REPORT

on

UNDERGROUND WATER AT "WINGAROO" FIVE MILE LAGOON DISTRICT, FLINDERS ISLAND

1. INTRODUCTION

The property of Wingaroo is situated in the Five Mile Lagoon district in the north-eastern part of Flinders Island.

The property includes the beds of two large lagoons which however, have been completely drained. The beds are now utilised for grazing cattle and to a slight extent for agricultural purposes. The draining of the lagoons removed the only local supply of surface water for watering the stock. To provide such a supply numerous wells have been sunk in the vicinity of the lagoons, but the quality of the water obtained was not considered suitable. During the writer's visit two bore holes were sunk to give further information on the geological structure and the underground water.

11. TOPOGRAPHY.

Between Patriarch Inlet and North Point there is a straight tract of low-lying, sandy coast. The low lying country extends inland to the west and south as a gently undulating plain. The north-western margin is formed by the granite hills of the Gin Bottle, Mts. Blythe, Boyes, &c. The southern boundary is formed by the hills and mountains between Mt.Arthur on the west coast and the Patriarchs on the east coast. Parelleling the shores of Marshall Bay, a low range of hills forms the western boundary of the plains.

The drainage of the plains is to the east and north by means of small streams forming tributaries of Foo Choo Creek, Arthur River &c. These streams especially the smaller ones only contain running water during and after periods of heavy rainfall. The drainage system is an inefficient one as is evident from the number of shallow lagoons interspersed over the plains.

The plain has a general level not exceeding 50 feet above sea level. The surface rises to the west and south as it merges into the foothills of the bounding ranges. The hills forming the western boundary rises to heights of 400 feet, but there is a gap at the north and not more than 200 feet above the sea. The mountains to the north-west and south rise to heights ranging up to 1,000 feet and more above sea level.

111. GEOLOGY

The oldest rocks on Flinders Island are the slates and quartzites occurring around Brougham Sugarloaf and the hills forming portion of the southern boundary of the plain. They resemble similar rocks in north-eastern Tasmania and are, therefore, referred to the Cambro-Ordovician system.

The remaining high hills and mountains (excepting the ridge parallel to Marshall Bay) are composed of granite.

This rock intrudes the slates and quartzites as does the Devonian granitic rocks of north-eastern Tasmania. It is similar in structure, texture (coarse to medium in grain), and mineral composition (quartz, felspar and biotite) and is regarded as being referrable to the Devonian series of intrusions.

The hills on the western side of the plain have numerous outcrops of limestone on them. Very few outcrops of rocks occur on the plains, but such outcrops as do exist consist of thin beds of limestone. The only other sources of information as to the geological structure of the plains are the wells, bore-holes and numerous low cuttings in drains. The information together with that obtained from other parts of Flinders Island suggests that there occurs a series of sands, clays and thinly bedded limestones.

Apart from the rising ground to the hills to the west and south-west the highest parts on Wingaroo are two ridges one of which occurs between the two drained lagoons and the other occurs east of the eastern lagoon. These ridges are formed mainly of clay as far as can be judged by the surface. On the ridge east of the eastern lagoon a small quarry exposed a thin bed of soft earthy limestone.

At certain localities e.g. west of the western lagoon, south of the eastern lagoon, and in a tract ½ to ¾ mile east of the eastern lagoon, solid outcrops of limestone occur. These can be traced for considerable distances in the drain cuttings &c. but generally appear to give place when followed horizontally to clayey beds containing nodules of limestone. This is apparently a characteristic of the thin beds of limestone and would account for the different nature of the limestone at the quarry referred to above and also for the fact that only nodules in clay were encountered in No.2 bore-hole (to be described below).

Apart from the clay ridges and the limestone outcrops the surface is occupied by sandy or gritty soil, or the alluvium of the lagoons and creek beds. Of the wells sunk on the property Nos. 1,3, and 4 were sunk from the floor of the lagoon and passed through peat, clay and gravelly clay to intersect a layer of fine greyish sand about 8 feet below the surface. The Nos. 2,5 and other wells and excavations though not sunk from the lagoon eventually encountered the fine greyish sand. It was evident therefore, that it occurred under the surface in many localities. In order to confirm the deduction from Geological evidence that it occurred under the surface generally, the No.2 bore-hole was sunk from the summit of the clay ridge on the eastern side of the eastern lagoon, as it was considered that beneath the clay ridges was the only likely place where it would not exist.

