AREA "C"

This is the region from the Woakwine Range to the coast. Water table contours are available for an east-west strip from the Woakwine Range through Lake St. Clair to the Robe Range. Groundwater moves eastwards from the Robe Range and westwards from the Woakwine Range towards Lake St. Clair. The water level of this lake is an expression of the water table; the lake appears to be acting as an evaporative sink as indicated by the water table contours.

It should be noted that the lake level and surrounding water table levels are below mean sea level, Port Adelaide. Other lakes to the north are also below sea level and probably behave as evaporative areas (Borchardt, 1970).

The level of Lake George to the south is unknown but it is above sea level because it has a controlled outlet to the sea.

MONITORING

Groundwater Levels

Measurements are made at monthly intervals. Water table contours for selected months are shown on Figs. 4 to 10, and water level hydrographs from representative bores are presented on Figure 11.

All levels show a regular seasonal fluctuation. Levels commence to rise in April and May at the onset of the wet season, and continue rising until about September or October when levels start declining. The decline of water levels is exponential. Irregularities in the decline can sometimes be correlated with precipitation recorded at nearby rainfall stations. The other occasions may have resulted from localised precipitation which was not recorded at the stations.

The hydrographs illustrate some important features. The commencement of rising water levels and the highest level are progressively delayed with increasing depth to the water table. This reflects increasing travel times for infiltration.

The water table rise does not appear to have been affected by the depth to water in Sub Areas A & B, where the zone of fluctuation is in rock such as rubbly limestone or sandstone. These materials do not appear to have a soil moisture deficit. In certain parts of sub area C where the water table occurs in sand the range of fluctuation is smaller at depth reflecting increasing soil moisture deficits with increasing depth, for example bores A12, P8, A17, P6.

In March, 1970 levels commenced to rise in shallow water table areas before an excess of precipitation over evopotranspiration occurred.

This effect may be due to the fact that:-

(a) precipitation and evapotranspiration figures are not being analysed at intervals of time small enough to describe the process accurately. In other words there may be storm intensities, durations, and frequencies, for different periods of the year, critical to groundwater recharge.

(b) The soil moisture deficit is not the dominant factor affecting the quantity of infiltration at the onset of the wet season. The vertical permeability of the soil and rock mass is greater than the permeability of the substance itself, due to the presence of soil cracks, rock fractures, solution tubes, and root tubules.

The sub-areas show differing seasonal fluctuations. The largest fluctuations are observed in Sub Area A, and the smallest in Sub Area C. This reflects in part the head distribution but more importantly the differences in the Specific Yield (S_y), of the aquifer through which the water level fluctuates.

Water level fluctuations cannot be converted to actual changes in storage because there are no definite determinations of the Specific Yield and without these values it is impossible to arrive at quantitative estimates of the water budget.

Groundwater Quality

In general there is little variation in the isohalsine contour pattern with the seasons (Figs.12 to 16) apart from a freshening effect on the western side of the ranges (e.g. Reedy Creek Ranges), from July to August and a contraction of this better quality water zone in March. This effect is observed in samples collected at a shallow depth below the water table.

Most of the shallow bores and some of the deeper bores show little variation in salinity over a year (Figure 17), for example bores A19, A29, R7, R8 in Sub Area B. In the other two sub-areas where there is a general increase in salinity with depth, water quality deteriorates slightly as levels rise during the winter and improve as levels fall in summer e.g. bores A22, and R10 (75 ft. sample depth). This effect is magnified in bores intersecting the salt water/fresh water interface near Lake St. Clair, where extreme variations in salinity have occurred during the measured period. For example bore P6 (Fig.17) when measured at a depth of 55ft. shows variation in salinity of about 1400 p.p.m., and at a depth of 75ft. variations are greater than 14,000 p.p.m. It is considered that this effect is caused by the following mechanism: Between the salt water and fresh water areas there is an interface and the position of this interface is a balance between the salt and fresh groundwater heads. At the onset of the wet season the salt water areas receive recharge more rapidly than the fresh water areas, where the water table is at a greater depth below the ground surface. The salt water head is increased relative to the fresh water head and the interface encroaches into the previously fresh water area. In a borehole which intersects an interface or zone of stratified salinity, the effect is observed as a rise in salinity at a certain level. At the end of the wet season, evaporation losses lower the water table in the salt water areas, the head decreases, and the interface retreats.

M.A. Cobb

pp B.M. HARRIS
ASSISTANT SENIOR GEOLOGIST

BMH:CF
24th September, 1971

M.A. Cobb

M.A. COBB
GEOLOGIST

REFERENCES

Borchardt, D.J., (1970). Groundwater Survey, Borehole and Lake Levelling, Hd. Waterhouse, Co. Robe. Dept. Mines unpublished report R.B. 70/19.

Harris, B.M. (1969). South East Water Resources, Hydrogeological Progress Report No. 4, Test Area 1 - Results of Geological and Geophysical Investigations, July 1969. Dept. Mines unpublished report R.B.69/63.

APPENDIX A

Logs of Selected Boreholes

Test Area I

SHEET 1 OF 1

DEPARTMENT OF MINES — SOUTH AUSTRALIA

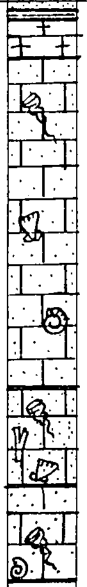
BORE LOG • HYDROGEOLOGY

Purpose of Bore Observation
Hundred Smith
Section 67
Owner Dept. of Mines
Address Adelaide
Driller Farrow
Commenced 4.4.70
Completed 6.4.70
Drill type Cable tool
Circulation Water
Logged by B.M. Harris
Date 6.4.70
R.L. Collar (M.S.L.) 55.05
R.L. Surface 53.37
Casing 20'6" of 6 inch
State No. 631006702
Bore Serial No. 397/70
Project No. A36
Docket No. 231/69
Depth 30ft.
Co-ords E
N

WATERS CUT

DEPTH (FT)	WATER LEVEL (FT)	SUPPLY (G.P.H.)	HOW TESTED	TOTAL SALTS PPM	ANALYSIS No.

REMARKS South East Investigation Test Area I- **Bore A36**
Top of Casing above surface 1'9"

CASING 1	WATERS CUT 2	WATER LEVEL 3	DEPTH (FT) 4	CORE 5	GRAPHIC LOG 6	AGE 7	UNIT 8	PENETRATION RATE 9	DESCRIPTION 10
20'6" of 6" Casing									0-5inches SAND, fine, very **silty,** clayey, grey
									5ins.-1ft. CLAY, grey
			10						1-3ft. CALCISILTITE, pale grey, very shelly, with strongly cemented calcrete fragments
									3-20ft. SANDY CALCARENITE, fine, pale yellow brown, strongly cemented, very shelly
			20						20-25ft. SANDY CALCARENITE, fine, pale grey, very shelly, bryozoal
									25-30ft. SANDY CALCARENITE, fine, offwhite, very shelly.
			30						END OF HOLE 30FT.
			40						
			50						

DEPARTMENT OF MINES — SOUTH AUSTRALIA

SHEET 1 OF 1

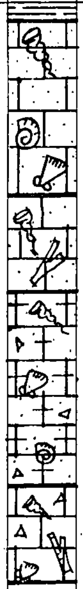
BORE LOG • HYDROGEOLOGY

Purpose of Bore Observation
Hundred Smith
Section 141
Owner Dept. of Mines
Address Adelaide
Driller Farrow
Commenced 6.4.70
Completed 6.4.70
Drill type Cable tool
Circulation
Logged by B.M. Harris
Date 6.4.70
R.L. Collar (M.S.L.) 30.75
R.L. Surface 30.45
Casing 18'4" of 6in.
State No. 631014102
Bore Serial No. 399/70
Project No. A37
Docket No. 231/69
Depth 30ft.
Co-ords E
N

WATERS CUT

DEPTH (FT)	WATER LEVEL (FT)	SUPPLY (G.P.H.)	HOW TESTED	TOTAL SALTS PPM	ANALYSIS No.

REMARKS South East Investigation - Test Area I - Bore A37

CASING 1	WATERS CUT 2	WATER LEVEL 3	DEPTH (FT) 4	CORE 5	GRAPHIC LOG 6	AGE 7	UNIT 8	PENETRATION RATE 9	DESCRIPTION 10
18'4" of 6" Casing			10 20 30 40 50						0-1ft. CLAY, black, silky 1-10ft. CALCARENITE, very fine, strongly cemented, calcerated at top, pale grey, sandy, shelly, content of shells increasing with depth. A few fragments of flint. 10-15ft. CALCARENITE, pale grey, fine, sandy, shelly, bryozoal, glaucomitic, black flint. **15 25ft. CALCIBITITE. pale grey to green, sandy shells, bryozoal, glauconitic, black flint. Becoming off white from 20ft.** 25-30ft. CALCARENITE, fine, offwhite, shelly, bryozoal with black flint END OF HOLE 30FT.

DEPARTMENT OF MINES — SOUTH AUSTRALIA

SHEET 1 OF 1

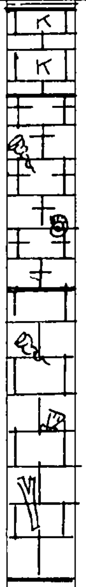
BORE LOG • HYDROGEOLOGY

Purpose of Bore Observation
Hundred Bray
Section 48
Owner Mines Dept.
Address Adelaide
Driller Farrow
Commenced 7.4.70
Completed 7.4.70
Drill type Cable tool
Circulation
Logged by B.M. HARRIS
Date 7.4.70
State No. 262004803
Bore Serial No. 400/70
Project No. A38
Docket No. 231/69
Depth 30ft.
R.L. Collar (M.S.L.) 27.24
R.L. Surface 24.89
Casing 30ft. of 1½in.PVC
Co-ords E
N

WATERS CUT

DEPTH (FT)	WATER LEVEL (FT)	SUPPLY (G.P.H.)	HOW TESTED	TOTAL SALTS PPM	ANALYSIS No.

REMARKS South East Investigation - Test Area I - Bore A38

1 CASING	2 WATERS CUT	3 WATER LEVEL	4 DEPTH (FT)	5 CORE	6 GRAPHIC LOG	7 AGE	8 UNIT	9 PENETRATION RATE	10 DESCRIPTION
30ft of 1½ inch P.V.C			10 20 30 40 50						0-5ft. CLAY, grey, silty 0.5-5ft. CALCRETE, dense, hard, grey, a few shell fragments near base. 5-15ft. CALCISILTITE, offwhite, shelly, sandy, bryozoa appearing after 10ft. 15-30ft. CALCARENITE, offwhite, shelly bryozoae, sandy, with flint END OF HOLE 30FT.

DEPARTMENT OF MINES — SOUTH AUSTRALIA

SHEET 1 OF 1.

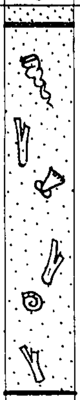
BORE LOG • HYDROGEOLOGY

Purpose of Bore Observation
Hundred Bray
Section 88
Owner. Dept. of Mines
Address
Driller. Farrow
Commenced. 8.4.70
Completed 8.4.70
Drill type Cable tool
Circulation water
Logged by B.M. Harris
Date 8.4.70
R.L. Collar (M.S.L.) 32.00
R.L. Surface 31.68
Casing 20ft. of 1½in.PVC
State No. 262008805
Bore Serial No. 401/70
Project No. A39
Docket No. 231/69
Depth 20ft.
Co-ords E
N

WATERS CUT

DEPTH (FT)	WATER LEVEL (FT)	SUPPLY (G.P.H.)	HOW TESTED	TOTAL SALTS PPM	ANALYSIS No.

REMARKS South East Investigation - Test Area I - Bore A39

CASING 1	WATERS CUT 2	WATER LEVEL 3	DEPTH (FT) 4	CORE 5	GRAPHIC LOG 6	AGE 7	UNIT 8	PENETRATION RATE 9	DESCRIPTION 10
20' of 1½" P.V.C.			10 20 30 40 50						0-1ft. SAND, grey to brown, fine, 1-20ft. SANDSTONE, yellow brown, fine to medium, shelly, some bryozoa, strongly cemented in part. Weakly cemented 15-20ft. END OF HOLE 20FT.

DEPARTMENT OF MINES — SOUTH AUSTRALIA

SHEET 1 OF 1

BORE LOG • HYDROGEOLOGY

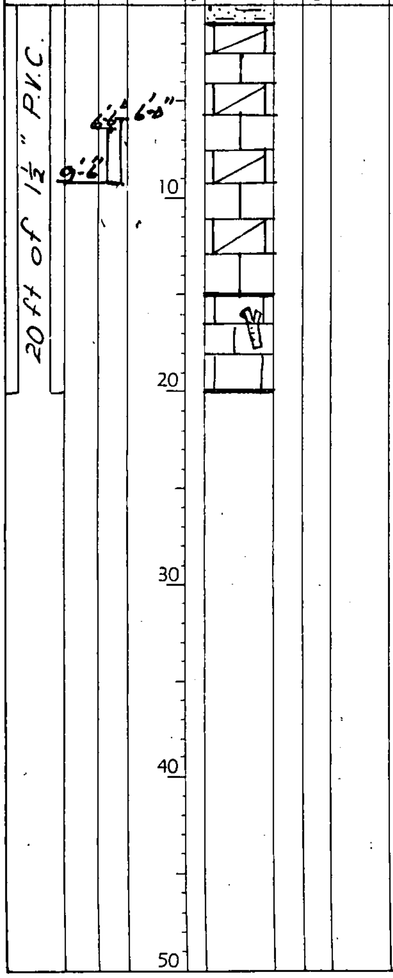
Purpose of Bore Observation
State No. 262004406
Hundred Bray
Section 44
Bore Serial No. 402/70
Owner Dept. of Mines
Address Adelaide
Project No. A40
Driller W.F. Farrow
Docket No. 231/71
Commenced 9.4.70
Completed 9.4.70
R.L. Collar (M.S.L.) 28.20
Depth 20ft.
Drill type Cable Tool
Circulation
R.L. Surface 26.12
Co-ords E
Logged by M.A. COBB
Date 2.9.71
Casing 20ft. of 1½" PVC
N

WATERS CUT

DEPTH (FT)	WATER LEVEL (FT)	SUPPLY (G.P.H.)	HOW TESTED	TOTAL SALTS PPM	ANALYSIS No.
9'6"	6'6"				
9'6"	5'11½"				

REMARKS South East Investigation - Test Area 1 - **Bore A40**

CASING 1	WATERS CUT 2	WATER LEVEL 3	DEPTH (FT) 4	CORE 5	GRAPHIC LOG 6	AGE 7	UNIT 8	PENETRATION RATE 9	DESCRIPTION 10



0-1ft. SILTY SAND, brown, angular grains

1-15ft. CALCIRUDITE Essentially whole shell and shell fragments. Fragments of calcreted calcarenite near top down to angular fragments of weak to moderately cemented calcarenite. Odd flint and orange staining of grain below 10ft.

