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Groundwater Development at Lamlash and Glen Rosa, Island of Arran

by WD/SC/85/1

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1. Introduction

In April 1982 a water well was drilled into superficial deposits to the west of Lamlash village on Arran in order to augment the existing public supply. This borehole was pump tested for a short period and had a specific capacity of 23 m^3/day/m, a value considerably higher than for other water wells on Arran, drilled into sandstone bedrock. Details of the borehole construction are given in Ball and Harrison (Hydrogeology in Scot. 83-2).

During 1983, prior to commissioning, this borehole was vandalised, causing its abandonment. However, the results were promising enough to make worthwhile the drilling of a second borehole at the same site in September 1984, along with an exploratory borehole into superficial deposits in Glen Rosa, to the west of Brodick. This report presents details of borehole construction and pumping tests carried out in both boreholes.

2. Lamlash

2.1 Geology

An extensive area of raised beach deposits occurs on the valley floor immediately west of Lamlash comprising mainly 'Intermediate' or '50-foot' raised beach (figure 1). The previous borehole, (Lamlash No. 3) sited at NGR NS 0215 3070, proved the following succession:

Table 1 Lamlash Borehole 3 - log

	Thickness (m)	Depth (m)
Soil	0.5	0.5
Fine sand with gravel	7.5	8.0
Fine sand	11.5	19.5
Silty clay	21.5	41.0

The new borehole (Lamlash No. 4) was sited 10.5 m east of No. 3 and proved the following:-

