RB 47/101

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DEPARTMENT OF MINES
SOUTH AUSTRALIA

REPORT ON GROUNDWATER INVESTIGATION

IN THE SOUTHWESTERN PORTION OF HD. WARRENBEN

FOR WARATAH GYPSUM COMPANY

ABSTRACT

North of Stenhouse Bay good quality groundwater was obtained in the past from shallow wells. Recent drilling has proved the existence of an aquifer probably yielding moderate to large supplies of fresh water.

INTRODUCTION:

The washing of gypsum before shipment is proposed by Waratah Gypsum Company and a groundwater investigation for that purpose was made in the period 15th to 18th January, 1956, by Mr. Sett, then on loan from the Geological Survey of India. He reported that in the vicinity of the gypsum works at Stenhouse Bay the prevailing groundwater conditions appeared to be such that a large supply sufficient for the requirements would not be obtainable from one single bore or well, and suggested piping water from an area approximately 14 miles north of Stenhouse Bay.

In a basin north of Marion Bay approximately seven miles northeast of the gypsum works four bore holes were drilled by the Waratah Gypsum Company and pump tested. The outcome of this investigation warranted further research and this Department was approached to supply further advice on the hydrological conditions and prospects of obtaining bore water from the basin or from an area close to Stenhouse Bay. Anticipated requirements were ten million gallons per annum of water of good quality, a salinity of less than 100 grains per gallon of total dissolved salts being preferable, and 500 grains per gallon being the upper limit of suitability for the washing of gypsum.

Between 18th and 22nd February 1958 the writer investigated the southwestern portion of Southern Yorke Peninsula to obtain all available data regarding the depth at which fresh water occurred and the thickness of the freshwater horizon. Conclusions were set out in a previous report in which twelve test holes were recommended, the results of these first dozen holes being encouraging so that in a progress report further drilling was recommended. Finally, a further five bores were drilled after discussion with Company officers, bringing the total depth of the 31 holes drilled to 1063 feet. Seven other bores with a total depth of 436 feet were drilled for landholders in the district, and these provided further important geological data.

Between the 9th of April and the 25th July, 1958, several visits were paid to the area and pump tests done on the bores completed.

The work in the area was completed on the 27th of July, 1958.

LOCATION & TOPOGRAPHY:

The investigated area lies north and north east of Stenhouse Bay in the Hundred of Warrenben and extends from Marion Bay to Meehan Hill in the east, and from the coast to a distance of seven miles inland. It covers approximately 60 square miles, a small portion of which is under cultivation and in use for pasture, the remainder being lightly to very heavily timbered.

A line of sand dunes lies along the coast, rising to 150 feet above sea level and in places extending inland as far as one quarter of one mile, the narrowest point being at Stone Hut Homestead where their total width does not exceed 3 chains. Just north of Marion Bay is a flat surrounded by numerous low ridges representing old sand dunes, separated by interdune flats or basins of various sizes. This flat is approximately nine feet above low tide level and there is a general rise to the northeastward culminating in Black Rock which is 150 feet above sea level. The contours as shown are taken from a map with a scale of 2 miles to the inch, produced by E. & W.S. Department.

In the flat a saline swamp is joined to the salt lakes and swamp north of Stenhouse Bay by an indefinitely marked narrow low lying connecting arm, possibly a potential swamp, with a slight outward bend to the west. With the exception of the main road from Corney Point to Stenhouse Bay the roads and tracks north of Marion Bay are in poor condition, some not having been used extensively for years, and being fairly rough over the ridge crossings. The lower parts of these roads become water logged after heavy rainfall and are impassable.

The annual rainfall averages seventeen inches.

GEOLOGY:

Good exposures of travertine limestone capping aeolianite and aeolianitic limestone occur in the coastal cliff faces near Stenhouse Bay. These recent sediments overlie basement rocks consisting of granitic gneiss, which is exposed near the jetty. Inland the available geological information is from recently constructed bores, most of which penetrated the limestone sediments, drilling being discontinued before reaching the underlying rocks. Bores to the north in Sec. 8B, however, penetrated the weathering products of granitic rocks and metasediments which are believed to form the basement rocks in the area. In some bores gritty clays were encountered and it may be just possible that they represent a bed of Permian glacial clays. Such clays however are not exposed in the coastal cliffs and their occurrence inland is therefore a matter of conjecture, particularly as the components of the clays vary somewhat with the composition of the underlying basement rocks, which suggests that they may originate from weathered basement rocks, rather than being of glacial origin.

EXISTING BORES AND WELLS IN THE AREA:

The district is not fully developed and in the past small groundwater supplies only were needed for watering stock. There is a number of wells in the Stenhouse Bay area proper, and just north of the coast, which yield 100 to 500 gallons per hour of good to excellent quality water. These wells are between 5 and ten feet deep, dependent on the surface level, while just north of the coastal sand dunes trenches of two to four feet depth have in the past supplied sufficient water for requirements. The waters obtained from these wells are excellent and suitable for domestic purposes, but in some cases clearing the ~~timber~~ and sometimes deepening the wells has caused a salinity increase to the point where thw water has become unusable for human consumption. It appears that there is a thin horizon of freshwater on top of saline water below and contamination has occurred after deepening of the wells. Further to the north deeper wells exist and the bore on Section 4 for example is 30 feet deep, the water level being approximately 9 feet. The quality of the water is good, a recent analysis indicating 124 grains per gallon of total salts, the fresh water horizon being considerably thicker in this area. Details of the existing bores and wells are given in Table I. Waratah Gypsum Company desired the investigation of a basin one quarter of a mile east of this bore. Four eight inch bores were drilled, three being to a depth of 30 feet, the most southerly one being discontinued at 34 feet. This bore obtained saline waters while the other three bores yielded moderate supplies of waters suitable for the washing of gypsum. A pump test made on the central bore revealed that the salinity increased from 270 grains per gallon of total dissolved salts to 600 grains per gallon after three days pumping at a rate of 1440 gallons per hour.

These results suggested the existence of a sufficiently large body of suitable water to warrant further investigations.

PRELIMINARY DRILLING PROGRAMME:

The results as obtained from the pump test on the first bores drilled by Waratah Gypsum Company showed that in the basin northeast of Marion Bay a large quantity of water was available but contamination with saline waters was envisaged. In an endeavour to determine the extent and thickness of the fresh water horizon and the occurrence of saline water at deeper level, fourteen bores were drilled on sites as shown on the accompanying map. The bores A, B, C, and M situated just north of the salt lakes indicate the occurrence of saline water close to the surface and possibly the occurrence of the saline swamp east of the main road. Drilling of bores D to L was suggested in the same basin as the bores drilled by Waratah Gypsum Company, (see map) so that more data on the depth at which saline water occurs would come available. All bores were planned to be continued to either an impermeable clay or to saline water, and those of the latter type would be backfilled to a point midway between the depths at which fresh and saline waters were obtained. The reason for this procedure was that pump testing the bore holes would decrease the pressure on the saline waters below, causing them to rise and contaminate the overlying good quality water, at a point immediately below the bottom of the bore, an occurrence facilitated by the high permeability of the aeolianite aquifer. Prior to the test drilling, the existence of a possible clay bed of sufficient thickness which could act as a seal between the two waters was unknown.

The results of the drilling of these bores is given in Table II.

All bores penetrated aeolianite and aeolianitic limestone only, in which they obtained saline waters. No clays were found to occur, and from the results it was clear that the fresh water horizon in the immediate vicinity of the salt lakes and saline swamp just east of the main road was either very thin or altogether absent. The bores to the north indicated that the freshwater horizon increases in thickness northward, an example being bore H, which obtained 37.7 grain water at 9½ feet, above 485 grain water at 48 feet.

A pump test had been proposed to investigate the yield and the possible increase of salinity after pumping for a short period, but with the results of these bores to hand further drilling to the northward was suggested, and pump tests were postponed until such time as more data became available.