15-20 CALCARENITE Fawn. Average grain size 0.5mm Calcareous chips plus odd fine tube (bryozoa?) Odd angular quartz grain. Some orange staining.

End of Hole 20ft.

DEPARTMENT OF MINES — SOUTH AUSTRALIA

SHEET 1 OF 1

BORE LOG • HYDROGEOLOGY

Purpose of Bore Observation

Hundred Symon

Section 95

Owner Dept. of Mines

Address Adelaide

Driller W.F. Farrow

Commenced 9.4.70

Completed 9.4.70

Drill type Cable Tool

Circulation

Logged by M.A. COBB

Date 2.9.71

R.L. Collar (M.S.L.)

R.L. Surface

Casing 18ft. of 6"

State No. 643009501

Bore Serial No. 403/70

Project No. A41

Docket No. 231/69

Depth 20ft.

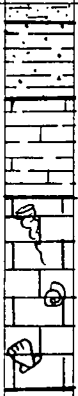
Co-ords E

N

WATERS CUT

DEPTH (FT)	WATER LEVEL (FT)	SUPPLY (G.P.H.)	HOW TESTED	TOTAL SALTS PPM	ANALYSIS No.

REMARKS South East Investigation - Test Area I - Bore A41

1 CASING	2 WATERS CUT	3 WATER LEVEL	4 DEPTH (FT)	5 CORE	6 GRAPHIC LOG	7 AGE	8 UNIT	9 PENETRATION RATE	10 DESCRIPTION
18ft of 6" Casing			10 20 30 40 50						0-1ft. SILTY SAND Pale grey-brown. Angular quartz grains & organic material 1-5ft. CLAY orange-brown mottled, plastic, 5-10% quartz sand. 5-10ft. CLAY Pale grey, calcareous. fragments of white calcarenite. 20-25% quartz. 10-20ft. CALCARENITE White, travertine, low density - shell and other fossil fragments with a fine white matrix. Odd well rounded quartz and fragments of a pale orange indurate sandstone near top. End of Hole 20ft.

DEPARTMENT OF MINES — SOUTH AUSTRALIA

SHEET 1 OF 1

BORE LOG • HYDROGEOLOGY

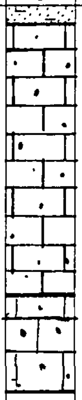
Purpose of Bore Observation
Hundred Symon
Section 193
Owner Dept. of Mines
Address Adelaide
Driller W.F. Farrow
Commenced 10.4.70
Completed 10.4.70
Drill type Cable Tool
Circulation
Logged by M.A. COBB
Date 2.9.71
R.L. Collar (M.S.L.)
R.L. Surface
Casing
State No. 643019301
Bore Serial No. 404/70
Project No. A42
Docket No. 231/69
Depth 20ft.
Co-ords E
N

WATERS CUT

DEPTH (FT)	WATER LEVEL (FT)	SUPPLY (G.P.H.)	HOW TESTED	TOTAL SALTS PPM	ANALYSIS No.
10	8'-9"				

REMARKS South East Investigation - Test Area I - Bore A42

CASING 1	WATERS CUT 2	WATER LEVEL 3	DEPTH (FT) 4	CORE 5	GRAPHIC LOG 6	AGE 7	UNIT 8	PENETRATION RATE 9	DESCRIPTION 10



0-1 **SILTY SAND** Orange brown, fine grained. 90% quartz. Angular - subangular

1-15 **CALCARENITE** Off white -buff, fine to medium grained.
1-5 Calcareous chips and odd yellow brown angular strongly cemented fragments. Odd quartz.
5-15 strongly cemented calcarenite fragment and fossil fragments

15-20 **QUARTZOSIS CALCARENITE** Pale brown-yellow 20-30% well rounded quartz (clear, milky, etc.) average grain size 1mm. Rest shell fragments and calcareous chips.

End of Hole 20ft.

DEPARTMENT OF MINES — SOUTH AUSTRALIA

SHEET 1 OF 1

BORE LOG • HYDROGEOLOGY

Purpose of Bore Observation
Hundred Lake George
Owner Dept. of Mines
Driller W.F. Farrow
Commenced 10.4.70
Drill type Cable Tool
Logged by M.A. COBB

Section 8
Address ADELAIDE
Completed
Circulation
Date

R.L. Collar (M.S.L.)
R.L. Surface
Casing 20ft. of 2" PVC

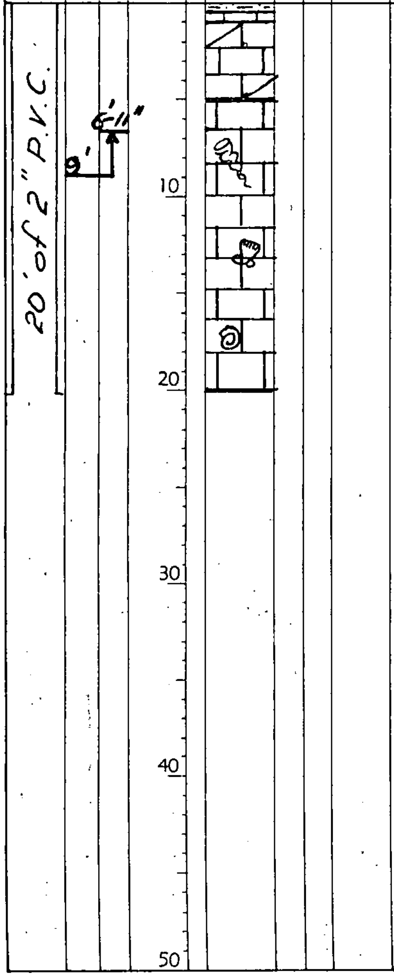
State No. 450000807
Bore Serial No. 405/70
Project No. A43
Docket No. 231/69
Depth 20ft.
Co-ords E
N

WATERS CUT

DEPTH (FT)	WATER LEVEL (FT)	SUPPLY (G.P.H.)	HOW TESTED	TOTAL SALTS PPM	ANALYSIS No.
9'	6'11"				

REMARKS South East Investigation - Test Area I - **Bore A43**

CASING 1	WATERS CUT 2	WATER LEVEL 3	DEPTH (FT) 4	CORE 5	GRAPHIC LOG 6	AGE 7	UNIT 8	PENETRATION RATE 9	DESCRIPTION 10



0-0.5ft. SANDY SILT Grey - brown. Angular - well rounded quartz. Organic material.

0.5-1ft. CALCARENITE White, low density, travertine - shell fragments.

1-5ft. CALCARENITE/CALCIRUDITE Fragmental shells, strong calcarenite (-1cm.) & calcareous chips. 10-20% well rounded quartz.

5-20ft. CALCARENITE, at top fragments of strongly cemented material, grey-orange. Odd complete shell and fragments.
10-15 High proportion of loose arenite size grains.
15-20 Average grain size 1mm. - Calcareous chips, shell fragments and bryozoa tubes (some eroded smooth) Pale grey. Odd quartz some stained orange. Only few well cemented fragments.

End of Hole 20ft.

DEPARTMENT OF MINES — SOUTH AUSTRALIA

SHEET 1 OF 1

BORE LOG • HYDROGEOLOGY

Purpose of Bore Observation

Hundred Lake George

Section 43

Owner Dept. of Mines

Address Adelaide

Driller W.F. Farrow

Commenced 13.4.70

Completed 13.4.70

Drill type Cable Tool

Circulation

Logged by M.A. COBB

Date 2.8.71

R.L. Collar (M.S.L.)

R.L. Surface

Casing 20ft. of 2" PVC

State No. 450004301

Bore Serial No. 408/70

Project No. A44

Docket No. 231/69

Depth 20ft.

Co-ords E

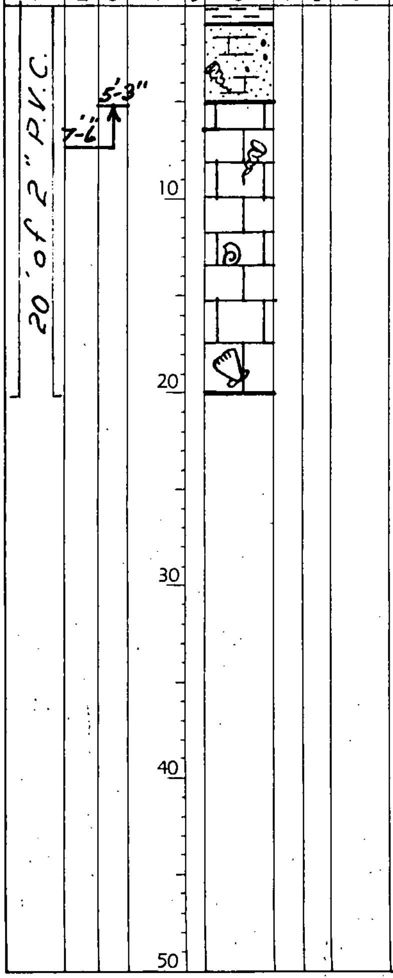
N

WATERS CUT

DEPTH (FT)	WATER LEVEL (FT)	SUPPLY (G.P.H.)	HOW TESTED	TOTAL SALTS PPM	ANALYSIS No.
7'6"	5'3"				

REMARKS South East Investigation - Test area I - **Bore A44**

CASING 1	WATERS CUT 2	WATER LEVEL 3	DEPTH (FT) 4	CORE 5	GRAPHIC LOG 6	AGE 7	UNIT 8	PENETRATION RATE 9	DESCRIPTION 10



0-1ft. SILT. Black, high organic content.

1-5ft. CALCAREOUS SAND Medium grey. About 50-60% fine grained moderately to well rounded quartz. Part calcareous chips and shell fragments.

5-20ft. CALCARENITE Pale grey. Essentially shell fragments and calcareous chips. Some silt. Some fragments of strongly cemented calcarenite at top. Odd tubule (bryozoa) near base.

End of Hole 20ft.

APPENDIX B

GROUNDWATER MOVEMENT IN THE GAMBIER LIMESTONE

Consider the flats west of Bore P1 where only the Gambier Limestone aquifer is present.

From Darcy's Law.

$Q = T\ i\ L$ where Q = discharge

T = transmissivity

i = hydraulic gradient

L = width of flow path

Let $T = 0.015\text{ft.}^2/\text{sec.}$ (from pumping test at P1)

$i = 2.5\text{ft./mile}$

$Q = 0.038\text{ft.}^3/\text{sec.}$ or 20,000 gallons/hour per one mile width of aquifer.

Velocity of bulk movement (V) = Ki

where K = hydraulic conductivity = $\dfrac{T}{\text{aquifer thickness}}$

The aquifer thickness is approximately 300ft.

$$V = \frac{1.5 \times 10^{-2}}{3 \times 10^{2}} \times \frac{2.5}{5.28 \times 10^{3}}$$

$$= 2.37 \times 10^{-8}\text{ft./sec.}$$

$$= 0.75\text{ft./year.}$$

APPENDIX C

Summary of Pumping Tests

Table 2 summarises the results of pumping in this area

TABLE 2

Pumping Test at Hole No.	Sub Area	Transmissivity (T) $ft^2/sec.$	Specific Yield	Comments
P1	A	1.4×10^{-2}	-	T applies to Gambier Limestone. S cannot be estimated.
*Hd. Bray	B	4.1×10^{-1}	0.19	T applies to Bridgewater Formation and Gambier Limestone. S applies to the Bridgewater Formation.

*This bore is 0.5 miles east of A8.

The test at Hole P1 did not continue long enough for the effects of gravity drainage to be negligible. In addition partial penetration of the aquifer in the pump and observation bore may have affected the results. The value of T is considered to be of the right order of magnitude but must be used with caution.

The second test was carried out on a private irrigation bore in the Hd. of Bray. The calculation of S is uncertain.

APPENDIX D

SPECIFICATIONS FOR DRILLING AND PUMP TESTING

Proposed Bore No.P10 Docket No. 1060/69

SOUTH AUSTRALIAN DEPARTMENT OF MINES
SPECIFICATION FOR PERCUSSION - DRILL HOLE

Client: Department of Mines

Initiation: Hydrogeology Section

Project: South East Water Resources

Water: For aquifer testing.

Location: Hundred Smith

Descriptive: Site not finally determined.

Required final size of casing: 10"

Estimated depth: 400ft.

STRATA EXPECTED

From	To (in feet)		Casing (approx. footage)
0	- 40'	Sand, sandy limestone and sandstone.	Slotted 10" from 0-60ft. (approx.)
40	- 400'	Limestone, fossiliferous (Gambier Limestone)	Open hole below 60ft.

Suspected Aquifer 5-10ft.

Water sampling required
All waters cut

Sampling required Every 5ft. or change of strata

Drill site to be indicated by Field Geologist.

Attention C.D. & M.E.

Geologist: B.M. Harris

Date: 21/9/71

Proposed Bore No. P10 Docket No.1060/69

SOUTH AUSTRALIAN DEPARTMENT OF MINES

SPECIFICATION FOR PUMP OUT TEST

Client Department of Mines

Initiation Hydrogeology Section

Project South East Water Resources
Test Area I

Water Supply For test of aquifer characteristics.