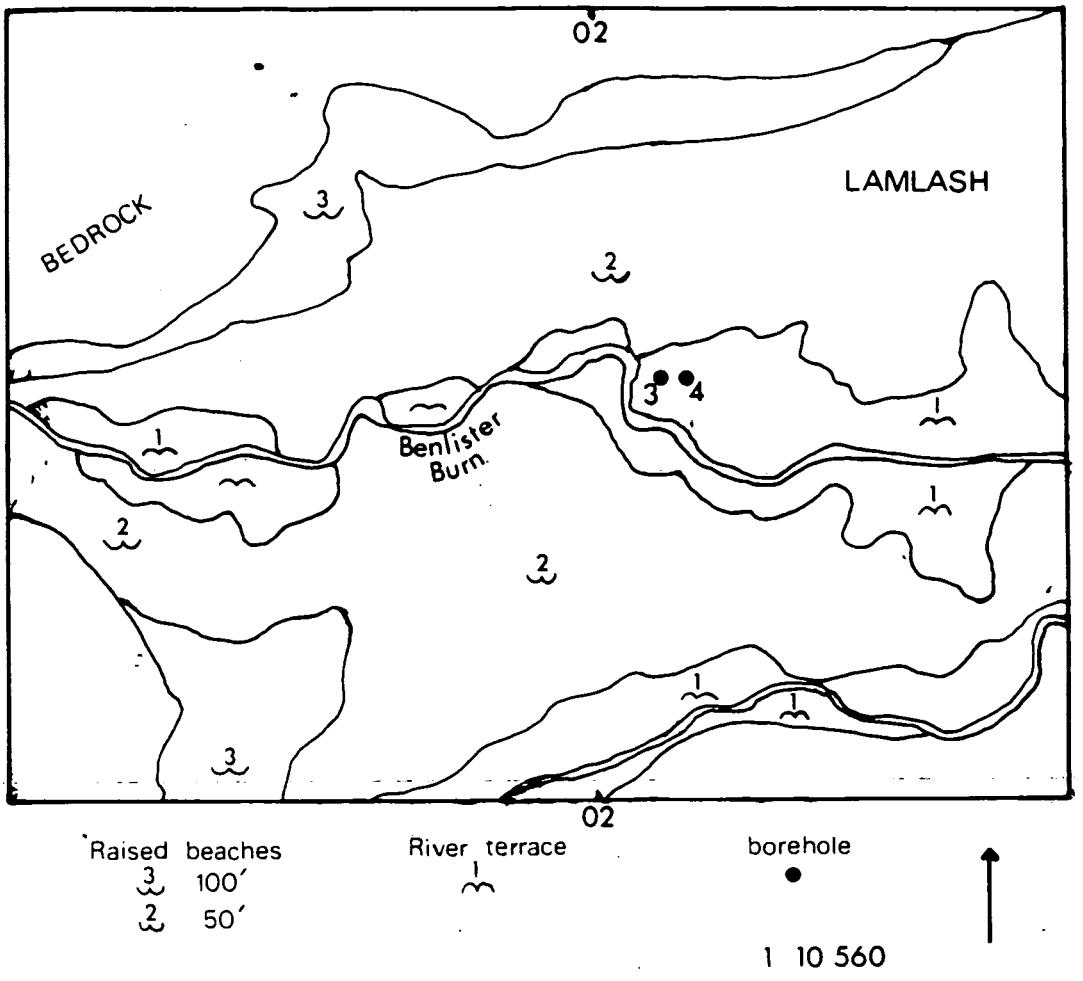


Fig. 1: Lamlash - geology and borehole locations

Table 2: Lamlash Borehole 4 - log

	Thickness (m)	Depth (m)
Soil	0.3	0.3
Fine sand and gravel	7.7	8.0
Fine brown sand	1.0	9.0
Fine sand and gravel	6.3	15.3
Silty brown sand	4.7	20.0
Silty grey clay	2.7	22.7

2.2 Borehole construction

Experience gained from Lamlash No. 3 meant that the well could be designed prior to drilling. It was known that the lower surface of the aquifer was approximately 20 m b.g.l. and that fine sand would be encountered at 8 m b.g.l.

Table 3: Lamlash No. 4 - borehole construction

Date of construction	September 1984
Elevation (m.A.O.D.)	5
Total depth (m.b.g.l.)	22.7 m
Nominal diameter (mm)	203
Plain casing (m x mm)	0-8 x 203
"Hydrotec" well screen (m x mm)	8-19.6 x 203
Rest water level (m.A.O.D.) (with date)	3.1 (20.9.84)

Figure 2 shows details of borehole construction. Upon completion of the borehole an air-lift test was carried out for 9 hours.

2.3 Test pumping

A short pumping test of 3 hours duration was carried out by BGS on 20 September using an Emu electric submersible pump. The vandalised borehole 3, 10.5 m away, was still usable as an observation well and therefore

