

## Drilling for water at Currie, King Island.

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## Abstract

Drilling and preliminary pump tests have shown that appreciable quantities of groundwater occur in sand dunes west of the race-course and behind British Admiral Beach. The potential of the latter area, from both storage and recharge considerations, is by far the greater of the two sites. The sand at the former site is coarser and has a greater permeability and would require less bores to extract a given quantity of water. Longer term pump tests, pumping from several holes simultaneously, are necessary to study the performance of the aquifers under these conditions and also to determine whether they will supply the required amount of water. The quality of the water west of the race-course is poorer than the present supply but may improve as pumping proceeds. The water behind British Admiral Beach is of better quality than the town supply. Water from all three locations is hard and is above the recommended hardness limit for a town supply. In the absence of a better supply, the hardness values of all three are within the limits which can be used.

The King Island Municipal Council requires additional water to supplement the town supply at Currie [BR310755]. The present supply is obtained from south of the town but is subject to severe water restrictions during dry months to limit water use. The installation of water meters has apparently had some effect on the overall water demand.

Drilling and subsequent pump tests by a private contractor some years ago established a possible additional supply near Camp Creek, but the water has an iron content that is too high for domestic use and which cannot be removed by aeration. The estimated cost of a treatment plant is about \$100 000 and the Council requested investigation of other possible underground water sources.

Surface surveys previously undertaken by the Department of Mines have indicated areas which showed some potential and two of these have been further investigated. The consultant engineer to the Council suggested that only areas within 4 km of Currie should be considered; both the areas examined are within this distance from the town. These two areas appear to be the nearest to Currie which have the potential to contribute fairly large additional amounts to the present supply using the present method of extraction of water (spear bores). Other areas may exist around the town where smaller additions may be obtainable.

This report is a compilation of data collected by geologist D.J. Sloane, technical officers B. Cox and D. Wyatt of the Department of Mines and N. Towns of the King Island Council.

## GENERAL GEOLOGY

The area around Currie is underlain mainly by stabilised sand dunes. These are of at least two ages, the older being quartz-rich and the younger, carbonate-rich (shell fragments). The basement rock is Precambrian granite intruded into siltstone, which is quite strongly baked. Several amphibolite dykes intrude the Precambrian rocks. The basement rocks are exposed along the shoreline and occasionally at inland locations along valleys (e.g. in Camp Creek) and in low lying areas (e.g. just south of the present water area). The surface of the basement rocks under the sand dunes is probably

irregular. A marine terrace, about 3 m above sea level and underlain by gravel, can be observed at various points along the coast. Jennings (1959) dated the gravel deposits as younger than the new dunes. Rounded gravel fragments were found in some of the drill holes under the dunes and these may represent an older marine terrace deposit or stream deposits.

#### SELECTION OF AREAS TO INVESTIGATE

The simplest method of extracting water from sand is that used in the present water reserve area. Here the water table is at shallow depth and can be pumped by suction from the surface.

The major criteria used in selecting areas for investigation are the occurrence of a considerable width of sand dunes and some low lying country where the water table is close to the surface. These low lying areas should be surrounded by a fairly thick layer of saturated sand. The bedrock shall almost certainly rise, in general, in an inland direction, although there are probably undulations within this surface. This slope, together with the surface seaward slope on the dunes, causes the groundwater to flow towards the shore. It is the aim in installing bores to intercept this water before it flows into the ocean. It is unlikely that a system could be designed to intercept all the water from any area, before it reaches the sea.

It was known from previous surveys that an area west of the race-course and an area behind British Admiral Beach had possibilities of supplying considerable quantities of water. An inspection along the beach in both areas indicates large seepages as free-running streams. At British Admiral Beach, in areas where there are no streams, the sand at the back of the beach is damp from seepage water.

Other areas around Currie could possibly be considered for investigation. The sand dunes north of Currie Harbour are about one kilometre wide, but there is a possibility of contamination of the water from the tip, as was the case with the water from bores near Camp Creek. Locating an area with fairly thick saturated sand with the water table close to the surface may be difficult. Another area where some water may be obtainable is on the golf course. Some water seeping through this area bypasses the water reserve area and enters the sea. The quantity of such water would require investigation. The potential of this latter area seems less than the area west of the race-course and certainly much less, in terms of likely volume stored, than the area behind British Admiral Beach.

In areas where the saturated sand extends to more than about 7 m below the surface, the possibility of burying the pumping system should be examined. With larger sections of saturated sand against the bore hole within suction depth of a pump, larger flow rates can be expected. The bores, suction lines and pump could be installed in trenches to within about one metre of the water table.

#### DRILLING

Each area was drilled with an auger drill to establish the depth of saturated sand, the depth of the water table and to collect a sample of water to test the salinity. The depth limit of the drill was about 10 m and in a number of holes, basement rock had not been struck at the final depth. In other cases, the probable basement had been struck at shallower depth. Gravel beds were occasionally struck which prevented further drilling. The results of the drilling investigations are given in Appendix 1. The approximate location of each hole is shown on Figure 1.

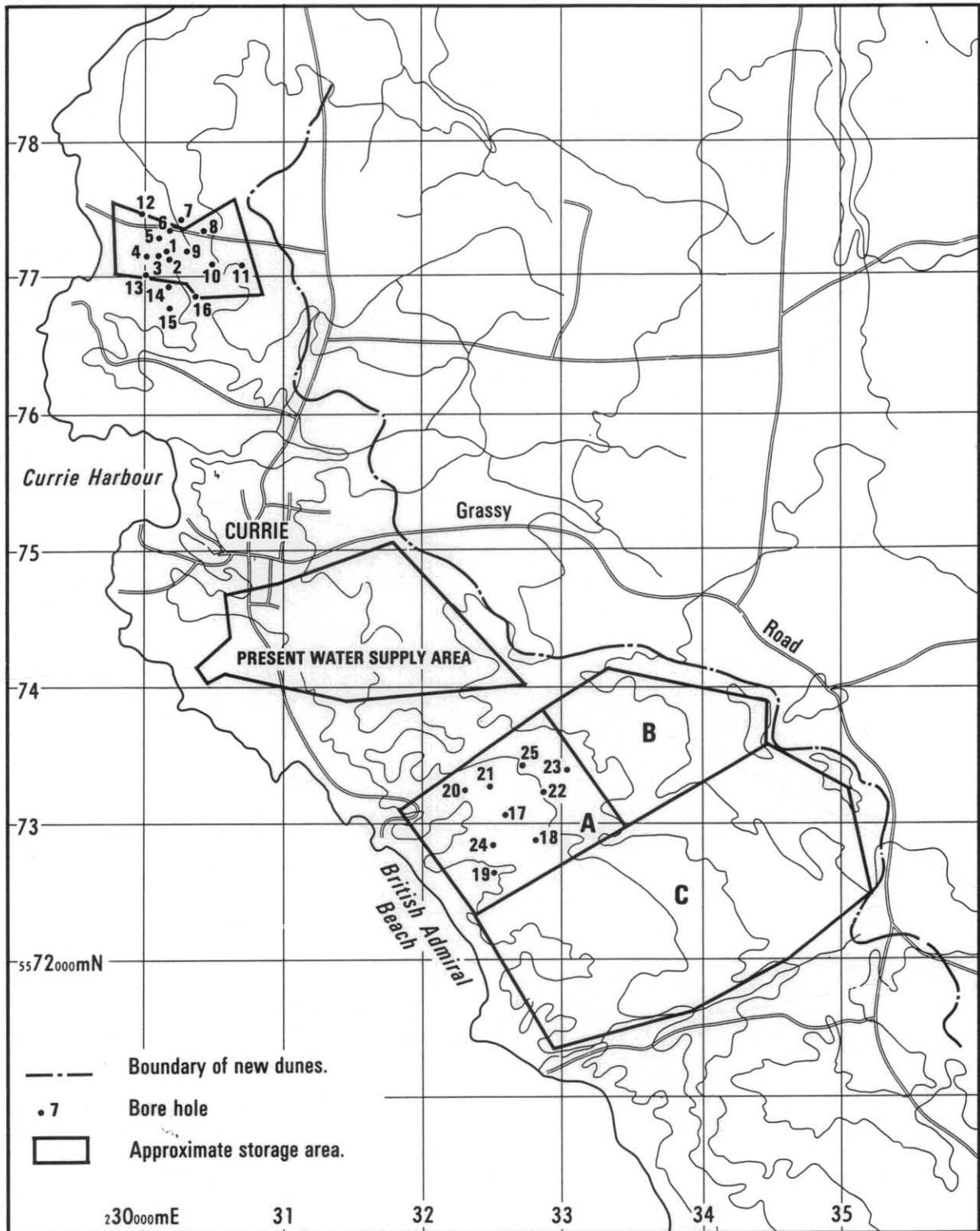


Figure 1. Location of areas under investigation.

