DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

REPT.BK.NO. 87/135

REPORT ON GROUNDWATER OF THE CARRABIE BASIN

GEOLOGICAL SURVEY

by

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GROUNDWATER AND ENGINEERING

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DISK NO. 53

REPORT ON GROUNDWATER OF THE CARRABIE BASIN

ABSTRACT

The Carrabie Basin is situated in the western portion of the foot of southern Yorke Peninsula, covering an area of approximately 100 km^2. The aquifer is unconfined Bridgewater Formation. Recharge is by direct infiltration of rainfall. A field survey was carried out to update the existing data base, land owners were interviewed for information on current and future land use and groundwater requirements, also the local District Council provided information on their future requirements of the Basin as a groundwater supply. The results of the interpretation of previous geophysical surveys, pump testing analysis and more recent recharge and safe yield results are included. Although several different methods to determine recharge and safe yield were applied, the results were of the same order of magnitude.

INTRODUCTION

The project was undertaken for 2 main reasons; to update the existing data base and to act as an information source for use in a computer model of the Carribie Basin aquifer undertaken by a post graduate student at the S.A.I.T.

The Carribie Basin covers an area of approximately 116 km^2 and is situated in the western portion of the foot of Yorke Peninsula (Fig. 1). A water well survey was conducted in early 1986 within the basin and selected wells were levelled to A.H.D.

With the recent subdivisions of the Corny Point & Pines areas, shack owners may in future lobby for a reticulated water supply provided by groundwater from the Carribie Basin.

PHYSIOGRAPHY

Topography

Recent vegetated coastal dunes form the western boundary of the basin. They consist of fine, unconsolidated sands overlying partially consolidated aeolian limestones. To the east, the boundary is formed by a topographic high, while to the south it is bounded by limestone ridges giving an overall saucer shape to the basin. There is a gentle slope from east to west with some isolated swampy salt lakes on the north and north eastern edges of the coastal dunes.

There are no permanent or clearly defined water courses and any surface runoff collects in interdunal depressions.

An older dune system (Bridgewater Formation) which is consolidated and capped with calcrete forms gentle ridges orientated in a general north easterly/south westerly direction. The low salinity groundwater "basin" is generally less than 10 m above A.H.D. with the basin boundaries rising from 10 m to a maximum of 40 m A.H.D.

Land Use

The farming activity is mainly cereal cropping with sheep and cattle grazing. Pig farming is increasing because of its current profitability.

Vegetation

Cereal crops are mainly barley and oats with a lesser amount of wheat. Native scrub remains in areas considered by farmers to be too rocky to cultivate cereal crops, or too poor to support grazing. Recent Government regulations prohibit scrub clearing without permits. Salt tolerant plants and shrubs are prevelant in the swampy areas (Fig. 2).

Climate and Rainfall

The climate is of a Mediteranean type, hot dry summers and mild winters with the highest rainfall occurring in the months May to September. The average rainfall for Corny Point is 442 mm. Rainfall data at Corny Point has been recorded since 1888 and are presented in Appendix 1.

PREVIOUS WORK

During the decade 1940-1950 exploration wells in the central part of the foot of Yorke Peninsula for stock watering mainly intersected shallow basement. In the mid 1950's however a driling programme in the western portion of Southern Yorke Peninsula produced wells with good quality water at shallow depth. During the period 1964-1966 several Departmental geophysical suveys were conducted in the Carribie basin, using electrical resistivity, gravity and seismic reflection methods (Hussin 1966). See Figure 3. Sixteen wells were drilled and completed from which ten are currently being used as observation wells. These groundwater exploration methods confirmed an unconfined aeolianite aquifer with a maximum thickness of 20 m and thinning toward the boundaries of the basin. Of the sixteen holes drilled only seven were pumped to obtain aquifer parameters. The results from these tests were of limited use because of discharge water being recirculated to the aquifer, even though the discharge outfall was 370 m from the pumped well (Bleys 1966) with the above qualifications taken into account, aquifer characteristics appear to the uniform throughout the Basin. Bleys calculated an average transmissivity value of 2056 m^2/day and hydraulic conductivity of 109m/day. In a subsequent report Bleys estimated recharge to be 1400 ML/year and "safe yield" to be 1000 ML/year.

GEOLOGY

The stratigraphy of the southwestern portion of Yorke Peninsula consists essentially of two units, Pleistocene calcareous aeolianite unconformably overlying Archaean/Lower Proterozoic basement (Hussin 1966). See cross sections on Figure 4.

Basement rocks are exposed along the coast from Berry Bay to Point Annie, in the form of massive whaleback beach outcrops. These outcrops are all very coarse augen gneiss, having a granitoid texture, with some finer grained schistose bands. Similar outcrop occurs at Daly Head but is more broken in appearance. At Royston Head massive dark grey gneiss crops out (Crawford 1965). See Figure 5.

These basement rocks occur at depth to the south and east (well driller's logs). Inland, basement rocks do not crop out, however interpretation of driller's logs suggests that the clays with mica and quartz interesected at the bottom of some wells are weathered basement. In some areas, clays greater than 30 m in thickness have been recorded from the results of geophysical surveys and are thought by Bleys (1966) to be Permian glacial valley fills or buried sea inlets.

The extensive sheets of calcareous aeolianite which unconformably overlie basement rocks are of the Bridgewater Formation which crops out extensively along South Australian coasts.

HYDROGEOLOGY

Aquifer Distribution

The main aquifer in the Carribie Basin can assumed to be unconfined, although it is probable that in some areas of the basin it may be confined because of the occurence of low permeability calcrete or clay layers.

However, the calcrete can be redissolved and solution holes would perforate the continous layers thus establishing hydraulic continuity between "sub aquifers". This suggests that overall the aquifer can be considered as unconfined.

Aquifer thickness varies between 11 m in the north east part of the basin to 24 m near the centre. The interpretation of available geological logs and geophysical data indicates that the whole of the toe of Southern Yorke Peninsula is covered by sediments with the ability to act as aquifers.

Groundwater of less than 1000 mg/L is available from most of the wells within the Carribie Basin with the exception of an area to the north east of the Basin, where salinity is greater than 2000 mg/L (Fig. 6) (ommitting the clay pan area of higher salinity caused by evaporation). Over the last 20 years, ground water quality in most S.A.D.M.E. observation wells has shown no appreciable increase in salinity.

To determine aquifer characteristics, Bleys (1966) conducted several pumping test on observation wells, drilled in the 1964-1966 drilling programme. From these results transmissivity, hydraulic conductivity values and one specific yield value of 0.16 (CRB7) were determined (Table 1).

Table 1: Transmissivity & Hydraulic Conductivity Data

OBS. NO.	TRANSMISSIVITY (m^3/day/m)	HYDRAULIC CONDUCTIVITY (m^3/day/m^2)
CRB 7	1765	103
8	1444	67
9	1685	100
10	193	10
13	1043	62
14	3290	178
16	4976	243
AVERAGE	2056	109

Recharge

Recharge is by direct infiltration of rainfall and dependent on the material overlying the aquifer. Rainfall in the months of June and July provides most recharge (Fig 7a,b,c).

Since 1888 rainfall data has been collected continuously at Corny Point. The rain guage station is only 9 km from the basin. The average annual rainfall of 442 mm is a fair approximation for the entire Basin.

To be able to calculate the amount of rainfall which reaches the aquifer, factors such as evapotranspiration, and loss due to surface run off must be considered. Since there are no surface watercourses runoff is insignificant.

Potential evapotranspiration is a figure deduced from mean monthly air temperatures with allowance made for the number of daylight hours per month at the latitude of interest (35 degrees south). The amount of rainfall excess to potential evapotranspiration is 96 mm/year. While the amount of effective

rainfall to fall before recharge occurs is 49 mm. Subtracting this figure from the average total effective rainfall of 96 mm/year recharge to the basin is 47 mm/year or 2900 ML/year (Wischusen 1987).

By using the amount of chloride in rainfall with relation to chloride in groundwater, the amount of annual recharge can be estimated. To do this, chloride concentrations in groundwater were obtained from the observation network wells, and their distance from the coast determined. The average of the sum of these values (Appendix 3) was used in the formula.

Cl in rain = $(0.99/\sqrt[4]{d} - 0.23) \times 35.5$ mg/L (Hutton 1976)

where d is the distance from the coast in km (6.48 km)

i.e. $Cl = \left(\frac{0.99}{1.58998} - 0.23 \right) \times 35.5$

$= 14.38$ mg/L

$$\text{Annual recharge} = \frac{\text{chloride in rainfall} \times \text{average annual rainfall}}{\text{chloride in groundwater}}$$

Cl in rainfall = 14.28 x 442
= 6311

Average Cl in groundwater (Appendix 3) = 179 mg/L

i.e. Annual recharge = $\frac{6311}{179}$

Annual recharge = 35 mm/year

As the average value of T.D.S. for the basin was well below 1000 mg/L values above this figure were discarded as anomolous.

This is an independent evaluation of recharge using chemical properties rather than water level fluctuations and the results are of the same order of magnitude.

Given that the results are an estimation only, they do not warrant changing the safe yield of the Basin.

Groundwater Flow

From the potentiometric surface in Figure 8 it can be seen that groundwater flow is in the direction east to west. To determine the average velocity of groundwater flow the equation $v = \frac{Ki}{O}$ was used

where K = Hydraulic Conductivity 109 (m/day)

i = hydraulic gradient 4.8×10^{-4} from contour flows

= specific yield 0.16

.. $v = \frac{109 \times 4.8 \times 10^{-4} \times 365}{0.16}$

v = 120 m/year

From this the travel time/year from the basin centre to the coast can be calculated using:

$T = \frac{D}{V}$

D = distance travelled

V = velocity

.. $T = \frac{5200}{119.35}$

= 43.56 years

The amount of flow to the sea can be calculated using

$Q = \frac{TiWX365}{1000}$ ML/year

Where

T = transmissivity 2056 m^3/day/m

i = hydraulic gradient 4.8×10^{-4}

w = width of aquifer 8200 m

$Q = \frac{2056 \times 4.8 \times 10^{-4} \times 8200 \times 365}{1000}$

Q = 3000 ML/year

Observation Network

Departmental observation wells were drilled in the 1964 - 1966 geophysical survey. Unfortunately the only reliable data available is from 1977 onwards. The frequency of readings is six monthly from March 1980 and prior to that, monthly. Only depth to water readings are recorded as none of the wells are equipped (Fig. 9). Full analysis results are available from all wells except CRB 1 and CRB 17.

GROUNDWATER USE AND POTENTIAL

The extraction of groundwater from the Carribie basin is limited to windmills for stock use with the yield varying from 0.5 to 2.5 L/sec. The discharge from the windmills is piped to holding tanks which often were seen to overflow because of continuous pumping. A small portion of the overflow probably recharges the aquifer. The total amount of groundwater extracted per year for stock is probably less than 100 ML. Water loss due to evaporation from the clay pans is approximately 200 ML/year (Wischusen 1987). Current groundwater use is fairly static, due to the nature of the land and its inability to be used for irrigation. Previous attempts at irrigation have been uneconomic due to the high permeability of the soil and the excessive application rates of water required. The land itself is very poor in terms of its usage for irrigated crops, needing high application rates of fertilizers.

The potential groundwater extraction rate from the entire basin is 1000 ML/year (2750 m^3 day) (Wischusen 1987). However, local government plans for future subdivisions do not include the provision of reticulated water supplies rather, shack owners will need to supply their own needs i.e. rainwater and private wells, which will not be within the Carribie Basin proper.