Location: Hundred Smith

Casing: (perforated) 10 inch diameter set from 0 to 60 ft. below surface

Static water level below surface: 5ft. (approx.)

Distance to observation boreholes: As set out by field geologist

Water is required for testing aquifer characteristics

Single stage test of 4,320 minutes duration (nominal)

Aquifer is from 0 to 400 ft. below surface

Thickness of aquifer penetrated is 400 ft.

Suggested pump setting: 100 ft. below surface.

Water pumped is to be disposed of as far down gradient as possible, preferably at least ½ mile.

Date 21st September, 1971

B.M. HARRIS
GEOLOGIST

S.E. WATER RESOURCES INVESTIGATION

TEST AREA NO. 1

PROGRESS REPORT NO. 5

by

B.M. HARRISS AND M.A. COBB.

The following comments apply to the pump test results:-

1. COMPARISON OF PERMEABILITIES

In Appendix C:-

T (Gambier) = 1.4×10^{-2} cusec/ft.
T (Bridgewater + Gambier) = 4.1×10^{-1} cusec/ft.

Hence, approximately,

T (Bridgewater) = 0.41 - 0.014 cusec/ft
= 0.40 cusec/ft.

The test for T (Bridgewater = Gambier) was 0.5 miles east of A8.

The thickness of Bridgewater formation is -

Location	Thickness
P2	45 feet
R5	(50 - 5) = 45 feet.

Hence, assume thickness of Bridgewater at test site d = 45 feet.

$$K_B = \frac{T}{d}$$

$$= \frac{0.40}{45} \text{ ft./sec.}$$

$$= 8.9 \times 10^{-3} \text{ ft./sec.}$$

$$= 2.9 \times 10^{-4} \text{ cu./sec.}$$

It is interesting to compare the permeability of the Bridgewater formation with the soil profile permeabilities at Konetta lysimeters, which are as follows:-

Profile	Description	Permeability K (cm/sec)
N.S.		
9"	Black clay	?
3'-9"	Granular limestone with black organic clay	3×10^{-3}
	Grey-green calcareous clay	1.4×10^{-4}
5'-3"	Hard limestone (calcrete)	0
6'-3"		
8'-0"	White sand (presumed top of Bridgewater)	2.9×10^{-4} (Calculated above)

Konetta lysimeters are located near R2 where the Bridgewater formation is (20-3) = 17 feet beneath the bottom of the clay and calcrete surface material, which is 3 feet thick.

2. RELATIVE HYDRAULIC IMPORTANCE OF SOIL, BRIDGEWATER AND GAMBIER LIMESTONE HORIZONS AT KONETTA

At Konetta.

(a) For granular limestone

$$T = K.d.$$

$$= \frac{3 \times 10^{-3}}{2.53 \times 12} (3.75-0.75)$$

$$= 2.95 \times 10^{-4} \text{ cusec/ft.}$$

(b) For calcareous clay

$$T = \frac{1.4 \times 10^{-4}}{2.54 \times 12} (5.25-3.75)$$

$$= 6.9 \times 10^{-6} \text{ cusec/ft.}$$

(c) For Bridgewater

$$T = 8.9 \times 10^{-3} (2.0-5.25)$$

$$= 0.13 \text{ cusec/ft.}$$

(d) For Gambier

$$T = 1.4 \times 10^{-2} \text{ cusec/ft.}$$

Hence (i) the transmissivity of the soil horizons is negligible in comparison with either, or the combined, Bridgewater and Gambier transmissivities.

(ii) In the winter, when the soil horizons are saturated, pump test results should therefore be the same as for a test conducted in the summer.

3. EXTENT OF BRIDGEWATER FORMATION

In Fig. 3 (Drawing 69-335) of Harriss's report BK. No. 69/63 dated 15.9.69, the Bridgewater formation is shown as continuous from A to B.

On Fig. 1 of Harriss's and Cobb's report BK. 71/153, the Bridgewater formation is shown discontinuous.

4. THE PROBLEM OF CONTINUITY

(a) At P1 the mean grade from October 1969 to March 1971 was 6.5 ft./mile,

$$\text{i.e., } i = \frac{6.5}{5280}$$

$$= 1.23 \times 10^{-3} \text{ ft./ft.}$$

Per foot width

$$Q_1 = T.i.$$

where $T = (1.4 \times 10^{-2}) + 0.13$ cusec/ft.

$= 0.14$ cusec/ft.

Hence $Q = 0.14.\ 1.23.\ 10^{-3}$

$= 1.72.\ 10^{-4}$ cusec/ft.

(b) At a point 2 miles to the west of P1 where the Bridgewater formation is absent,

$i = 3$ ft./mile

$= 5.7 \times 10^{-4}$ ft./ft.

Per foot width

$Q_2 = Ti$

where $T = 1.4 \times 10^{-2}$ (Gambier only)

Hence $Q_2 = 1.4 \times 10^{-2} \times 5.7 \times 10^{-4}$

$= 8.0 \times 10^{-6}$ cusec/ft.

(c) Continuity

Presumably the difference between Q_1 and Q_2 needs to be accounted for by evaporation (Q_E) in the vicinity of the western edge of the Bridgewater formation, which is about ½ mile west of P1

$Q_E = Q_1 - Q_2$

$= (1.72 \times 10^{-4}) - (0.08 \times 10^{-4})$

$= 1.64 \times 10^{-4}$ cusec/ft.

Assume Q_E occurs over a distance of ¼ mile, i.e. 1,300 ft., then evaporation rate per s.ft. of land surface area is E_R where

$$E_R = \frac{1.64 \times 10^{-4}}{1300} \text{ cusec/s.ft.}$$

$= 1.26 \times 10^{-7}$ ft./sec.

$= 1.26 \times 10^{-7} \times 12 \times 100 \times 60 \times 60 \times 24$ points/day

$= 13$ points/day.

If this evaporation took place over ½ mile, then the rate would fall to $E_R = 6$ points/day, which is feasible.

(d) Groundwater salinity

A consequence of the above assessed evaporation phenomena would be a crowding of the isohalsines near the downstream boundary of the Bridgewater/Gambier division. The crowding could be expected to occur somewhere close to the line of the Princes Highway (refer drawing 71-715 - Fig. 1).

In fact, the isohalsine maps attached to the report do show a fairly abrupt increase in salinity from 500 to 1,000 p.p.m. along this line.

A similar abrupt increase from 500 to 1,000 p.p.m. occurs on the eastern fringe of the Dairy Range, which is also a dividing line between Bridgewater and Gambier formations. However, the water table contour lines in this area suggest water movement in a westerly and northerly direction, which is inconsistent with the salinity data. Quite possibly, the contour interval of 5 feet combined with a low density of observation bores has marked the true shape of the unconfined water table shape. It is therefore quite possible that the water table contours reflect the natural surface contours shown in Fig. 2, in which case the salinity and water contours would be consistent.

(e) Vegetation indicators

In (c) herein it is suggested that if the higher transmissivity (and water grade line) through the Bridgewater formation near Konetta leads to a correspondingly higher evaporation rate near the Bridgewater/Gambier boundary (i.e. in the vicinity of the Princes Highway), then, assuming the increased evaporation takes place over a $\frac{1}{2}$ mile distance, this would correspond to 6 points per day throughout the year.

What would virtually happen is that this division line region would be supplied with more water than the land, both to the immediate east and immediate west. In other words, more water would discharge in this region than in the adjacent country. It is reasonable, therefore, to conjecture that a change in vegetation pattern would occur in this region. Does this, in fact, occur?

(f) Bore hydrograph behaviour along the line Pl, A23, A24, A25, A26

The water discharging as vapour at Pl is supplemented by water which has flowed through the Bridgewater aquifer roughly in the direction A26, A25, A24, Pl. Also, there is less summer vapour discharge at A26, A25 than winter recharge because portion of the winter recharge at A26, A25 is later discharged at Pl.

Other things being equal (particularly uniformity of aquifer in the fluctuating water table zone) then the hydrographs at A26, A25 will be different than at Pl. In theory

(i) A26, A25 should have a greater amplitude than Pl. If it should happen that the winter peaks of the hydrographs at both locations are clipped off because of the water table breaking natural surface, then the trough should still be deeper at A26, A25 than at Pl.

(ii) The hydrograph at A26, A25 should start the rising limb after Pl.

Referring to Fig. 11, Drawing 71-718, the following data can be extracted:-

	Date	A27	Date	A26	Date	A23
Peak 1970	Aug.	2.50	Sept.	7.70	Sept.	4.5
Trough 1970	March	5.65	April	11.25	April	9.85
Rise 1970		3.15		3.55		5.35

All figures refer to depth of W.T. below N.S. The position of A27 does not precisely correspond to Pl, but is an approximation.

Both A26 and A23 have a greater amplitude than A27.

The rising limb at A27 starts before A26, A23.

The almost nil decline in A27 from mid-December to end of March strongly suggests that sub-surface water is being fed to this location during this period.