EXTENDED DRILLING PROGRAMME AND DRILLING FOR PRIVATE LANDHOLDERS:

Local conditions in fact prevented the investigation of the area north of the basin A, although a single bore is situated in that area, and the siting of additional bores was somewhat restricted as bores at too great a distance from the Gypsum Works would be uneconomical. Sites for the bores P, Q, R and S were chosen to obtain information both on the extent of the good water area and its thickness, and to investigate the possible occurrence of clays or decomposed granites further inland. As private landholders became aware of the potentials of the area, requests were received to drill water bores in their country, and useful information was obtained from such bores in Sections 61, 8B and 4C. Details of bores O to T, and all other bores drilled during the project are given in Table III. This table shows that the bores in Section 8B penetrated basement rocks and obtained only a small supply of fresh water from granitic rock, while the overlying sediments contained no recoverable water, the bores being outside the northern limit of the fresh water basin. A test bore T to obtain additional data was therefore drilled to 62 feet; and this obtained no water and penetrated the basement rocks.

THE AQUIFER:

The old established wells in the area along the coast or along the coastal sand dunes obtained good water after penetrating the travertine limestone covering the underlying aeolianites. Deepening of these wells rendered them often too saline for domestic usage. Recently drilled bore holes reveal that in the district, aeolianites and aeolianitic limestone act as good aquifers, the aeolianites being highly permeable as indicated by the small drawdown as shown on Table IV. Since they outcrop at the shoreline it is not surprising that seawater has access to these rock types and that saline water occurs at shallow depth near the coastline.

The rainwater and runoff has percolated downwards into these rocks over a great number of years, and accumulated as a fresh water layer which increases in salinity with depth.

The pressure of this weight of fresh water limits the ingress of seawater and depresses its surface to a lower level, a further restrictive factor being the occurrence of an impermeable clay bed three quarters of a mile north of Stone Hut, where the clay overlies the salt water and acts as a seal.

Table VIII shows clearly that the thickness of the fresh water bed close to the coastline and in the immediate vicinity of the salt lakes and swamp, is less than 20 feet. The average for the eight bores in this area being about eleven feet, with a minimum and maximum respectively of nil and eighteen and one half feet in bores M and D. The average thickness of the fresh water body further to the north is thirty-three feet, the bore T located in the north east of Section 4C not being included in the calculations.

This table VIII shows also that the thickness of the water bearing bed increases to a maximum of 47 feet in bore S and decreases then to 17 feet in a north easterly direction.

Reduced levels of the Static water levels in some of the bores are at Table VI, and these and other aneroid levels show clearly that the water body has a practically horizontal upper surface only a few feet above low tide level. The water occurs in a flat saucer shaped depression with its maximum thickness in the vicinity of bores P and 3.

A section through the bores 1, 2, 3, 5, P, F and J shows the position of the clay bed encountered in the bores 1 to 5 and P, and the dip in northward direction of the saline water surface. Since the water obtained at lower level in bore F contains considerably less dissolved salt than the deeper water in bore J, is the upper surface of the saline water as indicated on the cross section an approximate. The Section is prepared in an attempt to clarify the position of the fresh water bed lying above the saline water below and to indicate the position of the clay bed possibly forming a barrier for the further northward movement of the saline water at shallow depth.

INTAKE AREA:

The area investigated has no defined surface drainage system, probably because of the high permeability of the soil and subsoil. Many sinkholes in the travertine limestone were observed, which may have originated in an earlier period when geological or climatic conditions were different. Since surface runoff into these sinkholes was observed after heavy rainfall, it is believed that they dispose of a considerable quantity of fresh water, which in the uniform geological conditions obtaining, moves in a south westerly direction through the aeolianite, following the general fall of the natural surface.

It may appear that the annual intake in the catchment area is large, because of the high permeability of the sediments. The C.S. & I.R.O. recently made a survey in another area of similar rainfall where groundwater occurs at 30 feet in recent highly permeable sand, a perhaps comparable area where neither water courses nor a definite drainage system occur. Moisture measurement on the sediments indicated that where not augmented by surface runoff, the rainwater wet the soil and subsoil profile for a depth of only sixteen feet, below which the sands remained dry. The conclusion is that no intake takes place unless the water table is less than sixteen feet below the surface unless the rainfall intake is locally augmented by runoff. Comparison with the area under consideration is possibly not justified as information about the permeability in both areas is not complete but the conclusions obtained by C.S. & I.R.O. should be kept in mind in considering the annual intake in the area investigated.

The bores in Section 8B and Bore T penetrated on an average 40 feet of aeolianitic limestones and marls before encountering weathered basement rock and the granitic rocks. These limestones and marls contain no water, and bearing in mind the results of the moisture measurements mentioned above, these bores should be considered outside the catchment area, which places the basins northern boundary further to the southward. The coastal dunes and the salt lakes in the south west form the southern limit of the catchment area, but information about the eastern boundary is insufficiently known so that the area as indicated on the map and covering 18 square miles is only a rough estimate.

GROUNDWATER QUALITY:

Domestic quality water is obtained from shallow wells, and salinities of 40 grains per gallon of total dissolved salts are common. Such wells occur only in an area along the coast and north of the salt lakes, Tea Tree well being a good example, and the maximum supplies are approximately 500 gallons per hour. Further inland such good quality water is not readily available, the established wells as shown in Table I containing as much as 110 grains per gallon or more. Exceptionally good water was however obtained in the bores F, G, H and Waratah Gypsum bore No. 3. The other bores drilled during the project encountered water with a higher salt content, analyses being given in Tables I, II, III and VII. In Table VI which shows the final test results, bores are grouped together, and the increase in salinity with increasing depth is quite apparent.

Group I comprises bores with waters unsuitable for washing gypsum, the salt content at about 12 feet depth being above 300 grains per gallon and increasing considerably with two to three feet of extra depth.

Group II comprises the bores, mainly within one mile distance from the coast line, with good to excellent quality waters at shallow depth, the total dissolved salts being between 50 and 133 grains per gallon but where the waters encountered at deeper levels were of much greater salinity and contained up to 1440 grains per gallon of dissolved salts.

Group III includes all bores where good quality water at shallow depth overlies deeper waters containing less than 500 grains per gallon of total dissolved salts.

Group IV includes the bores in which good quality waters only are encountered highest salinity being 182 grains per gallon obtained in Sec. 61, bore 2.

The bores on Section 61 were not continued to either saline waters or a clay seal but a clay horizon is expected to occur at depth, and no very great increase in salinity is anticipated at deeper levels.

Group IV denotes the bores yielding the best quality water and the area where such waters are obtainable is outlined approximately on the map.

STABILITY OF THE SALINITY UNDER HEAVY PUMPING:

Evidences of increase in salinity in deepened wells, and also on Waratah Gypsum Company's bore after a pump test of several days were available previous to the investigation, and in order to gain more insight into the behaviour of the saline water pump tests were made on ten bores. Since the permeability of the soil and subsoil is high it was considered possible that the water pumped from the bores and discharged on the surface nearby would return to the aquifer and be recirculated. Discharge of this water away from the vicinity meant a mile of pipeline, and since Waratah Gypsum Company had fire hose available in quarter-mile lengths these were used to minimise such a possibility. A further precaution was short period pumping at low rate, maximum discharge being 1000 g.p.hour, which however was expected under the existing conditions to give the required information on aquifer characteristics.

In the pump test the step up method was followed, starting at a rate of 400 gallons per hour, this being increased to 700 gallons per hour, and finally to 1,000 gallons per hour, each rate being held for one hour. However after the initial three hour test, some bores were pumped for one quarter of an hour at the maximum capacity of the pump, a rate of 1440 gallons per hour, pumping then being discontinued. It was considered that removing the pressure of the overlying freshwater horizon would result in an upward movement of the saline waters below, and to minimise this effect and to prevent contamination it was arbitrarily decided that the bores should not be deeper than midway through the first water bed. As the thickness of this bed could be determined only by penetrating it in full, each bore was drilled to the saline water and then backfilled as required, as shown in Table VIII.