The No. 2 bore-hole was sunk from the highest point of the clay ridge some 25 chains south of the Wingaroo homestead. The summit of the ridge was 26 feet by level survey above the floor of the lagoon. The strata passed through were

FEET	
0-1	Sandy soil.
1-4	Brownish clay.
4-5	Black clay with white calcareous nodules.
5-6.5	Brown sand.
6.5-8	Yellowish-brown sandy clay (with one piece of a sea shell?)
8-12	Calcareous clay giving place to white eartny limestone
12-13	Dark Clayey sand.
13-18	Dark sandy clay with calcareous nodules.
18-22	Clay and sand.
22-23	Clay
22-24	Sand
24-27	Sand becoming coarser with quartz pebbles up to ⅛ inch diameter
27-29.5	Gravel with pebbles up to ⅛ inch
29.5-31	Clay and sandy clay
31-33	Fine greyish green sand. Consists of fine quartz grains of darker minerals and small broken pieces of sea shells

Water was encountered in the sand and the sand also entered the casing.

The sand was identified by Mr. C.J. Robinson, the Manager of Wingaroo, as being identical with that encountered in the wells. It also agreed in level with that met with under the lagoons It was quite evident, therefore, that the fine sand (locally termed slurry) extends throughout the area (at a height about 12 feet above sea level).

The only section of strata below the fine sand is that given in the No.1 bore-hole. The fine sand was passed through and then alternating beds of fine sand and coarse sand containing almost perfect sea shells were passed through to a depth of 78 to 80 feet. Between 65 and 68 feet there was a bed of compact fine white sand.

The shells obtained included the following genera and species (the shells are very similar to, if not identical with, the existing ones on Tasmanian beaches and so the existing genera and species are used with attached notes when there is any difference from the existing shells) .

FROM 10 TO 55 FEET.

Cuspidaria exarata.
Marcia corrugata.
Ostrea.
Pecten or Chamlys.
Sigapatella calyptraeformis (?)
Glycymeris.
Pectunculus (This shell does not occur on the Tasmanian beaches. It somewhat resembles P.McCoyii).

FROM 55 TO 80 FEET.

Dosinia (flatter than present species.)
Divaricella cumingi.
Nugulana crassa.
Clausinella placida.
Marcia.
Glycymeris.
Cardium
Glycymeris or Pectunculus.
Fusinus novae hollandae
Cancellaria.
Verconella tasmaniensis.
Massarius tasmanicus.
Conus anemone.
Cantharidus fasciatus.
Sigapatella calyptraeformis.
Polinices conicus.
Turritella Gunnii (?)
Dentalium.

The following shells were obtained from the surface near limestone outcrops from which they had apparently weathered out.

Marcia.
Nassarius.
Pyrazus.
Amphipeplea.
Ameria.

It is to be noted that a larger form of Ameria is living in the fresh water lagoons at present.

The above shells generally resemble or are identical with living species with the exception of the Pectunculus and pectunculus like forms of Glycymeris; the flatter form of dosinia; and the dentalium. The general assemblage of the shells suggests a Recent to Pleistocene age but the Pectunculus and Dentalium possibly suggests an age ranging back to Tertiary. In this connection it is to be noted that R.M. Johnston describes the following fossils from limestone from Heathy Valley near the Patriarchs.

Pectunculus	Cainozoicus.
Nucula.	tumida
Turritella	cf. T.Warburtonii.

Johnston regarded these as establishing a Tertiary age, but stated that further examination was necessary.

1V. UNDERGROUND WATER SUPPLIES.

After the draining of the lagoons, it became necessary to develop supplies of water for watering the stock. The general absence of other surface supplies and facilities for conservation of surface water necessitated the development of the underground water. Several wells were sunk and water being met with at shallow depths, the problem appeared to have been solved. However, it was found that the quality of the water deteriorated and affected the cattle. Moreover the quantity was not sufficient in summer to keep up a regular supply for the stock. The problem as to quantity could have been solved by sinking more wells, but in view of the unsatisfactory quality this was not a solution to the problem. Deeper sinking of wells could not be attempted with ordinary methods, owing to the nature of the fine sand and lack of knowledge as to methods for sinking in such ground.

This was the position at the time of the writer's visit. A brief geological survey established the geological structure and this was confirmed by No.2 bore hole. An examination of existing analyses up till that time proved that the quality of the water was deteriorating as regard the content of dissolved mineral substances. Examination of the wells revealed other deleterious substances.