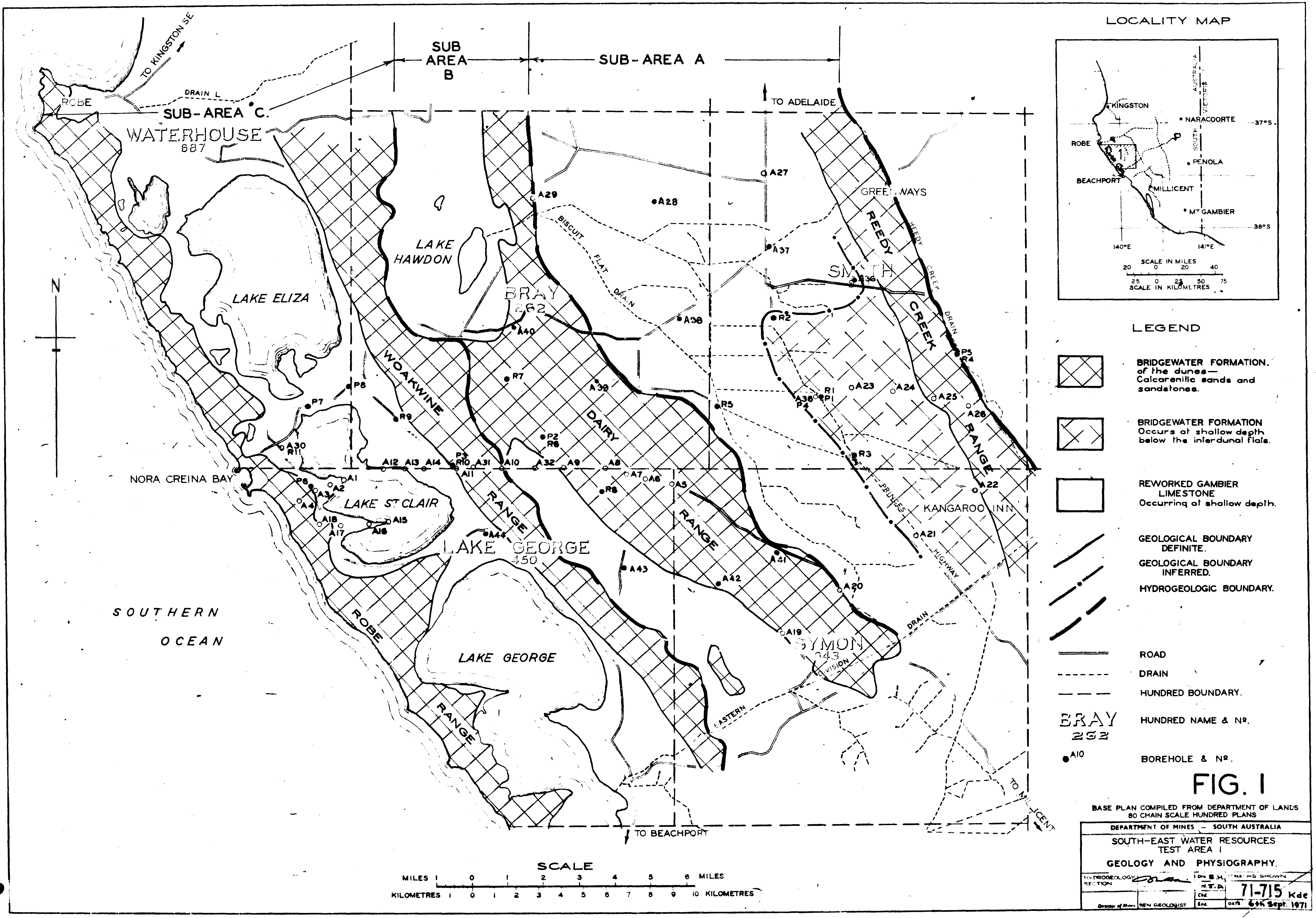


FIG. 1

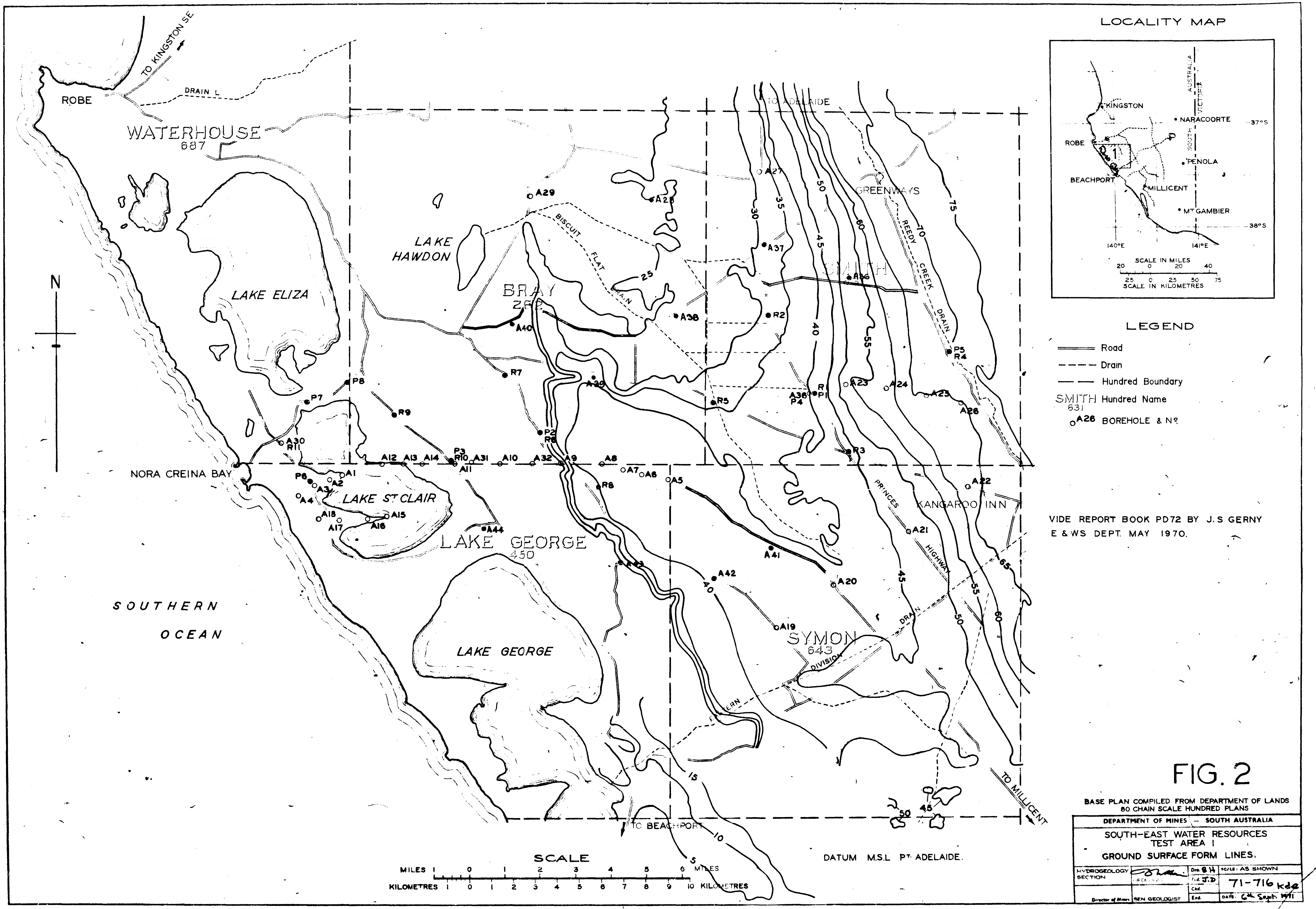
BASE PLAN COMPILED FROM DEPARTMENT OF LANDS
80 CHAIN SCALE HUNDRED PLANS

DEPARTMENT OF MINES – SOUTH AUSTRALIA

SOUTH-EAST WATER RESOURCES
TEST AREA I

GEOLOGY AND PHYSIOGRAPHY.

HYDROGEOLOGY SECTION
Drn. B.H.
N.J.D.
Chd.
Exd.
SCALE AS SHOWN
71-715 Kde
Director of Mines
SEN. GEOLOGIST
DATE 6th Sept. 1971

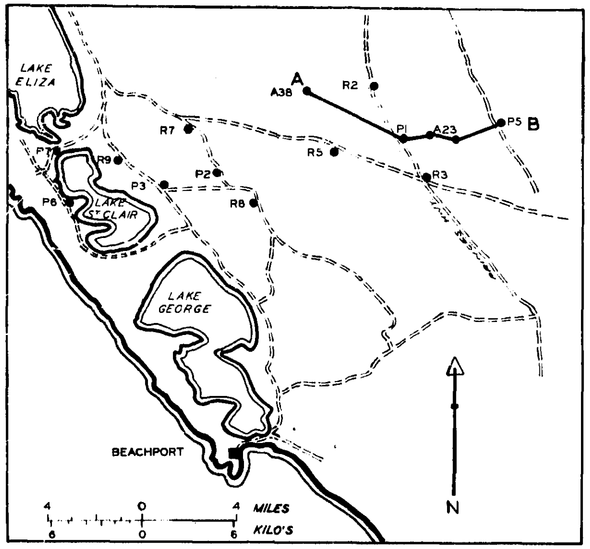


VIDE REPORT BOOK PD72 BY J.S GERNY
E & WS DEPT. MAY 1970.

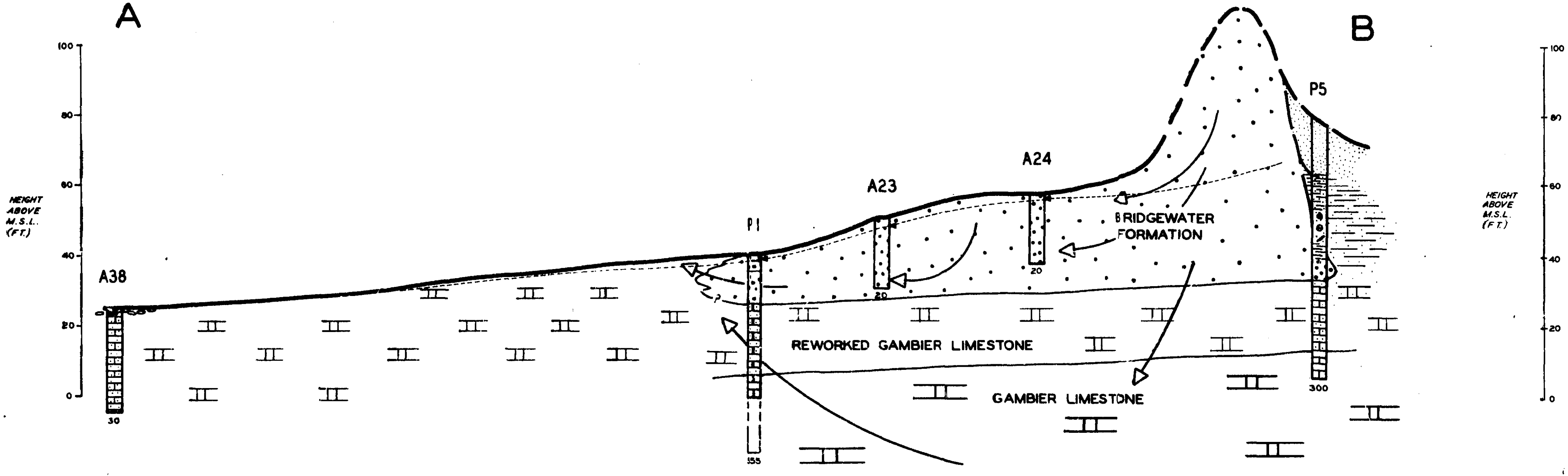
FIG. 2

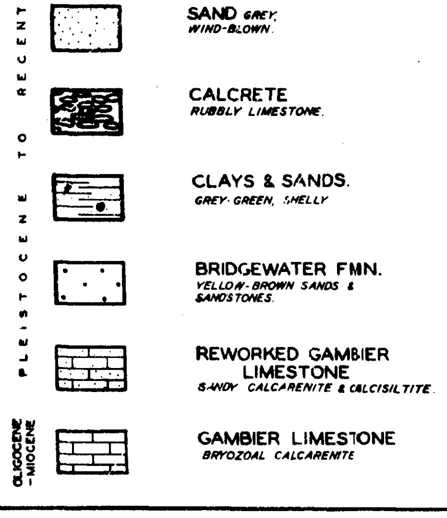
BASE PLAN COMPILED FROM DEPARTMENT OF LANDS
80 CHAIN SCALE HUNDRED PLANS

DEPARTMENT OF MINES — SOUTH AUSTRALIA			
SOUTH-EAST WATER RESOURCES TEST AREA I GROUND SURFACE FORM LINES.			
HYDROGEOLOGY SECTION	GEOLOGIST	Drn. B H	SCALE: AS SHOWN
		Td. J.D	71-716 kde
		Ckd.	
Director of Mines	SEN. GEOLOGIST	Exd.	DATE: 6th Sept 1971



LOCALITY PLAN





TYPICAL SECTION

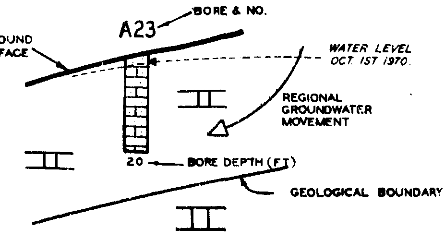
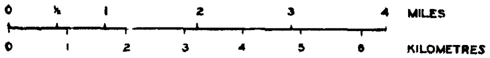


FIG. 3.

HORIZONTAL SCALE



DEPARTMENT OF MINES - SOUTH AUSTRALIA

SOUTH EAST WATER RESOURCES
TEST AREA ONE

GEOLOGICAL SECTION A. — B.

HYDROGEOLOGICAL SECTION	ASST. SEN. GEOLOGIST.	DRN. B.M.H.	SCALE : AS SHOWN
		TCD. J.D.	71 717 KDE
		CKD.	
DIRECTOR of MINES	SENIOR GEOLOGIST	EXD.	DATE : 6th Sept. 1971

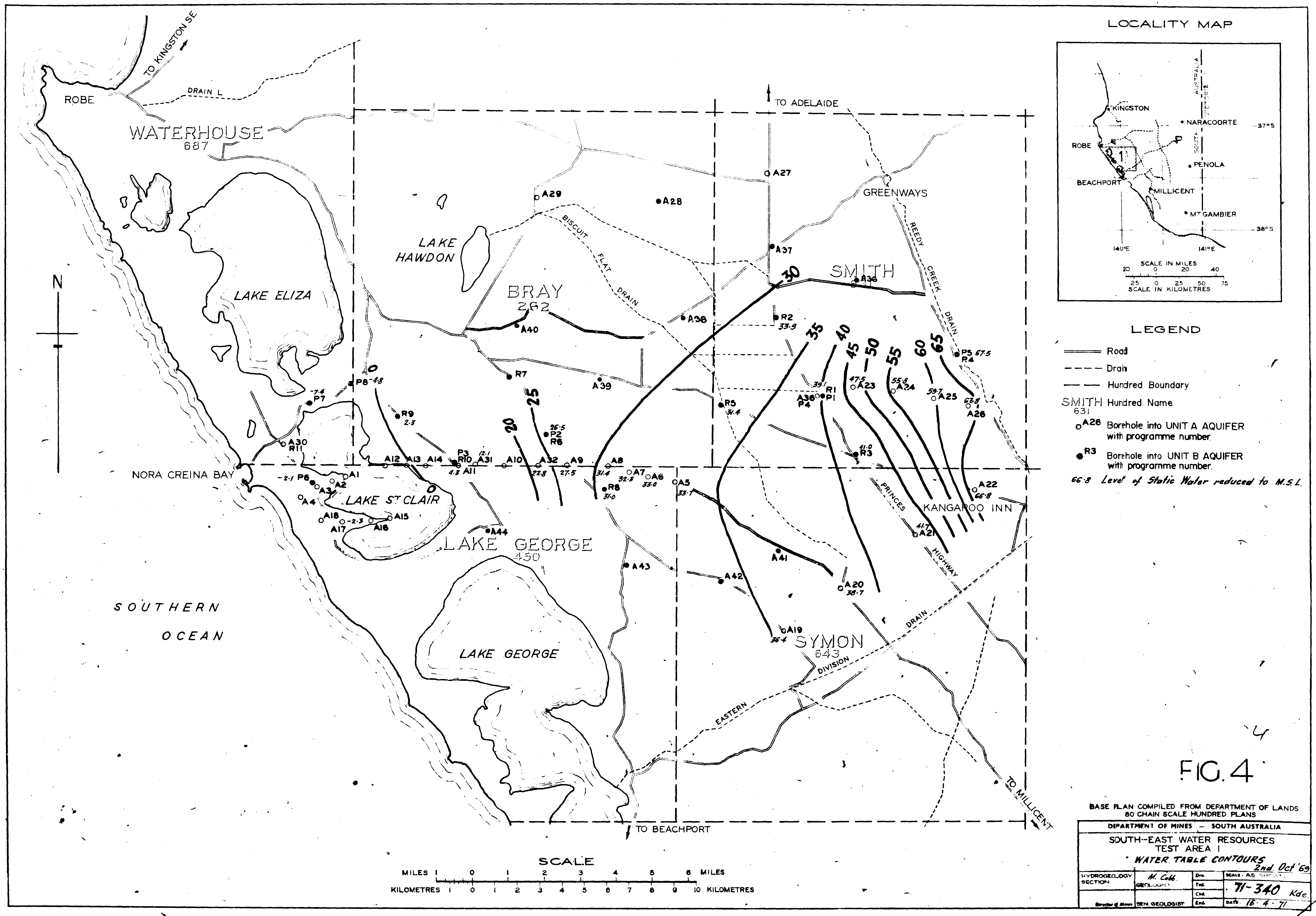


FIG. 4

BASE PLAN COMPILED FROM DEPARTMENT OF LANDS
80 CHAIN SCALE HUNDRED PLANS

DEPARTMENT OF MINES — SOUTH AUSTRALIA

SOUTH-EAST WATER RESOURCES
TEST AREA 1
WATER TABLE CONTOURS
2nd. Oct '69

HYDROGEOLOGY SECTION	M. Cobb. GEOLOGIST	Drn.	SCALE: AS SHOWN
		Tcd.	71-340 Kde.
Director of Mines	SEN. GEOLOGIST	Ckd.	
		Exd.	DATE: 15·4·71