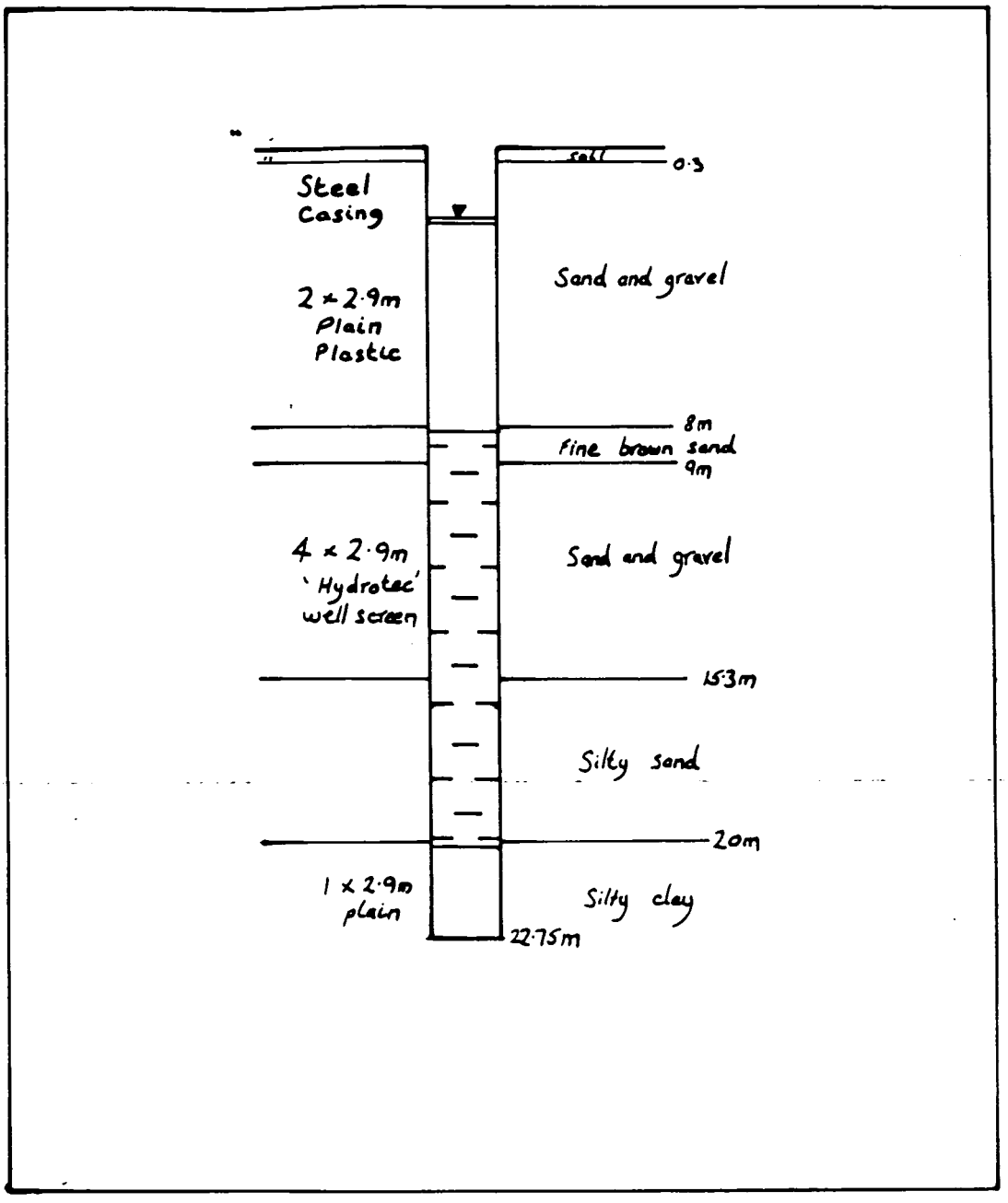


Fig. 2: Lamlash - borehole construction

enabled more useful data to be collected during the test. Details of the test are given in Table 4.

Table 4: Lamlash No. 4 - details of pumping test

Duration	3 hours
Discharge	2.72 litres/second
Maximum drawdown in pumped well	2.40 m
Maximum drawdown in Lamlash No. 3 (10.5 m away)	0.64 m

Figure 3 shows a Jacob analysis using drawdown data from bh 3 (observation well). Two distinct breaks in slope are evident indicating the time taken for the spreading cone of depression to encounter recharge boundaries, the Benlister Burn and its nearby tributary. Even after only 3 hours pumping, equilibrium conditions are almost established due to recharge from the streams. Analysis of the early part of the curve in Figure 3 has enabled approximate values for transmissivity and storativity in the aquifer to be calculated.

Table 5: Lamlash boreholes - aquifer properties

Transmissivity (bh. 3)	75 m^2/day
Storativity (bh. 3)	2.13×10^{-3}
Specific capacity (bh. 4)	98 m^3/day/m
Specific capacity (bh. 3 (17.8.82)	23 m^3/day/m

The four-fold increase in specific capacity between the two boreholes is remarkable even taking into consideration the greater amount of fine sand and gravel encountered in bh. 4. The increase can only be explained by a more thorough air-lift having been carried out in bh. 4 which flushed a greater amount of fine material out through the well screen from the surrounding formation.