A. POSSIBLE SUPPLIES OF UNDERGROUND WATER

As the shallow underground water was unsatisfactory as regards quantity and quality, the only other possible source was any water occurring at greater depths. There was every possibility of such occurring, but it was doubtful as to whether there would be any difference in quality and quantity and also as to whether the upper waters could be shut off. Accordingly No.1 bore-hole was sunk to test the possibilities. In addition to that in the upper layer of fine sand other supplies appear to have been met with at approximately the following depths- 20, 35, 48, and 78 feet. At times the well was quite dry and during one night no water entered the hole and it is therefore obvious that the casing had shut off the upper waters temporarily if not permanently. Generally the supplies from the upper levels were not large, but the supply obtained near the bottom gave pumping tests of at least 100 gallons per hour from a depth of 20 feet. It was, therefore, deemed advisable to test this supply as regards quality over a period of several months to ascertain if any alteration occurred. If the supply proves satisfactory then supplies can be obtained from this depth at other points throughout the property.

B. QUANTITY

As stated above, pumping tests proved that 100 gallons per hour could be taken out of the hole without lowering the water level below 20 feet. If greater quantities were pumped the level would be lowered and this would permit supplies to enter the hole at a greater rate. When pumping from the hole for use, the pump would be installed at a depth of 50 to 70 feet and it is certain that pumping could be carried out at a rate greater than 100 gallons per hour. As to how much the pumping rate could be increased can only be determined by testing. When determined, it would be advisable to set the pump to work at a rate calculated not to lower the water level below the pump .

C. QUALITY

The general effect of the dissolved mineral substances is as follows. The content of total solids regulates the quality in that it determines the amount of salts taken by the animals in drinking their daily amount of water. A certain amount of salts can be dealt with, but over that it becomes dangerous. The chlorides and sulphates are the most plentiful salts and of these the effect of the sulphates (sodium and magnesium) is much the greater. Alkaline carbonates (sodium) are bad but the carbonates are mostly present as bi-carbonates of magnesium and calcium. A water to be of good quality must, therefore, be low in total solids and all salts but particularly of sulphates and alkaline carbonates. The requirements of different classes of stock vary considerably with the different classes in the following order - sheep, cattle (grazing) horses (at grass), horses (in work) and milking cows, sheep being capable of drinking waters with greater amounts of dissolved mineral substances and horses and milking cows those with least. Limiting figures for Tasmania should be obtainable from the Agricultural Department.

The shallow wells were sunk early in 1929, and the water appeared to be of suitable quality for watering the dairy cattle. Samples were taken and analysed at the laboratories of the Departments of Agriculture in Tasmania (28/2/29) and Victoria (20/2/29). These were generally similar, but the samples analysed in Victoria showed a higher content of dissolved mineral substances. As a result of the Tasmanian analyses it was reported that the water from the Nos. 1,2, and 4 wells was suitable for stock, but that from No. 3 was dangerous if used for long periods. As a result of the Victorian analyses it was stated that the water from No.2 well should not effect stock and that the remainder should affect stock in order of their mineral content, No.3 being quite unsuitable for dairy cows and Nos. 1 and 4 not being recommended for this purpose, but being suitable for grazing stock.

Further analyses were made in Tasmania on 25/6/39 when it was reported that No.2 was unfit for stock, while No. 4 was doubtful, but that the water from two new shallow wells (near No. 5 and No.6) was fit for stock.

The results of usuage of the water indicated that it was deteriorating in quality as judged by its effect on the stock. The analyses of 25/6/30 appeared to verify this as judged by the amount and nature of the dissolved mineral substances. These changes can be seen from the table of analyses for Nos.2 and 4 wells . However, the analyses of samples taken during the writer's visit and shown under headings of 5/12/30 prove that the conception of progressive deterioration does not entirely explain the changes in composition of the water. The No.2 well water shows only a slight increase in total solids and chlorides with a considerable reduction in sulphate in comparison with the analyses of 25/6/30. The No.4 well water shows a content of total solids similar to those of 20/2/29 and 25/2/29, and a considerable improvement as regards chlorides and sulphates.