Pollution:

Pollution potential is low to moderate. A number of hand dug wells have been abandoned which act as convenient sites for receiving a variety of farm waste e.g. disused machinery, fencing and dead stock.

Pollution from pig farms is high given the nature of the aquifer and its recharge mechanism.

Sea water ingress close to the coast due to overpumping could also become a problem if the aquifer is over stressed.

CONCLUSIONS AND RECOMMENDATION

In his report Wischusen estimated safe yeild to be 1000 ML/year figure to that of Bleys. Bleys estimates recharge to be 1400 ML/year whereas Wischusen based his results on a recharge of 2900 ML/year.

If extraction of groundwater on an increased scale is planned it is recommended that a series of observation wells be constructed along the coast to monitor water levels and quality and ensure that advance warning is given of incursion of saline groundwater.

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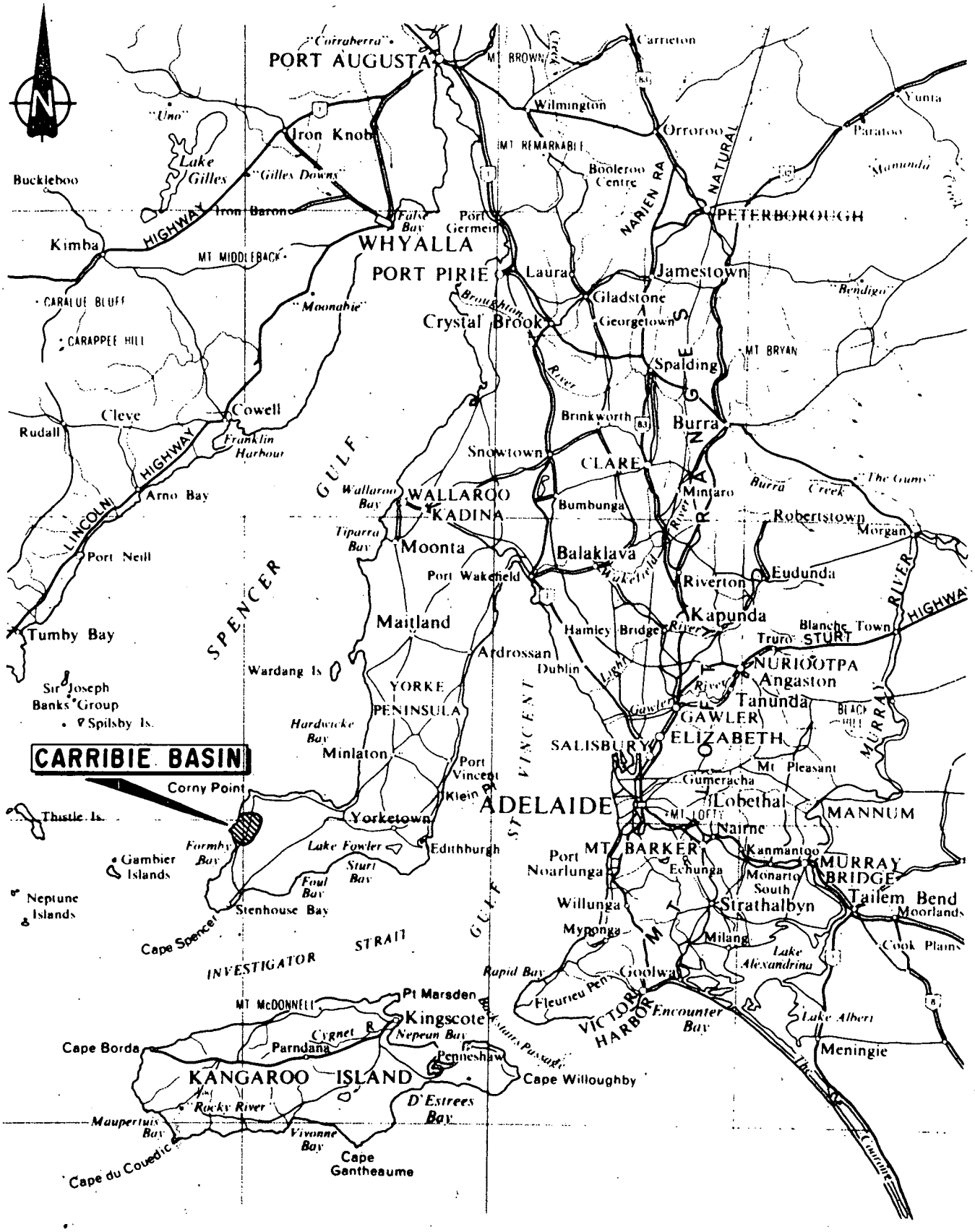


FIG..... 1

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED S. M.	24 · 2 · 88 C.D.O. DATE
CARRIBIE BASIN GROUNDWATER INVESTIGATION	DRAWN R.H.	SCALE 1:2000 000
LOCALITY PLAN	DATE NOV 1987	PLAN NUMBER S19719
	CHECKED	

1322

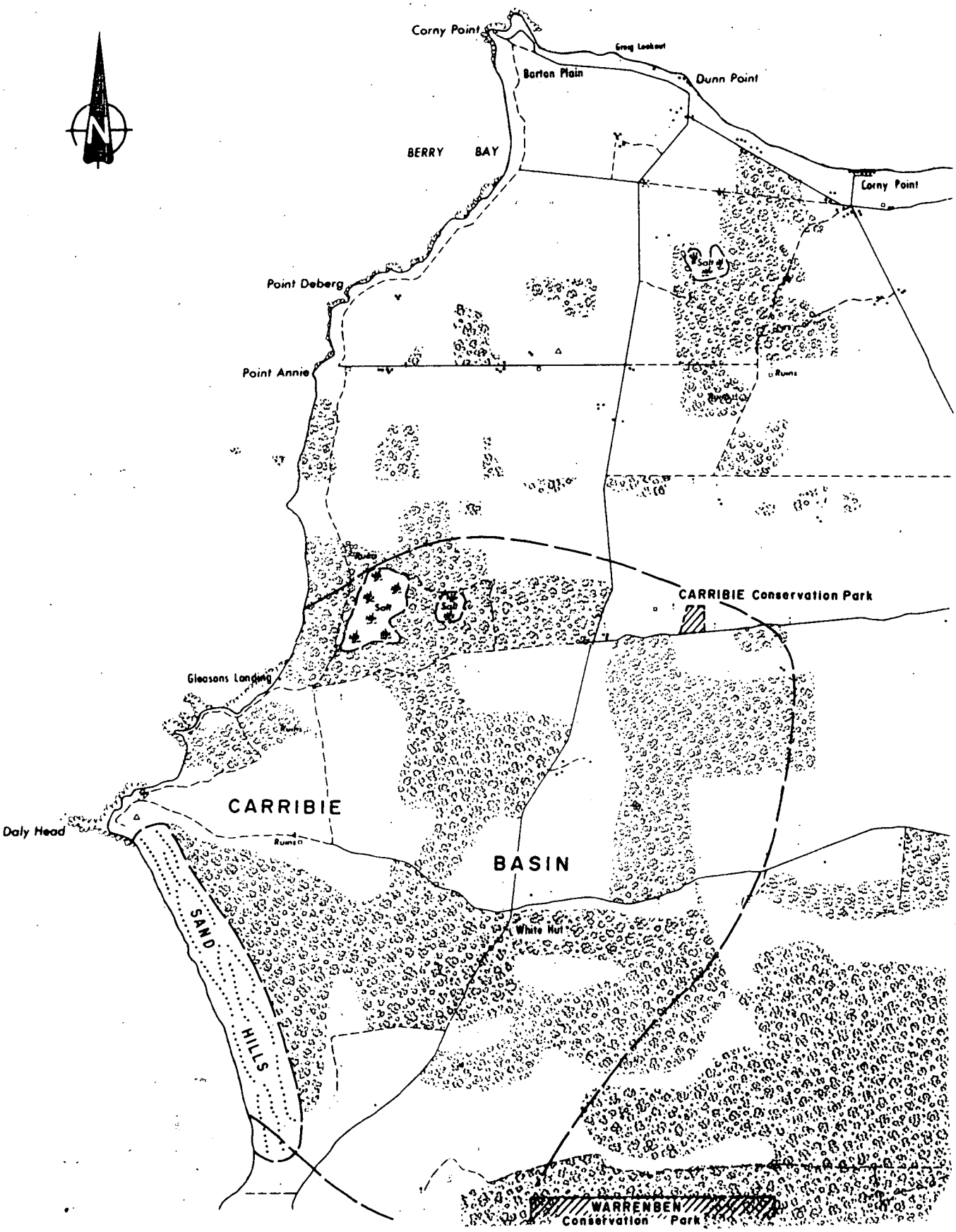


FIG.....2

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

CARRIBIE BASIN GROUNDWATER INVESTIGATION

LAND USE

COMPILED S.M.	C.D.O. 24.2.88 DATE
DRAWN R.H.	SCALE 1:100 000
DATE Nov 1987	PLAN NUMBER S19720
CHECKED	

4522

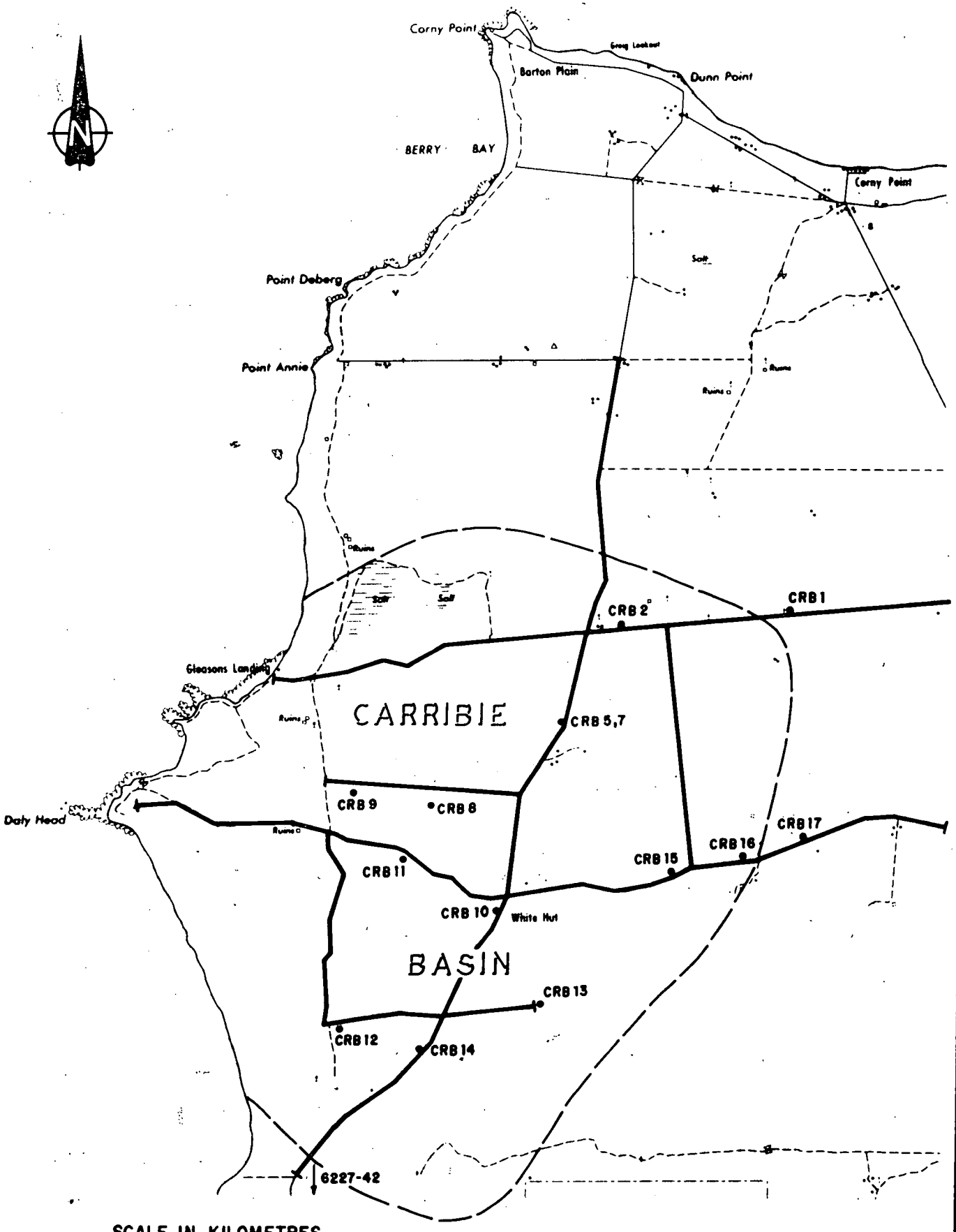


FIG.....3

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED S. M.	C.D.O. 24.2.88 DATE
CARRIBIE BASIN GROUNDWATER INVESTIGATION	DRAWN R. H.	SCALE
RESISTIVITY SURVEY, 1966	DATE Nov 1987	PLAN NUMBER S19721
	CHECKED	