The test indicates that Lamlash No. 4 should be capable of yielding up to 5 litres/second on a long term basis without an undue drawdown being

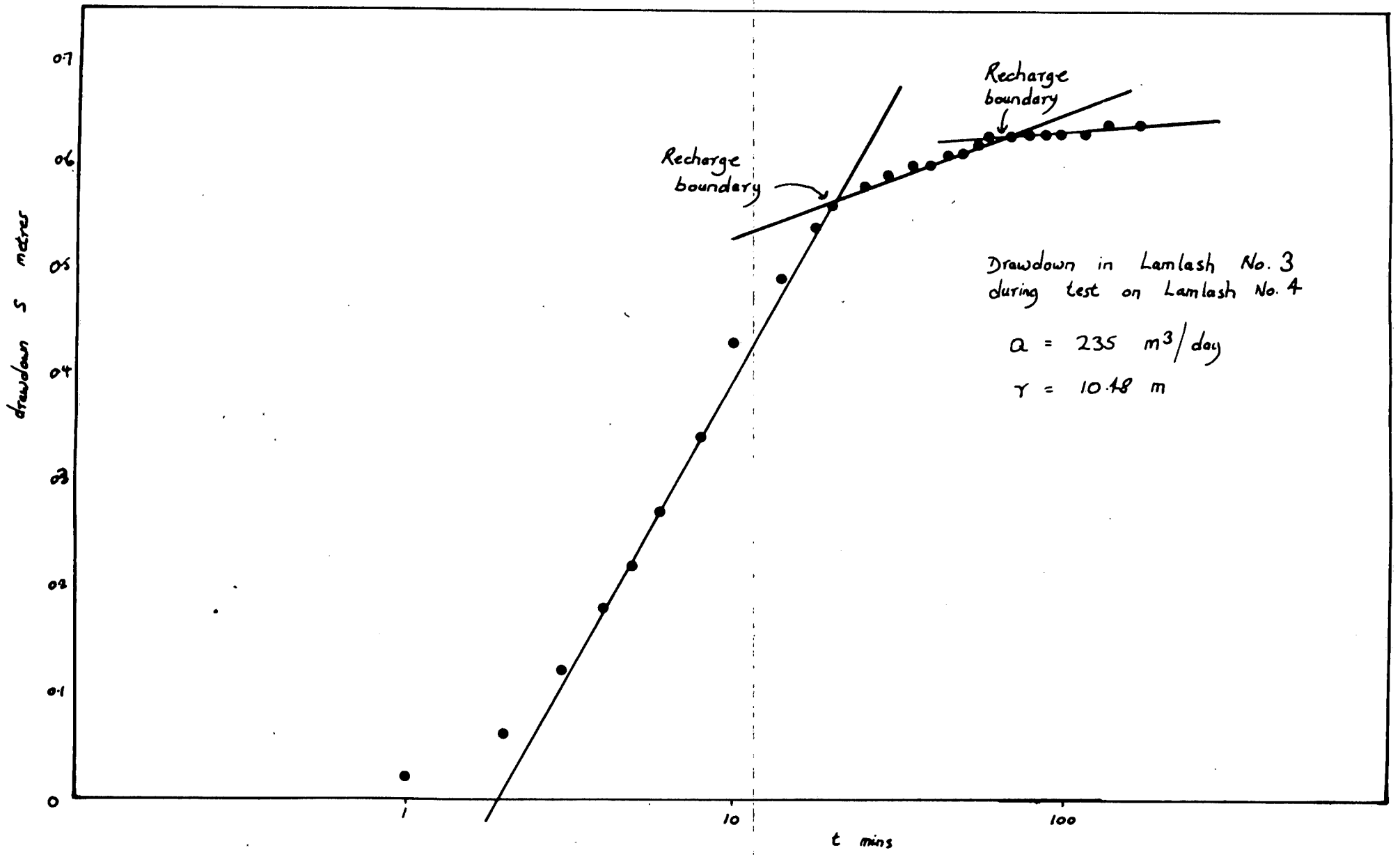


Fig. 3: Lamlash - Jacob analysis

created in the well. Recharge will be provided both from the aquifer and the surface watercourses, of which the Benlister Burn will contribute the greater share.

