

Abstract

Drilling and spear bore installation on the 'Woolnorth' property indicates that there are good prospects of obtaining small irrigation quantities of water from the unconsolidated sand deposits. A surface carbonate-rich sand is separated from a lower, finer grained quartz-rich sand by a layer of carbonaceous clay and peaty material. The quality of the water is likely to be good enough for irrigation. The installation of a small set of spears to examine long-term output and salinity is recommended.

INTRODUCTION

The Van Diemens Land Company at 'Woolnorth' is interested in locating sufficient groundwater for irrigation of crops. The most likely source of water with a suitable quality is from the dune sands and other sand deposits that occur mainly to the north and north-west of the settlement area. Auger drilling to a maximum depth of seven metres has been undertaken to examine the near-surface sequence and to establish a few spear bores, so that yields and water quality can be assessed.

GEOLOGY

The basement rocks in the settlement area are comparatively unmetamorphosed Precambrian quartzite and slate. A low ridge of resistant quartzite extends from the settlement area to Woolnorth Point. Tertiary basalt and agglomerate crop out along the coast west of the settlement area.

Quaternary sand covers a large part of the area near the settlement. The surface material consists largely of carbonate-rich sand made up dominantly of shell fragments, with minor amounts of quartz fragments. A quartz-rich fine sand underlies the carbonate sand at most locations where drilling was undertaken (with the possible exception of Hole 12). Some horizons of this material consist almost entirely of fine sand-size material, but often, particularly at deeper levels, the sand contains a variable quantity of shell fragments and complete shells up to 20 mm diameter. Between the two sand types is an horizon rich in carbonaceous material and including peaty material and wood fragments.

The quartz sand with shell fragments is probably a marine deposit, although some of the zones without the large shell fragments may be wind-blown material. The carbonaceous layer between the two sand beds probably represents swamp and lagoonal deposits developed on this sand at a time of lower sea level, while the carbonate-rich sand overlying the peat layer is of windblown origin.

AUGER DRILLING AND SPEAR BORE TESTS

Sixteen holes were augered to a maximum depth of seven metres. Approximate positions of these holes are shown on Figure 1 and logs of material encountered are given in Appendix 1. These logs only represent approximate levels, as the augers were only withdrawn every 1.8 m to examine the material being drilled.