4522

NORTH

SOUTH

ELEVATION (m AHD)

+40
30
20
10
0
-10
-20

6328-363

CRB 2

CRB 7

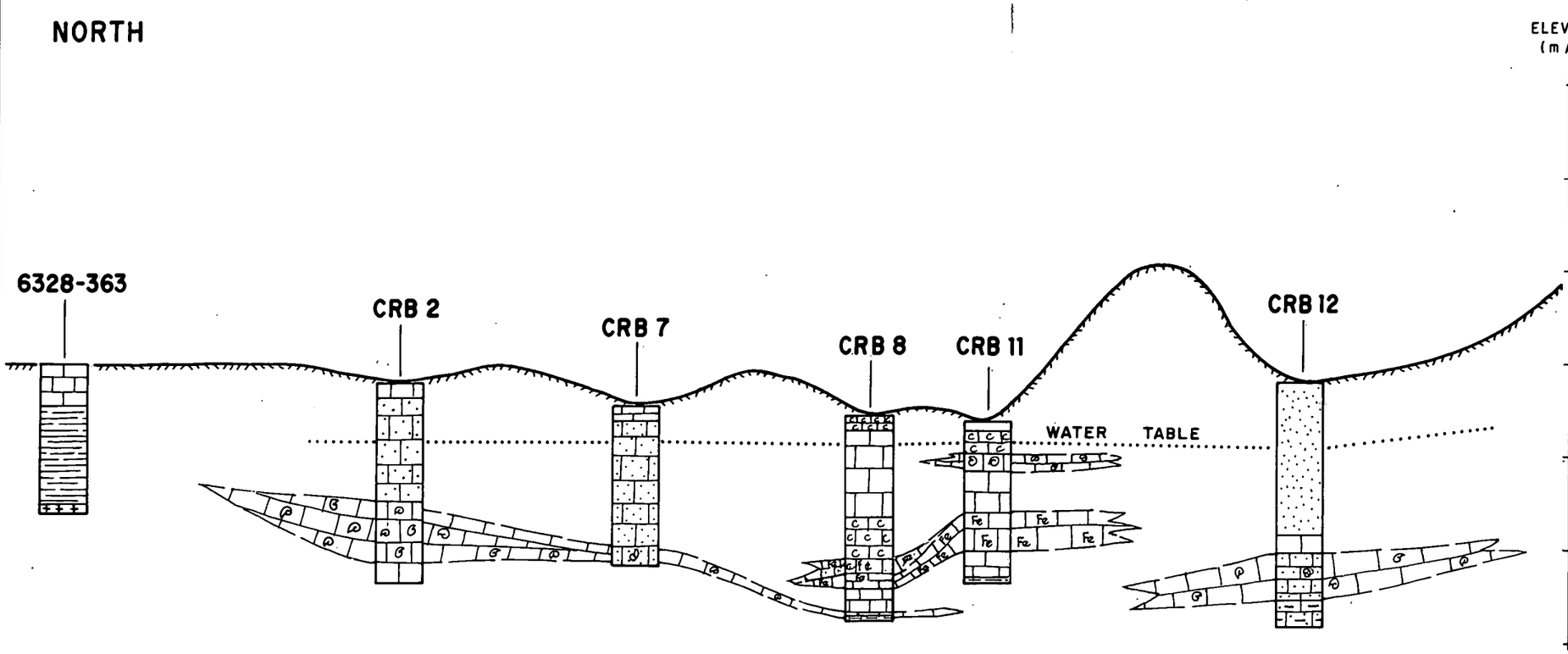
CRB 8

CRB 11

CRB 12

6227-42

WATER TABLE



WEST

EAST

ELEVATION (m AHD)

40
30
20
10
0
-10
-20

CRB 9

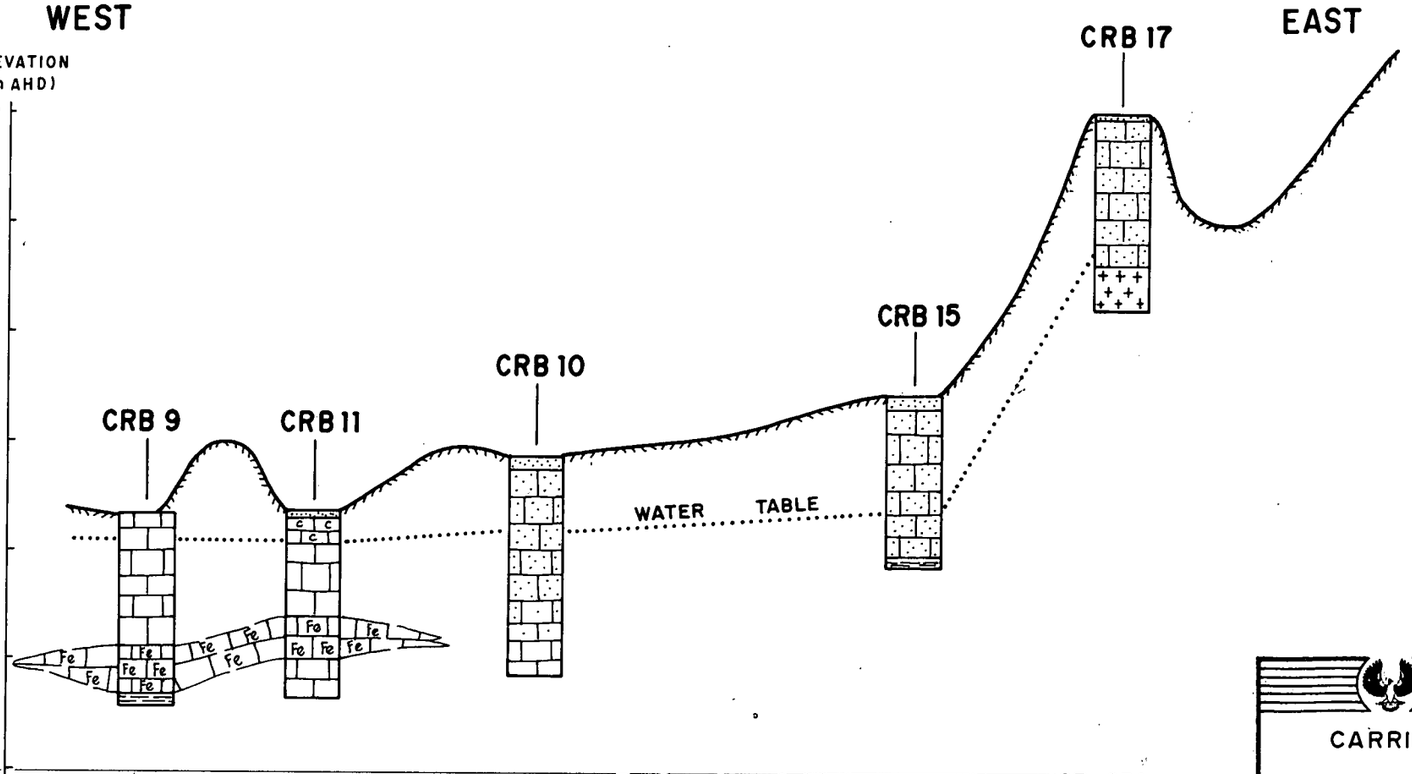
CRB 11

CRB 10

CRB 15

CRB 17

WATER TABLE



For location of sections see plan no. 87-830 (Fig. 9)

REFERENCE

- Calcrete
- Calcareous Sand
- Marl
- Ferricrete
- Shell fragments
- Aeolianite
- Clay (weathered basement)
- Basement