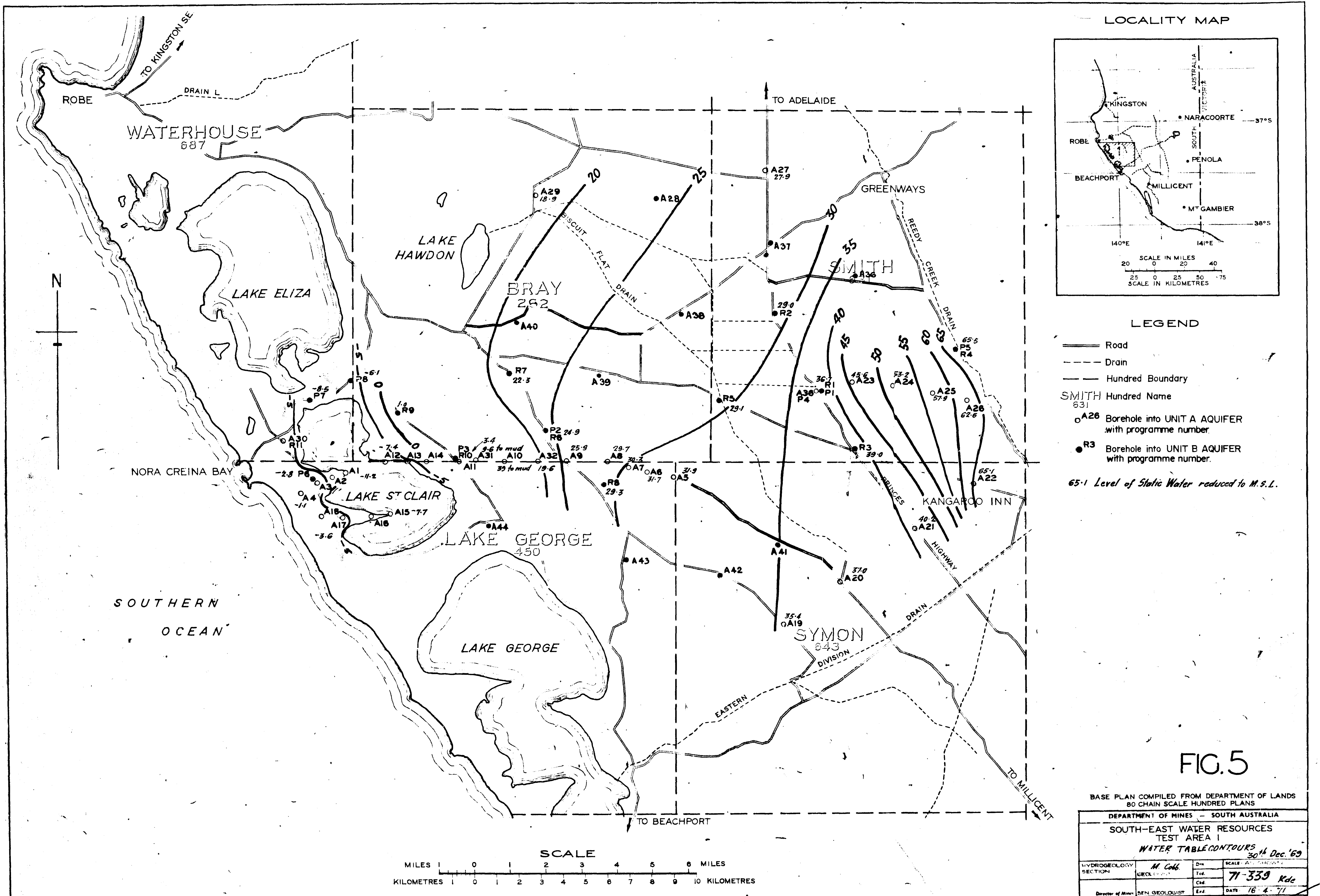


FIG.5

BASE PLAN COMPILED FROM DEPARTMENT OF LANDS
80 CHAIN SCALE HUNDRED PLANS

DEPARTMENT OF MINES – SOUTH AUSTRALIA

SOUTH-EAST WATER RESOURCES
TEST AREA I
WATER TABLE CONTOURS 30th Dec. '69

HYDROGEOLOGY SECTION	M. Cobb. GEOLOGIST	Drn.	SCALE: AS SHOWN
		Tcd.	71-339 Kde
		Ckd.	
Director of Mines	SEN. GEOLOGIST	Exd.	DATE 16·4·71

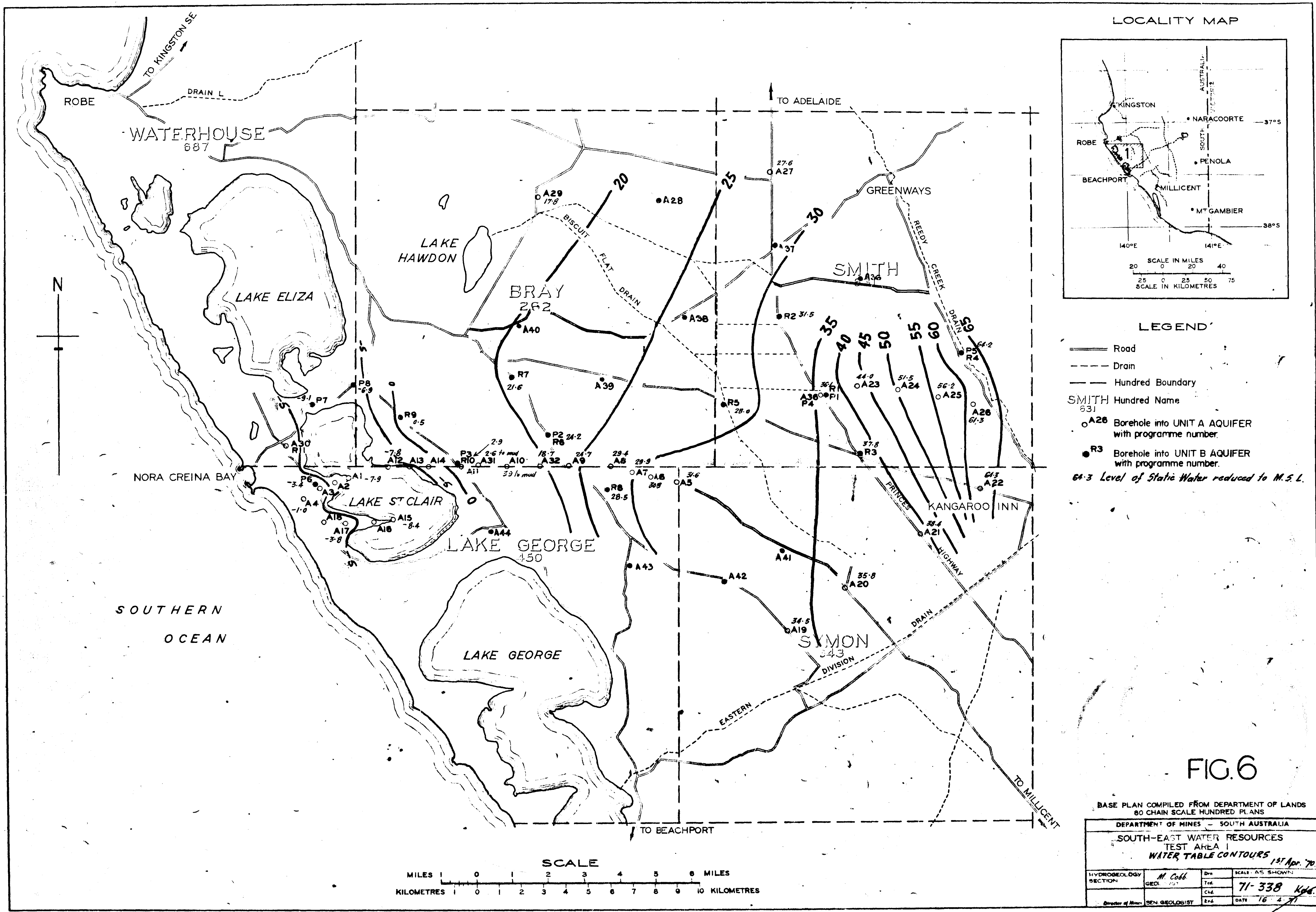


FIG.6

BASE PLAN COMPILED FROM DEPARTMENT OF LANDS
80 CHAIN SCALE HUNDRED PLANS

DEPARTMENT OF MINES – SOUTH AUSTRALIA

SOUTH-EAST WATER RESOURCES
TEST AREA 1
WATER TABLE CONTOURS
1ST Apr. '70.

HYDROGEOLOGY SECTION	M. Cobb. GEOLOGIST	Drn	SCALE: AS SHOWN
		Tcd.	71-338 Kds.
		Chd.	
Director of Mines	SEN. GEOLOGIST	Exd.	DATE 16 4 71

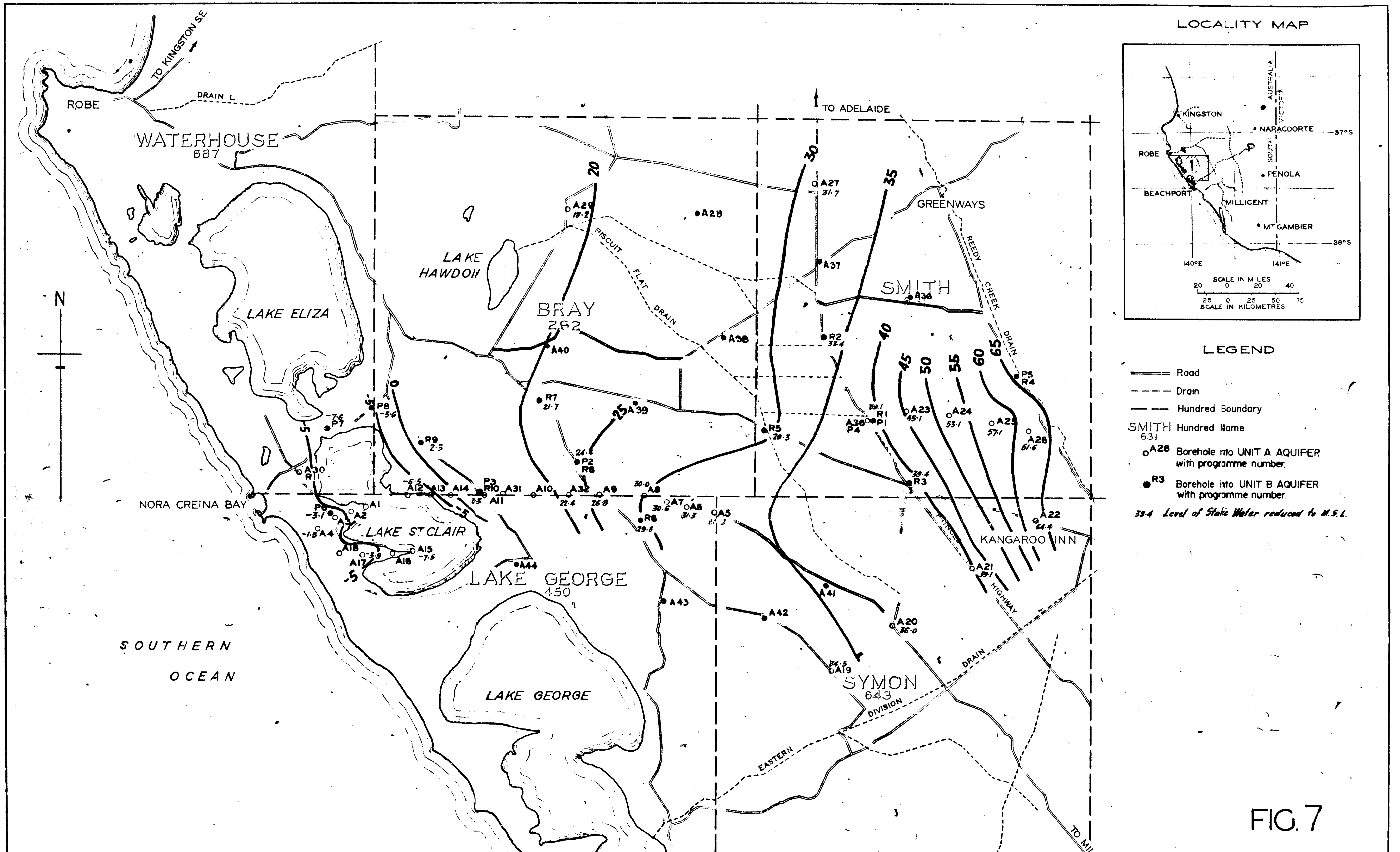


FIG. 7

BASE PLAN COMPILED FROM DEPARTMENT OF LANDS
80 CHAIN SCALE HUNDRED PLANS

DEPARTMENT OF MINES - SOUTH AUSTRALIA

SOUTH-EAST WATER RESOURCES
TEST AREA I
WATER TABLE CONTOURS
2nd. July 70.