The pump testing programme was started on bore D. Although it was intended to start the pump test at a rate of 400 gallons per hour, the pumping equipment was supplied with a regulating valve at the delivery pipe and yields could only be measured at the end of the fire hose, the distance between the outlet and pump hampering quick adjustment to the correct output. Pump discharges at some bores were therefore not regulated to the outputs originally planned.

The analyses of the water obtained from bore D show that the original salinity of 180 grains fell to 140 grains in the first 22 minutes of the test, after which it gradually increased to 220 gr./gall. increasing further to 320 gr./gallon after 3½ hours pumping. The analysis of the water in the column at suction level as observed by means of a dionic probe gives a different picture, there being a continuous increase of salinity from 200 gr./gallon at the start to 760 gr./gallon at the end of the test, while the water at the bottom of the bore increased even more rapidly, the difference between beginning and end of the test being 660 grains per gallon.

It is believed that at the start of the pump test before the cone of depression was properly developed, some fresh subsurface water was drawn from the immediate vicinity of the bore into the column, refreshing the top waters. This assumption would be in agreement with the gradually increasing salinity of the water at suction level, as the influence of the fresher water should be less felt in at that level.

The steep increase in saline content of the bottom waters suggests that in the highly permeable aquifer the salt water readily moves upward when a small weight of overlying fresh water is removed. This is emphasized by the small draw down in water level and in the rapid re-establishment of the original water level fifteen minutes after cessation of pumping. It must however be borne in mind that this bore D is close to the coast line and the thickness of the freshwater horizon is not more than 18½ feet, probably a little less.

It is interesting to note that analyses of the waters standing in bore D 24 hours after the pump test show that the original conditions were re-established in this period of time.

No decline of water level was observed in the adjacent bores I and J after pumping, and in fact a rise in bore J was measured, which may possibly be a tide effect, although in such case a rise should have been measured in bore I. A similar rise in water level was measured in bore H after pumping bore G. The pump test on the bores C, E, F, P and 3 indicates that the upward movement of saline water under pumping is less pronounced as distance increases from the sea. The pattern of the increase in the dissolved salts is irregular as shown in bores 3 and F, the increase being fifteen and forty grains per gallon respectively at the water level, and fifty five and forty grains per gallon at the bottom of the bores. The analyses made during the test on bore P are somewhat irregular probably owing to a failure of the temperature thermistor of the Dionic tester's probe.

The results obtained in bore G are better than originally expected. This bore, however, is situated at the base of an old sand dune and the downward movement of freshwaters stored in the dune may have affected the results by compensating for the water removed by pumping.

The pump test on the bores S, 1 and 2 show that in the area in which they are located the danger of contamination is at its minimum. The analyses of the bottom waters in bore 2 made during the test might be explained by movement of fresh waters from the surrounding area along a defined line of crevices, although this is problematical. The field analyses made may be at any time 20% below or above the correct values, a consistency in values below the exact salinity must be regarded as somewhat remarkable.

The water level in bore 1 is 32'4" below the top of the casing. Pumping with a centrifugal pump therefore was impossible, and a plunge pump fitted to the boring plant was used. This equipment made it impossible to use the probe in the bore below the pump barrel so that variation in salinity of the bottom water could not be measured. Because of the equipment it was also impossible to obtain a yield smaller than 1500 gallons per hour and it was considered that in half an hour of pumping at 1500 g.p.h. and half an hour at 3,000 gallons per hour sufficient data were obtainable to draw conclusions. This bore 1 penetrated hard aeolianitic limestone from 12 feet onwards, and the installation of a sand screen as in the other final bores was not considered necessary. It is likely that crevices exist in this hard limestone, allowing a good flow of groundwater to the bore, resulting in a small drawdown at a pumping rate of 3,000 gallons per hour and a stable salinity. Similar conditions were not encountered in other bores.

No similar pump test was made on bore 5, and therefore no information on salinity stability is available.

All bores on Section 4C, 58 and 61 encountered a clay bed, probably forming an obstruction for the northward movement of the deeper saline water, but this probably does not eliminate the danger of contamination of the freshwater body with saline water. In spite of this contamination danger it is believed that prospects of obtaining a large supply of groundwater of consistent salinity are expected in the area north of bore R.

USABLE GROUNDWATER STORED IN THE BASIN:

In a previous paragraph the thickness of the fresh water horizon in the aquifer was discussed and it was shown that there is a defined area where the fresh water bed is at its maximum thickness. Detailed calculations on the quantity stored in the area tested by drilling could be attempted from the data available, but such calculations may give erroneous results. For example, the bores in the coastal area indicate the occurrence of water suitable for the requirements, but they are only shallow, and give no information on the thickness of the freshwater layer or the position of interface between the fresh and saline waters. Further inland the bores are mainly drilled in a specific area limited by local considerations, and it is believed that if bores were drilled to the east, equally good quality water should be obtained in a horizon of similar shape. It is therefore difficult to arrive at a correct figure for the volume of groundwater stored. In the appendix an attempt is made to calculate the quantity of freshwater stored in a portion of the basin in order to gain an insight into the volume of freshwater stored in that portion. Generally speaking, it is considered that the basin contains a large quantity of good quality water, some of which could be extracted if precautions are taken to prevent its removal causing an inland movement of the saline water, which would contaminate future supplies.

YIELD OF THE AQUIFER:

The levelling survey made in the area indicated that the water level in the aquifer throughout the area is at mean sea level. It is expected that a portion of the annual rainfall percolates downwards and augments the stored volume of fresh water, and since in the past no large supplies were pumped out, a considerable quantity of good quality water must have accumulated in the aquifer. This would cause a rise in the water level unless there is a natural outlet for the surplus waters. It is understood that Snowlake in the past contained fresh water, although now contaminated by the dumping of saline residues from the works. It is also understood that this lake's surface is at sea level and the lateral movement of freshwater towards the lake would act as a natural outlet. It is believed that some surplus waters still move into this lake but are contaminated with the saline waters pumped into it.

Since the aquifer outcrops in the coastal cliffs, and at the sandy beaches is partly covered by highly permeable beach sands it is possible that, as no obstruction for the movement of fresh water occurs, some finds its way towards the sea. The volume of annual intake or recharge of the aquifer is really the controlling factor, as, subject to the removal of the small supplies used for watering stock and domestic purposes, it represents the quantity theoretically available for use by the Company without causing depletion of the stored water in the aquifer. The water used by the vegetation is not taken into consideration as most plant roots penetrate less than 6 feet and therefore probably do not obtain their requirements from the aquifer. Details are given in the appendix of an attempt to arrive at an approximate figure for the annual intake and the yield of the aquifer.

The results of the pump tests must be treated with caution. The most important feature of the aquifer is the occurrence of the saline water, which is kept at a low level by the pressure from the overlying fresh water. A release of this pressure will result in the upward movement of the salt waters and also possibly its gradual encroachment inland. The pump test showed that upward movement readily occurs in the coastal area, but the tests further inland were too short to show any movement of that nature, which could only be brought about by a continuous discharge over a long period of time, the supply not being returned to the area and thus to the aquifer.

Such a test would involve considerable expense and time and is considered beyond the scope of this investigation which has already established the existence of a large quantity of ground water, which is available for use if developed carefully. The results of the pump test indicate that supplies up to 3,000 gallons per hour can be obtained from one single bore without immediately affecting the quality of the ground water, although the depletion of a confined area around one single bore could bring about an increase in salinity. The alternate use of a number of bores spaced over the area would prevent depletion at one point, encourage lateral movement of freshwater over a more extensive area, and restrict the possibility of localized contamination by upward moving salt water at any one point.

CONCLUSIONS:

The area north of Marion Bay is underlain by basement rocks consisting of granitic gneiss and metasediments, overlain by the weathered products of these basement rocks. They are covered by aeolianites and aeolianitic limestones, these rocks being blanketed by a thin horizon of travertine limestone and fine sands.