SCALE IN KILOMETRES

0 1 2 3

V/H = 100

FIG. 4

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

CARRIBIE BASIN GROUNDWATER INVESTIGATION

GEOLOGICAL SECTIONS

COMPILED S.M.	C.D.O. 24-2-88 DATE
DRAWN R.H.	SCALE AS SHOWN
DATE Nov 1987	PLAN NUMBER 87-827
CHECKED	

4522

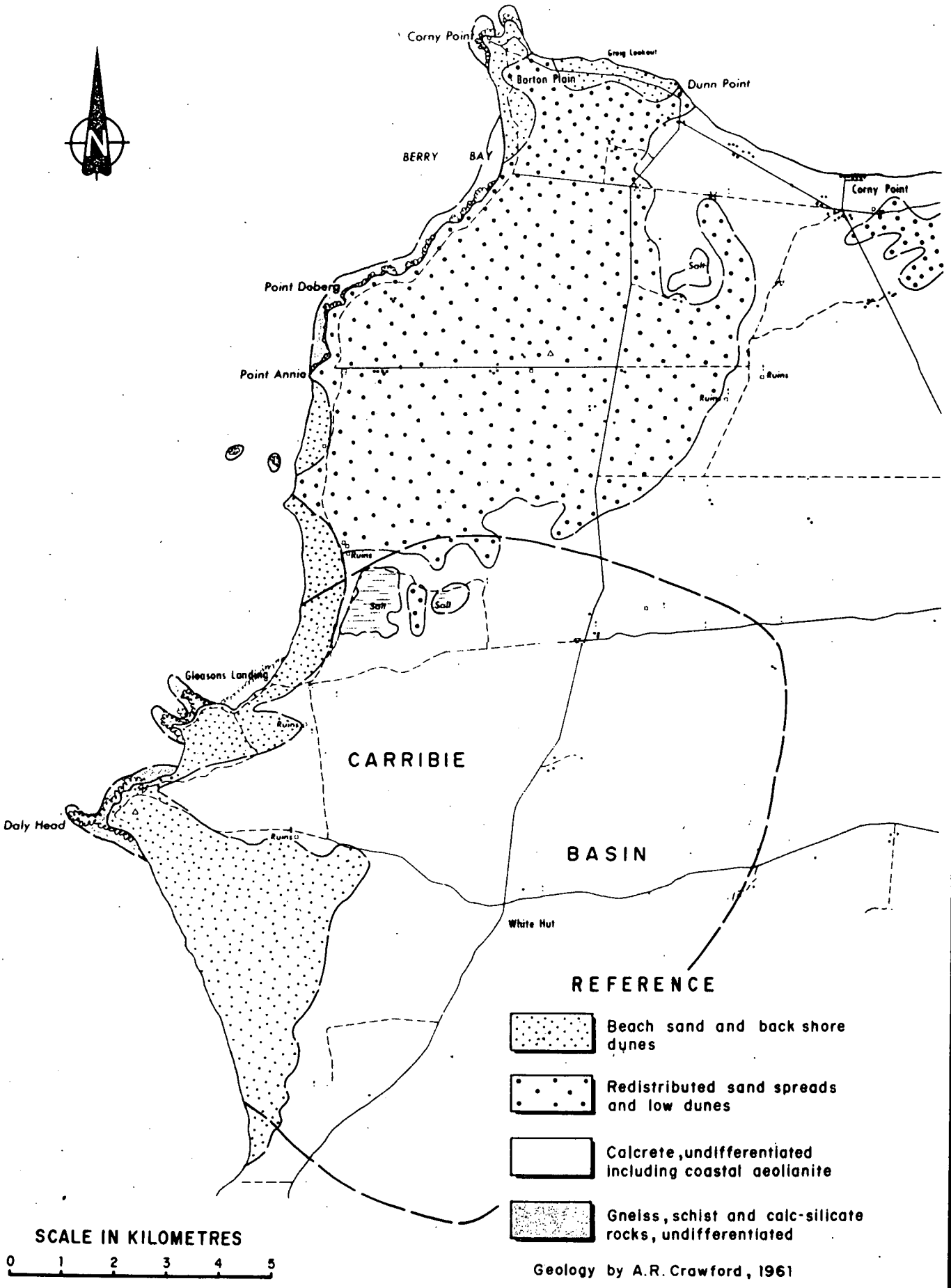


FIG..... 5

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED S.M.	C.D.O. 24.2.88 DATE
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REGIONAL GEOLOGY	DATE Nov 1987	PLAN NUMBER S19722
	CHECKED	

4522

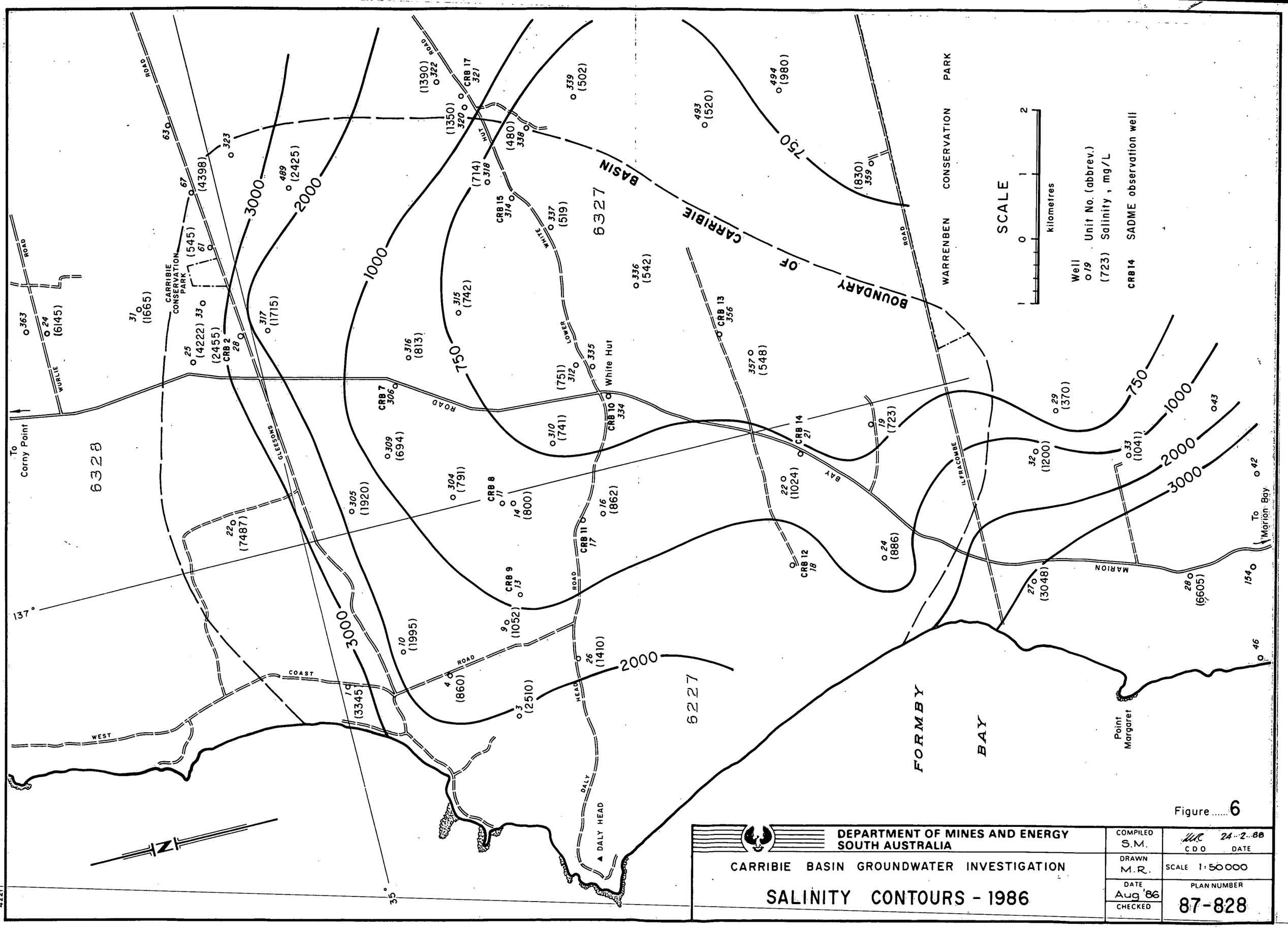

Figure 6

DEPARTMENT OF MINES AND ENERGY
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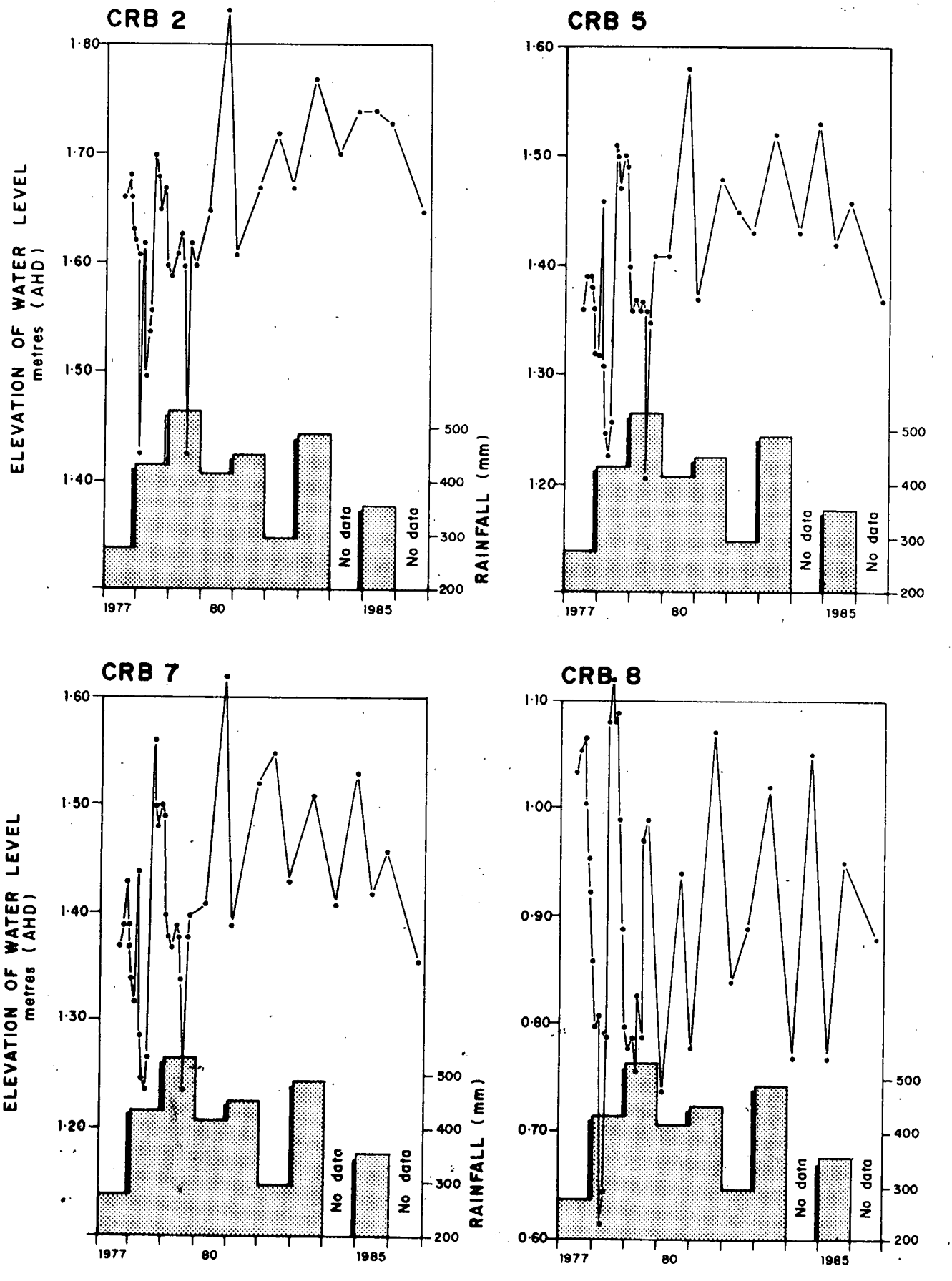
CARRIBIE BASIN GROUNDWATER INVESTIGATION

SALINITY CONTOURS - 1986

COMPILED S.M.	MR 24-2-88 CDO DATE
DRAWN M.R.	SCALE 1:50000
DATE Aug '86	PLAN NUMBER 87-828
CHECKED	

4221



For location of wells see plan number 87-829 (Figure 8)