There are two main factors to be considered in connection with the quality of the water viz. the water is encountered at shallow depth and rain water can readily percolate to such depths, and the question of the distribution of the rainfall throughout the year. The better quality of the water when the wells were freshly dug is probably due to the fact that the upper layers of the water were rainwater that had percolated from the surface and had not properly mixed with and become part of, the water in the sand bed. These would enter the well first but as pumping continued and this water table was lowered, the water from lower layers began to enter the well without any dilution from the purer overlying water.

The variation in the composition of the No.4 well is probably only explainable by the different periods of the year at which samples were taken. The sample of 25/6/30 was taken after a period of very low rainfall between January and June while that of 5/12/30 was taken after a period of much greater rainfall (e.g. at Smita the nearest station with a complete series of published data only 645 points fell in the first six months of the year while 1316 points fell in the following five months.

The water from No.2 well is largely used for the dairy cows and if the cows have suffered in condition it is probably due mainly to the water from this well. Judged by the dissolved mineral substances this water would be suitable for sheep and grazing cattle and probably also for dairy cattle.

The content of dissolved solids as revealed by the earlier analyses does not form the only criterion for judging the quality of the water. On visiting the wells it was found that all the older wells smelt strongly of hydrogen sulphide. Moreover the pipes were being corroded rapidly and also all metal work was blackened by the water. It was obvious, therefore, that the hydrogen sulphide was attacking the iron and probably forming ferrous sulphide which would account in some part at least for the dark coloration of the water. It would appear that the presence of the hydrogen sulphide and the ferrous sulphide would have a harmful effect on the cattle equivalent to if not greater than that of the dissolved solids. Further information on this matter should be sought from the Agricultural Department. It should be noted that the analyses of 5/12/30 show small amounts of hydrogen sulphide. These do not necessarily represent the true content as the gas has so many opportunities of escaping from solution and passing into the atmosphere.

The analyses of the water from four depths in the No.1 bore hole show that the quality was improving with depth. The water from the greatest depth was generally similar to those first obtained from the wells when first dug. In one important point viz. content of sulphate, it is a much better water.

The No.2 bore-hole water is of poor quality. This is probably due to the fact that being under a ridge of clay the rain water does not have much ready access to it, as in the lagoons and the water obtained, therefore, represents the real quality of the water in the sand layer at this place.

D. IMPROVEMENTS OF THE QUALITY OF THE WATER

No economical means exist whereby the content of dissolved mineral substances (mainly sodium chloride and magnesium sulphate) can be reduced.

As regards the hydrogen sulphide, however, every effort should be made to prevent it acting on the metal work and to remove it from the water.

It would be advisable if possible to refrain from using iron pipes in casing the bore-holes. This, however, appears impossible unless large holes were sunk and cement or wooden pipes without metal work were put down inside the metal casing and the latter withdrawn. The best method of attacking this problem appears to be that of using iron pipes coated with tar, bitumen, cement or some such material which will completely cover the metal work and prevent the water attacking it. It might be possible to use this casing while sinking the bore-holes or alternatively to use ordinary casing and then insert the lined casing inside the other which would be withdrawn either before or after (depending upon the nature of the ground) the insertion of the lined casing.

The pump itself could be of acid resisting material and the pump rods and delivery pipes should be of material not acted upon by hydrogen sulphide or of metal work coated with the cement etc. referred to above.

These precautions would tend to deliver the hydrogen sulphide water at the surface without it having attached metal work and formed ferrous sulphide etc. Once at the surface, it would be easier to keep the water away from metal by using cement tanks, troughs etc. As soon as the water was delivered at the surface it would be advisable to let it run over cascades in order to allow the hydrogen sulphide gas to pass out of solution by evaporation into the atmosphere. This would greatly reduce the amount in solution and if it was found necessary to reduce it further, aeration (pumping of air through the water) would be found to be effective.

If it is found impossible to eliminate the formation of ferrous sulphide, filtering through sand beds would tend to remove same. This, however, need only be necessary if it were found that the content of ferrous sulphide was harmful. In general, filtration would have little or no effect on the water except possibly removing the ferrous sulphide and any organic matter.

CONCLUSIONS & RECOMMENDATIONS.

The general descriptions given above state fully the conditions and problems existing in connection with underground water supplies at Wingaroo and the following recommendations are made in connection therewith.

(1) The supply obtained at the bottom of No.1 borehole should be thoroughly tested out. As far as possible, the casing should be coated with tar, bitumen etc., the pump should be of acid resisting material, and the pump rods and pipes either coated or be of material (wood, cement etc) not acted upon by hydrogen sulphide. As soon as the water is delivered to the surface it should be passed over cascades and aerated if necessary and all pipes, tanks, troughs etc. should be coated (if made of metal) or constructed of cement.