The aeolianitic sediments are good aquifers containing fresh water, with saline waters occurring below in the coastal area. On Sections 4C, 8B, 58 and 61 the saline water is separated from the freshwater body by a clay bed.

A defined surface drainage sytem is non existent and the annual intake into the aquifer is entirely dependent on downward percolation of rainwater, the surplus of the annual recharge probably being discharged into the sea at low tide along concealed springs since the water level in the area is at mean sea level and the aquifer outcrops in the coastal cliffs.

The fresh water body is considered to be extensive and at present small stock supplies are being used only. Large yields of fresh water in the coastal area are not obtainable because of the occurrence of saline waters at deeper levels, contaminating the fresh waters above whenever a pressure release is brought about by withdrawing small to moderate supplies of the freshwater. To the north the danger of contamination is less noticeable but still existent, so that withdrawal of a large supply from one single bore cannot be recommended. It is considered that using the bores 1, 2, 3, 4 and S alternatively and keeping bore P as a standby would minimise the pressure release in one particular area and produce a limited decrease in pressure over a large area, less likely to cause upward movement of the saline waters below.

Prospects are good for obtaining a yield of 3,000 gallons per hour from three different bores, each delivering 1,000 gallons per hour over a long period of time. The quality of the water should be less than 150 grains per gallon, and suitable for the washing of gypsum.

C. Bleys
Geologist
HYDROLOGY SECTION

CB:ACK
2/10/58

APPENDIX

Some calculations on the annual intake in the basin north of Marion Bay

Intake recharging the aquifer is expected to occur in an area of approximately 18 square miles.

The annual rainfall is 17 inches and monthly falls of two inches and more are considered effective for intake. Precise figures from the area are unknown but as annual rainfall is similar to the fall at Warooka the average figures from that locality are used. The average rainfall above two inches is as follows:

May	June	July	August	Total in 4 months
2.19	2.63	2.59	2.43	9.83

In other parts of the Peninsula the quantity percolating downwards was taken at 0.8 inch of 17.2 inches per annum. This figure however is considered much too high in view of the results obtained by C.S. & I.R.O., and 0.1 inch of rainfall reaching the aquifer is considered more appropriate. Since 1 inch of rainfall per square mile is equal to 14 mill. gallons, the annual intake should be 0.1 x 18 x 14 = 15 mill. gallons approximately.

Some calculations on the quantity of water stored in the aquifer

The full extent of the aquifer and area in which water is stored is not accurately known but it is considered that its extent is equally large as the intake area.

The porosity of the aquifer is a maximum of 30% but for the calculations as hereunder an effective porosity of 15% should give more reliable results.

The thickness of the aquifer varies between nil to 39½ feet, the average being 25 feet.

The quantity stored in the aquifer should be 18 x 25 x 15/100 x 12 x 14 Mill. = [redacted] 11,340 mill. gall. This quantity of water however is not obtainable since only one half can be considered free moving water and further the lowering of one foot in water level will force the saline water upward so that the possible usable yield of the fresh water aquifer is 18 x 1 x 15/100 x 12 x 14 x ½ = [redacted] 225 mill. gall. approximately.

Table No. I

BORE DETAILS - OLD EXISTING WELLS

S.A. DEPARTMENT OF MINES

SUMMARY OF BORE RECORDS

Ground Water Survey

Hundred WARRENBEN

County FERGUSSON

BORE	SECTION	DEPTH in feet below surface			SUPPLY	SALINITY		HEIGHT above sea level	Strata passed through	Remarks
		Total	Water cut	Static level	Gallons per hour	Grains per gallon	Analysis No.			
~~W 91~~ WQ1	4D	30		9	?	224	1171/57			Drilled by private contractor.
W 92 WQ2	4D					780	1081/57			" " "
~~W 93~~ WQ3	4D					27	1082/57			" " "
~~W 95~~ WQ3	4D					17	1172/57			" " "
	1	20		19	small	326	117/56			½m. E. of Cable Hut
	2	6½		2½	good	171	176/56			Jolley's Well
	2	8½		6½	500	54	169/56			Black Tank Well
	24	6½		3¼		56	179/56			Pondalowie well
	26A	22¼		20½		153	178/56			Killing yard well
	adj. 8C					46	181/56			
	78	29		22	good	152	1002/58		Travertine and aeolianite	
	79	5		4'8"	small	76	1001/58		Travertine limestone	West of river
	79	8¼		8	small	92	300/58		Travertine limestone	North of river
	3A	6		3	500	50	180/56		Travertine limestone	Tea Tree Well
	3A	6		4½	500	32	1166/58		Travertine limestone	Tea Tree Well
	69	10		8	small	480	1003/58		Travertine limestone and aeolianite	Stone Well
	43	8		6	small	30	298/58		Travertine limestone	
	58	17	16	14	100	122	279/58		Travertine and aeolianitic limestone	
	4D	30		15	1000	74.74	1252/53		Travertine and aeolianitic limestone	Bore in area A.
	4D	30		15	1000	124	1251/58		Travertine and aeolianitic limestone	Bore in area A.
	4D	-	-	-	-	81.79	1251/53		Travertine and aeolianitic limestone	House well
	4D	12		10	1000	79	295/58		Travertine limestone and aeolianite	Lever well
	8B	56			1600	108	632/58			near road
	8B	90		50	100 +	48.80	1261/53		Travertine aeolianite and granite	Water in basement rocks
	8B	48'8"		40'1"		284	172/56		Travertine and recent sediments	House well

Table No. II

BORE DETAILS OF PRELIMINARY DRILLING PROGRAMME

S.A. DEPARTMENT OF MINES

SUMMARY OF BORE RECORDS

Ground Water Survey

Hundred WARRENBEN

County FERGUSSON

BORE	SECTION	DEPTH in feet below surface: Total	Water cut	Static level	SUPPLY: Gallons per hour	SALINITY: Grains per gallon	Analysis No.	HEIGHT above sea level	Strata passed through	Remarks
A	79	15	7	6	-	74	1146/58		Travertine and aeolianite	Observation bore.
A	79	15	12	6	-	670	1147/58		" "	" "
A	79	15	14	6	-	1250	1148/58		" "	" "
B	79	19'4"	8	6	-	445	1149/58		Travertine and aeolianite	Observation bore.
B	79	19'4"	13½	6	-	620	1150/58		" "	" "
B	79	19'4"	17	6	-	620	1151/58		" "	" "
C	79	28	9	8	1440 +	77	1152/58		" "	" "
C	79	28	27	8		910	1153/58		Travertine and aeolianite	" "
D	E	27	8	6		120	1177/58		" "	Observation bore.
D	E	27	26½	8		770	1178/58		Travertine and aeolianite	" "
D	E	18	8	6		576.8	1352/58		" "	After ½ hour pumping
E	4D	42	9	7½		50	1179/58		" "	Observation bore.
E	4D	42	40	7½	1000 +	570	1180/58		" "	" "
E	4D	42	41	7½	1000 +	650	1181/58		" "	" "
F	4D	33	10	8	1000 +	112	1182/58		" "	Observation bore.
F	4D	20	10	8	1000	123.8	1401/58		" "	After 3 hours pumping
F	4D	33	31	8	1000 +	570	1184/58		" "	Observation bore.
G	4D	36	9½	8	1000 +	26	1165/58		" "	Observation bore.
G	4D	29	9½	8	1440 +	28.1	1351/58		" "	After 3 hours pumping
H	4D	49	9½	8		37.7	1206/58		" "	Observation bore.
H	4D	49	48	8		485	1207/58		" "	" "
I	E	29	9½	9		190.6	1208/58		" "	Observation bore.
I	E	29	28	9		505	1209/58		" "	" "
J	E	24	8	6½		133.7	1210/58	11	" "	" "
J	E	24	23	6½		840	1211/58	11	" "	" "
K	4D	42	8	6		25.3	1212/58		" "	" "
K	4D	42	42	6		1440	1213/58		" "	" "
L	4D	42	9	8		47.4	1214/58		" "	" "
L	4D	42	40	8		900	1215/58		" "	" "
M	79	15	9	7		1350	1216/58		" "	" "
N	79	12	9	8½	small	348.9	1217/58		" "	" "
N	79	23	22	8½		810	1218/58		" "	" "