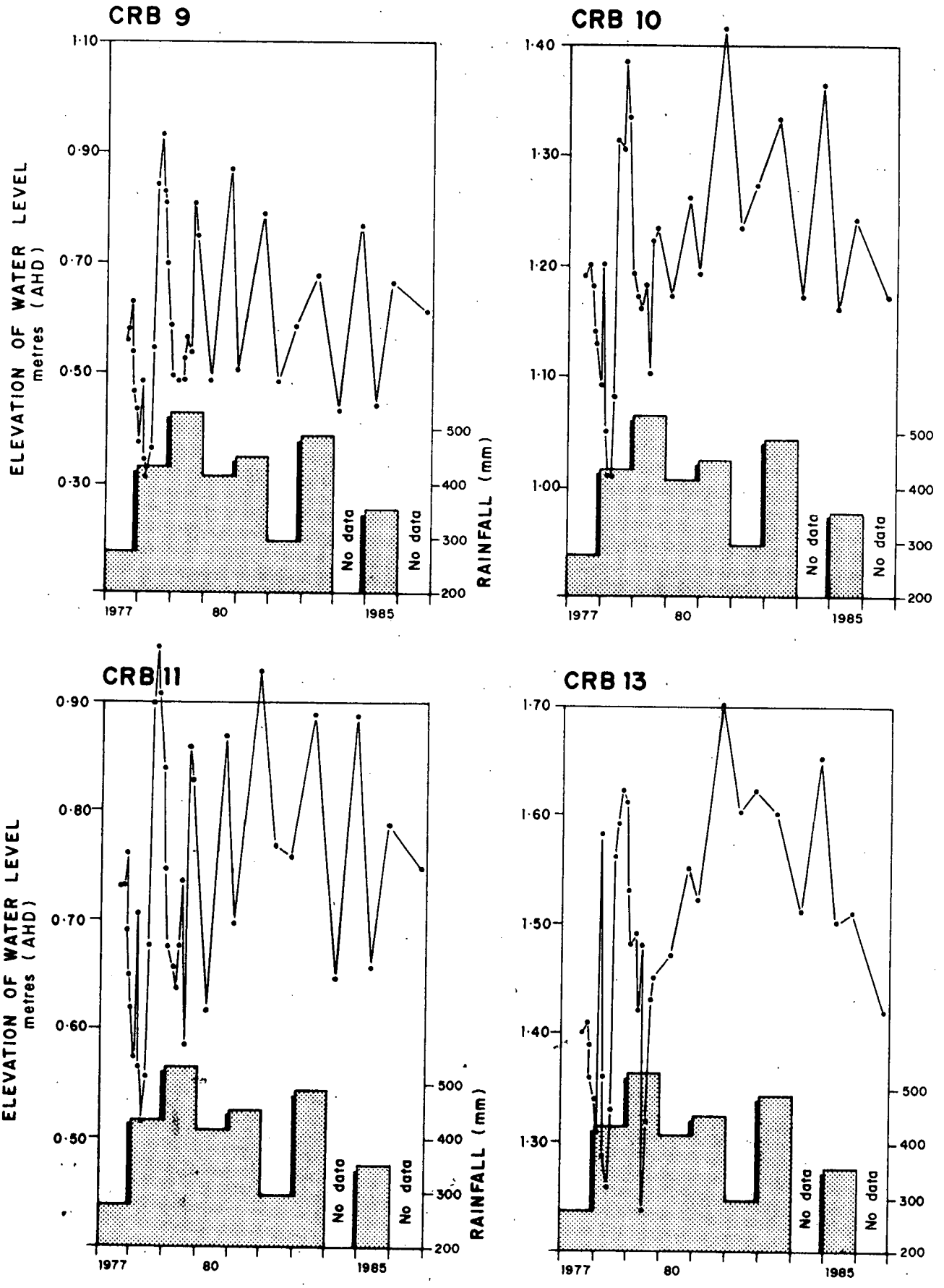
Figure 7a

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

CARRIBIE BASIN GROUNDWATER INVESTIGATION

HYDROGRAPHS FOR OBSERVATION WELLS CRB 2,5,7 and 8

COMPILED S.M.	C.D.O	24-2-88. DATE
DRAWN R.H.	SCALE	——
DATE Nov. '87	PLAN NUMBER	
CHECKED		S 19723



For location of wells see plan number 87-829 (Figure 8)

Figure 7b

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

COMPILED S.M.

C.D.O. 28.2.88 DATE

CARRIBIE BASIN GROUNDWATER INVESTIGATION

HYDROGRAPHS FOR OBSERVATION WELLS CRB 9,10,11 and 13

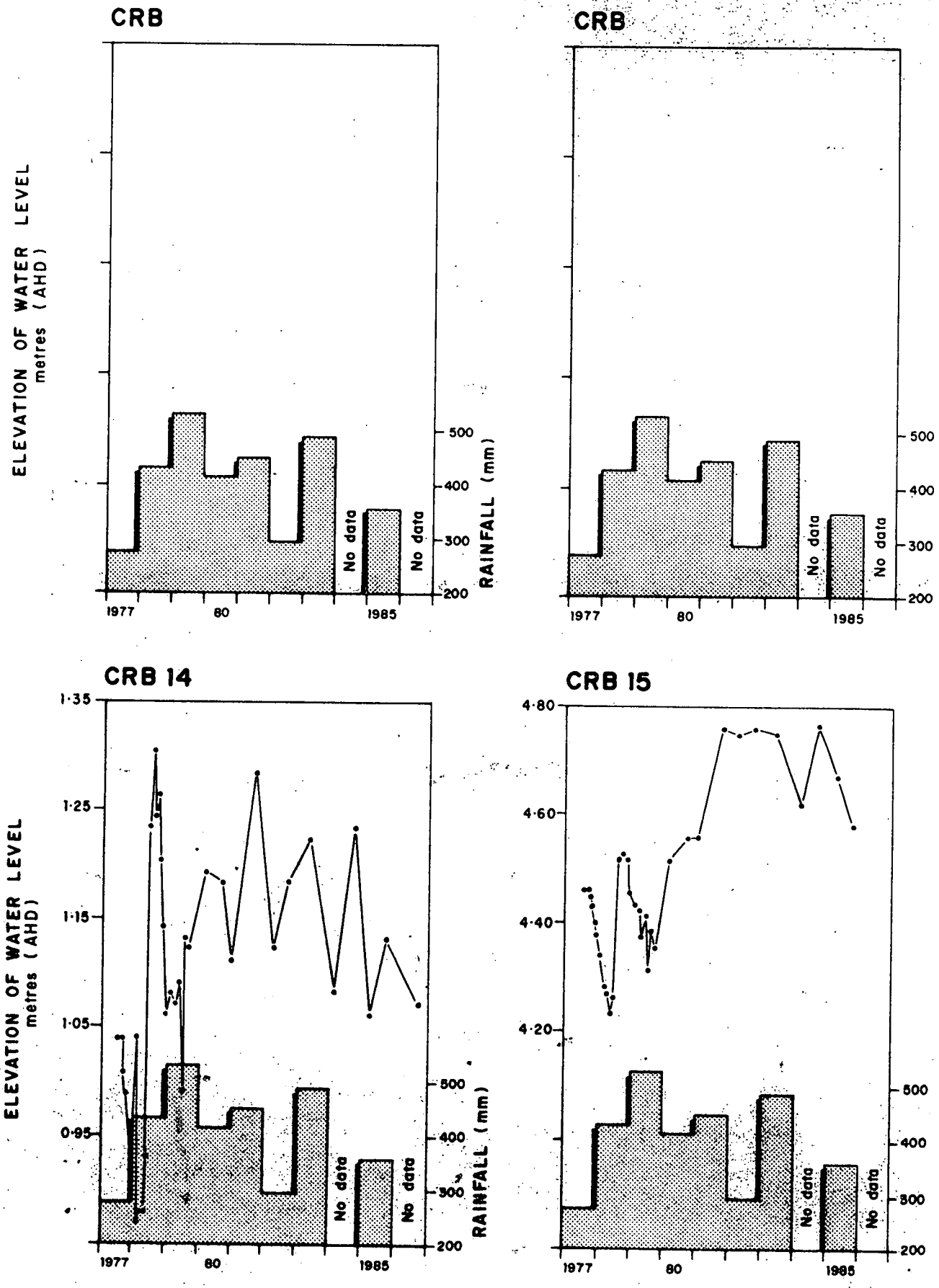
DRAWN R.H.

SCALE ——

DATE Nov. '87

CHECKED

PLAN NUMBER S19724



For location of wells see plan number 87-829 (Figure 8)

Figure 7c

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

CARRIBIE BASIN GROUNDWATER INVESTIGATION

HYDROGRAPHS FOR OBSERVATION WELLS CRB 14,15

COMPILED S.M.	C.D.O. 24 2 88 DATE
DRAWN R.H.	SCALE ——
DATE Nov. '87	PLAN NUMBER
CHECKED	S19725

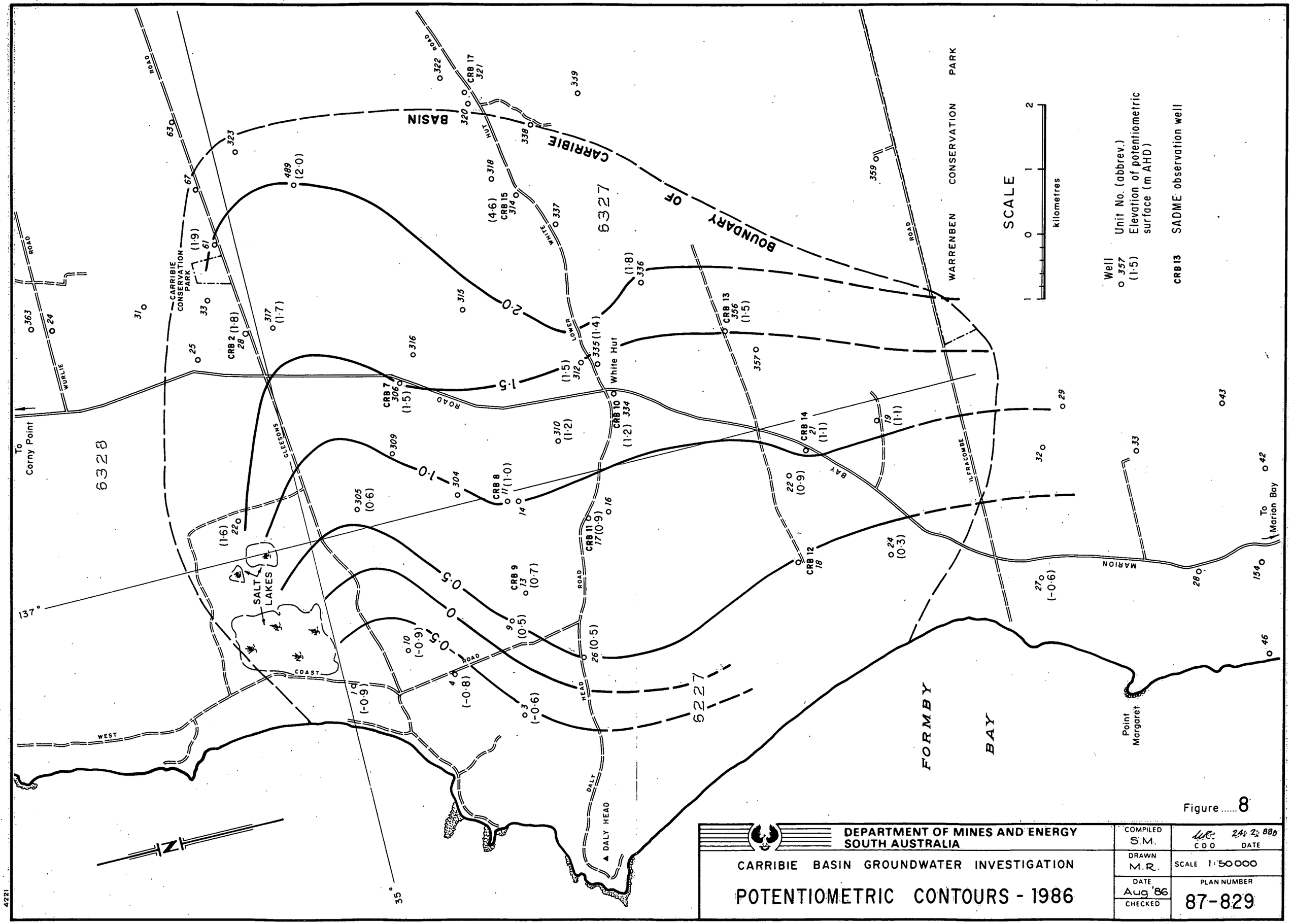


Figure 8

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED S.M.	CDO 24.2.88 DATE
CARRIBIE BASIN GROUNDWATER INVESTIGATION	DRAWN M.R.	SCALE 1:50000
POTENTIOMETRIC CONTOURS - 1986	DATE Aug '86	PLAN NUMBER 87-829
	CHECKED	