5 cm

### Northern area

Sixteen holes were drilled in this area. The area outlined on Figure 1 shows the extent of sand dune country likely to supply water to any bores developed. Development of a battery of spears near Hole 12 may draw water from north of the area examined. Holes 7, 14 and 15 struck clay at fairly shallow depth which may limit the potential of the area. In Hole 13, the thickness of saturated sand is fairly small and the flow rate into the cased hole was low. Hole 9, in the middle of the area, had only one metre of saturated sand indicating a high in the basement at this point.

Three of the above bores (1, 4 and 13) were cased so that they could be pumped. Hole 1 had 3.6 m of stainless steel screen installed to a depth of 4.8 m, while the others were cased with slotted PVC pipe, the slots being cut with a hacksaw. A further hole (1A) was drilled about 6 m away from Hole 1 and this was used as an observation hole during a short pump test. The drawdown information on this hole is plotted on Figure 2. A feature of this plot is the rise in the water level between 5 minutes and 15 minutes after pumping started, after which there is a gradual decline in the water level as expected. A transmissivity value calculated on this last section of the graph gives a value of  $205 \text{ m}^2/\text{day}$ , a fairly high figure for sand dunes and one which may reduce with longer pumping.

Holes 4 and 13 were pumped for a short period; the results are given in Appendix 1. Hole 4 gave a good output but Hole 13 was rather poor, considering the coarse sand that occurred in the hole. Holes 2, 3, 5, 6 and 12 contained thick sections of saturated sand and, if cased, would almost certainly deliver similar quantities of water to Holes 1 and 4. Holes 10 and 11 were at higher levels with a deeper water table. Neither struck basement and were still in saturated sand at the final depth. Hole 5 ended in rounded gravel fragments.

A more extensive pump test of the area is necessary and as a first stage of this investigation, four further holes were installed around Hole 1A. The layout of the holes and the hydrological information is shown on Figure 3. These additional holes were cased with slotted PVC pipe surrounded by a gravel envelope. All of the holes delivered water at a rate of about 45 l/min or more over short pumping periods, with at least two holes (3 and 4) requiring less than half the possible drawdown, the water level being more than 2 m above the base of the holes. Over a long pump test of 4-7 days, it is likely that these four bores together could be pumped safely at at least 150 l/min without drawing down to the base of the holes. The central hole could be used as an observation hole to record water levels.

### Southern area

Nine investigation holes were drilled in this area to examine the groundwater potential. A large part of most of the bore holes was drilled in dominantly quartz sand of the old dune system. Hole 17 ended in possible bedrock, Holes 18, 19 and 21 in gravelly sand, Hole 20 in possible weathered granite and the remainder in quartz sand. The proven thickness of saturated sand in these holes varied from 3.6-7 m, with most in the 5-6 m range. A thin clayey zone was struck in many of these holes. This usually occurred at 2-4 m from the surface and probably represents an old soil horizon which has been covered by later dunes. Alternatively, it could represent part of the present soil profile.

Three holes (17, 19 and 20) were cased for pump testing with 3.6 m of metal screen. The results of these pump tests are given in Appendix 1. In the case of Hole 17, an observation hole was drilled 6.9 m away and

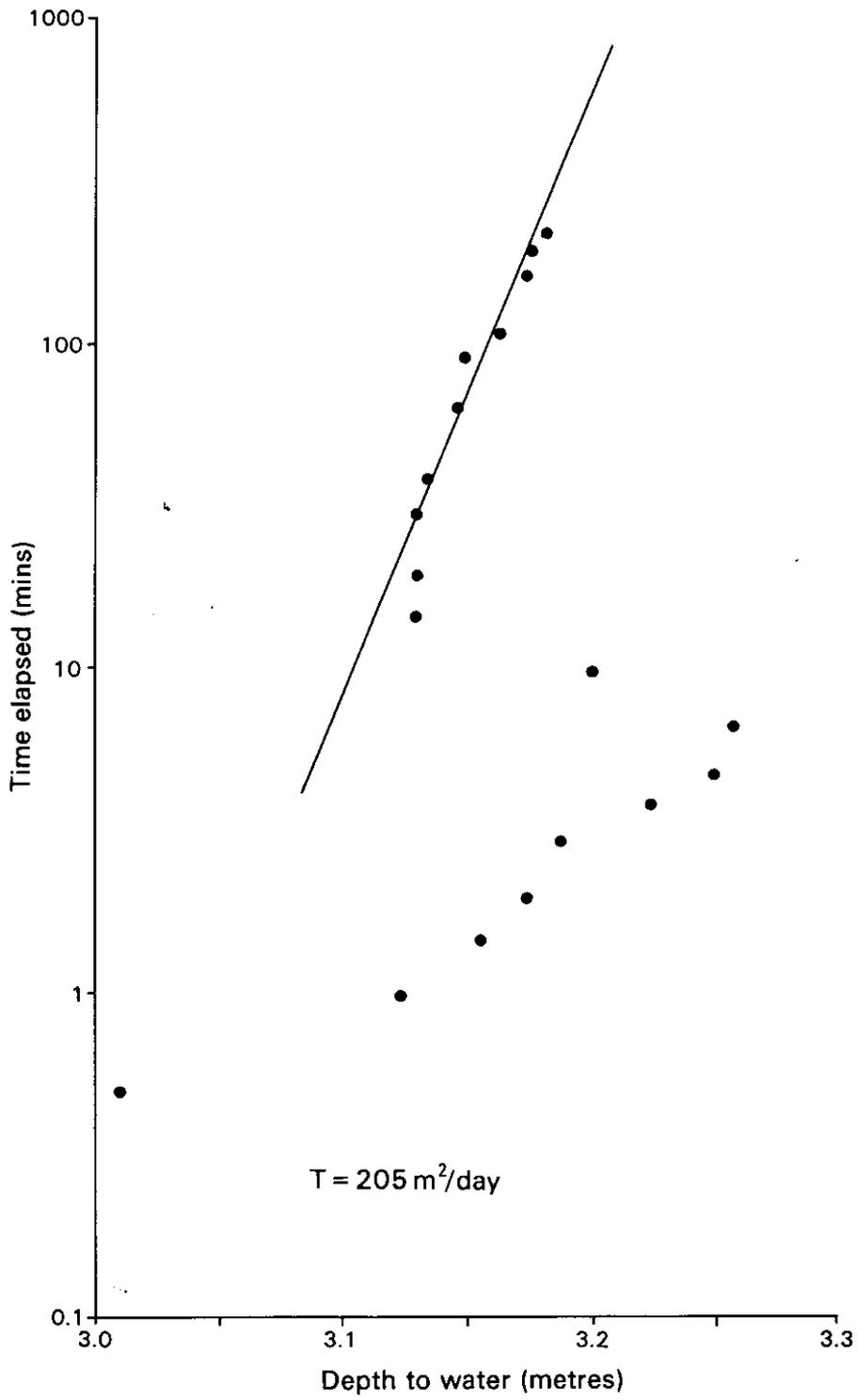
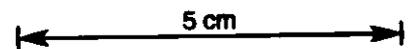


Figure 2. Pump test, Hole 1, northern area.