6974

Table No. III

BORE DETAILS - REMAINDER OF RECENT BORES

S.A. DEPARTMENT OF MINES

SUMMARY OF BORE RECORDS

Ground Water Survey

Hundred WARRENBEN

County FERGUSSON

BORE	SECTION	DEPTH *in feet below surface*			SUPPLY	SALINITY		HEIGHT *above sea level*	*Strata passed through*	*Remarks*
		Total	Water cut	Static level	*Gallons per hour*	*Grains per gallon*	*Analysis No.*			
O	4D	20	14	12½		80	1254/58		Travertine and aeolianite, clay at bottom	Observation bore
O	4D	52	52	12½		253	1255/58		" " " " " "	" "
P	58	29	14	12	1440 +	158	1256/58	15	" " " " " "	" "
P	58	52	14	12	"	415	1257/58	15	" " " " " "	" "
P	58	29	14	12	1440 +	200.8	1400/88	15	" " " " " "	After 3 hours pumping
Q	86	31	9	6	"	59	1349/58		" " "	Observation bore
Q	86	54	51	6	"	390.5	1350/58		" " "	" "
R	86	5	9	6½	"	119	1354/58	10	" " "	" "
R	86	41	41	6½		541.1	1353/58	10	" " "	" "
S	58	60	13	11	1440	73	1348/58		" " " clay at bottom	" "
S	58	60	34	11	1440	97.2	1347/58		" " " " " "	" "
T	4C								Travertine aeolianite and granitic material at bottom	Dry bore
1	58	61	31	30	2880	108.8	1471/58		" " clay at bottom	
2	58	52	15	31	1000 +	87.5	1474/58		" " " "	Observation bore
2	58	52	15	31	1000 +	88.0	1473/58		" " " "	After 3 hours pumping
3	58	35	11	9	1000 +	78.1	1476/58		" " " "	After 3 hours pumping
4	58	34	15	12	1000	48.2	1478/58		" " " "	After ½ hr. pumping
4	58	34	15	12	1000	50.9	1479/58		" " " "	After 1½ hr. pumping
4	58	44	15	13½	2880	114.7	1543/58		Travertine limestone	After 1 hr. pumping
5	58	53	13	11	300	73	1348/58		Travertine limestone clay at bottom	
5	58	62	33	30	500	81.9	1544/58		" " " "	After 1 hr. pumping
61	61	20½	18½	17¼	100 +	116	175/56		Travertine and aeolianitic limestone	
	61	60	46	93	1000 +	98.5	1481/58	47	Travertine and aeolianitic limestone	At north end of section
	61	50	34	33	1000	149	1483/58	36	Travertine limestone and aeolianite	In centre of section
	4C	44	26	25	1000	72.4	1491/58		Travertine and aeolianitic limestone, clay at bottom	
	8B	53	43	42	-	1100	1484/58		Limestone, at 30 ft. marl, at 50 ft. amphibolite	New bore 1 abandoned
	8B	60	58	30½	250	42.9	1486/58		Limestone, at 41 ft. marl, at 50 ft. decomposed granite	New bore No. 2
	8B	104	76	60	104	73.1	1487/58		Travertine, aeolianitic limestone, at 43 ft. marl, at 55 ft. decomposed granite.	New bore No. 3
	8B	65	50	36	180	274.7	1489/58		Travertine, marl, decomposed granite at 50 ft.	New bore No. 4

TABLE IV

MAXIMUM DRAWDOWN OBTAINED

Name	Depth ft.	Water level ft.	Supply	ATS	Drawdown
C	18	9	1440	125	1'2"
D	68½	6.6	1000	Variable	11"
E	24	9	1000	Variable	4"
F	20	10	1000	Variable	2'7"
G	29	9½	1000	25	6¼"
S	35	13	1440 +	100	3'3"
P	52	12	1000 +	200	9½'
1	61	30	3000	100	11"
2	33	13	1440	100	6"
3	29	8	1200 +	90	1'½"
4	34	12	2880	114	7"
5	61	30	300 max.	100	20'

TABLE V.

WATER LEVELS OF SOME BORES IN HD. WARRENBEN COMPARED WITH SEA LEVELS

Bore	Section	Ground Level above low tide level	Water level above low tide level	Water level below high tide level
J	E	9.19	2.69	1.01
R	68	8.16	1.86	1.84
P	58	13.55	2.13	1.57
Sect. 61, I	61	45.11	2.91	0.79
Sect. 61, II	61	34.22	0.22 (app.)	2.48 (app.)

TABLE VI

INCREASE IN SALINITY WITH DEPTH

Bore	Shallow water W.St.	Shallow water ATS	Deeper water W.St.	Deeper water ATS	Deeper water W.St.	Deeper water ATS	Group
A	7	74 g/g.	12 ft.	670	14	1250	Group I
B	8	445	13 ft.	620	17	620	Group I
M			-		15	1350	Group I
N	12	348.9	23	810			Group I
C	9	77	27	910			Group II
D	8	120	26½	770			Group II
E	9	50	40	570	41	650	Group II
F	10	112	31	570			Group II
I	10½	190	24	505			Group II
J	8	133	23	840			Group II
K	8	25.3	42	1440			Group II
L	9	47.4	40	900			Group II
R	9	119	41	541			Group II
G	9½	26					
H	9½	37	48	485			Group III
O	14	80	52	253			Group III
P	14	158	48	415			Group III
Q	9	59	51	390			Group III
S	13	73	34	97			Group IV
1	31	108					Group IV
2	15	88					Group IV
3	11	78					Group IV
4	15	114					Group IV
5	33	81.9					Group IV
Sec. 4C	26	72.4					Group IV
Sec. 61	46	98.5					Group IV
Sec. 61	34	152					Group IV