4221

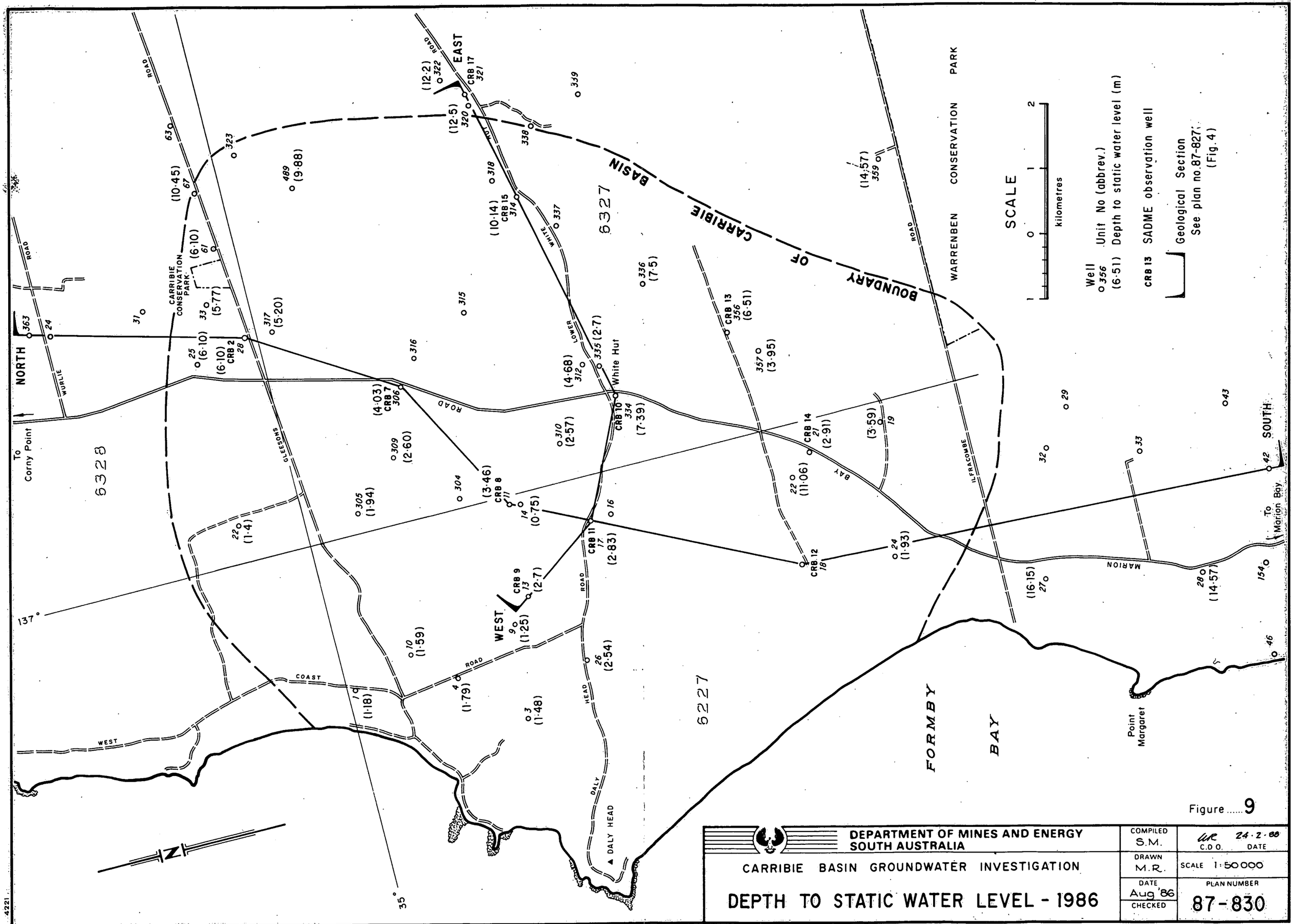


Figure 9

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED S.M.	C.D.O.	DATE 24·2·88
CARRIBIE BASIN GROUNDWATER INVESTIGATION	DRAWN M.R.	SCALE 1:50 000	
DEPTH TO STATIC WATER LEVEL - 1986	DATE Aug '86	PLAN NUMBER 87-830	
	CHECKED		

4221

BUREAU OF METEOROLOGY REPORT OF MONTHLY AND YEARLY RAINFALL BY P.C.D.S. 1/ 6/86 PAGE 2084

T = TRACE RAINFALL BETWEEN 0.1 & 0.4 MM - = MISSING OBSERVATION ROUNDED TOTALS

STATION : 022..2 ANY POINT POST OFFICE 36 55 S, 137 04 E 4.0 M ELE

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
1888	RAINFALL (MM)	49	8	3	7	67	66	97	34	26	8	18	2	330
1888	NO OF RAINDAYS	-	-	-	2	11	16	20	15	12	4	6	6	-
1889	RAINFALL (MM)	31	0	31	74	77	101	60	86	65	45	38	40	578
1889	NO OF RAINDAYS	5	0	7	10	15	23	17	18	16	9	8	6	132
1890	RAINFALL (MM)	17	12	5	23	50	105	119	77	62	59	38	5	569
1890	NO OF RAINDAYS	3	2	1	3	10	20	21	21	15	16	7	5	124
1891	RAINFALL (MM)	9	2	12	10	17	35	89	27	44	38	24	32	339
1891	NO OF RAINDAYS	3	2	3	6	8	17	23	18	14	16	8	5	117
1892	RAINFALL (MM)	17	4	21	30	45	56	60	85	76	82	13	34	523
1892	NO OF RAINDAYS	3	2	6	11	15	17	15	18	16	19	8	9	137
1893	RAINFALL (MM)	7	7	6	38	118	92	38	51	82	25	18	6	460
1893	NO OF RAINDAYS	5	1	2	12	15	19	13	18	16	11	6	-	125
1894	RAINFALL (MM)	10	0	35	22	68	59	95	66	34	37	3	12	439
1894	NO OF RAINDAYS	4	0	6	7	18	18	19	21	13	10	3	5	114
1895	RAINFALL (MM)	19	0	41	122	20	67	89	72	29	11	3	9	482
1895	NO OF RAINDAYS	3	1	9	12	7	16	20	13	10	6	4	5	106
1896	RAINFALL (MM)	41	48	7	67	59	51	39	58	16	12	0	31	661
1896	NO OF RAINDAYS	8	5	5	14	14	15	14	17	13	5	1	2	113
1897	RAINFALL (MM)	4	13	20	28	30	53	63	66	37	7	3	1	325
1897	NO OF RAINDAYS	3	4	9	7	12	16	18	18	11	7	5	2	110
1898	RAINFALL (MM)	0	5	6	69	76	122	57	54	28	62	15	7	477
1898	NO OF RAINDAYS	0	3	2	13	14	18	13	16	9	8	0	2	106
1899	RAINFALL (MM)	20	19	4	41	45	77	9	31	52	25	23	17	363
1899	NO OF RAINDAYS	8	4	3	7	12	17	5	12	11	11	9	4	103
1900	RAINFALL (MM)	10	2	48	51	27	100	32	100	28	13	24	6	441
1900	NO OF RAINDAYS	6	1	10	16	13	18	16	22	14	6	2	3	127
1901	RAINFALL (MM)	9	3	10	82	35	90	89	59	43	36	22	10	488
1901	NO OF RAINDAYS	7	1	4	7	9	15	18	13	16	12	8	3	113
1902	RAINFALL (MM)	8	21	29	6	17	92	43	27	32	45	7	101	428
1902	NO OF RAINDAYS	7	4	6	4	8	18	14	11	11	12	4	10	107
1903	RAINFALL (MM)	11	19	22	47	52	113	75	57	27	35	27	22	507
1903	NO OF RAINDAYS	4	5	7	13	11	19	21	16	8	8	10	7	129
1904	RAINFALL (MM)	27	26	6	38	34	83	81	71	21	36	9	0	432
1904	NO OF RAINDAYS	7	7	4	7	17	16	15	19	7	12	5	0	116
1905	RAINFALL (MM)	23	1	8	77	84	87	81	56	53	67	7	1	545
1905	NO OF RAINDAYS	4	2	3	13	9	18	20	13	19	13	3	2	119
1906	RAINFALL (MM)	2	6	17	32	31	138	95	72	51	22	72	9	544
1906	NO OF RAINDAYS	1	2	4	11	14	15	20	19	14	8	10	4	122
1907	RAINFALL (MM)	0	1	10	123	50	33	55	65	26	37	26	16	442
1907	NO OF RAINDAYS	0	2	4	15	13	9	19	16	11	14	10	3	117
1908	RAINFALL (MM)	2	10	7	17	62	105	42	33	59	37	5	18	397
1908	NO OF RAINDAYS	1	3	5	4	18	14	14	19	18	8	3	2	109

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'0' = RAINFALL BETWEEN 0.1 & 0.4 MM '-' = MISSING OBSERVATION ROUNDED TOTALS

STATION : 022002 CORNY POINT POST OFFICE 34 55 S, 137 04 E 4.0 M ELEV

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
1909	RAINFALL (MM)	8	10	25	61	37	39	89	115	20	37	25	13	479
1909	NO OF RAINDAYS	3	4	3	13	12	17	22	22	8	8	8	5	125
1910	RAINFALL (MM)	4	0	38	3	116	90	114	40	72	55	37	15	584
1910	NO OF RAINDAYS	1	0	6	4	20	16	22	14	14	16	11	8	132
1911	RAINFALL (MM)	0	78	9	7	52	87	56	38	59	30	16	54	486
1911	NO OF RAINDAYS	0	9	4	6	15	20	17	13	11	8	6	4	113
1912	RAINFALL (MM)	1	22	34	18	9	50	73	70	59	17	22	18	393
1912	NO OF RAINDAYS	1	3	2	7	6	16	17	15	18	8	12	7	112
1913	RAINFALL (MM)	3	15	30	6	40	20	33	56	58	48	31	34	374
1913	NO OF RAINDAYS	2	7	8	4	14	5	17	18	18	11	9	1	114
1914	RAINFALL (MM)	16	0	59	66	48	10	58	6	13	6	24	16	322
1914	NO OF RAINDAYS	3	1	5	14	12	5	15	6	6	3	6	4	80
1915	RAINFALL (MM)	4	0	3	36	50	88	78	93	62	12	4	5	435
1915	NO OF RAINDAYS	3	0	5	8	14	14	16	16	22	7	2	3	110
1916	RAINFALL (MM)	5	1	8	43	36	158	109	99	27	41	78	14	619
1916	NO OF RAINDAYS	3	1	2	12	8	22	18	21	10	11	18	5	131
1917	RAINFALL (MM)	7	176	35	11	81	103	106	89	98	41	16	11	774
1917	NO OF RAINDAYS	4	5	10	5	18	19	21	14	16	13	5	5	135
1918	RAINFALL (MM)	3	1	30	18	93	42	59	103	11	51	4	11	426
1918	NO OF RAINDAYS	3	2	2	5	17	14	15	15	4	7	5	5	94
1919	RAINFALL (MM)	14	38	4	6	56	43	38	47	54	19	7	15	341
1919	NO OF RAINDAYS	3	7	1	3	9	13	14	11	15	7	4	4	91
1920	RAINFALL (MM)	2	1	10	16	45	140	74	60	35	43	43	37	506
1920	NO OF RAINDAYS	1	1	4	8	11	24	17	15	10	6	5	8	110
1921	RAINFALL (MM)	39	2	20	6	115	51	78	52	46	40	63	8	520
1921	NO OF RAINDAYS	2	2	2	3	11	9	11	11	13	8	8	1	81
1922	RAINFALL (MM)	43	0	7	35	70	70	67	58	26	19	1	39	435
1922	NO OF RAINDAYS	4	0	4	7	16	13	15	14	6	13	1	8	101
1923	RAINFALL (MM)	10	2	0	7	120	97	90	64	81	56	9	47	583
1923	NO OF RAINDAYS	3	1	1	3	18	24	22	17	14	12	6	7	128
1924	RAINFALL (MM)	8	34	15	30	59	97	19	49	53	53	37	2	456
1924	NO OF RAINDAYS	7	6	3	9	12	16	11	14	18	10	5	2	113
1925	RAINFALL (MM)	2	8	1	54	49	25	66	34	66	13	17	2	337
1925	NO OF RAINDAYS	2	3	1	5	12	9	19	14	16	5	5	1	92
1926	RAINFALL (MM)	0	9	11	32	79	70	59	70	49	30	8	29	446
1926	NO OF RAINDAYS	0	3	3	9	15	14	16	16	13	10	5	6	110
1927	RAINFALL (MM)	7	35	21	6	56	36	50	65	16	4	39	32	367
1927	NO OF RAINDAYS	2	3	3	5	13	10	16	16	6	4	6	6	88
1928	RAINFALL (MM)	11	33	6	13	43	61	53	14	33	53	3	13	336
1928	NO OF RAINDAYS	5	2	3	5	9	15	12	4	11	16	1	3	86
1929	RAINFALL (MM)	10	3	11	27	22	80	55	46	44	32	24	25	379
1929	NO OF RAINDAYS	4	1	5	8	9	18	13	13	10	7	9	4	101