It is recommended that a longer term pump test at 5 litres/second is carried out on Lamlash No. 4 before deciding on the correct size of pump for permanent use.

Although the size and extent of the valley superficial deposits at Lamlash are unknown, it is probable that they could provide further amounts of groundwater by drilling more boreholes.

3. Glen Rosa

3.1 Geology

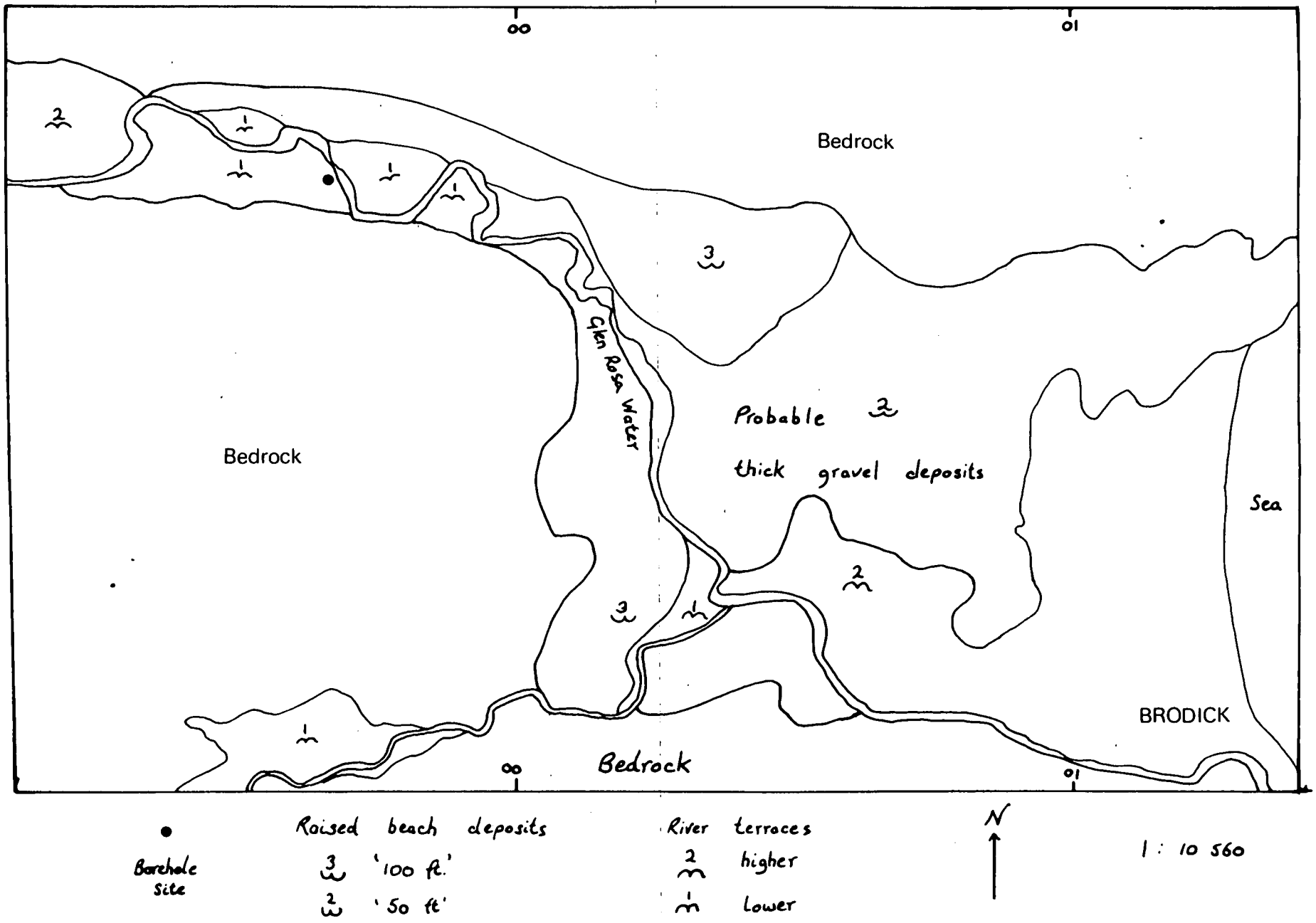
The broad floor of the Glenrose Water, 1 km north-west of Brodick, contains a well-developed sequence of raised beach deposits (Figure 4). Very little is known about these deposits at depth, but a similar thickness to that at Lamlash could be expected in the lower reaches of the valley. A shallow gravel pit at NS 010 374 reveals fine to medium grained sand and gravel occurring above water table, but no information as to the total thickness of this deposit is available.