HYDROGEOLOGY SECTION	M. Cobb. GEOL	Drn	SCALE: AS SHOWN
		Trd.	71-337 Kde
		Ckd.	
Director of Mines	SEN GEOLOGIST	Exd.	DATE 16.4.71

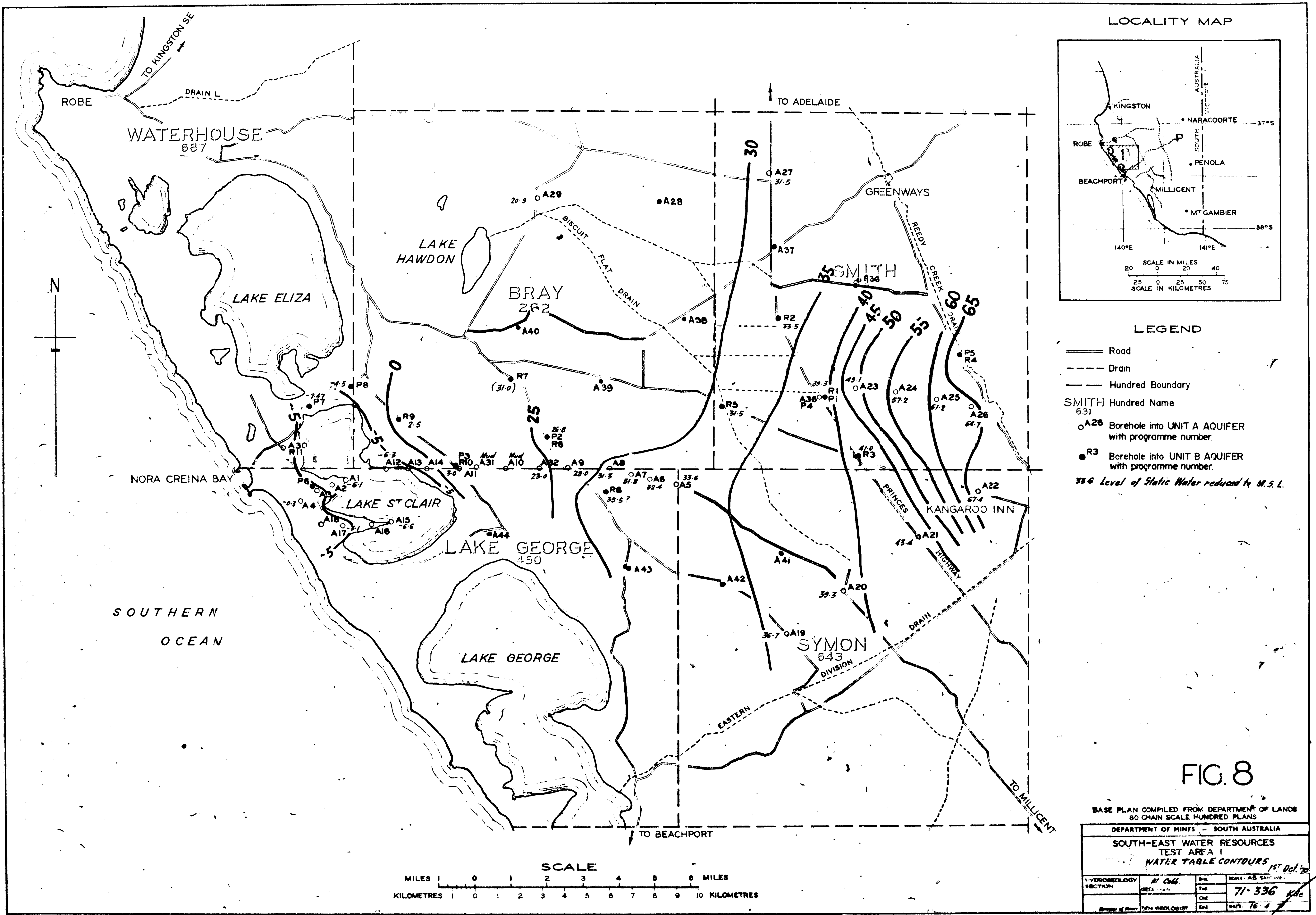


FIG. 8

BASE PLAN COMPILED FROM DEPARTMENT OF LANDS
80 CHAIN SCALE HUNDRED PLANS

DEPARTMENT OF MINES – SOUTH AUSTRALIA

SOUTH-EAST WATER RESOURCES
TEST AREA I
WATER TABLE CONTOURS
1ST Oct. '70

HYDROGEOLOGY SECTION	M Cobb GEOL [illegible]	Drn.	SCALE: AS SHOWN
		Ted.	71-336
		Ckd.	
Director of Mines	SEN GEOLOGIST	Exd.	DATE: 16 · 4 · 71

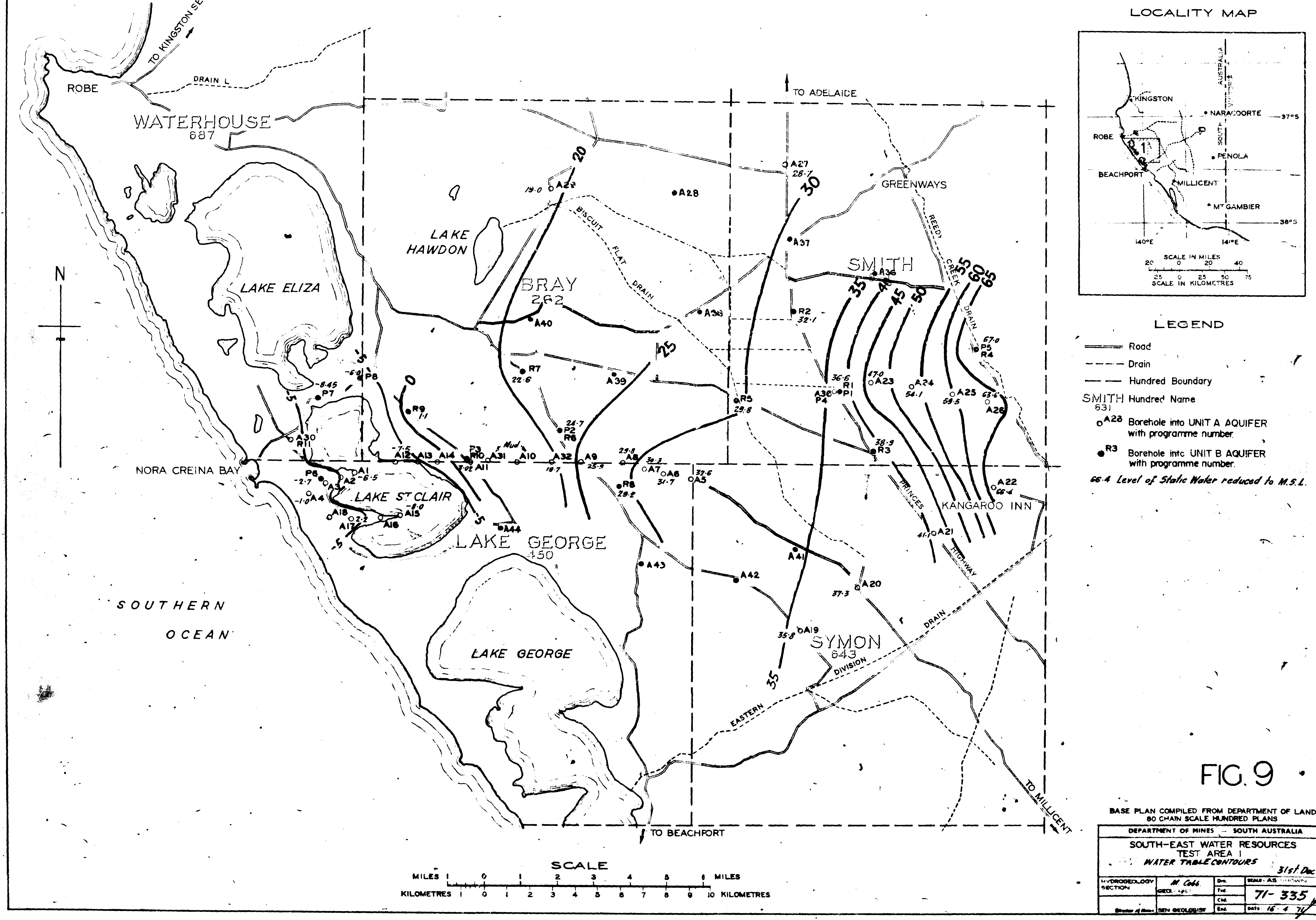


FIG. 9

BASE PLAN COMPILED FROM DEPARTMENT OF LANDS
80 CHAIN SCALE HUNDRED PLANS

DEPARTMENT OF MINES — SOUTH AUSTRALIA

SOUTH-EAST WATER RESOURCES
TEST AREA 1
WATER TABLE CONTOURS
31st Dec '70.

HYDROGEOLOGY SECTION	M. Cobb. GEOLOGIST	Drn.	SCALE: AS SHOWN
		Tcd.	71- 335
		Chd.	
Director of Mines	SEN. GEOLOGIST	Exd.	Date: 16 · 4 · 71

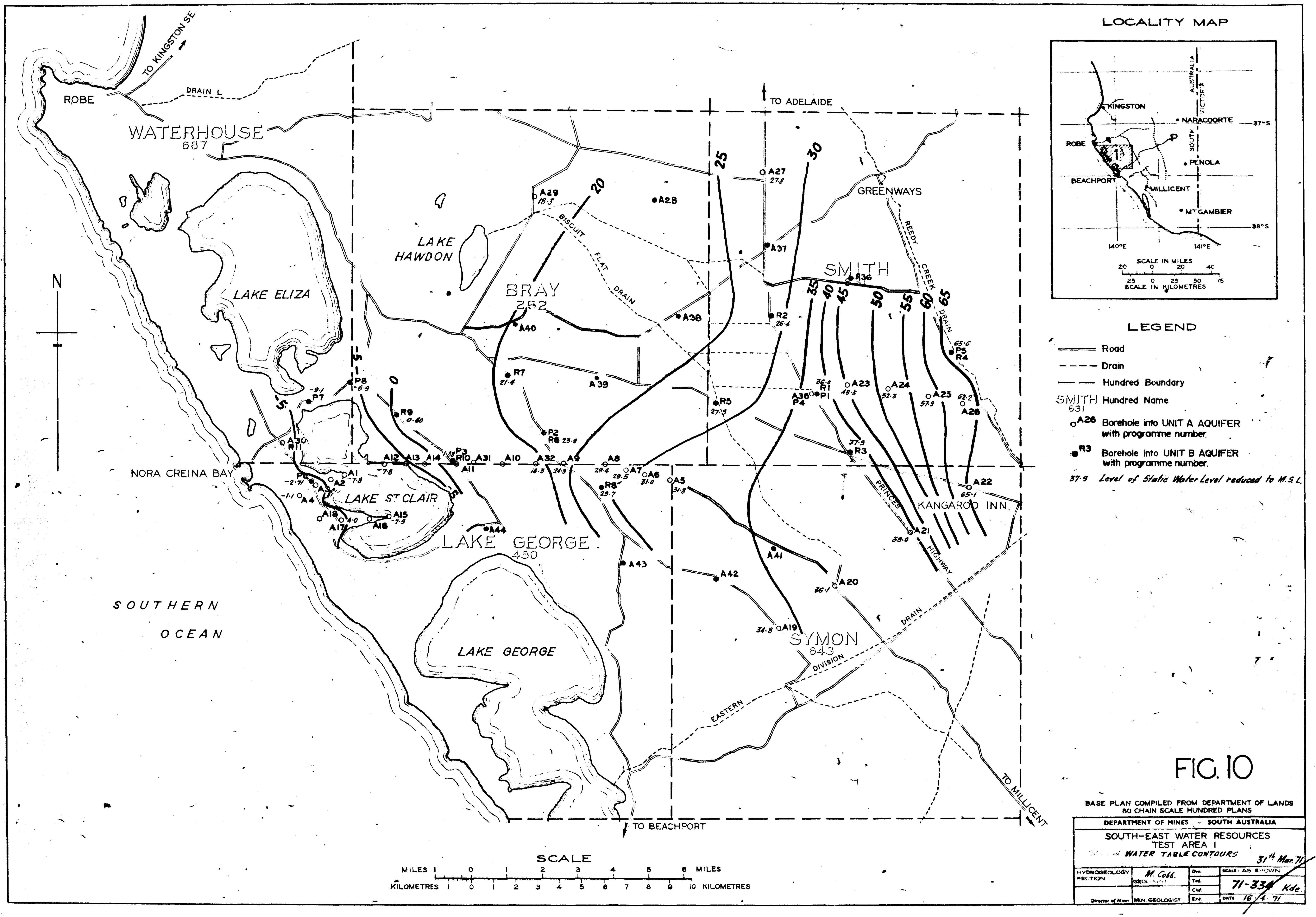


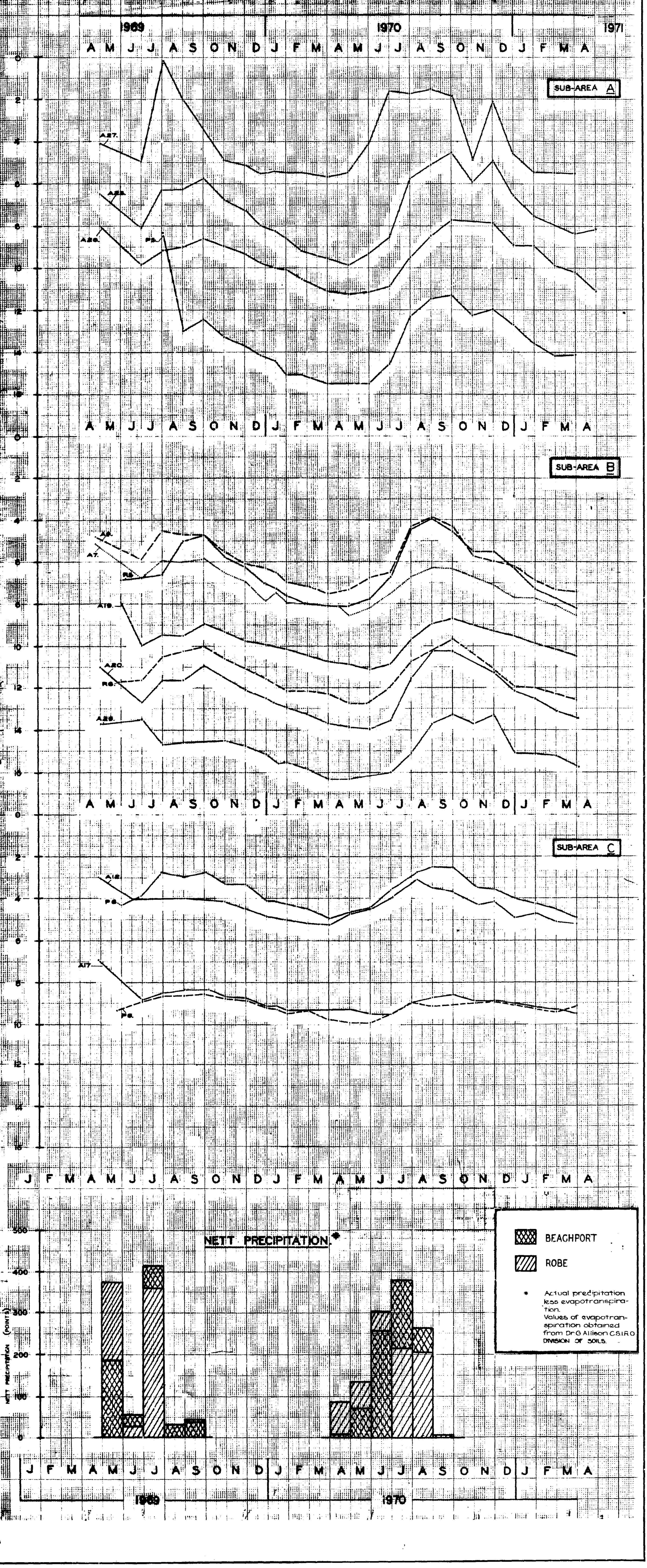
FIG. 10

BASE PLAN COMPILED FROM DEPARTMENT OF LANDS
80 CHAIN SCALE HUNDRED PLANS

DEPARTMENT OF MINES — SOUTH AUSTRALIA

SOUTH-EAST WATER RESOURCES
TEST AREA I
WATER TABLE CONTOURS
31st Mar. 71

HYDROGEOLOGY SECTION	M. Cobb. GEOLOGIST	Drn.	SCALE: AS SHOWN
		Tcd.	71-334 Kde.
		Ckd.	
Director of Mines	SEN. GEOLOGIST	Exd.	DATE 16/4/71



* Actual precipitation less evapotranspiration. Values of evapotranspiration obtained from Dr G Allison C.S.I.R.O DIVISION OF SOILS.