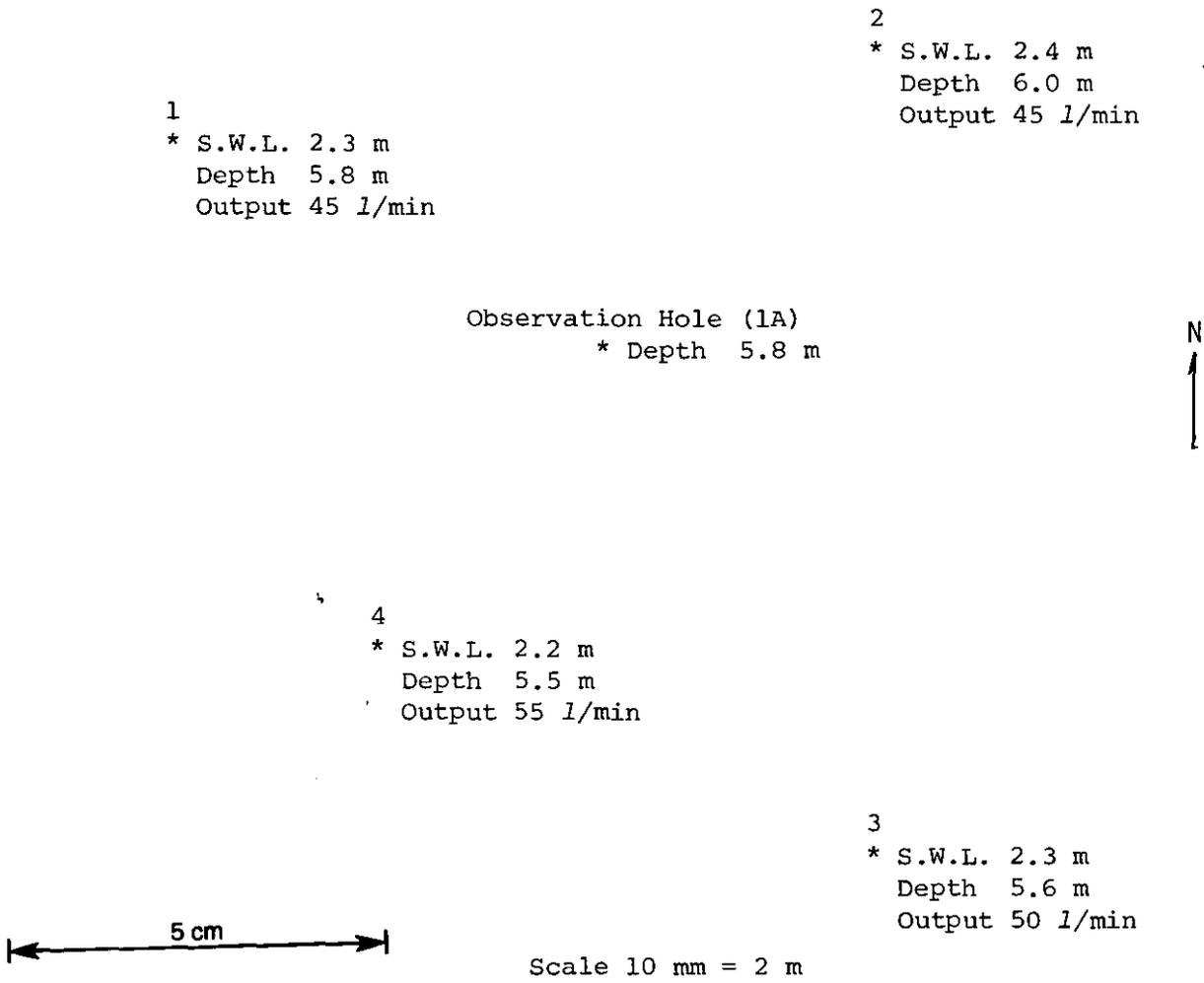
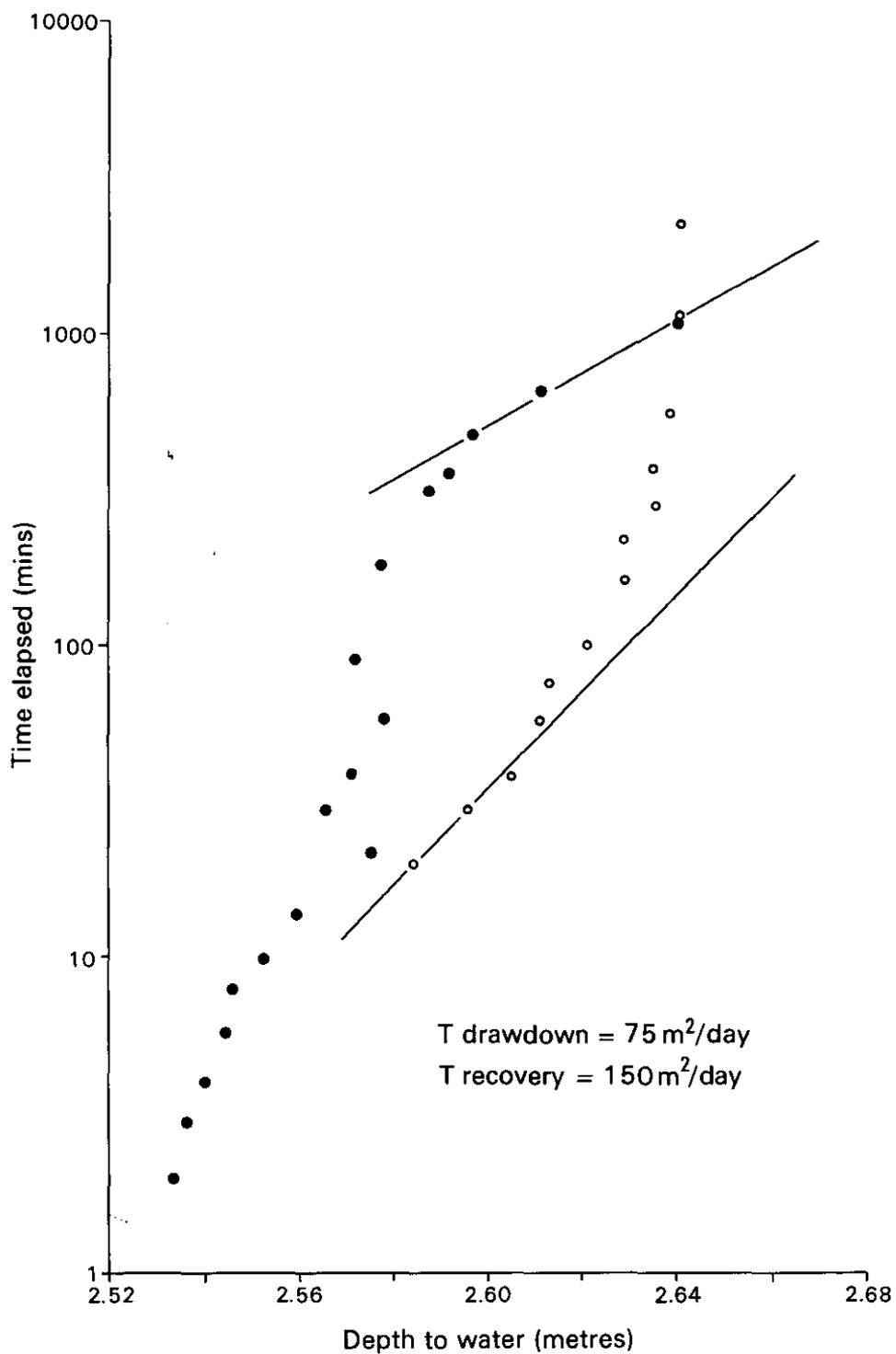


Figure 3. Closely spaced holes, northern area.