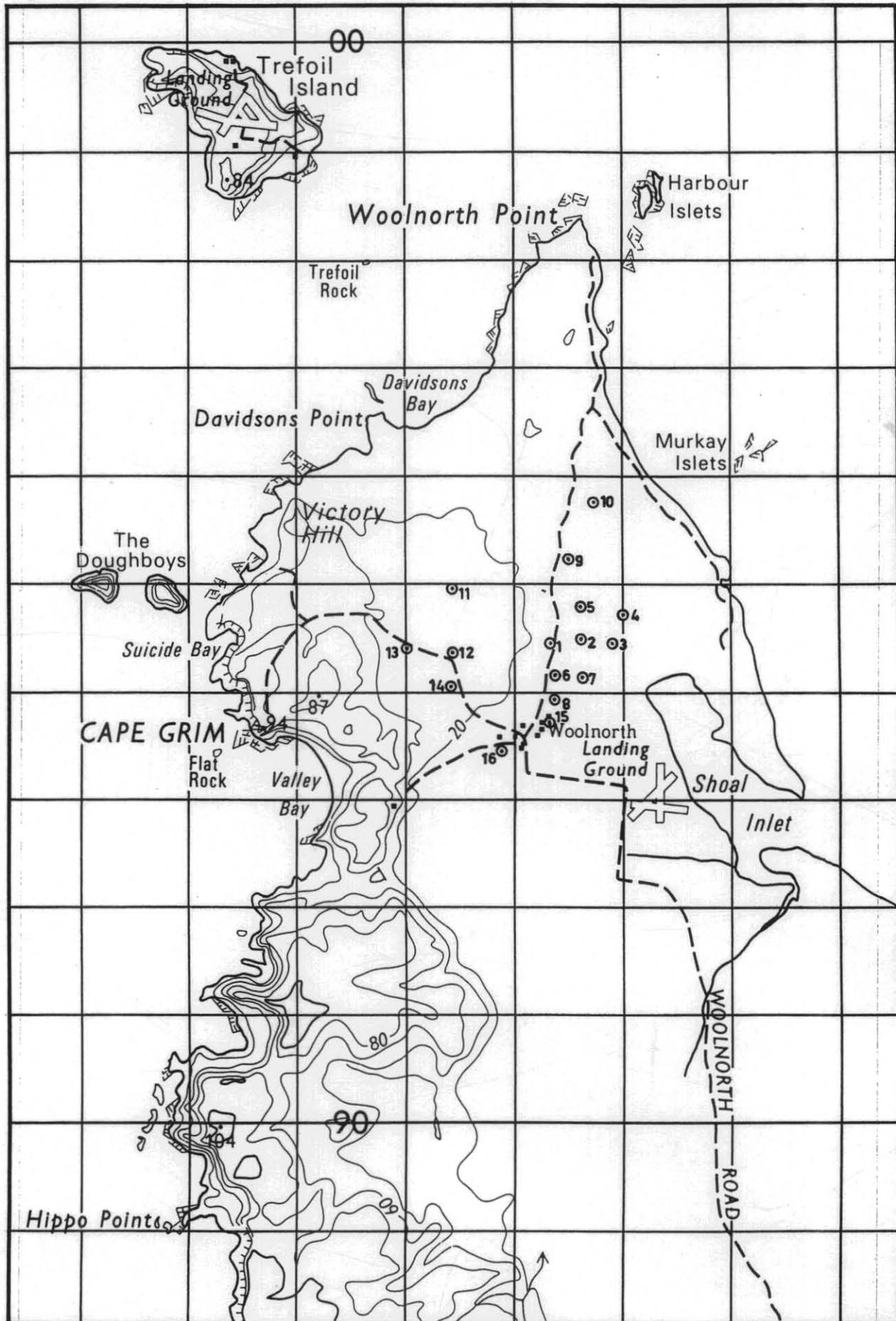
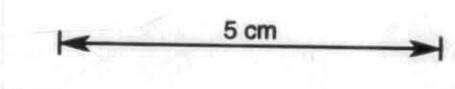


Figure 1. Location of auger holes



Spears 50 mm in diameter with 1.5 m long screens were installed in Holes 4, 7, 12, 15 and 16 and pumped for periods of up to about two hours. Rates of up to 36 litres per minute (500 gallons per hour) were obtained. Output varied for different locations and, as expected, lower rates were obtained from the finer grained quartz sand (see Hole 4 and the lower part of Hole 15). The material in the lower part of Hole 12 is coarser grained than in nearly all of the other holes and this is probably the reason for the larger output.

In most holes drilled, the peat layer between the two sand layers is probably relatively impermeable. When permanent spears are installed, overall yields are likely to be greater if two screens are placed so that one is adjacent to the lower part of the coarser carbonate sand and the other is placed at the bottom of the hole against the finer sand.

When selecting a screen for extracting water from unconsolidated sand, an opening size about equivalent to the 50% size of the aquifer material is often used. It is therefore recommended that a screen with smaller openings be used for the lower sand than for the upper one. The sizing analyses (figs. 2, 3) show that the 50% size for four of the six lower sand samples examined is between 150-200 micrometres (μm), while for the upper sand it is between 240 and 280 μm . To retain 50% of the material on the outside of a screen would require screens with this range of openings. Taking the mid-point of these ranges (i.e. 175 μm and 260 μm) the screen sizes would be No. 7 and No. 10. Screens with larger openings can often be used in coastal sand areas, particularly if a coarser sand is artificially placed around the outside of the screen (artificial gravel pack). It is suggested that No. 10 and No. 15 screens would be appropriate sizes (the number of the screen is a measure of the opening in thousandths of an inch). A material with an average size of about five times the average size of the material in which the water is contained is usually placed around the screen. It should have a relatively small range in size.