The exploratory borehole was sited on a river terrace adjacent to the Glen Rosa Water upstream from the camp site at Glen Rosa Farm. The borehole log is given in Table 6.

Table 6: Glen Rosa borehole log

	Thickness (m)	Depth (m)
Soil	0.45	0.45
Sandy gravel: medium-grained with cobbles, mainly of granite. Little clay	5.35	5.80
Silty sand: grey, fine-grained	0.35	6.15
Silty clay: red-brown	3.85	10.00
Sandy gravel	0.90	10.90
Bedrock or boulder: schist	0.10	11.00

Figure 4: Glen Rosa - geology and borehole location



3.2 Borehole construction

Figure 5 and Table 7 give details of borehole construction.

Table 7: Glen Rosa - borehole construction

Date of construction	September 1984
Elevation (m.A.O.D.)	approx. 11 m
Total depth (m.b.g.l.)	11.0
Nominal diameter (mm)	203
"Hydrotec" well screen (m x mm)	3-5.8 x 203
Rest water level (m.A.O.D.) (with date)	approx. 9.9 (26.9.84)

After insertion of the well screen, an air-lift test was carried out for 9 hours.

3.3 Test pumping

A 3-hour pump test was carried out by B.G.S. on 26 September using a 'Goodenough' suction pump. As no observation well was available, this test could only give a figure for specific yield. Details of the test are given in Table 8.

Table 8: Glen Rosa - details of pumping test

Duration	3 hours
Discharge	1.5 litres/second
Maximum drawdown	2.02 m
Specific capacity	64 m^3/day/m

Figure 6 shows a Jacob analysis of the pump test which demonstrates that drawdown equilibrium was achieved after 60 minutes pumping. The break in slope on the graph is a recharge boundary, namely the Glen Rosa Water.

A constant yield figure of 1.5 litres/second is probably realistic for this well although the layer of gravel from which the water was abstracted is medium to coarse grained with very little fines content and should be capable of a higher pumping rate. It is possible that the lower part of