The supply should then be used for the stock and its effect noted and samples sent in at intervals of a month for analyses. (These tests could perhaps be made with the existing casing and an ordinary pump etc. but with all surface arrangements as described above. This would of course involve the formation of ferrous sulphide).

If the tests proved that the water retained its quality and was also satisfactory as to quantity &c., then other boreholes could be sunk to tap this supply at other parts of the property.

This water is of good quality at present and is particularly low in sulphates and is well worth the above investigations.

(2) The total solids in No.4 well do not seem to be the main factor in determining the quality of the water, as they are generally similar to those when the water was first tapped. Moreover, the chlorides and sulphates appear to have decreased in quantity. It must be remembered, however, that this may be as stated above due to the time of the year at which the samples are taken.

It would probably be worth while, however, to clean out this well or sink another near it and line it with cement or concrete and take all the precautions in the well as in the bore-hole. Then pump the water and thoroughly cascade it and take all precautions described for the surface installation. This could also be tested by observation of the cattle and periodical analyses as stated above. As a result it might be found possible to obtain a suitable supply in this vicinity.

Mines Department, HOBART
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(Sgd) P.B. NYE
GOVERNMENT GEOLOGIST

ANALYSES OF UNDERGROUND WATERS, WINGAROO

(expressed in parts per million)

CONSTITUENTS	No. 1 Well 28/2/29	20/2/29	5/12/30	No. 2 Well 20/2/29	28/2/29	25/6/30	5/12/30	No. 3 Well 28/2/29	20/2/29
Total Solids	1714	2480	1624.0	1640	885	5714	6058.4	5143	7610
SiO_2			16.0				30.4		
Fe			0.1				0.3		
Al			2.0				2.4		
Ca		107	88.6	57		114	425.9		436
Mg	93	72	53.6	30	5.7	114	192.2	300	72
Na	486	N.D.	404.4	N.D.	327	1914	1345.9	1414	N.D.
Cl	807	900	534.6	800	433	2257	2508.5	2128	3880
SO_4	328	560	271.6	50	119	743	485.6	1300	480
H_2S			Nil				9.82		
CO_3		Nil	171.2	Nil		571	428.8		Nil
HCO_3		280		210					670
Volatile			80.4				642.0		

N.D. = not determined

ANALYSES OF UNDERGROUND WATERS, WINGAROO

(expressed in parts per million)

CONSTITUENTS	No. 4 Well 28/2/29	No. 4 Well 20/2/29	No. 4 Well 25/6/30	No. 4 Well 5/12/30	Near No. 5 Well 25/6/30	No. 5 Well 5/12/30	No. 6 Well 25/6/30
Total Solids	1714	2490	3286	2224.0	2000	2148.0	257
SiO_2				28.0		17.6	
Fe				1.4		0.2	
Al				18.0		1.7	
Ca		271	57	261.6		15.6	
Mg	93	186	143	53.2	57	34.8	
Na	486	N.D.	1014	383.4	387	730.6	94
Cl	807	1000	1986	685.4	514	904.7	86
SO_4	328	900		205.7	328	316.8	
H_2S				2.8		Nil	
CO_3			86	316.4		99.6	49
HCO_3		720					
Volatile				253.2	714	24.4	

N.D. = not determined

ANALYSES OF UNDERGROUND WATERS, WINGAROO

(expressed in parts per million)

CONSTITUENTS	No. 1 Bore Hole 5/12/30				No. 2 Bore Hole 5/12/30
	20 feet	35 feet	48 feet	78 feet	
Total Solids	3900.0	2332.0	2036.0	1796.4	4532.0
SiO_2	92.0	73.6	50.4	34.4	28.0
Fe	2.3	1.7	0.3	8.0	4.2
Al	4.4	1.7	1.8	2.5	83.6
Ca	337.3	283.0	217.2	214.4	270.0
Mg	111.8	67.2	62.0	48.9	108.3
Na	819.0	381.4	386.1	318.8	1090.1
Cl	1521.6	698.8	658.0	598.3	1884.8
SO_4	333.3	292.1	222.4	16.5	246.9
CO_3	353.6	314.0	289.2	346.0	344.8
H_2S	7.02	16.84	8.42	4.21	9.82
Volatile	320.4	216.4	149.6	208.4	395.2