WATER QUALITY

After drilling, the conductivity of the water in each hole was measured. The conductivity has a direct relationship with the water's salinity, the conversion being only approximate because of the variation in the particular constituents. The water on which the measurement is taken also may not be completely representative of the quality of water after pumping for a period. Some stratification of water with respect to quality can be expected.

Where spears were installed and pumped, samples of water were collected and chemically analysed. These results are given in Appendix 2. In general, water qualities are in the range that is usually suitable for irrigation. Water from Hole 12 has a slightly higher salinity, and crop sensitivity to water salinity would need to be examined before using any of the water. The water is essentially a bicarbonate water, although chloride ions form a significant proportion of the constituents. The high bicarbonate values result in the value of a factor known as "residual sodium carbonate" being between one and two. A high value (>1.5) in arid areas can cause some problems with breakdown of soil structure but this is unlikely to occur where there is fairly regular rainfall.

PROSPECTS FOR IRRIGATION SUPPLIES

The drilling and spear bore testing has shown that water can be obtained over a wide area and it is likely that the areal extent is considerably greater than that tested. Wherever there is a considerable thickness of sand, there are good prospects of obtaining water. One requirement for the establishment of spear bores in sand is that the water table should be fairly close to the surface. For this reason, low-lying areas were selected for investigation and similar areas should be selected to establish any permanent system of spears.

Before any great expense is undertaken establishing a system to supply irrigation quantities, it would be advisable to instal a small system and pump it for an extended period to examine the performance of the aquifer and to monitor any changes of salinity with time. From the investigative drilling it would be reasonable to assume that at least three metres of saturated sand is present over much of the area, giving in the order of one million cubic metres (220 million gallons) of water stored under each square kilometre of area (assuming 30% porosity for the sand). It would not be possible to extract all of this water but a significant proportion of it should be available. Winter rains should replace the water extracted during the summer. The prospects of an irrigation supply are reasonably good, although it may be necessary to develop a set of spears in more than one area to extract the desired amount of water.

CONCLUSIONS AND RECOMMENDATIONS

Auger drilling and spear bore installation has shown that the extensive sand deposits north of the settlement contain considerable quantities of water. Sufficient water for irrigation supplies is a definite possibility. The water quality appears to be good enough for a general irrigation supply.

The presence of sand beds with different average grain sizes and their separation by a bed of low-permeability carbonaceous clay and peat complicates the method of spear bore installation. However with care in installation (e.g. with screens at different levels and gravel packs surrounding them) it should be possible to extract the water successfully.

Before systems to extract large quantities of water are installed, a small set of spears should be installed and tested for output and salinity over an extended period.

The more favourable areas for the establishment of an array of spears, particularly an irrigation scheme, would be locations surrounded by fairly extensive areas of proven water-bearing sand. This may mean moving a little further away from the areas to be irrigated.

[3 July 1985]