FIG. 11

DEPARTMENT OF MINES - SOUTH AUSTRALIA

SOUTH-EAST WATER RESOURCES
TEST AREA ONE

WATER LEVEL HYDROGRAPHS

HYDROGEOLOGICAL SECTION	ASST SEN GEOLOGIST	DRN BMH TCD J.D CKD EXD	SCALE AS SHOWN 71-718 KDE DATE 6th Sept. 1971
DIRECTOR of MINES	SENIOR GEOLOGIST		

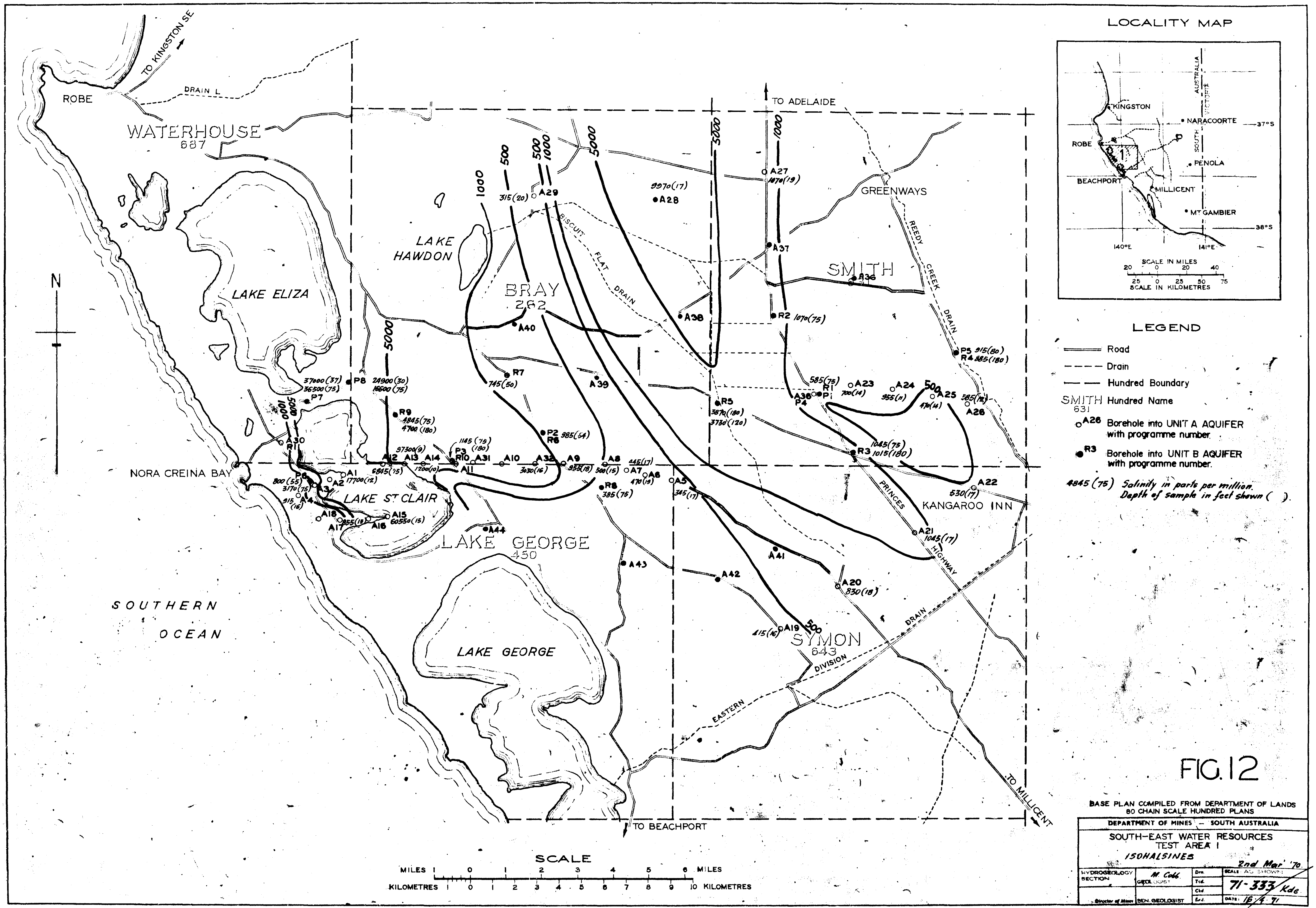


FIG. 12

BASE PLAN COMPILED FROM DEPARTMENT OF LANDS
80 CHAIN SCALE HUNDRED PLANS

DEPARTMENT OF MINES – SOUTH AUSTRALIA

SOUTH-EAST WATER RESOURCES
TEST AREA 1
ISOHALSINES

2nd Mar '70.

HYDROGEOLOGY SECTION	M. Cobb. GEOLOGIST	Drn.	SCALE: AS SHOWN
		Tcd.	71-333 Kde.
		Ckd.	
Director of Mines	SEN. GEOLOGIST	Exd.	DATE: 16.4.71

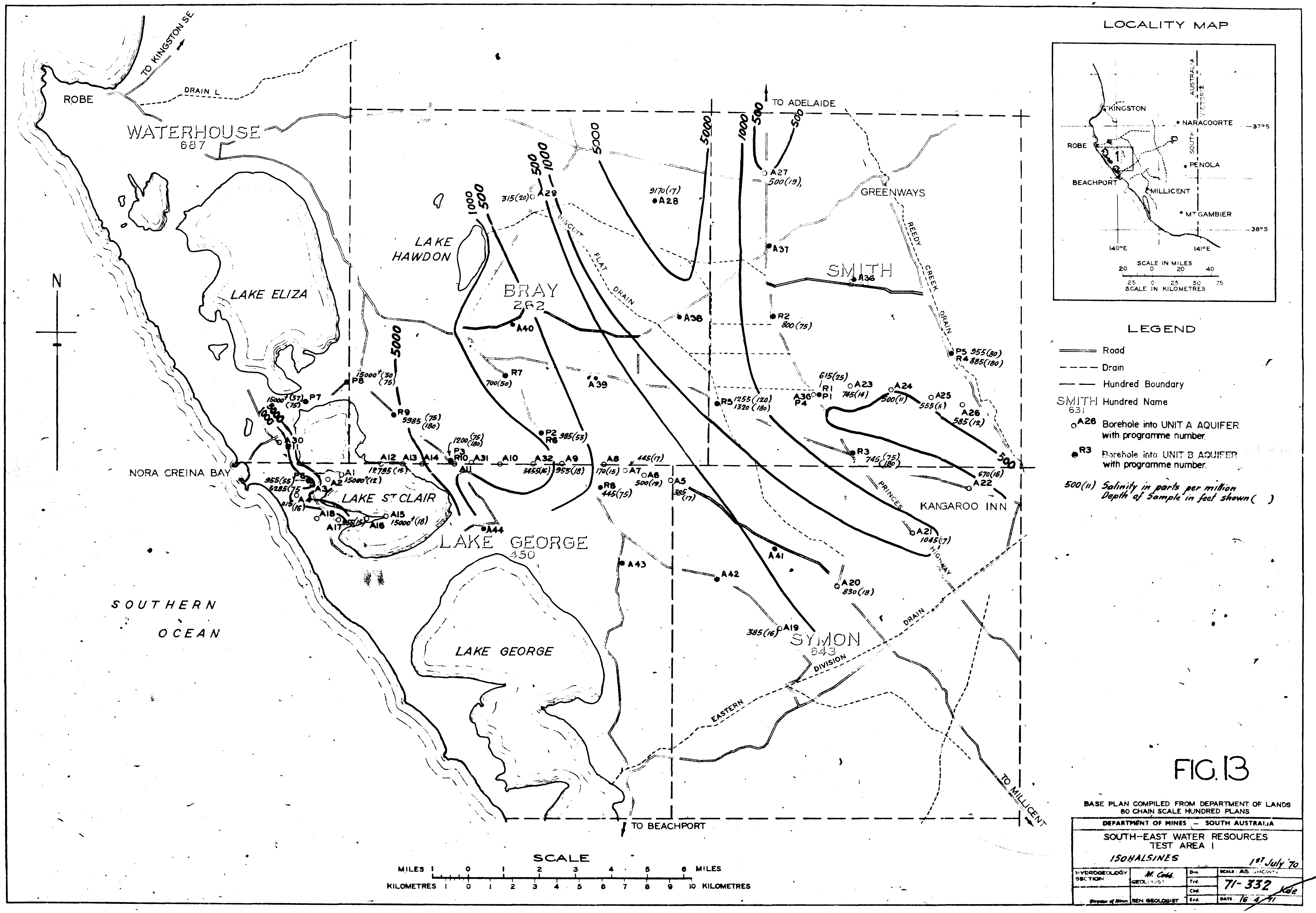


FIG. 13

BASE PLAN COMPILED FROM DEPARTMENT OF LANDS
80 CHAIN SCALE HUNDRED PLANS

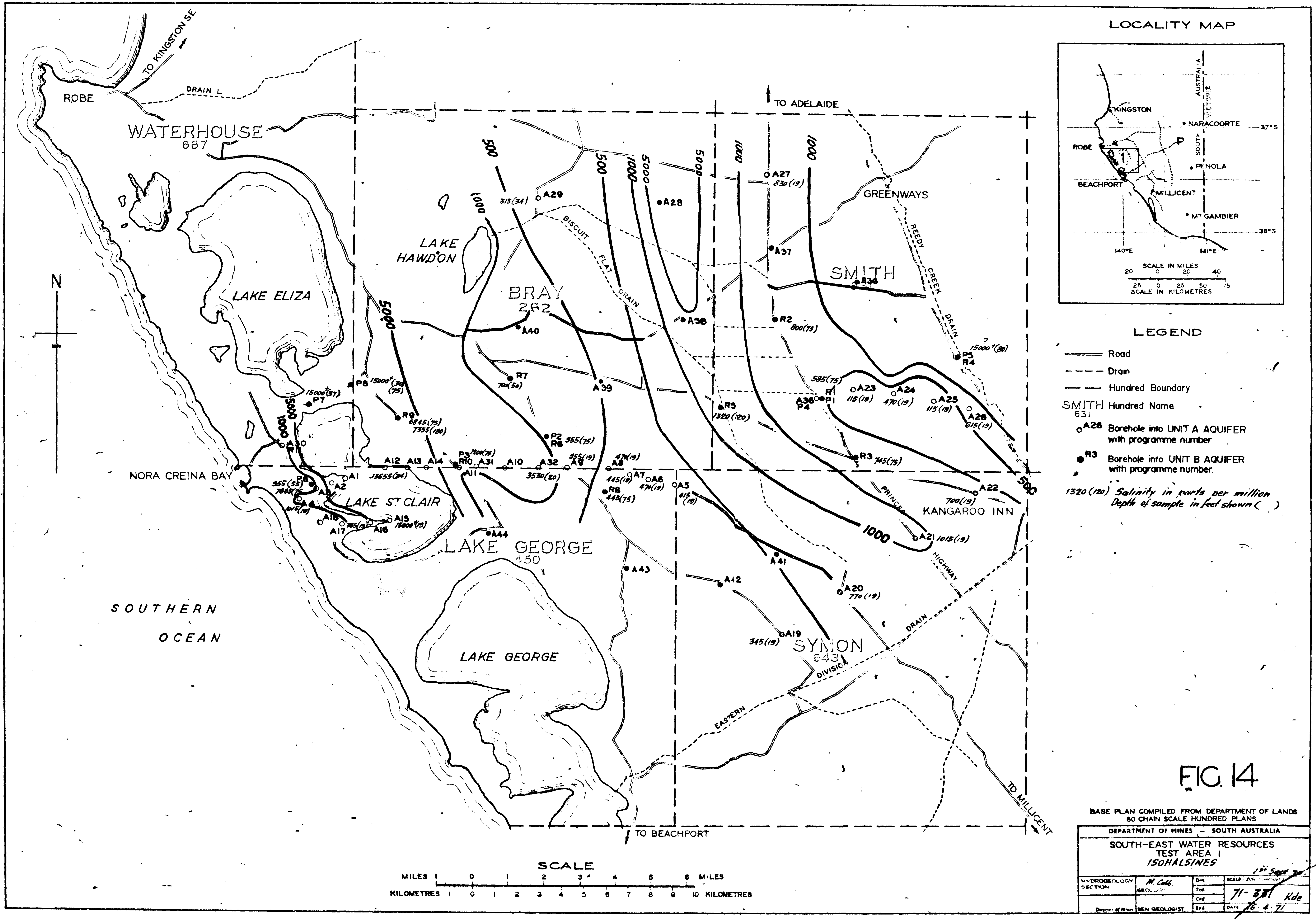
DEPARTMENT OF MINES – SOUTH AUSTRALIA

SOUTH-EAST WATER RESOURCES
TEST AREA 1

ISOHALSINES

1st July '70

HYDROGEOLOGY SECTION	M. Cobb. GEOLOGIST	Drn.	SCALE: AS SHOWN
		Trd.	71-332 Kde
		Ckd.	
Director of Mines	SEN. GEOLOGIST	Exd.	DATE: 16.4.71



LEGEND

- Road
- Drain
- Hundred Boundary
- SMITH 631 Hundred Name
- ○A26 Borehole into UNIT A AQUIFER with programme number
- ●R3 Borehole into UNIT B AQUIFER with programme number.
- *1320 (120) Salinity in parts per million Depth of sample in feet shown ( )*

FIG. 14

BASE PLAN COMPILED FROM DEPARTMENT OF LANDS
80 CHAIN SCALE HUNDRED PLANS

DEPARTMENT OF MINES – SOUTH AUSTRALIA

SOUTH-EAST WATER RESOURCES
TEST AREA 1
ISOHALSINES

1st Sept 70.