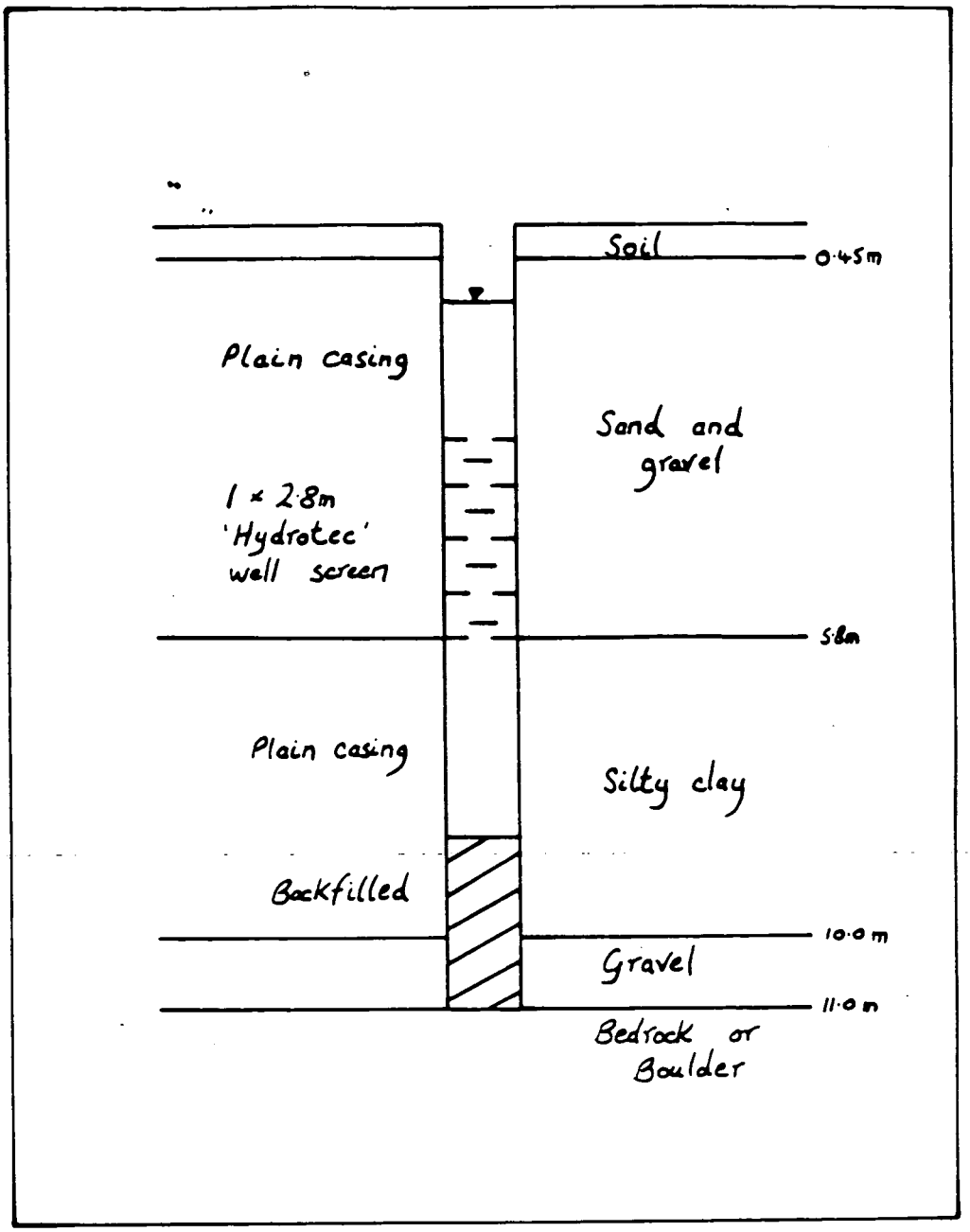


Figure 5: Glen Rosa - borehole construction

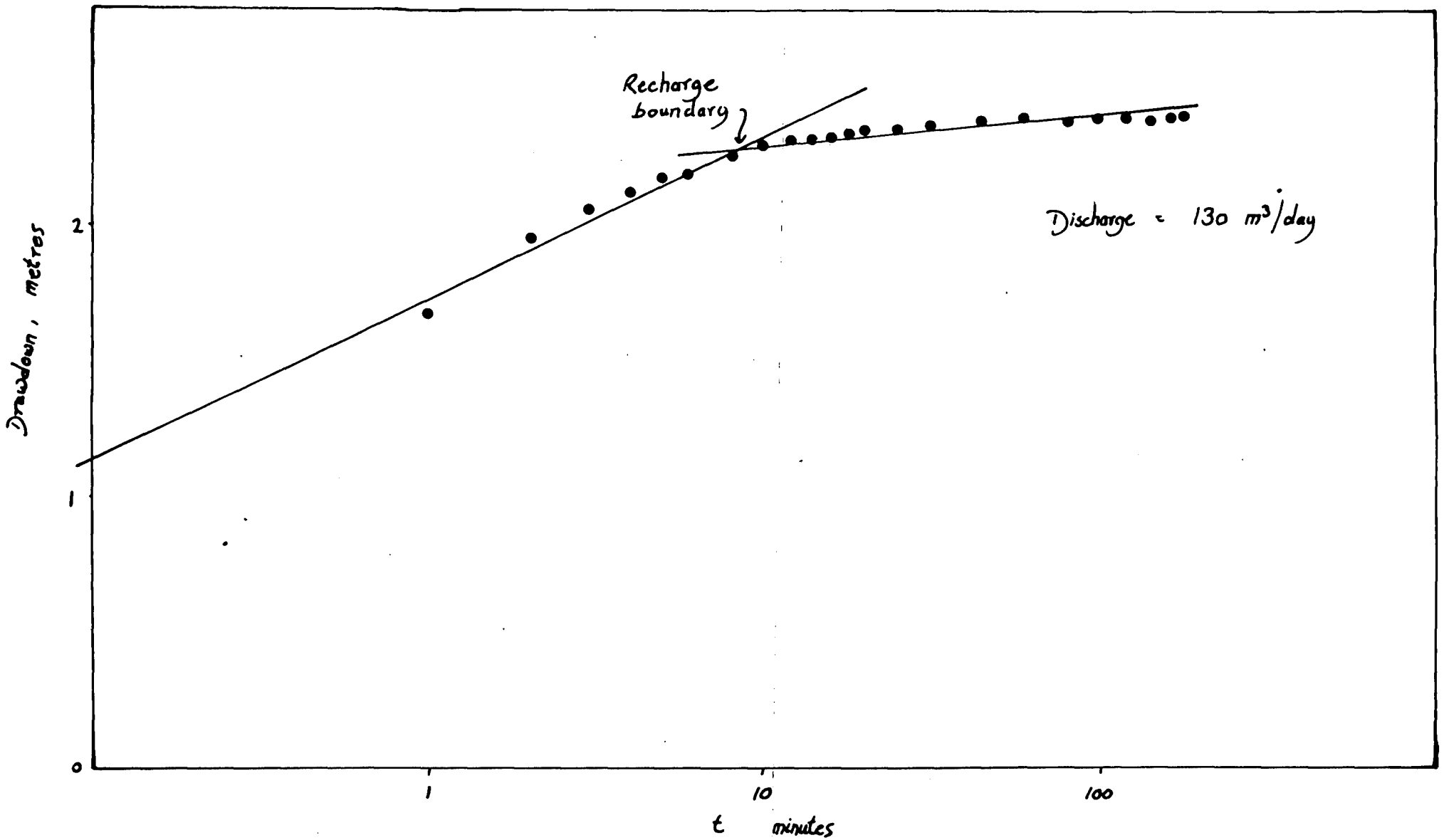


Figure 6: Glen Rosa – Jacob analysis

the well screen is still clogged with silt and may even be partly inserted into the underlying silty clay.

If larger amounts of water are required in Glen Rosa, this may be achieved by the drilling of two or three extra boreholes, provided they are adequately spaced.

The gravel is probably thicker downstream from the present site where the terraces are broader (see Figure 4). Greater quantities of groundwater should be available here, the only disadvantage being that longer pipe runs would be required to reach the Glen Rosa storage tank.

In general the prospects for the development of groundwater in Glen Rosa appear very good.

4. Conclusions

1) The most recent borehole at Lamlash (Lamlash No. 4) has a 3-hour specific capacity of 98 m^3/day/m, its yield/drawdown characteristics being much superior to the adjacent No. 3 borehole.
2) The safe long-term yield of the borehile is probably about 5 litres/second, although this should be confirmed by pump testing.
3) Further supplies of groundwater are likely to be available from the superficial deposits at Lamlash.
4) The Glen Rosa exploratory borehole proved 5.35 m of gravel which yielded 1.5 litres/second for a specific capacity of 64 m^3/day/m.
5) The results from this test indicate that more groundwater may be obtained in this part of Glen Rosa by the drilling of extra boreholes.
6) The gravel deposit is likely to be thicker and therefore to yield more groundwater downstream of the present site, where greater amounts could be pumped from single boreholes.