Hole 17 was pumped for over nine hours, with the recovery recorded for one hour after pumping ceased. Transmissivity figures are given on the drawdown/time plot (fig. 4). The value for the drawdown plot and the recovery plot should be approximately equal, but the recovery was recorded over a much shorter period and this is probably the reason for the higher value.

The water table was closest to the surface in Hole 17 and this area was selected for a more intense investigation. From information obtained from the drilling of other investigation holes in this region, it appeared that some of holes may offer more potential as water suppliers than Hole 17. For example in Hole 24, a promising zone occurs below about 6 m from the surface, but a surface suction pump could not drawdown very far into this zone.

Six closely spaced holes were installed around the observation hole drilled near Hole 17 (fig. 5). Slotted 50 mm diameter PVC pipe surrounded by a layer of gravel was installed in each hole. A range of outputs from 15 l/min to 38 l/min was obtained from short pump tests on these holes. This variation in output from hole to hole may be due to variations in permeability of the sand near the hole, or it may be that the bore construction is not entirely suitable for this sand, which is finer than that in the northern area. However the output of Hole 2 of the closely spaced bores compared favourably with Hole 17, which had 3.6 m of screen installed. Each bore had a thin layer of clayey sand which was quite often at different



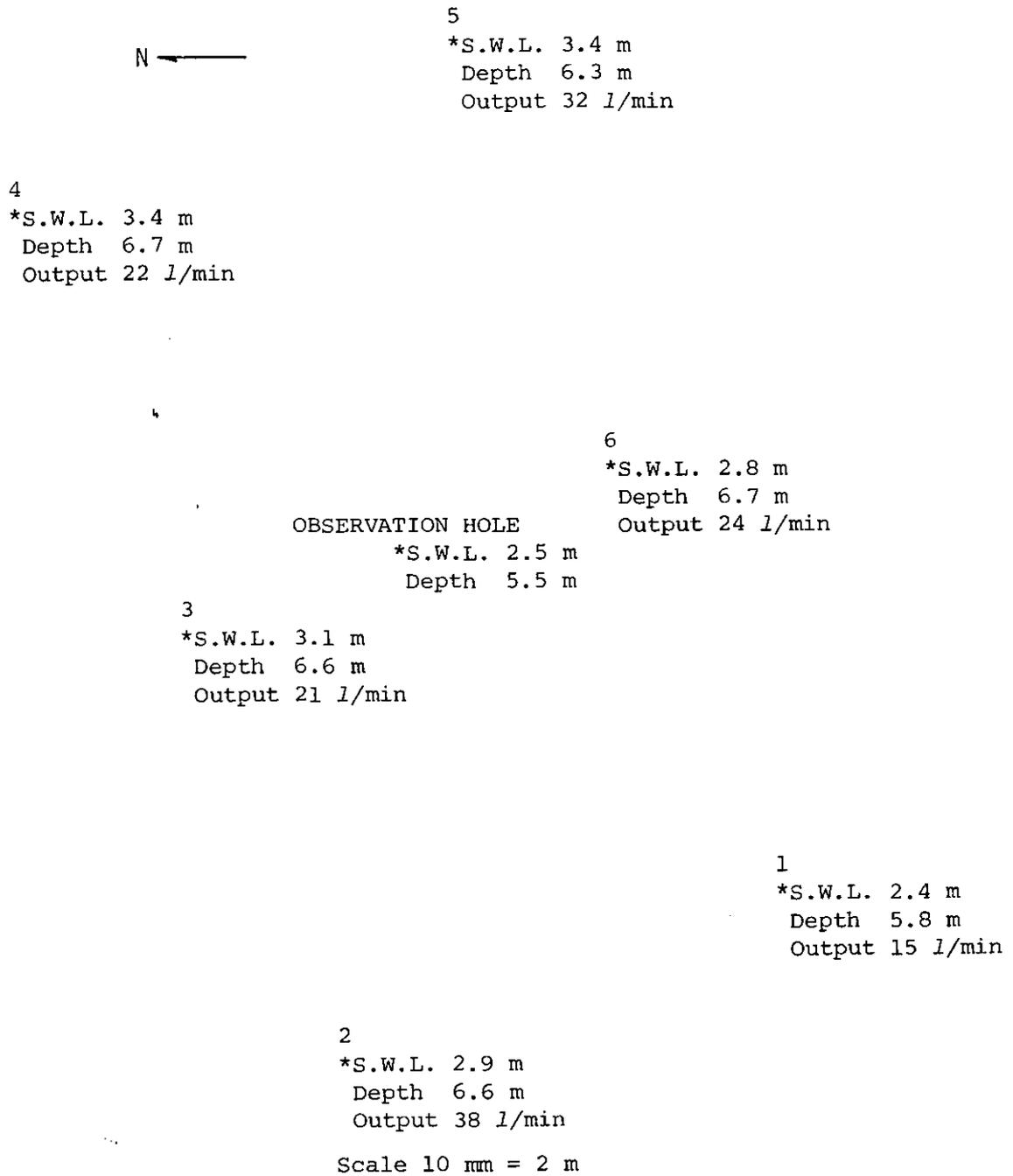


Figure 5. Closely spaced holes, southern area.

Table 1. CALCULATED AND OBSERVED SALINITY VALUES

Hole	TDS (ppm) from chemical analysis	TDS (ppm) from meter reading	Meter reading multiplied by 1.643	Meter reading multiplied by 1.932
2		330		640
3		370		720
4	850	520	850	
5		380		730
6		470		910
7		390		750
8		390		750
9		250		480
11		350		680
13	530	330	540	
14		400		770
17	410	240	390	
18		250		480
19	420	260	430	
20	490	320	530	
21		250		480
22		230		440
23		230		440
24		250		480
25		210		410

levels, suggesting a sloping surface. This could influence the output of the bores. In spite of the variation in pumping rates, the six bores pumped together could probably deliver up to about 115 l/min over a long pump test of 4-7 days. Such a pump test would be useful in assessing the potential of the area.

#### WATER QUALITY

Water samples obtained during drilling were tested with a salinity meter which gives an indication of the total dissolved solids content. The instrument is calibrated to measure water with chloride as the dominant anion. As the water around Currie is bicarbonate dominant, the values obtained are quite distant from the values obtained on samples when chemically analysed. However it should be possible to use the figures to indicate relative amounts of total dissolved solids. There is also a difference in the meter value when the water is clear from when it contains sand and silt. From many of the holes, turbid water from the bottom of the uncased hole was tested, whereas clear water was tested when the bores were cased and pumped. In only one case (Hole 4) was both the turbid water and clear water tested and these readings were 440 and 520 ppm respectively. This water was also chemically analysed and gave a value of 850 ppm for TDS.

The water from the six pumped holes was chemically analysed as well as tested with the salinity meter. If a conversion factor (1.643) is calculated for Hole 1A from the figures of 560 ppm for the meter reading as against 920 ppm for the chemical analysis, a value for TDS can be calculated from meter readings for the water from the remaining five holes. The calculated and observed values are given in Table 1.

It can be seen that by use of this factor, the meter readings can be converted to near the chemical analysis values. If a similar factor (1.932) is calculated from a meter reading from turbid water from Hole 4 (440 ppm)

with a chemical analysis of 850 ppm, the remaining holes could be converted in a similar way.

These calculated values for TDS are probably less accurate than those for the clear water samples because of variation of the amount of sediment in the sample tested. However, they are probably fairly near the true TDS value.

Results of six chemical analyses are given in Table 2. The main features of these is the relatively high TDS for the northern holes (especially Holes 1 and 4), the variation in TDS of the northern holes, the much lower TDS for the southern holes and the relatively high hardness of the water from all holes. The higher chloride content of the water from the northern holes may be due to greater amounts of sea spray falling on the area. The recommended limit for hardness for a town supply is 100 ppm (Hart, 1974), but where no other water supply is available, up to 500 ppm can be tolerated. The present water supply has more than the recommended limit.