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'#' = RAINFALL BETWEEN 0.1 & 0.4 MM '=' = MISSING OBSERVATION ROUNDED TOTALS

STATION : 022002 CORNY POINT POST OFFICE 34 55 S, 137 04 E 4.0 M ELEV

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
1930	RAINFALL (MM)	1	30	1	23	18	13	64	98	51	24	14	5	342
1930	NO OF RAINDAYS	1	2	1	6	4	5	18	19	13	9	6	4	88
1931	RAINFALL (MM)	2	1	21	18	68	89	49	45	52	11	19	3	378
1931	NO OF RAINDAYS	3	2	5	5	20	19	18	19	12	5	8	1	117
1932	RAINFALL (MM)	4	43	21	69	26	110	62	54	4	39	8	5	485
1932	NO OF RAINDAYS	1	6	7	16	7	18	18	19	11	8	6	4	121
1933	RAINFALL (MM)	8	2	6	18	96	21	41	75	51	21	6	8	353
1933	NO OF RAINDAYS	4	2	2	4	13	10	15	17	13	8	4	2	94
1934	RAINFALL (MM)	5	2	21	68	7	41	37	97	79	44	26	6	433
1934	NO OF RAINDAYS	3	1	4	7	2	16	14	16	14	11	10	3	101
1935	RAINFALL (MM)	6	1	39	43	51	68	69	47	31	68	18	19	460
1935	NO OF RAINDAYS	4	2	13	14	15	19	17	9	9	12	3	4	121
1936	RAINFALL (MM)	20	14	1	19	27	59	62	53	11	45	22	21	354
1936	NO OF RAINDAYS	1	4	1	9	5	12	17	18	7	14	7	4	99
1937	RAINFALL (MM)	28	16	4	10	76	51	31	50	53	18	26	25	388
1937	NO OF RAINDAYS	6	4	2	5	14	14	14	12	13	5	8	7	104
1938	RAINFALL (MM)	16	89	1	82	27	55	37	84	17	1	8	20	437
1938	NO OF RAINDAYS	3	10	2	9	7	14	16	15	7	1	4	3	91
1939	RAINFALL (MM)	44	23	15	30	33	83	40	91	16	38	59	9	481
1939	NO OF RAINDAYS	2	4	4	11	11	16	15	16	9	9	11	4	112
1940	RAINFALL (MM)	27	10	8	59	71	38	103	42	31	24	33	6	452
1940	NO OF RAINDAYS	4	4	3	11	12	9	18	11	10	7	8	3	100
1941	RAINFALL (MM)	72	7	29	13	19	30	64	54	73	36	21	11	429
1941	NO OF RAINDAYS	3	3	7	5	8	10	15	10	15	7	2	5	90
1942	RAINFALL (MM)	22	8	8	13	68	124	71	74	84	20	37	7	536
1942	NO OF RAINDAYS	3	3	3	3	16	16	-	17	11	8	3	4	-
1943	RAINFALL (MM)	16	48	0	51	25	58	87	72	42	37	9	9	454
1943	NO OF RAINDAYS	4	6	0	13	8	12	20	19	11	8	5	2	108
1944	RAINFALL (MM)	4	21	13	82	92	15	76	10	22	43	33	19	430
1944	NO OF RAINDAYS	3	4	3	10	15	6	15	9	9	9	7	10	100
1945	RAINFALL (MM)	6	14	3	0	37	57	40	50	50	0	44	42	343
1945	NO OF RAINDAYS	2	5	1	0	10	13	11	22	13	0	7	5	89
1946	RAINFALL (MM)	70	122	23	18	37	62	83	43	24	34	25	9	550
1946	NO OF RAINDAYS	7	4	5	4	4	12	18	13	11	9	6	3	96
1947	RAINFALL (MM)	4	11	31	23	50	70	136	56	74	74	44	16	589
1947	NO OF RAINDAYS	2	3	6	9	13	12	23	15	9	13	8	6	119
1948	RAINFALL (MM)	1	21	4	35	42	39	50	76	16	65	27	27	403
1948	NO OF RAINDAYS	1	3	1	10	12	13	14	14	11	10	7	4	100
1949	RAINFALL (MM)	21	50	0	3	44	35	49	42	20	64	83	2	413
1949	NO OF RAINDAYS	3	5	0	2	13	11	15	13	7	12	12	2	95
1950	RAINFALL (MM)	-	4	1	5	34	57	28	39	17	56	9	27	-
1950	NO OF RAINDAYS	-	3	1	3	10	13	12	11	8	8	3	3	-

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'*' = RAINFALL BETWEEN 0.1 & 0.4 MM '-' = MISSING OBSERVATION ROUNDED TOTALS

STATION : 022002 CORNY POINT POST OFFICE 34 55 S, 137 04 E 4.0 M ELEV

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
1951	RAINFALL (MM)	8	8	1	39	87	82	95	80	16	55	8	51	530
1951	NO OF RAINDAYS	1	1	1	12	11	-	-	-	5	-	2	-	-
1952	RAINFALL (MM)	21	8	3	41	168	46	54	36	44	26	50	12	509
1952	NO OF RAINDAYS	2	2	2	8	17	8	11	7	9	7	9	-	-
1953	RAINFALL (MM)	5	10	3	30	24	107	78	74	42	15	28	49	465
1953	NO OF RAINDAYS	1	3	2	-	8	17	15	16	9	6	9	5	-
1954	RAINFALL (MM)	21	1	8	107	25	62	58	21	45	53	32	22	455
1954	NO OF RAINDAYS	3	1	2	9	7	15	-	12	12	10	6	5	-
1955	RAINFALL (MM)	3	29	20	41	85	141	50	87	49	50	37	14	606
1955	NO OF RAINDAYS	2	5	2	8	15	19	-	19	11	13	7	5	-
1956	RAINFALL (MM)	21	3	6	43	97	122	71	67	50	50	5	10	545
1956	NO OF RAINDAYS	5	-	2	11	13	19	19	19	-	14	4	4	-
1957	RAINFALL (MM)	0	2	9	23	32	78	78	42	27	6	13	9	319
1957	NO OF RAINDAYS	0	1	2	9	10	10	13	12	11	5	-	5	-
1958	RAINFALL (MM)	1	2	34	14	105	17	80	55	72	49	19	14	462
1958	NO OF RAINDAYS	1	1	6	2	-	6	-	16	-	-	5	5	-
1959	RAINFALL (MM)	2	24	19	15	12	11	43	36	33	57	30	30	312
1959	NO OF RAINDAYS	1	-	4	3	-	7	11	10	10	-	7	-	-
1960	RAINFALL (MM)	12	36	17	60	122	41	58	59	59	11	58	8	541
1960	NO OF RAINDAYS	1	6	4	12	-	-	15	18	15	9	6	2	-
1961	RAINFALL (MM)	3	14	15	77	18	32	44	55	24	4	7	2	295
1961	NO OF RAINDAYS	2	4	3	14	-	14	16	14	8	6	5	2	-
1962	RAINFALL (MM)	3	21	17	11	58	39	33	77	15	50	15	37	376
1962	NO OF RAINDAYS	2	2	5	3	9	9	10	15	9	-	5	6	-
1963	RAINFALL (MM)	24	9	2	47	111	100	124	57	21	6	4	4	509
1963	NO OF RAINDAYS	5	3	2	6	14	15	21	-	9	2	1	1	-
1964	RAINFALL (MM)	3	17	2	47	37	80	102	30	68	56	61	15	518
1964	NO OF RAINDAYS	1	3	1	6	9	14	19	16	10	14	9	8	110
1965	RAINFALL (MM)	0	1	5	16	89	45	58	65	28	7	20	6	340
1965	NO OF RAINDAYS	0	2	2	3	-	8	15	14	9	4	9	6	-
1966	RAINFALL (MM)	2	6	26	6	43	61	102	38	63	26	12	59	444
1966	NO OF RAINDAYS	2	2	8	4	11	14	21	12	16	9	3	11	113
1967	RAINFALL (MM)	5	72	3	11	15	14	100	65	26	10	1	5	327
1967	NO OF RAINDAYS	2	4	3	3	6	6	16	11	10	3	2	3	69
1968	RAINFALL (MM)	5	5	68	99	96	63	67	58	30	43	37	14	565
1968	NO OF RAINDAYS	1	3	8	9	19	14	13	20	8	9	11	3	118
1969	RAINFALL (MM)	7	69	29	47	76	53	65	35	59	0	14	9	463
1969	NO OF RAINDAYS	3	7	4	10	13	11	15	10	18	0	5	4	100
1970	RAINFALL (MM)	12	0	5	29	48	50	67	98	43	15	14	17	398
1970	NO OF RAINDAYS	7	0	2	10	13	-	15	21	-	5	5	3	-
1971	RAINFALL (MM)	3	2	14	96	63	66	55	86	48	14	23	58	528
1971	NO OF RAINDAYS	2	1	5	14	-	17	17	20	15	8	6	6	-