HYDROGEOLOGY SECTION	M. Cobb. GEOLOGIST	Drn.	SCALE: AS SHOWN
		Tcd.	71-331 Kde
		Chd.	
Director of Mines	SEN GEOLOGIST	Exd.	DATE 16·4·71

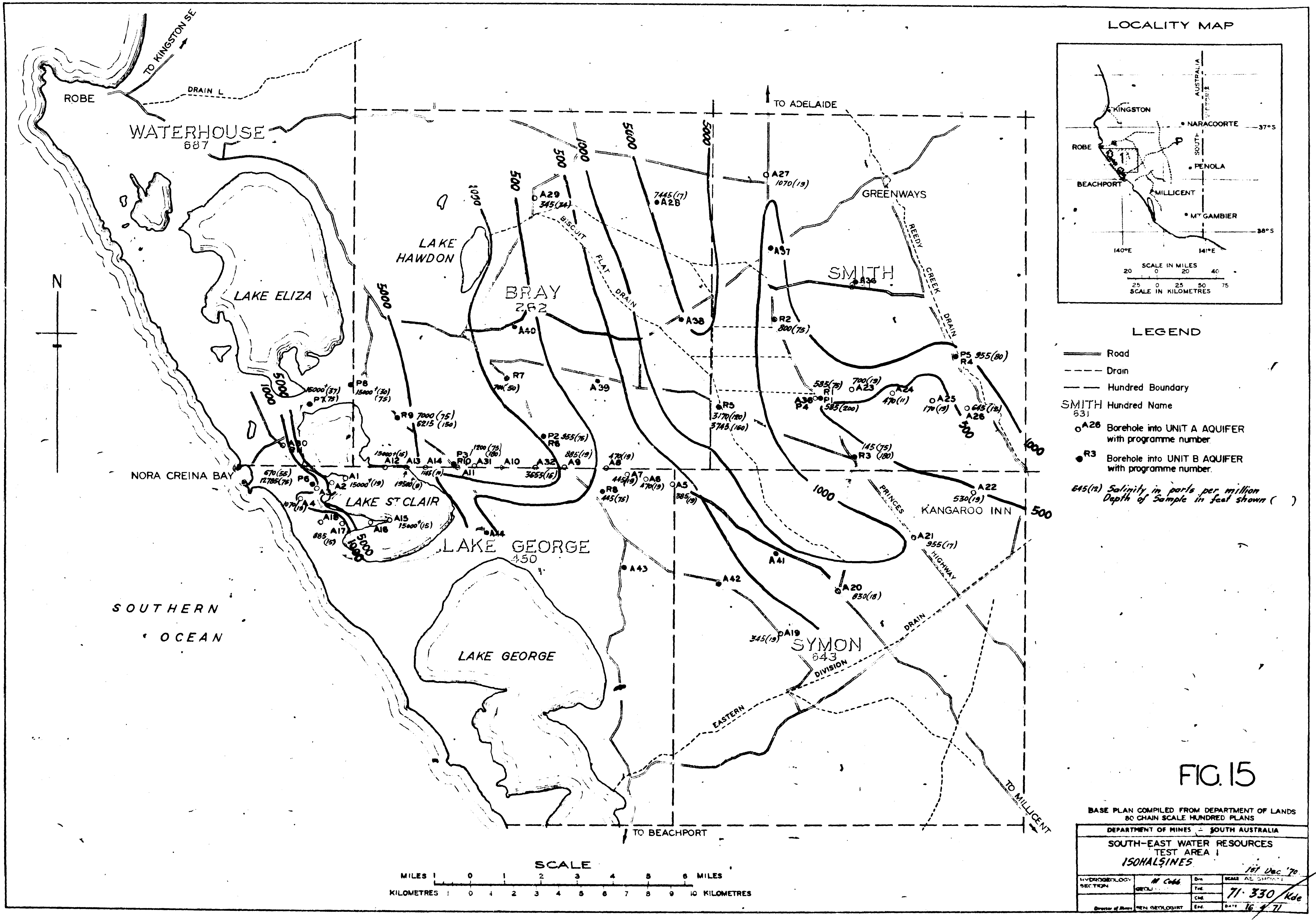


FIG. 15

BASE PLAN COMPILED FROM DEPARTMENT OF LANDS
80 CHAIN SCALE HUNDRED PLANS

DEPARTMENT OF MINES - SOUTH AUSTRALIA

SOUTH-EAST WATER RESOURCES
TEST AREA 1
ISOHALSINES

1st Dec '70

HYDROGEOLOGY SECTION	M Cobb GEOL	Drn.	SCALE AS SHOWN
		Tcd.	71·330/Kde
		Ckd.	
Director of Mines	SEN GEOLOGIST	Exd.	DATE 16/4/71

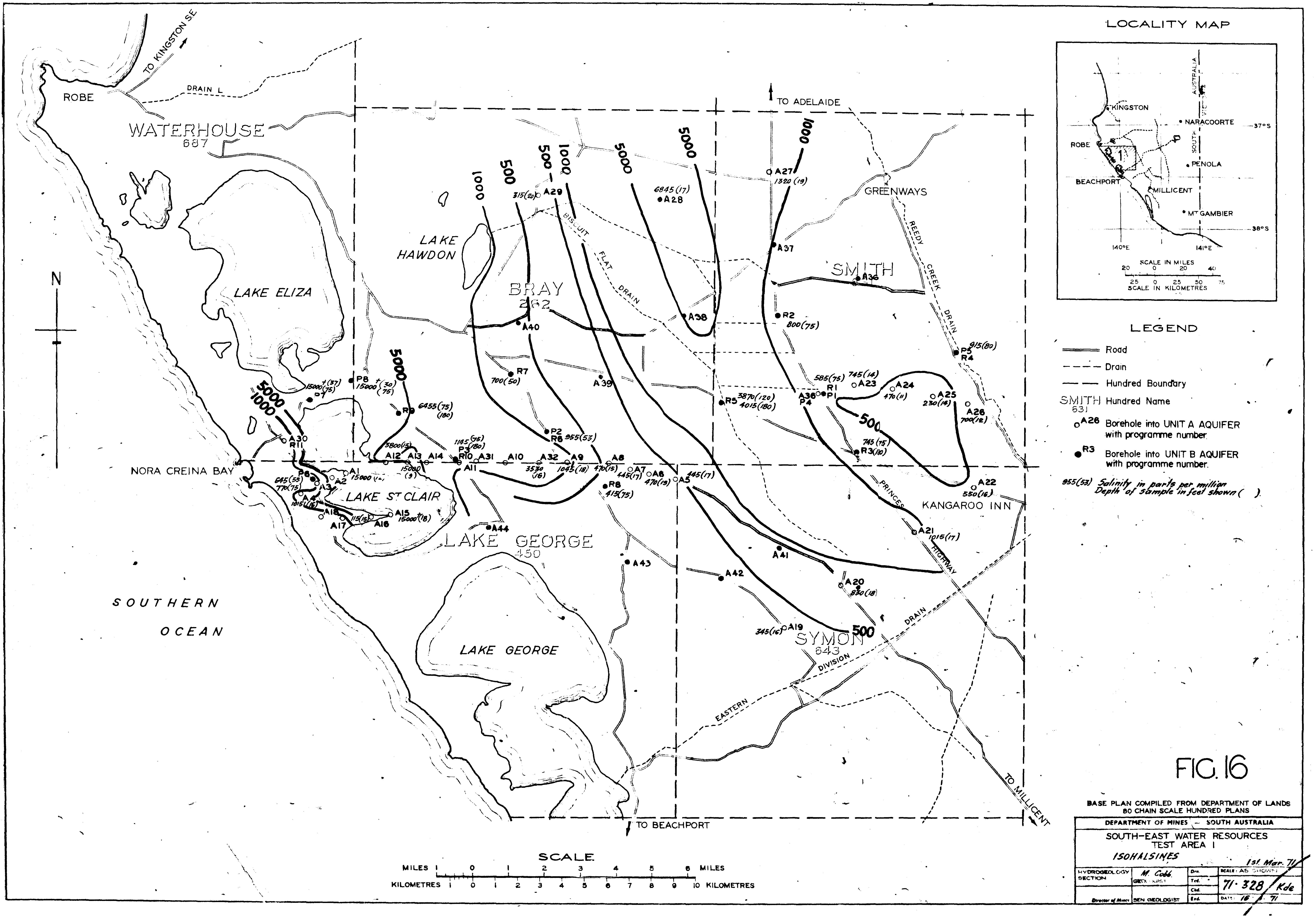


FIG. 16

BASE PLAN COMPILED FROM DEPARTMENT OF LANDS
80 CHAIN SCALE HUNDRED PLANS

DEPARTMENT OF MINES – SOUTH AUSTRALIA

SOUTH-EAST WATER RESOURCES
TEST AREA I

ISOHALSINES

1st Mar. 71

HYDROGEOLOGY SECTION	*M. Cobb.* GEOLOGIST	Drn.	SCALE: AS SHOWN
		Tcd.	*71·328 / Kde*
		Ckd.	
Director of Mines	SEN. GEOLOGIST	Exd.	DATE: *16 · · 71*

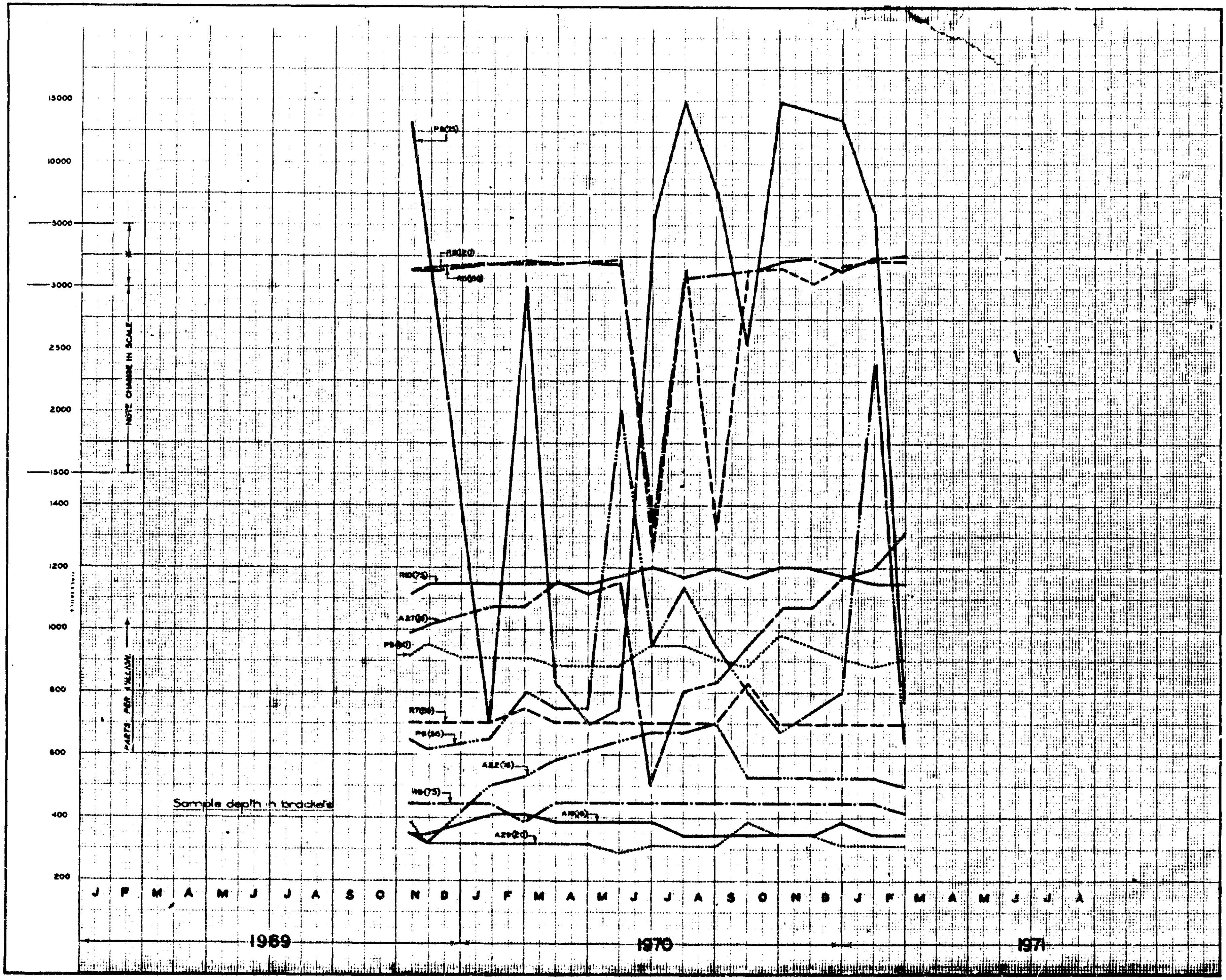


FIG. 17

DEPARTMENT OF MINES - SOUTH AUSTRALIA.

SOUTH - EAST WATER RESOURCES
TEST AREA ONE

GROUNDWATER SALINITY HYDROGRAPHS.

HYDROGEOLOGICAL SECTION	ASST. SEN GEOLOGIST	DRN MJC	SCALE
		TCD JD	71-719 KDE
		CKD	
DIRECTOR OF MINES	SEN GEOLOGIST	EXD	DATE 1-9-71