The total dissolved solids content of Holes 1A and 4 is greater than the present town supply. This is probably partly due to the slow movement of water through the sand. Pumping the water over a long period will speed up the flow and its replacement by rainwater and probably cause a drop in TDS. This has occurred with the present town supply. In 1952, the TDS for the town supply was 761 ppm, in 1964 it was 658 ppm (Matthews, 1966) and the latest known figure is 580 ppm (Mrs Haynes, pers. comm.). The extent of the decrease that might be expected is not known, but it is apparent from the converted meter readings that Holes 1A and 4 are two of the highest values in the northern area and pumping will draw the less saline water from the other areas towards the pumped area. The water at present is suitable for garden use, particularly on the sandy soils that occur around Currie and for cold water domestic supplies. Its use in hot water services can be expected to cause serious encrustation on elements as can be expected from the present water supply.

The quality of the water from behind British Admiral Beach is better than the present water supply.

Table 2. ANALYSIS OF WATER SAMPLES

Item	Hole 1A	4	13	17	19	20
pH	7.3	7.6	7.9	7.7	8.0	7.8
Conductivity $\mu$ S/cm	1460	1320	910	640	630	760
	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
CO <sub>3</sub>	nil	nil	nil	nil	nil	nil
HCO <sub>3</sub>	380	360	290	280	280	280
Cl	330	280	160	83	85	120
SO <sub>4</sub>	39	36	27	12	12	20
SiO <sub>2</sub>	5	5	5	<5	<5	5
Ca	130	120	94	90	85	90
Mg	33	29	21	12	13	16
Fe	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Al	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
K <sub>2</sub>	8.9	6.5	7.2	2.8	3.1	4.7
Na	190	160	91	48	48	70
Total dissolved solids	920	850	530	410	420	490
Permanent hardness	150	130	81	44	36	61
Temporary hardness	310	290	240	230	230	230
Alkalinity as CaCO <sub>3</sub>	310	290	240	230	230	230

### AQUIFER GRAIN SIZE RANGE

Samples of the water-bearing material of ten of the holes set up for pumping were collected and sized. The results of these sieve analyses are given in Table 3 and Figures 6 and 7. Each of the pumped investigation holes were sampled (three from each area) and samples from two of each of the closely spaced sets of holes were analysed.

From Figures 6 and 7 it can be seen that the 'average size' of the sand from the northern area is larger than that from the southern area. These sands are largely representative of the younger and older dune systems. The effective size is also a little larger for the northern area. The particles have a high degree of sorting (low uniformity coefficients) as can be expected from sand dune material.

For screened bores without a gravel pack, the slot size should be selected to retain about 40-50% of the aquifer, *i.e.* for the southern area the screen slot opening should be about 200  $\mu$ m and for the northern area the opening should be about 250-450  $\mu$ m depending on whether 40% or 50% is retained. A figure that should be reasonably safe would be 350  $\mu$ m.

A gravel pack around the outside of the screen or slotted casing allows a larger slot opening to be used in the screens. The material used in this gravel pack material in the closely spaced bores has been sized (fig. 6). The gravel pack material is about the correct size range for the northern area, but it is a little coarse for the sand from the southern area. A more suitable gravel pack designed for the northern sand is shown on Figure 6. This could be produced by removal of some of the finer material from the gravel used in the bores. In general, the gravel pack should be about five times the size of the aquifer material over the main part of the size range. The screen or slotted casing should retain about 90% of the gravel pack material. In the bores installed, the slots in the PVC casing were cut with a hacksaw which produces a slot 1-1.2 mm wide. This is about the correct size for the suggested gravel pack design and is close to the size required for the gravel actually used.

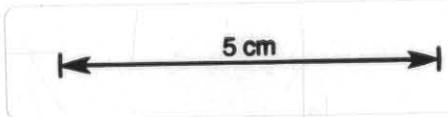
It was found that slotted pipe against the aquifer in both areas did not allow much sediment to enter the bores after the first 5 minutes of pumping and after about 10 minutes, there was virtually no sediment entering the bores. The individual sand grains are much smaller than the slot openings, so groups of sand grains must wedge across the openings. There is therefore some flexibility in the slot sizes that can be used. The size relationships mentioned in the previous paragraph are those that should be aimed at in production bores. Disturbance of the casing would probably disrupt bridged grains and cause sediment to enter the hole and cause wear on the pump. For testing purposes, the well designs used are suitable, although screens with a larger open area may increase the flow rate for the southern area. The design for the northern area is probably suitable for production bores.

### VOLUME OF WATER IN STORAGE

With some assumptions, it is possible to make estimates of the quantity of water that is stored within the areas investigated and the likely recharge from rainfall. To make a calculation of the amount of water stored requires an estimate of the porosity of the sand *i.e.* the percentage of void space per unit volume of aquifer material. The porosity of the sand samples used for the sizing analysis has been measured. These values can only be regarded as approximate because porosity varies according to the packing arrangements and laboratory measurements may not be the same as the field

Table 3. SIZING ANALYSIS OF SAMPLES FROM BORES

Size mm	Hole 1			Hole 4			Hole 13		
	mass	%	Cum.%	mass	%	Cum.%	mass	%	Cum.%
1.003	3.5	2.0	2.0	5.6	1.7	1.7	12.56	4.6	4.6
.853	2.33	1.3	3.3	5.96	2.5	4.2	9.48	3.4	8.0
.710	3.45	2.0	5.3	14.0	4.3	8.5	19.07	6.9	14.9
.500	16.85	9.6	14.9	51.12	15.8	24.3	54.76	19.9	34.8
.251	84.55	48.1	63.0	164.62	51.0	75.3	123.01	44.7	79.5
.125	60.62	34.5	97.5	73.75	22.9	98.2	51.29	18.6	98.1
.063	3.19	1.8	99.3	4.11	1.3	99.5	3.62	1.3	99.4
.045	0.82	0.5	99.8	0.94	0.3	99.8	0.98	0.4	99.8
<.045	0.59	0.3	100.1	0.52	0.2	100.0	0.62	0.2	100.0
	Hole 1 North Set			Hole 3 North Set			Hole 17 South area		
1.003	0.75	0.7	0.7	1.55	0.9	0.9	3.03	1.6	1.6
.853	0.8	0.7	1.4	2.04	1.1	2.0	3.09	1.7	3.3
.710	2.41	2.1	3.5	4.43	2.5	4.5	5.05	2.7	6.0
.500	11.82	10.2	13.7	21.54	12.0	16.5	16.26	8.8	14.8
.251	57.34	49.4	63.1	91.31	50.8	67.3	26.68	14.5	29.3
.125	41.83	36.0	99.1	56.59	31.5	98.8	125.58	68.2	97.5
.063	1.18	1.0	100.1	2.06	1.2	100.0	3.85	2.1	99.6
.045				0.22	0.1	100.1	0.31	0.2	99.8
<.045							0.28	0.2	100.0
	Hole 19 South area			Hole 20 South area			Hole 1 South Set		
1.003	2.66	1.5	1.5	0.45	0.4	0.4	0.98	0.3	0.3
.853	1.87	1.0	2.5	0.47	0.4	0.8	1.3	0.5	0.8
.710	2.46	1.4	3.9	0.72	0.6	1.4	1.26	0.4	1.2
.500	8.3	4.6	8.5	3.76	3.3	4.7	3.01	1.0	2.2
.251	30.87	16.9	25.4	26.85	23.4	28.1	7.99	2.7	4.9
.125	125.8	0.9	94.4	74.61	65.1	93.2	267.05	91.6	96.5
.063	6.86	3.8	98.2	5.86	5.1	98.3	7.94	2.7	99.2
.045	1.37	0.8	99.0	0.96	0.8	99.1	0.88	0.3	99.5
<.045	2.1	1.2	100.2	0.98	0.9	100.0	1.19	0.4	99.9
	Hole 2 South Set			Gravel pack material					
3.350				44.92	9.7	9.7			
2.000				62.57	13.5	23.2			
1.003	0.84	0.5	0.5	249.63	53.7	76.9			
.853	2.25	1.3	1.8	30.9	6.5	83.4			
.710	3.18	1.9	3.7	26.22	5.6	89.0			
.500	7.86	4.6	8.3	20.21	4.4	93.4			
.251	23.62	13.8	22.1	27.21	5.9	99.3			
.125	128.43	74.1	96.2	3.66	0.8	100.1			
.063	3.70	2.2	98.4	0.56	0.1	100.2			
.045	1.14	0.7	99.1						
<.045	1.59	0.9	100.0						