40-5

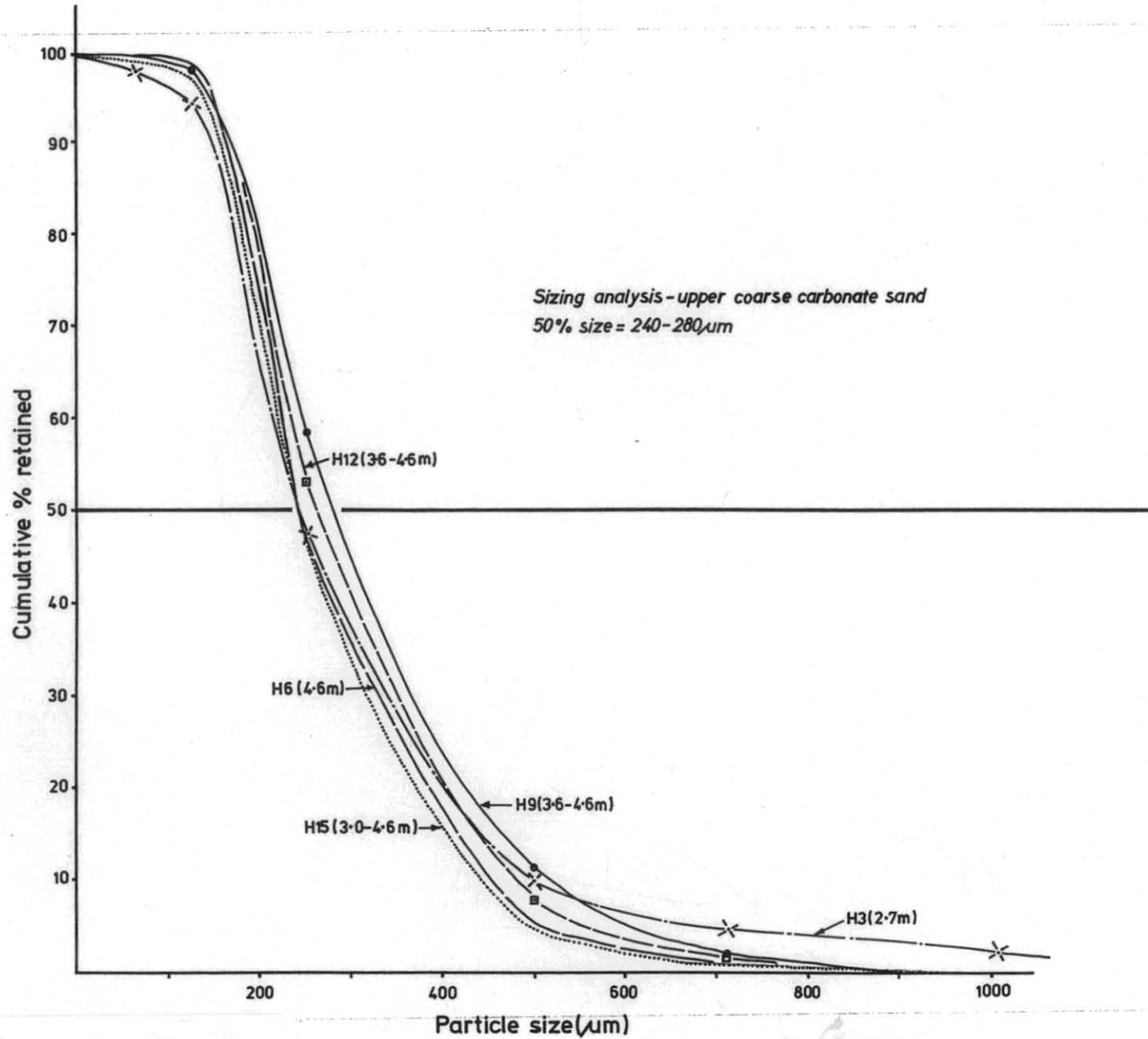


Figure 2.