Table No. VII

DEPARTMENT OF MINES—ADELAIDE

Hd. WARRINER

DETAILED ANALYSES OF UNDERGROUND WATERS IN PORTION OF CO. FERGUSSON

Serial No.	Section No.	Chlorine, Cl.	Sulphuric Acid radicle, SO_4	Carbonic Acid radicle, CO_3	Nitric Acid radicle, NO_3	Sodium, Na	Potassium, K	Calcium, Ca	Magnesium, Mg	Iron, Fe	Silica, SiO_2	Total Saline Matter Grains/Gall.	Total Saline Matter Ounces/Gall.
D	E	332.5	19.0	16.4	nil	153.7		27.8	27.4			576.8	1.32
F	4D	58.0	4.2	16.1	nil	28.7		11.3	5.5			123.8	0.28
G	4D	10.3	nil	7.1	nil	5.2		4.7	0.8			28.1	0.06
H	4D	9.6	1.5	12.5	trace	5.1		7.3	1.7			37.7	0.09
I	E	103.3	3.6	14.0	trace	46.4		14.8	8.5			190.6	0.44
J	E	66.8	3.1	14.9	nil	28.3		14.8	5.8			133.7	0.31
K	4D	7.8	0.5	7.4	nil	4.7		4.1	0.8			25.3	0.06
L	4D	14.2	3.4	12.3	trace	8.1		7.3	2.1			47.4	0.11
M	79	202.0	4.9	16.1	nil	80.7		27.5	17.7			348.9	0.80
P	58	105.6	4.9	17.0	nil	45.9		18.7	8.7			200.8	0.48
Q	68	232	5.3	13.2	nil	82.8		37.6	19.6			390.5	0.89
R	68	300.7	24.3	18.0	nil	152.6		24.5	21.0			541.1	1.24
S	58	42.3	3.3	15.6	nil	20.8		11.5	3.7			97.2	0.22
1	58	46.6	4.4	17.6	nil	24.9		10.9	4.4			108.8	0.25
2	58	38.3	1.8	15.0	nil	19.3		9.3	3.8			87.5	0.20
2	58	37.3	2.4	15.5	nil	18.5		11.0	3.3			88.0	0.20
3	58	36.5	1.4	11.3	nil	15.8		10.3	2.8			78.1	0.88
4	58	16.8	2.4	11.4	nil	8.0		7.3	2.3			48.2	0.11
4	58	20.1	0.9	11.1	nil	8.0		8.7	2.1			50.9	0.12
4	58	60.1	1.9	11.1	nil	21.2		15.4	5.0			114.7	0.26
5	58	30.2	3.5	17.7	nil	10.5		8.6	3.4			81.9	0.19
	4D	30.24	5.23	12.00	nil	16.76		7.15	3.36			74.74	0.17
	4D	37.45	4.28	10.50	trace	18.12		7.22	4.22			81.79	0.19
	4D	24.3	2.9	17.7	trace	19.3		5.4	2.8			72.4	0.17
	61	29.7	8.9	22.8	nil	26.4		7.5	3.2			98.5	8.23
	8B	16.80	2.43	11.65	trace	10.35		4.93	2.64			48.80	0.11
	8B	12.6	6.7	12.9	trace	12.5		2.7	1.5			42.9	0.10
	8B	37.9	nil	10.2	trace	6.4		12.3	6.3			73.1	0.17
	8B	144.9	12.8	17.4	nil	66.3		21.4	11.9			274.7	0.63

Serial No.	Section No.	Assumed Composition of Salts: Calcium carbonate	Calcium sulphate	Calcium chloride	Magnesium carbonate	Magnesium sulphate	Magnesium chloride	Sodium carbonate	Sodium sulphate	Sodium chloride		Sodium nitrate	Potassium chloride	Silica	Hardness (degrees English): Total	Temporary	Permanent	Due to calcium	Due to magnesium	Analysis No.
D	E	27.4	26.9	24.6				107.3		390.6		nil			182.1	27.4	154.7	69.3	112.8	1352/58
F	4D	26.9	1.7			3.8	18.4			73.0		nil			50.7	26.9	23.8	28.1	22.6	1401/58
G	4D	11.8					3.1			13.2		nil			15.1	11.8	3.3	11.8	3.3	1351/58
H	4D	18.2			2.3	1.9	2.3			13.0		trace			25.2	21.1	4.1	18.2	7.0	1206/58
I	E	23.4	5.1	10.8			33.3			118.0		trace			71.9	23.4	48.5	36.9	35.0	1208/58
J	E	24.9	4.4	9.7			22.7			72.0		nil			60.8	24.9	35.9	36.9	23.9	1210/58
K	4D	10.2			1.8	0.6	0.8			11.9		nil			13.5	12.3	1.2	10.2	3.3	1212/58
L	4D	18.2			2.0	4.3	2.3			10.6		trace			26.9	20.7	6.2	18.2	8.7	1214/58
M	79	26.9	6.9	40.7			69.3			205.1		nil			141.4	26.9	114.5	68.6	72.8	1217/58
P	58	28.4	6.9	14.7			34.1			116.7		nil			82.4	82.4	54.0	46.6	35.8	1400/58
Q	68	22.0	7.5	73.7			76.8			210.5		nil			174.6	27.0	152.6	93.9	80.7	1354/58
R	68	30.0	34.4	6.6			82.2			387.9		nil			147.6	30.0	117.6	61.2	86.4	1353/58
S	58	26.0	3.7			0.9	13.7			52.9		nil			43.9	26.0	17.9	28.7	15.2	1347/58
1	58	27.2			1.18	5.5	11.0			63.3		nil			45.3	29.3	16.0	27.2	18.1	1471/58
2	58	23.2			1.5	2.3	11.4			49.1		nil			38.82	24.8	14.0	23.2	15.6	1474/58
2	58	25.9	2.0			1.3	11.7			47.1		nil			41.0	25.9	15.1	27.4	13.6	1473/58
3	58	18.8	2.0	6.1			11.0			40.2		nil			37.3	18.8	18.5	25.8	11.5	1476/58
4	58	18.2			0.7	3.0	5.9			20.4		nil			27.6	19.0	8.6	18.2	9.4	1478/58
4	58	18.5	1.3	2.5			8.2			20.4		nil			30.3	18.5	11.8	21.7	8.6	1479/58
4	58	18.5	2.7	19.9			19.6			54.0		nil			59.1	18.5	40.6	38.5	20.6	1543/58
5	58	21.5			6.7	4.4	2.3			47.0		nil			35.5	29.3	6.2	21.5	14.0	1544/58
	4D	17.85			1.83	6.55	5.91			42.60		nil			31.68	20.03	11.65	17.85	13.83	1252/53
	4D	17.51	0.71			4.74	12.77			46.06		trace			35.39	17.51	17.88	18.03	17.36	1251/53
	4D	13.5			9.7			4.8	4.3	40.1		trace			25.0	25.0	nil	13.5	11.5	1498/58
	61	18.7			11.1			6.5	13.2	49.0		nil			31.9	31.9	nil	18.7	13.2	1481/58
	8B	12.31			6.00	3.05	1.14			26.30		present			23.18	19.43	3.75	12.31	10.87	1261/53
	8B	6.7			5.2			9.2	1.0	20.8		trace			17.9	17.9	nil	6.7	6.2	1486/58
	8B	17.0		15.2			24.7			16.2		trace			56.6	17.0	39.6	30.7	25.9	1487/58
	8B	29.0	18.1	12.5			46.6			168.5		nil			102.5	29.0	73.5	53.5	49.0	1489/58

TABLE VIII

SHOWING UPPER LIMIT OF FRESH AND SALINE WATER BODIES AND THICKNESS OF THE FRESH WATER HORIZON

Bore No.	Fresh water struck below surface in ft.	Saline Water struck below surface in ft.	Thickness of fresh water bed in ft.	Original depth of bore in ft.	Bore back filled to in ft.	Remarks
A	7	12	5	15	10	Observation bore
B	8	13½	15½	13	19	" "
C	9	27	18	28	18	" "
D	8	26½	18½	27	18½	Observation bore pump tested.
M	-	-	nil	15	surface	Observation bore
N	9	22	11	23	surface	" "
I	10½	28	17½	29	19	" "
J	8	23	15	24	15	" "
E	9	40	31	42	24	Observation bore pump tested.
F	10	31	21	33	20	" "
G	9½	49	39½	49	29	" "
H	9½	48	38½	49	29	Observation bore
K	8	42	34	42	24	" "
L	9	34	25	42	25	" "
O	14	52	32	80		" "
P	14	52	38	58	33	Final bore pump tested
Q	9	51	42	54	31	Observation bore
R	9	41	32	41	25	" "
S	13	-	47	60	34	Final bore pump tested
1	31		30	61	45	Final bore pump tested
2	15		37	52	33	" " "
3	11		42	53	24½	" " "
4	15		26	41	not filled back	" "
5	13		27	62	surface	Abandoned after pump test
Sec.4C	26		17	44	36	Bore for private landholders
T	-	-	nil	62	surface	Observation bore.

PUMP TEST - WARATAH GYPSUM COY. BORES.