REFERENCE No.	LAB. SERIAL No.	LOCALITY					SEDIMENT ANALYSIS PARAMETERS							
1978/10		CURRIE, KING ISLAND (Northern Area)					M =	V =	Sk =	K =				
COARSE AGGREGATE			FINE AGGREGATE							A77-1957 (concrete)				
COARSE		AGGREGATE		FINE AGGREGATE			BINDER		N.A.A.S.R.A. (road materials)					
COBBLE		PEBBLE		GRANULE	S A N D					SILT				
					V. COARSE	COARSE	MEDIUM	FINE	V. FINE					
-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	ø	
75	53	37.5	26.5	19	9.5	4.75	2.36	1.18	0.6	0.3	0.15	0.075	0.038	Aust. Stand. Sieve

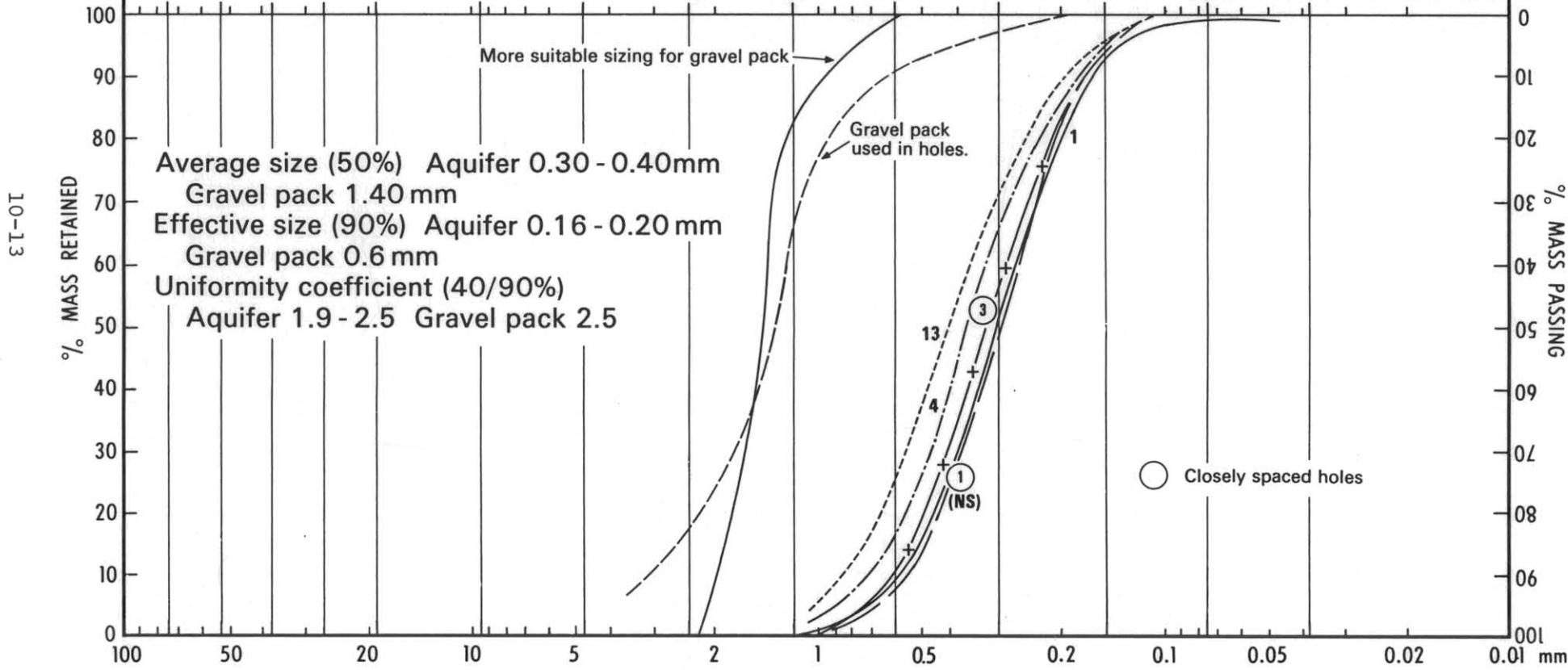
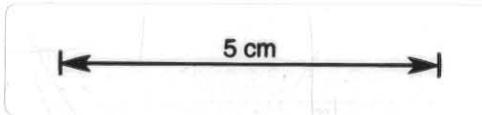


Figure 6. Particle size distribution, northern area.

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REFERENCE No.	LAB. SERIAL No.	LOCALITY					SEDIMENT ANALYSIS PARAMETERS							
<b>1978/10</b>		<b>CURRIE, KING ISLAND (Southern Area)</b>					M =	V =	Sk =	K =				
COARSE AGGREGATE			FINE AGGREGATE				A77-1957 (concrete)							
COARSE		AGGREGATE		FINE AGGREGATE		BINDER		N.A.A.S.R.A. (road materials)						
COBBLE	PEBBLE		GRANULE	S A N D			SILT							
				V. COARSE	COARSE	MEDIUM	FINE	V. FINE						
-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6 $\phi$		
75	53	37.5	26.5	19	9.5	4.75	2.36	1.18	0.6	0.3	0.15	0.075	0.038	Aust. Stand. Sieve

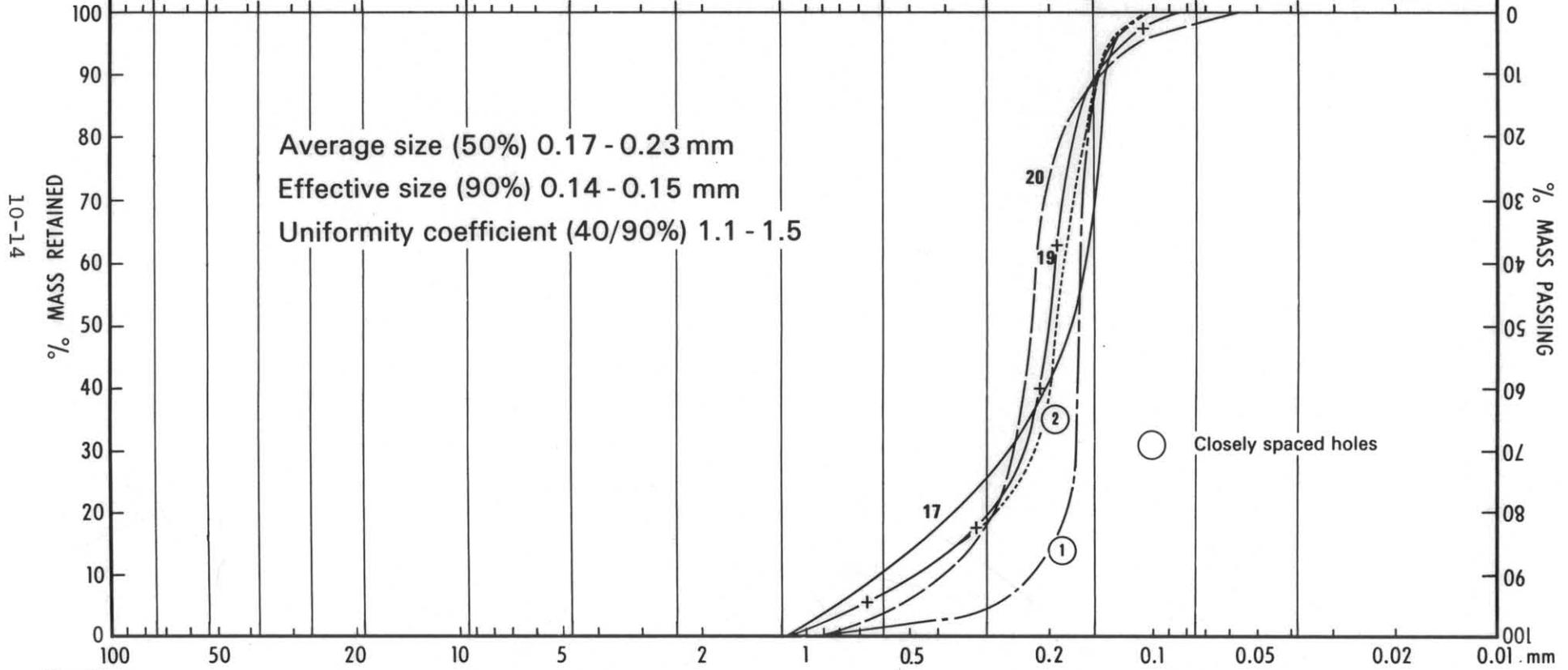


Figure 7. Particle size distribution, southern area.