"T" = RAINFALL BETWEEN 0.1 & 0.4 MM "-" = MISSING OBSERVATION ROUNDED TOTALS

STATION : 022002 KOONY POINT POST OFFICE 34 55 S, 137 04 E 4.0 M ELEV.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
1972	RAINFALL (MM)	96	19	0	28	15	38	65	84	21	16	1	19	402
1972	NO OF RAINDAYS	7	4	0	6	4	7	17	15	5	7	1	2	75
1973	RAINFALL (MM)	1.	9	35	27	53	81	75	68	57	22	4	25	466
1973	NO OF RAINDAYS	2	2	3	-	13	13	10	13	13	4	3	8	-
1974	RAINFALL (MM)	21	2	2	53	62	28	85	37	57	64	9	8	428
1974	NO OF RAINDAYS	4	1	2	8	12	11	18	11	17	8	2	4	98
1975	RAINFALL (MM)	20	0	31	1	78	23	62	53	45	64	22	7	406
1975	NO OF RAINDAYS	2	0	5	1	13	7	18	11	16	14	-	3	-
1976	RAINFALL (MM)	10	9	1	21	21	50	22	39	43	26	18	19	279
1976	NO OF RAINDAYS	4	5	3	9	9	15	10	11	10	8	11	7	102
1977	RAINFALL (MM)	16	12	99	8	34	37	37	27	31	22	19	15	277
1977	NO OF RAINDAYS	4	1	7	5	15	11	12	9	-	8	6	5	-
1978	RAINFALL (MM)	10	1	2	6	31	112	89	50	77	11	24	18	431
1978	NO OF RAINDAYS	3	1	2	5	14	24	23	14	19	4	2	3	114
1979	RAINFALL (MM)	4	26	5	36	57	23	55	69	118	45	46	47	531
1979	NO OF RAINDAYS	1	3	3	9	13	11	19	19	16	9	6	5	114
1980	RAINFALL (MM)	2	2	1	52	42	90	62	27	18	81	22	15	414
1980	NO OF RAINDAYS	1	2	2	12	8	20	20	16	10	15	7	7	120
1981	RAINFALL (MM)	6	10	35	7	52	130	53	73	16	29	37	4	452
1981	NO OF RAINDAYS	3	3	9	4	10	26	18	21	9	8	9	3	123
1982	RAINFALL (MM)	11	5	31	46	45	67	25	24	15	15	1	9	294
1982	NO OF RAINDAYS	4	3	9	8	15	16	17	4	9	7	1	3	96
1983	RAINFALL (MM)	7	9	78	75	47	30	94	58	31	29	20	10	488
1983	NO OF RAINDAYS	-	2	8	10	8	9	17	13	10	7	6	2	-
1984	RAINFALL (MM)	3	1	14	17	23	37	54	92	53	-	-	-	-
1984	NO OF RAINDAYS	2	1	6	6	9	10	18	22	13	-	-	-	-
1985	RAINFALL (MM)	0	2	24	38	23	41	36	94	46	25	11	13	353
1985	NO OF RAINDAYS	0	1	2	5	9	14	7	20	5	6	4	8	81

MEANS AND MEDIANS FOR THE PERIOD 1888 TO 1985 USING ALL AVAILABLE DATA

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
MEAN RAINFALL (MM)	13	17	16	36	54	66	65	59	42	33	23	18	442
MEDIAN RAINFALL (MM)	8	9	11	30	47	61	62	57	43	35	20	14	440
NO. OF RAINFALL OBS.	97	98	98	98	98	98	98	98	98	97	97	97	96
MEAN NO. OF RAINDAYS	3	3	4	8	12	14	16	15	12	9	6	4	106
NO. OF RAINDAY OBS.	95	95	97	96	92	95	93	96	94	93	95	94	

APPENDIX 2

CRB1 6328-63

Depth (m)	
0 - 0.3	Brown soil.
0.3 - 9.1	Off-white aeolian lime sand.
9.1 - 10.7	Cream clayey aeolian lime sands.
10.7 - 13.7	Yellow clay with limestone fragments.
13.7 - 13.9	Red slightly limey clay.
13.9 - 16.8	Greenish grey clay with mica specks and quartz. Probable weathered gneissic bedrock.

CRB2 6328-28

Depth (m)	
0 - 1.5	Off-white fine limestone.
1.5 - 12.2	Off-white fine-medium grained aeolian lime sand.
12.2 - 13.7	As above with hard cemented limestone bands. Some shell fragments.
13.7 - 19.8	Pale grey shelly limestone.
19.8 - 21.3	Off-white fine grained lime sand.

CRB5 6327-308

Depth (m)	
0 - 0.6	Calcrete limestone.
0.6 - 12.2	Off-white fine-medium grained aeolian lime sands.

CRB7 6327-306

Depth (m)	
0 - 1.5	Partly calcreted consolidated limestone - grey.
1.5 - 6.1	Fine to medium lime sand - some quartz - light grey.
6.1 - 15.2	Fine to medium lime sand - consolidated - some quartz light grey, - very rare shells.
15.2 - 17.0	Slightly sandy fine to medium limesand - buff.

CRB8 6227-11

Depth (m)	
0 - 0.15	Aeolianite with clay and calcrete dark brown to black.
0.15 - 1.5	Calcrete with aeolianite brown cream.
1.5 - 3.6	Aeolianite, cream.
3.6 - 6.7	Aeolianite slightly cemented, cream. Some calcrete.
6.7 - 9.7	Aeolianite with calcrete bars and cemented aeolianite, cream.
9.7 - 11.3	Calcrete some aeolianite, buff to cream.
11.3 - 12.8	Calcrete some aeolianite, light cream.
12.8 - 15.2	Aeolianite and calcreted shell fragments, buff and cream.
15.2 - 17.1	Aeolianite and calcrete stained by iron oxide some shell fragments, light red brown.
17.1 - 18.3	Aeolianite with calcrete bars, cream.
18.3 - 21.3	Aeolianite cemented, calcrete bars and shell fragments, cream.
21.3 - 21.9	Clay, stiff some aeolianite, green grey.

CRB9 6227-13

Depth (m)	
0 - 0.5	Aeolianite with calcrete nodules, black.
0.5 - 1.5	Aeolianite, cream.
1.5 - 2.4	Aeolianite, cream.
2.4 - 3.6	Aeolianite cemented, light brown.
3.6 - 5.2	Aeolianite with some calcrete cream.
5.2 - 6.7	Aeolianite but darker in colour, buff.
6.7 - 9.1	Aeolianite cemented some calcrete and shell fragments, buff.
9.1 - 12.2	Aeolianite with iron stained calcrete, some fossil fragments red-brown to light buff.
12.2 - 15.2	Aeolianite cemented some calcrete, cream.
15.2 - 16.7	Aeolianite with calcrete, cream.
16.7 - 17.3	Clay with some aeolianite, green grey.

CRB10 6327-334

Depth (m)	
0 - 1.2	Pale brown marl soil with calcrete.
1.2 - 13.7	Off-white medium grained aeolian lime sand.
13.7 - 15.2	Shell fragments and aeolian lime sands. Consolidated.
15.2 - 16.7	Off-white medium grained aeolian lime sands.
16.7 - 19.8	Pale brown aeolian lime sand and shelly limestone. Hard in places.

CRB11 6227-17

Depth (m)	
0 - 0.15	Sandy soil with some calcrete.
0.15 - 0.9	Calcrete and aeolianite, brick red.
0.9 - 3.0	Aeolianite highly cemented, some calrete cream.
3.0 - 4.2	Aeolianite cemented some shells, buff.
4.2 - 5.5	Aeolianite limey, pale cream.
5.5 - 6.7	Aeolianite cemented, cream and buff.
6.7 - 9.7	Aeolianite cemented calcrete stained with iron oxide, buff.
9.7 - 13.7	Aeolianite cemented, grey - cream.
13.7 - 16.4	Aeolianite marly, light cream.
16.4 - 17.0	Clay, grey green.

CRB12 6227-18

Depth (m)	
0 - 0.45	Calcareous sand medium grained with fragments of sandy limestone.
0.45 - 7.9	Calcareous sand medium grained light brown with some limestone fragments.
7.9 - 16.8	Aeolianite, cream fine grained with some limestone.
16.8 - 18.3	Sandy limestone, cream with abundant large shell fragments.
18.3 - 25.6	Aeolianite medium grained light brown with some dense limestone fragments and shell fragments.
25.6 - 26.2	Aeolianite fine-medium grained slightly clayey.

CRB13 6327-356

Depth (m)	
0.15 - 1.2	Sand clayey with some calcrete granules, brown.
1.2 - 3.0	Calcrete, cream.
3.0 - 6.1	Aeolianite mainly quartz grains little lime in part cemented to limestone, cream.
6.1 - 7.6	Aeolianite limestone fine sandy, cream.
7.6 - 13.7	Aeolianite limestone solid fine sandy, probably some iron oxides inclusion, pasty coloured.
13.7 - 15.2	Aeolianite, partly limey and cemented, cream.
15.2 - 16.7	Aeolianite unconsolidated some hard bands, buff.
16.7 - 17.0	Clay fine sandy some aeolianite limestone, brown and grey.

CRB14 6227-21

Depth (m)	
0 - 0.15	Sandy soil with calcreted limestone, dark brown.
0.15 - 2.4	Calcreted limestone, cream.
2.4 - 4.6	Aeolianite, quartz in it of different colours, cream.
4.6 - 6.7	Aeolianite with soft cemented bars, cream.
6.7 - 9.7	Aeolianitic limestone with dolomitic calcrete light cream.
9.7 - 13.7	Aeolianitic limestone with dolomitic calcrete buff to light red brown.
13.7 - 15.2	Aeolianite well cemented.
15.2 - 17.7	A single fossil., light red brown.
17.7 - 18.3	Aeolianite limestone with dolomitic calcrete. Aeolianite mainly with shell fragments, light cream.

CRB15 6327-314

Depth (m)	
0 - 1.2	Calcrete and marl soil.
1.2 - 12.2	Off-white fine grained aeolian lime sands.
12.2 - 15.5	Off-white medium grained unconsolidated lime sands.
15.5 - 15.8	Grey and yellow clay.

CRB16 6327-319

Depth (m)	
0 - 1.5	Aeolianite calcreted, cream.
1.5 - 9.1	Aeolianite, slightly cemented, some calcrete at the top cream.
9.1 - 12.8	Aeolianite with calcrete iron stained. Pale red once cream.
12.8 - 14.3	Aeolianite, marly and some calcrete. Shell fragments, cream.
14.3 - 15.8	Clay, varicoloured.
15.8 - 17.4	Aeolianite, some clay, white to cream.
17.4 - 20.4	Aeolianite cemented, cream to grey.
20.4 - 21.9	Clay with aeolianite and some shell fragments buff.
21.9 - 22.2	Granite.

CRB17 6327-321

Depth (m)	
0 - 0.6	Sandy soil.
0.6 - 1.5	Slightly consolidated lime sand - common quartz grains - light grey.
1.5 - 3.0	Fine to coarse lime sand - common quartz grains - grey and brown.
3.0 - 4.6	Fine to medium consolidated limesand - light grey.
4.6 - 6.1	Fine to coarse lime sand - common quartz - partly consolidated - grey.
6.1 - 7.9	Fine to medium lime sand - rare quartz - pale yellow brown.
7.9 - 12.2	Fine to medium lime sand - some rare quartz - consolidated pale yellow brown.
12.2 - 15.2	Limestone - slightly sandy and clayey - buff.
15.2 - 16.7	Calcareous stiff clay - very abundant large mica flakes and fragments decomposed granite - red brown.
16.7 - 17.7	Weathered granite - reddish.
17.7 - 18.0	Granite.

6227 - 42

Depth (M)	
0 - 0.6	Dark grey sandy soil.
0.6 - 3.6	Light brown sandy limestone.
3.6 - 6.1	Light pinkish yellow limstone.
6.1 - 7.9	Pinkish yellow slightly clayey limestone.
7.9 - 10.3	Pinkish yellow slightly clayey limestone.
10.3 - 12.5	Yellow slightly sandy limestone.
12.5 - 14.0	Red marl with some limonite grains.
14.0 - 15.2	Dark grey very sandy clay - lot of mica.
15.2 - 17.7	Dark grey clayey sand and mica -? decomposed granite.
17.7 - 18.3	Granite.

APPENDIX 3

OBS. No.	TDS ppm	Cl ppm	D(km)
5	384	100	5.5
7	674	198	5.5
8	650	188	5.0
9	858	278	3.7
10	530	126	7.7
11	735	232	5.6
13	575	159	6.9
14	762	269	4.1
15	492	118	9.8
16	496	121	11.0
Average	591	179	6.48 km