Bore No.	Time	W.L. Top Casing	ATS Top Water	ATS Suction Level	ATS Bottom bore	Draw-down	Output	Remarks
					4th June			
D	11.00							start pump
D	11.10		470		750			pumping stopped
D	14.15	6'6½"	220		550			restart pump
D	15.00							pump stopped
J	8.30	7'6"	160		135			before pumping
D	9.10	6'6½"	170		180			started and stopped
I	9.16	11'2"	170		270			" " "
L	9.30	10'7"	80		(50?)			" " "
E	9.50	8'11"	55		170			" " "
F	10.19	11'7½"	120		120			
G	16.23	6'10½"	240		180			
R	16.10	8'7½"	180		115			
					5th June			
D	08.55	6'4½"	180	200	410			
D	09.23						200	start pumping
D	09.45	7'3"	120	200		10½"	250	
D	10.00						500	253 g/h. increase
D	10.15	7'3"	160		530	10½"	500	
D	10.30	7'3"	220		880	10½"	500	
D	10.45			500			720	170 g/h. increase
D	11.05	7'3"	220	650		10½"	720	
D	11.35	7'4½"	180(?)	620	850	11"	720	
D	11.50	7'4½"	320	630	1070	11"	1,000	280 g/h. increase
D	12.25	7'4½"	340	700	1070	11"	1,000	
D	12.55	7'4½"	320	700	1070	11"	1,000	stop test.
D	13.10	6'7½"	320	760	1070	3"		15 mnts. after test.
I	09.00	11'2"	170		270			
J	09.10	7'6"	160		160			
I	12.50	11'2"	170		230			
J	13.00	7'4½"	160		160			Increase of W.L. 1½"

Bore No.	Time	W.L. Top Casing	ATS Top Water	ATS Suction Level	ATS Bottom Bore	Draw-down	Output	Remarks
				5th June				
E	14.38	8'6"	35		55		230	Pumping started
E	15.10	8'11"	35		240	5"	230	
E	15.30						400	170 g/h. increase
E	15.48	8'11"	40	170	240	5"	400	
E	16.00						700	300 g/h. increase
E	16.10	9'½"	40	240	440	6½"	700	
E	16.30	8'8"	60	320	380	2"	700	
E	17.00	8'10"	55	270	440	4"	1,000	300 g/h. increase
E	17.30	9'	75	330	480	6"	1,000	
E	18.00	8'10"	100	330	480	4"	1,000	Stop pump
H	17.50	8'9"	80					
H	17.50	8'9"	80					
				6th June				
G	09.35	9'7½"	20		30		?	start pump
G	11.30	9'8"	30			½"	?	no output for June
G	12.00			35			450	pump trouble
G	12.30	10½"	35	35	35	5"	450	
G	12.55	9'11¾"	30	35	35	4½"	450	
G	13.00						720	270 g/h. increase
G	13.30	10"	20	30	30	4½"	720	
G	13.50	10"	20	30	30	4½"	720	
G	14.15	10"	20	30	30	4½"	720	
G	15.00	10¼"	20			4¾"	1,000	280 g/h. increase
G	15.30	10'1½"	20	30	30	6"	1,000	
G	15.40	10'1¾"	25	30	30	6¼"	1,000	
G	16.00	10'1¾"	25	30	30	6¼"	1,000	Stop pump
E	08.55	8'8"	105	105	110			15 hrs. after test
D	09.05	6'5"	135	200	200			" " "
H	09.25	8'10"	170		100			
H	15.30	8'8"	65		80	+2"		2" increase in W. level.

Bore No.	Time	W.L. Top Casing	ATS Top Water	ATS Suction Level	ATS Bottom Bore	Draw-down	Output	Remarks
				10th June				
F	13.36	1'4½"	75					
F	14.00	11'4½"	75	95	110		480	start pump
F	14.25	13'7"	65	110	140	2'2½"	480	
F	15.15	12'11½"	115	120	150	1'7"	480	
F	15.48	13'5½"	110	150	150	2'11"	700	
F	16.15	13'5½"	110	155	155	2'1"	700	increase to 1,000
F	16.45	14'	110	120	150	2'6½"	1,000	
F	17.15	14'½"	115	140	150	2'7"	1,000	stop pump 17.15
F	17.20	11'6½"				2"		2" below starting level
J	13.46	7'7½"	160		170			Top casing
K	13.50	6'9"	22		30			
WGIII	13.55	13'4"	175		180			
D	15.35	6'6"	150		150			
G	16.04	9'7½"	35		35			
WGIII	16.50	13'4"	180		180			
J	17.00	7'6"	180		180			

PUMP TEST RESULTS

11th June.

Bore No.	Time	W.L. Top Casing	ATS Top Water	ATS Suction Level	ATS Bottom bore	Draw-down	Output	Remarks
P	09.55	12'4½"	120		180			Start pump
P	10.00						400	
P	10.20	12'8"	180	165	200	3½"	400	
P	10.45							irrigation to 10.45
P	11.00	12'9"	120	165	200	4½"	400	
P	11.30	12'10"	140	165	200	5½"	400	
P	11.30						700	300 g/h. increase
P	11.50	12'10¾"	110	165	200	6¼"	700	
P	12.25	12'11"	120	160	180	6½"	700	
P	12.30						1,000	300 g/h. increase
P	12.45	13'1"	120	195	220	8½"	1,000	
P	13.00	13'½"	120	170	230	8"	1,000	possible
P	13.50	13'2"	130	190	240	9½"	1,000	failure
P	14.45	13'2"	120	180	220	9½"	1,000	of temp gauge.
P	15.10	13'2"	110	160	220	9½"	1,000	"
S	10.10	13'1"	65	120	120			"
S	15.00	13'½"	120	120				"

12th June.

Bore No.	Time	W.L. Top Casing	ATS Top Water	ATS Suction Level	ATS Bottom bore	Draw-down	Output	Remarks
								Failure in temp gauge.
C	09.10	8'7"	80	80				Start pumps.
C	09.20	9'	100	120		5"	500	No sand screen in bore
C	11.10	9'1½"	100	120		6½"	400	
C	11.30	9'2"	100	120		7"	700	300 g/h. increase
C	11.45	9'3½"	100	170		8½"	700	
C	12.15	9'3¼"	100	170		8¼"	700	
C	12.30	9'4"	100	180		9"	700	
C	12.30						1,000	300 g/h. increase
C	12.36	9'6"	105	170		11"	1,000	
C	13.00	9'5"	115	180		10"	1,000	
C	13.15	9'5½"	125	180		10½"	1,000	
C	13.30	9'6"	125	180		11"	1,000	
C	13.30						1,440	440 g/h. increase
C	13.40	9'9"	125	180		1'2"	1,440	

Bore No.	Time	W.L. Top Casing	ATS Top Water	ATS Suction Level	ATS Bottom Bore	Draw-down	Output	Remarks
				15th July 1958				
2	14.45	14'2"	115	115	90	-	-	Start pumping
2	15.10	14'4"	110	110	110	2"	400	
2	15.45	?	110	110	110		400	Increase to 800 g/h.
2	15.46							Pump stopped for ½ hr.
2	16.15	14'4½"	110	110	90	2½"	800	Restart pump
2	16.30	14'5½"	110	110	95	3½"	800	
2	16.45	14'5¾"	110	110	95	3¾"	800	
⅜ 2	17.00	14'6½"	110	110	95	4½"	1,000	200 g/h. increase
2	17.15	14'7"	110	110	95	5"	1,000	
2	17.30	14'7½"	110	110	95	5½"	1,000	
2	17.45	14'8"	110	110	95	6"	1,000	Stop pumping. Drawdown on 1000 g/h not as yet established.
				16th July, 1958				
3	13.45	10'3½"	75	75	75	-	-	Start pump at 400 g/h.
3	14.00	10'8½"	75	85	115	5"	400	
3	14.15	10'11½"	75	85	120	11½"	400	
3	14.45	10'8"	80	80	120	5½"	400	300 g/h. increase
3	15.15	11'	90	90	130	8½"	700	
3	15.30	11'	90	90	130	8½"	700	
3	15.45	11'	90	90	130	8½"	700	300 g/h. increase
3	16.00	11'2½"	90	90	130	11"	1,000	
3	16.15	11'3"	90	90	130	11½"	1,000	
3	16.35	11'4"	90	90	130	1'½"	1,000	200 g/h. increase
3	16.50	11'4"	90	90	130	1'½"	1,200	Stop pump. Drawdown probably not established.