5 cm

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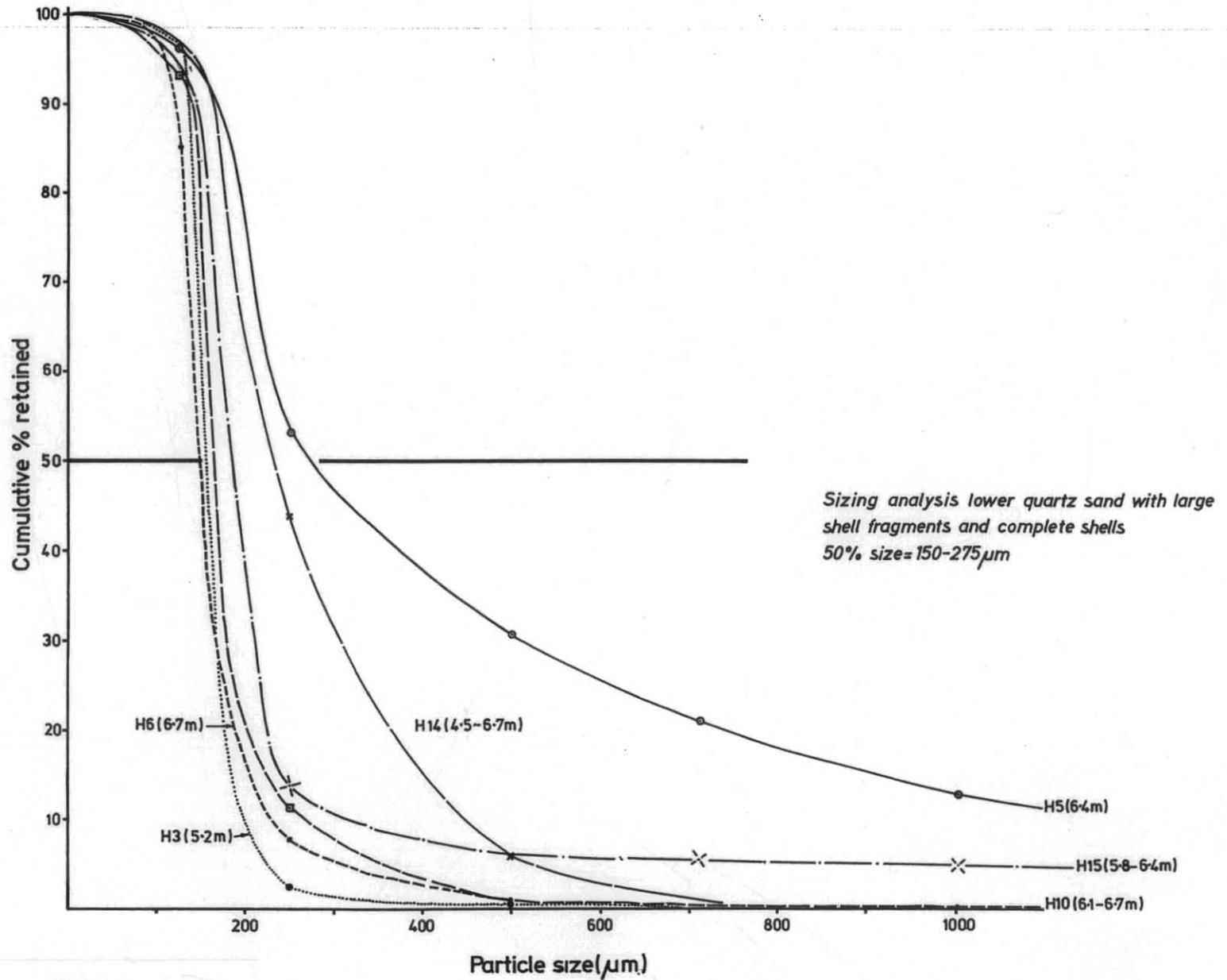
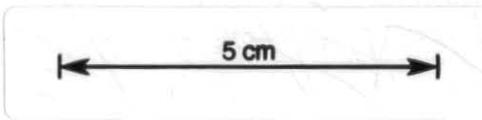


Figure 3.