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values. The values obtained are within the range of values quoted in the literature.

Table 4. POROSITY OF SAND SAMPLES

NORTH AREA		SOUTH AREA	
Hole No.	Porosity (%)	Hole No.	Porosity (%)
1	35	17	39.6
4	37.4	19	42.4
13	36.4	20	41.5
1 North set	38.7	1 South set	42.0
3 North set	39.4	2 South set	47.3
Average porosity	37.4	Average porosity	42.6

In saturated sand, these values approximate the percentages of water per unit volume of the aquifer material. It is not possible to extract all of this water through gravity drainage and the amount retained between grains and coating grains is the specific retention. The specific yield is the quantity that can be extracted. In general, about two-thirds of the stored water can be extracted and about one-third is retained.

#### Northern area

Taking the area outlined on Figure 1 and the drilling information which indicates that there is likely to be 3-4 m of saturated sand over the whole area, and a value of 23% for the volume of water per unit volume of aquifer (specific yield) that can be extracted from the sands, the volume of extractable water amounts to 437 000 or 328 000 m<sup>3</sup> (96,000,000 or 72,000,000 gallons), depending on whether the larger or smaller saturated thickness is used.

The average rainfall for Currie is about 900 mm/year (36 inches) and figures from the literature suggest 30-50% of this reaches the water table in sand dune areas. Over this area the annual recharge of water to the water table would be 130 000-217 000 m<sup>3</sup> (28-48 million gallons) using these values.

#### Southern area

Similar calculations can be made for the southern area. Drilling information was obtained from within area A. Using this and assuming a specific yield of 25% and a saturated thickness of sand of 5 m over the whole area the extractable water would amount to about 1 550 000 m<sup>3</sup> (340 million gallons). Areas B and C, although not investigated are unlikely to have significantly different conditions and extractable quantities of water for these areas amount to 1 300 000 m<sup>3</sup> and 4 000 000 m<sup>3</sup> (296 and 900 million gallons) respectively. The average figure for saturated sand thickness may be larger than 5 m which would result in greater storage values.

Using similar information for rainfall the recharge can be calculated as:

	50% recharge		30% recharge	
Area A	567 000 m <sup>3</sup>	(125 million gallons)	340 000 m <sup>3</sup>	(75 million gallons)
Area B	490 000 m <sup>3</sup>	(108 million gallons)	295 000 m <sup>3</sup>	(65 million gallons)
Area C	1 500 000 m <sup>3</sup>	(329 million gallons)	900 000 m <sup>3</sup>	(200 million gallons)

It can be seen from these figures that the potential of the southern area is large, although the finer sand reduces the rate at which the water can be extracted and a greater number of bores would be required for a given quantity of water than in the northern area.

#### CONCLUSIONS AND RECOMMENDATIONS

The investigations have shown that appreciable areas of fairly thick saturated sand exist in the areas examined north and south of Currie. The southern area has the potential to supply greater amounts of water than the northern area but the rate at which it can be extracted per bore is less because of the finer grain size of the aquifer.

There may be other areas where some water may be obtainable. Sand dunes north of Currie Harbour probably contain considerable amounts of water, but possible pollution from the garbage disposal area may be a difficulty and a suitable area to extract the water may be hard to find. There is probably some water underlying the golf course but the amount cannot be estimated without investigation. It is unlikely that it contains as much water as the areas already investigated.

Water quality in the southern area is much better than that in the northern area and also better than the present water supply. The water in all locations is harder than is recommended for a town supply, but in the absence of a better supply, all of the supplies could be used.

The method of installation of the bores with gravel packing around slotted casing is a successful method of testing and probably production for the northern coarser sand area. It is probably a successful method for test bores and may be suitable for production bores in the southern finer sand areas. It is likely that greater flows would be obtained with the use of stainless steel screens in the latter area but the cost of installation would be much higher.

The closely spaced sets of bores should be pump tested for a period of four to seven days with water levels being recorded in at least one observation hole. A close watch should be kept on the flow rate so that any variation is recorded. The pumping rate should be kept as constant as possible. It is likely that the northern set would deliver about 150 l/min (2000 gallons per hour) and the southern set about 115 l/min (1500 gallons per hour) over a long pump test. Recovery in the observation hole should be recorded for at least one day after pumping ceases. A sample of water should be collected for chemical analysis at the beginning and end of the test to determine whether any variation in composition takes place over the pumping period.

If these pump tests prove successful, the procedure should be to set up a system which will deliver about the quantity of water that is required and a long pump test performed on this system (7-12 days). If these tests prove successful, construction of the scheme could commence with reasonable safety subject to water quality checks.

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## APPENDIX 1

## Logs of bore holes at Currie, King Island

## NORTHERN AREA

## Hole 1

Depth (m)	Description
0-0.5	Dark brown soil.
0.5-5.5(?)	Yellow medium size sand, mainly shell fragments.
5.5(?) - 7.2	Light brown-grey shelly sand.
7.2-7.3	Clayey micaceous grit with definite granite fragments.
	3.6 m of screen was installed to a depth of 4.8 m with the remainder of the hole cased with 50 mm diameter PVC pipe. The standing water level was 1.8 m below the surface. It was pumped at 45 l/min for about 3½ hours. A salinity meter indicated about 480 ppm total dissolved solids.

## Hole 1A

This hole was drilled near Hole 1 to 6.4 m with gritty micaceous clay struck at this depth. 5.8 m of slotted PVC casing was installed and the hole was pumped at 45 l/min for about 3 hours. Salinity 560 ppm with a salinity meter.

## Hole 2

0-0.9	Brown soil and shelly sand.
0.9-6.6(?)	Fawn coloured shelly sand.
6.6(?) - 6.9(?)	Light grey shelly sand.
6.9(?) - 8.2	Green gritty clay-weathered granite?
	The water level was about 3.1 m below the surface. Salinity 330 ppm.

## Hole 3

0-0.9	Brown soil and fawn sand.
0.9-7.3(?)	Fawn sand, medium grain size, mainly shell fragments.
7.3(?) - 8.7(?)	Light grey-yellow sand.
8.7(?) - 9.2	Green gritty clay-weathered granite?
	Water level on completion 3.3 m. 370 ppm TDS.

## Hole 4

0-0.9	Dark brown humus-rich soil.
0.9-2.7	Yellow medium-grained sand.
2.7-6.4	Yellow-grey changing to greyish sand.
6.4-7.6	Grey sand.
7.6-7.9	Green gritty clay-weathered basalt?
	Slotted 50 mm PVC pipe was installed and the hole was pumped for about 1½ hours at 45 l/min with a drawdown to about 0.5 m from the bottom of the hole. 520 ppm TDS. 440 ppm before hole set up for pumping. Water level 2.7 m below surface.

## Hole 5

0-0.9	Dark brown soil and fawn shelly sand.
0.9-1.8	Fawn sand-shelly and dry.
1.8-6.4(?)	Damp fawn shelly sand.
6.4(?) - 7.8(?)	Grey sand, a little clay.