24th July, 1958

Bore No.	Time	W.L Top Casing	ATS Top Water	ATS Suction Level	ATS Bottom Bore	Draw-down	Output	Remarks
S	9.45	12'11"	65		110			Start pump at 500 g/h.
	10.00	13'8½"	110	110	125	9½"	500	No sand screen in bore.
	10.15	13'7"	110	110	110	8"	500	250 g/h. increase
	10.30	13'10"	110	110	110	11"	750	
	10.45	14'½"	110	110	110	1'½"	750	250 g/h. increase
	11.00	14'8"	110	110	110	1'9"	1,000	
	11.15	14'7"	110	110	110	1'8"	1,000	
	11.30	14'7"	110	110	110	1'8"	1,000	440 g/h. increase
	11.40	16'3"	110	110	110	3'4"	1,440	
	11.45	16'3"	110	110	110	3'4"	1,440	Stop pump
	11.50	13'2"				3"		after 5 minutes.

25th July, 1958

Bore No.	Time	W.L Top Casing	ATS Top Water	ATS Suction Level	ATS Bottom Bore	Draw-down	Output	Remarks
1	13.20	32'4"	110					Start pump at 1500
1	13.25	32'5"	115			1"	1,500	
1	13.40	32'5"	115			1"	1,500	
1	14.05	32'9"	110			5"	1,500	1,500 g/h. increase
1	14.15	33'3"	110			11"	3,000	

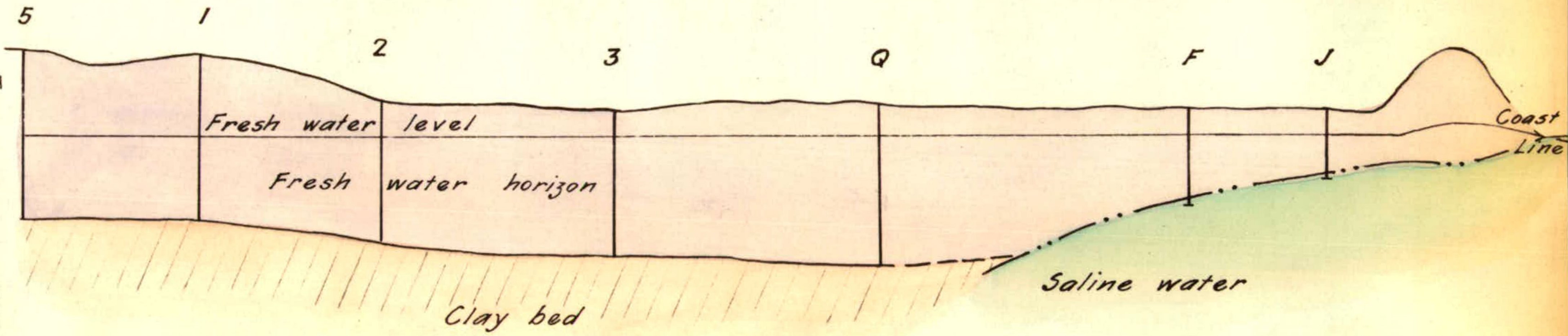
S.A. DEPARTMENT OF MINES

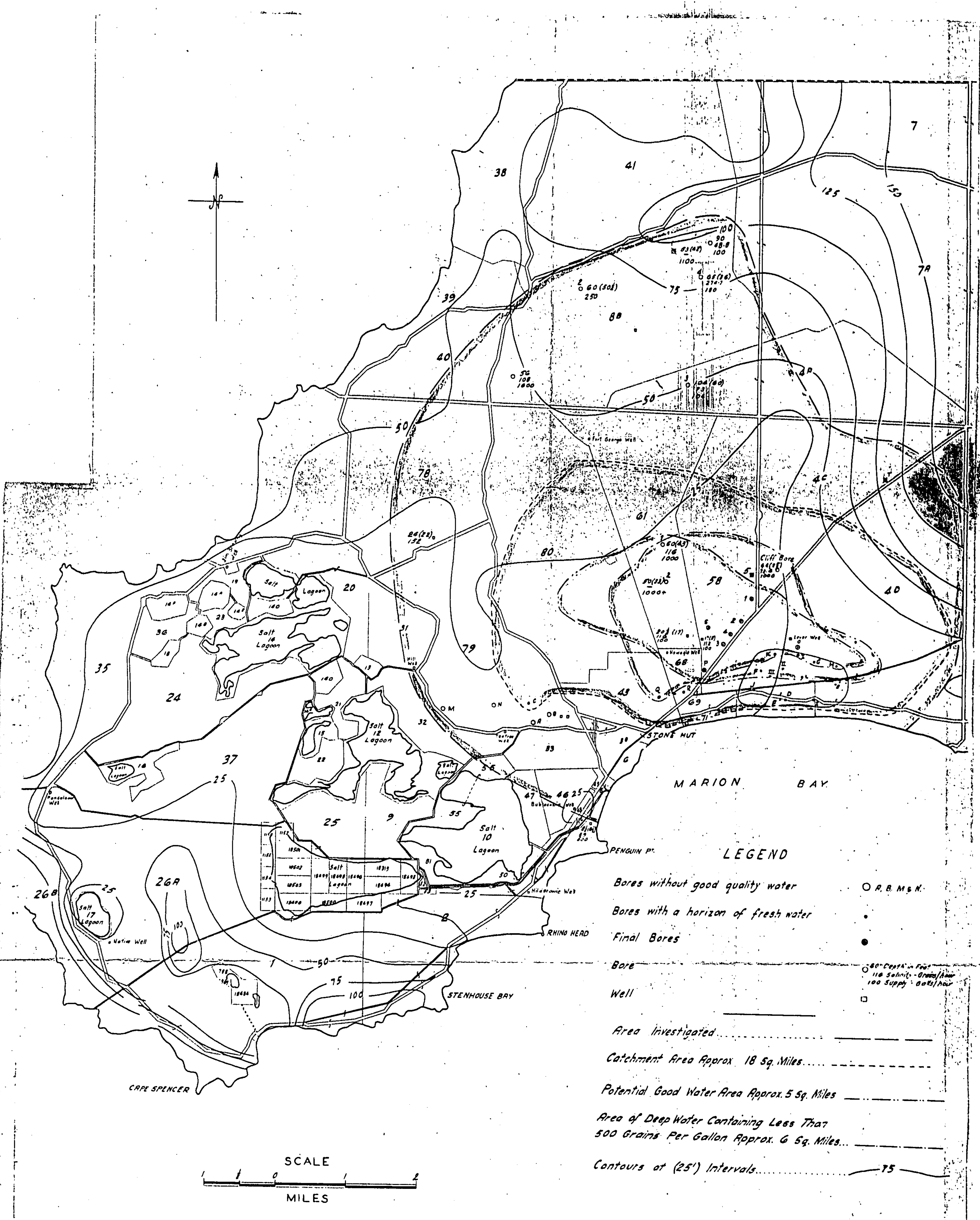
SKETCH SHOWING THE PORTION OF THE FRESH WATER HORIZON AND THE SALINE WATER BELOW

H^{D} WARRENBEN SECS. 58, 4^{B} & E

Approved	Passed	Drn.
Director		Tcd. R.R.
		Ckd.
		Exd.
D.M.	Rep.	
Scale: Horiz. 20 Chns - 1" Vert. 50' - 1"	S 1921 Gh 14	Date 6-10-58

To accompany report by C. Bleys.





To accompany report by C. Bleys.

S.A. DEPARTMENT OF MINES

UNDERGROUND WATER INVESTIGATIONS
S.W. PORTION Hº WARRENBEN
WARATAH GYPSUM Cº

Approved	Passed		
		Drn.	Scale 1M = 1"
		Trd R.W.	58-280
		Ckd R.R.	Ghe
Director		Exd.	Date 2-10-58

No.	Amendment	Exd	Date