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APPENDIX 1

Logs of auger holes

<i>Depth (m)</i>	<i>Description</i>
<i>Hole 1</i>	
0 - 0.9	Brown sandy soil
0.9- 4.9	Yellow sand, medium-grained, carbonate-rich
4.9- 5.1	Sand, becoming clayey
5.1- 5.3	Dark brown to black carbonaceous material
Standing water level about 1.9 m, conductivity 650 $\mu\text{S}/\text{cm}$ \approx 450 mg/l dissolved solids.	
<i>Hole 2</i>	
0 - 0.9	Brown clayey sand
0.9- 2.7	Yellowish carbonate sand, medium grain size
2.7- 3.7	Greyish clayey carbonate sand
3.7- 5.2	Carbonaceous material - dark brown
5.2- 7.0	Grey sand, siliceous, fine grained
Standing water level 2.1 m, conductivity 750 $\mu\text{S}/\text{cm}$ \approx 525 mg/l dissolved solids.	
<i>Hole 3</i>	
0 - 0.9	Brown sandy soil and plastic clay
0.9- 3.1	Yellow carbonate sand
3.1- about 4.3	Carbonaceous and clayey sand
about 4.3- 6.1	Grey quartz sand with large shell fragments
6.1- 7.0	Grey-blue clayey sand and clay
Standing water level 0.65 m, conductivity 960 $\mu\text{S}/\text{cm}$ \approx 670 mg/l total dissolved solids.	
<i>Hole 4</i>	
0 - 1.2	Brown silty sandy soil and plastic clay
1.2- 3.1	Yellow carbonate sand
3.1- 4.0	Grey clayey sand
4.0- 5.9	Grey fine quartz sand with large shell fragments
5.9- 6.1	Clayey sand and weathered shale (bedrock)
A spear with a 1.5 m screen was installed and pumped for two hours at about 12.5 l/min (170 gallons per hour), conductivity 780 $\mu\text{S}/\text{cm}$ \approx 550 mg/l total dissolved solids. The water has a slight H_2S smell. Standing water level 0.8 m.	
<i>Hole 5</i>	
0 - 1.5	Brown soil and clayey sand
1.5- 3.4	Yellow carbonate sand
3.4- 4.9	Grey to dark grey clayey sand
4.9- 7.0	Sand, shell fragments very abundant
Standing water level 0.7 m, conductivity 810 $\mu\text{S}/\text{cm}$ \approx 570 mg/l total dissolved solids.	

Appendix 1 (continued)

Depth (m)	Description
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Hole 6

0 - 0.9	Red-brown sand
0.9- 5.2	Yellow carbonate sand
5.2- 6.1	Black humic-rich quartz sand
6.1- 7.0	Grey quartz sand

Standing water level 3.3 m, conductivity 1010 μ S/cm \approx 700 mg/l total dissolved solids.

Hole 7

0 - 0.9	Brown sandy soil
0.9- 4.9	Yellow carbonate sand
4.9- 5.8	Black carbonaceous sandy clay, some woody fragments
5.8- 7.0	Grey quartz sand with shell fragments, fine grained

A spear was installed to 7 m with a 1.5 m screen and pumped for 1½ hours at 32 l/min (400 gallons per hour). Conductivity before pumping 760 μ S/cm, after 20 minutes pumping 900 μ S/cm and after 1½ hours 1010 μ S/cm \approx 700 mg/l, standing water level 2.4 m.

Hole 8

0 - 0.9	Light grey sand, fine quartz
0.9- 1.5	Brown clayey sand and plastic clay
1.5- 4.3	Yellow carbonate sand
4.3- 5.2	Black peaty material and sand with carbonaceous material
5.2- 7.0	Grey quartz sand, some shell fragments

Standing water level 1.6 m, conductivity 800 μ S/cm \approx 560 mg/l.

Hole 9

0 - 0.9	Sandy soil and brown clayey sand
0.9- 5.2	Yellow carbonate sand
5.2- 6.1	Brown carbonate sand, slightly clayey
6.1- 7.0	Dark brown clayey sand, probably siliceous sand, a few quartzite pebbles.

Standing water level 2.2 m, conductivity 850 μ S/cm \approx 600 mg/l total dissolved solids.