## Hole 5 (continued)

<i>Depth (m)</i>	<i>Description</i>
7.8(?) - 8.2	Some carbonaceous clay and gravel bed with rounded quartz and baked siltstone, matrix micaceous and gritty. Water level on completion 2.3 m, 380 ppm TDS.

## Hole 6

0-0.9	Brown soil and cream-yellow sand.
0.9-6.4(?)	Yellow sand, shelly, turning greyish.
6.4(?) - 7.9(?)	Greyish shelly sand.
7.9(?) - 8.2	Greenish gritty clay-weathered granite?
	Water level on completion 3.4 m, 470 ppm TDS.

## Hole 7

0-0.9	Dark brown soil and cream coloured sand.
0.9-2.7	Cream sand.
2.7-3.7	Brown-grey sand.
3.7-4.6	Blue-grey gritty clay with carbonate nodules up to 25 mm across.
	Water level one metre, 390 ppm TDS.

## Hole 8

0-0.9	Dark brown soil and light brown shelly sand.
0.9-5.5(?)	Fawn shelly sand.
5.5(?) - 6.4(?)	Grey sand.
6.4(?) - 8.5	Green gritty clay fairly soft-weathered granite.
	Water level one metre below surface, 390 ppm TDS.

## Hole 9

0-0.9	Brown soil.
0.9-4.6	Cream-yellow shelly sand.
4.6-5.5	Grey-brown sand.
5.5-6.4	Green gritty clay-granite derived material?
	Water level 4.6 m below surface, 250 ppm TDS.

## Hole 10

0-0.9	Brown soil and cream coloured sand.
0.9-2.7	Cream-yellow sand, shelly.
2.7-5.5	Reddish clayey sand.
5.5-8.2	Yellowish-brown sand, some shell and large amount of rounded quartz grains.
8.2-10.1	Quartz sand (Old dune system).
	Water level 8.2 m. No sample obtainable for salinity test.

## Hole 11

0-0.9	Dark brown soil and cream sand.
0.9-1.8	Cream sand, shelly.
1.8-5.5(?)	Brown clayey sand, rich in shell fragments.
5.5(?) - 10.1	Quartz sand, some clay?
	Water level 5.7 m, 350 ppm TDS.

## Hole 12

0-0.9	Brown soil
0.9-2.7	Cream sand, rich in shell fragments.

Hole 12 (continued)

Depth (m)	Description
2.7-5.2(?)	Brownish sand, shell rich.
5.2(?) - 6.4	Grey sand, a little clay.
6.4-6.9	Dark green gritty clay.

Hole collapsed at 3.1 m; this is probably the standing water level.

Hole 13

0-0.9	Fine brown sandy top-soil.
0.9-1.8	Fawn-yellow-brown sand, medium- to fine-grained, shelly.
1.8-4.6	Light yellow-brown sand, medium- to coarse-grained.
4.6-4.9	Green gritty clay-weathered granite?

Water level 2 m, 330 ppm TDS. The hole was pumped at about 15 l/min with a drawdown to the bottom of the hole.

Hole 14

0-0.9	Brown top-soil and cream shelly sand.
0.9-1.8	Cream sand, shelly.
1.8-2.9	Brown shelly sand.
2.9-3.2	Clayey grit with granite fragments - drill could not penetrate.

Water level at 2.3 m, 400 ppm TDS.

Hole 15

0-0.9	Brown soil and cream sand.
0.9-6.4	Cream shelly sand.
6.4-7.3	Brown sand.
7.3-7.6	Gritty green micaceous clay.

Hole collapsed at 5.2 m; probably the standing water level. It was not possible to collect a sample for salinity test.

Hole 16

0-0.9	Brown silty soil.
0.9-1.8	Brown and cream sand.
1.8-4.6	Cream to yellow brown sand (shelly) with cemented sand areas. A hard zone prevented further drilling.

SOUTHERN AREA

Hole 17

0-0.9	Brown soil and yellow shelly sand.
0.9-1.8	Brown sand becoming quartz-rich.
1.8-9.8	Brownish quartz sand, rounded quartz grains, some mica.
9.8-	Bedrock?

The hole was cased to about 5.8 m with two screens 3.7 m in length with 50 mm PVC pipe against the top section of the hole. The hole was pumped at 45 l/min for about 2 hours with a drawdown to within about one metre of the bottom of the screened section. 240 ppm TDS. An observation hole was installed 6.9 m from this hole with slotted PVC pipe. Hole 17 was pumped at a rate of about 38 l/min for over 9 hours with drawdown being measured in the observation hole.

Hole 18

Depth (m)	Description
0-0.9	Brown soil.
0.9-3.7	Grey-brown quartz sand.
3.7-6.4(?)	Brown quartz sand.
6.4(?) - 9.1	Shelly sand; a medium grain size.
9.1-9.8	Gravelly shelly sand, quartz fragments rounded and up to about 10 mm in diameter.
	Water level at 4.7 m, 250 ppm TDS.

Hole 19

0-0.9	Brown soil and grey sand.
0.9-1.8	Light yellow-grey quartz sand, some shelly fragments.
1.8-4.6(?)	Yellow quartz and shell fragment sand.
4.6(?) - 5.5(?)	Grey-brown quartz and shelly sand.
5.5-7.6	Light grey quartz and shelly sand, some grit fragments. Too hard to drill further.
	The hole was cased to 6.1 m with 3.7 m of screen and the top part of the hole with PVC casing; pumped at 18 l/min. The standing water level was 4 m and the dissolved solids content was measured at 260 ppm.

Hole 20

0-0.9	Brown soil and dark sand.
0.9-8.7	Cream-yellow sand becoming coarser with depth, quartz and shell fragments.
8.7-8.8	Green gritty clay-weathered granite?
	The hole was screened and cased to about 6 m and pumped at about 40 l/min. The standing water level was at 3.1 m and dissolved solids content was measured at 320 ppm.

Hole 21

0-0.9	Brown soil and cream-yellow shelly sand.
0.9-1.8	Yellow sand, quartz and shell fragments.
1.8-3.7(?)	Brown and red clayey quartz sand (a little shell fragment material). A small piece of decayed wood present.
3.7(?) - 8.8	White to cream quartz and shell fragments.
8.8-9.5	Gravelly sand, quartz and shell fragments. Gravel fragments up to 6 mm across and rounded.
	Water level at 3.4 m, 250 ppm TDS.

Hole 22

0-0.9	Brown soil and yellow shelly sand.
0.9-3.7(?)	Yellow fairly coarse shell fragments and quartz sand.
3.7(?) - 5.5(?)	Brown and reddish-brown clayey sand.
5.5(?) - 10.1	Brown and grey sand, fine- to medium grain size, mainly quartz.
	Water level at 5.3 m, 230 ppm TDS.

Hole 23

0-0.9	Brown soil and cream to grey shelly sand.
0.9-1.8	Cream-yellow sand-shelly fragments.
1.8-3.7	Brown clayey (or organic matrix?) sand.
3.7-10.1	Grey and brownish sand, mainly quartz.
	Water level at 3.4 m, 230 ppm TDS.

## Hole 24

<i>Depth (m)</i>	<i>Description</i>
0-0.9	Brown soil and light grey-cream sand.
0.9-2.7	Cream-yellow shell fragment and quartz sand.
2.7-4.6(?)	Brown clayey sand.
4.6(?) - 10.1	Light grey sand - mainly quartz, some shell fragments.
	Water level at 3.1 m and dissolved solids 250 ppm. The final 3.7 m of the hole collapsed quickly on removal of the auger suggesting a particularly good water-bearing section.

## Hole 25

0-0.9	Brown soil.
0.9-2.7	Yellow shell and quartz sand.
2.7-3.7	Grey quartz sand.
3.7-5.5	Brown clayey sand.
5.5-10.1	Light brown and becoming grey at bottom. Mainly quartz with some shell fragments.
	Water level at 4.8 m, dissolved solids 210 ppm.