Hole 10

0 - 0.9	Brown clayey sand and clay
0.9- 4.0	Yellow-cream carbonate sand
4.0- 5.5	Dark brown clayey sand - probably quartz
5.5- 7.0	Sand, fine-grained quartz, some fine shell fragments may be due to contamination from higher levels

Standing water level 0.8 m, conductivity 800 μ S/cm \approx 560 mg/l total dissolved solids.

Appendix 1 (continued)

Depth (m)	Description
<i>Hole 11</i>	
0 - 0.9	Brown sandy soil and clayey sand
0.9- 5.2	Yellow carbonate sand
5.2- 5.6	Clayey sand and quartz sand
5.6-	Hard, basement rock? (perhaps quartzite)

Standing water level 1.9 m, conductivity 1000 μ S/cm \approx 700 mg/l total dissolved solids.

<i>Hole 12</i>	
0 - 0.3	Brown clayey sand
0.3- 4.6	Yellow carbonate sand
4.6- 5.5	Grey clayey sand
5.5- 7.0	Grey sand, medium-grained, abundant shelly fragments

A spear was installed to 6.9 m and pumped for 1½ hours at 36 l/min (about 500 gallons per hour), 2.7 m of water remained in the hole while pumping at this rate. Conductivity after drilling 880 μ S/cm while after pumping 1400 μ S/cm \approx 1000 mg/l. Standing water level 2.6 m.

<i>Hole 13</i>	
0 - 1.2	Brown sand and plastic clayey sand
1.2- 5.2	Yellow carbonate sand
5.2- 7.0	Dark coloured sandy clay with thick layers of peaty matter

Standing water level 2.7 m, conductivity 1100 μ S/cm \approx 770 mg/l total dissolved solids.

<i>Hole 14</i>	
0 - 0.6	Brown sandy soil
0.6- 6.9	Yellow and yellow-grey sand, carbonate
6.9- 7.0	Grey clayey sand

Standing water level 5.0 m, conductivity 980 μ S/cm \approx 680 mg/l total dissolved solids

<i>Hole 15</i>	
0 - 0.9	Brown clayey sand
0.9- 4.9	Yellow carbonate sand
4.9- 5.8?	Dark brown carbonaceous sand and peat
5.8?- 7.0	Grey quartz sand with coarse shell fragments

A spear with 1.5 m screen was installed to 7.0 m and pumped for 10 minutes at 17 l/min (225 gallons per hour). It was then pulled back to 4.9 m and pumped for 1½ hours at 24 l/min (320 gallons per hour). Conductivity at end of pumping 870 μ S/cm \approx 600 mg/l dissolved solids. Standing water level about 0.9 m.

Appendix 1 (continued)

Depth (m)	Description
<i>Hole 16</i>	
0 - 1.2	Plastic clay and sandy clay
1.2- 4.6	Clayey sand with bands of cleaner sand
4.6-≈5.5	Dark brown peaty material and clayey sand
≈5.5- 7.0	Clayey quartz sand

A spear with 1.5 m screen was installed to 4.9 m and pumped at 15 l/min (200 gallons per hour), conductivity 1100 μ S/cm \approx 770 mg/l dissolved solids. Standing water level 1.2 m.

APPENDIX 2

Analyses of water samples

	Hole 4	Hole 7	Hole 12	Hole 15
pH	7.6	7.6	7.8	7.7
Conductivity (μ S/cm)	810	700	1100	800
<i>Item (mg/l)</i>				
CO ₃	nil	nil	nil	nil
HCO ₃	390	350	410	350
Cl	160	125	270	135
SO ₄	50	24	73	29
Ca	59	54	71	69
Mg	19	15	26	19
Fe	<0.1	<0.1	<0.1	0.1
Al	<0.2	<0.2	<0.2	<0.2
K	5.5	3.4	5.6	3.7
Na	100	90	155	83
TDS	690	530	980	660
Hardness - Permanent	nil	nil	nil	nil
- Temporary	230	195	280	250
Alkalinity	320	290	340	290

Analyses by Department of Mines laboratory, Launceston