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EASTERN SHORES AREA, ST LUCIA

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1. INTRODUCTION

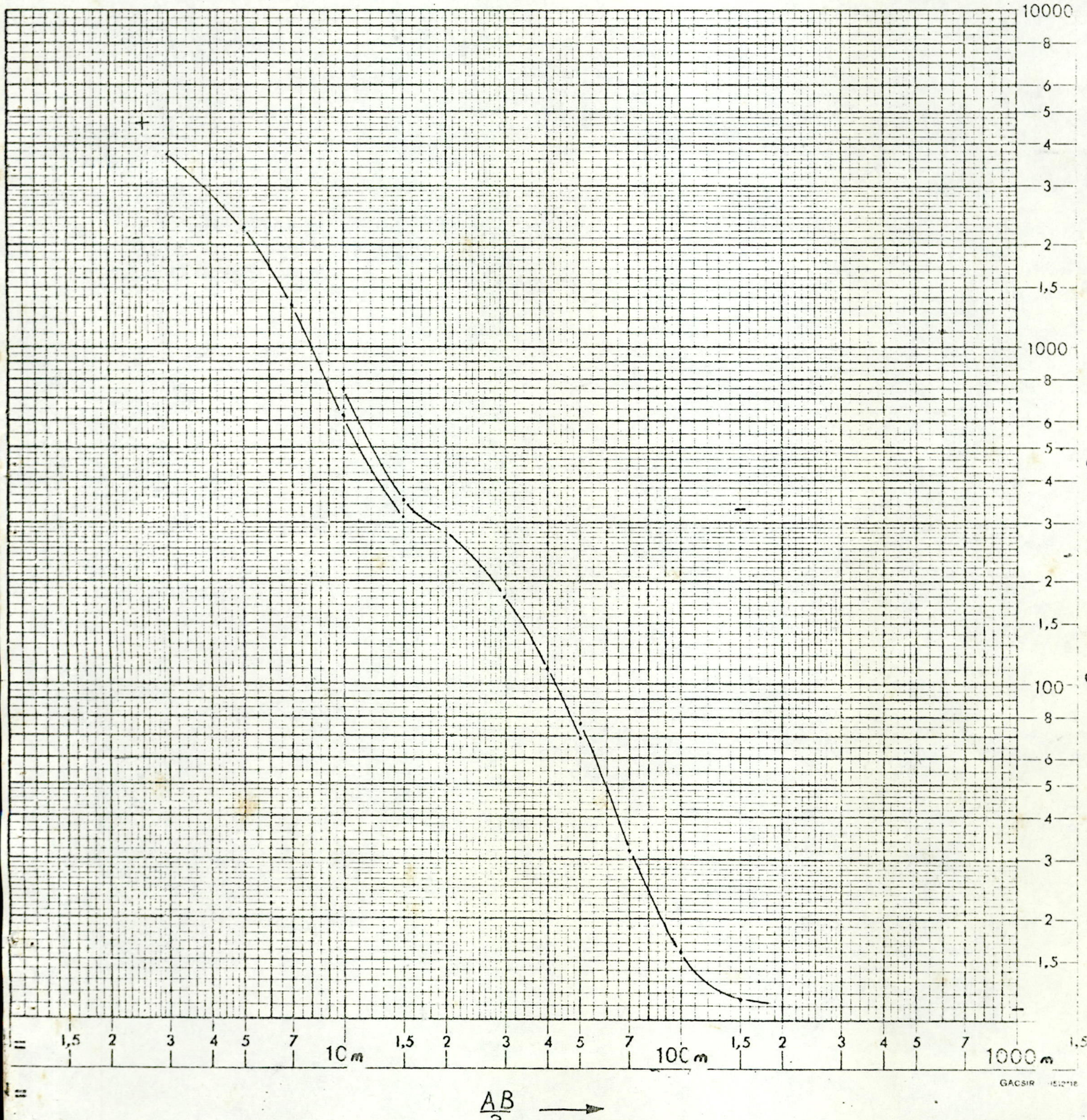
The main purpose of this investigation was to determine whether the electrical method was suited to the geohydrological circumstances as found on the eastern shores of Lake St Lucia i.e. to detect and to determine the thickness of a water saturated sand overlying a clayey bedrock and underlying a surface layer of dry sand. As will be seen in this report it has been possible to determine the configuration of the aquifer except over the dune area where, in view of the rugged topography, reliable sounding curves could only be obtained under special conditions.

A total of 17 soundings were carried out of which 15 were located on the southern profile which extends roughly ESE from the Old Jetty towards the sea. The northern traverse between Selley's Lake South and the sea straddles a high dune and it was only possible to carry out one sounding at the western extremity of the traverse and another on top of the dune. Both these sounding curves indicated that the bedrock is below sea level.

2. THE RESISTIVITIES OF THE FORMATIONS

The sounding curves in the Eastern Shores area are of the descending type which show that the resistivity decreases with depth. Figure 1 shows a typical example. At short current electrode spacings corresponding to a small depth of investigation the apparent resistivity is high (> 3000 ohm-m) denoting the presence of dry sand. At larger current electrode spacings the curve descends forming a slight platform at about 300 ohm-m. This is due to the presence of waterbearing sand. Finally the curve descends once more and flattens out at large current electrode spacings approaching a value of about 11 ohm-m. This is the resistivity of the conductive clayey (Pleistocene ?) bedrock. (For comparison it may be mentioned that the resistivity of sea-water is about 0,3 ohm-m whereas that of solid granite is about 5000 ohm-m).

ST. LUCIA ES 16 FIG. 1



From an analysis of all the sounding curves the following resistivity ranges for the various formations were obtained:

Formation	Resistivity range (ohm-m)
Surface layer (dry sand)	900 - 4600
Waterbearing sand (aquifer)	200 - 330
bedrock	11 - 32

It is seen that the contrast in resistivity between the formations is large which makes the resistivity method the obvious geophysical technique to use in this area.

3. POROSITY AND PERMEABILITY

The effective porosity of a formation is given by the relation

$$\phi^{-m} = \frac{\delta_f}{\delta_w} = F$$

where ϕ = effective porosity

m = cementation factor which for unconsolidated sand is roughly equal to 1,5

δ_f = resistivity of the formation

δ_w = resistivity of the water in the formation.

Measurements on water samples from the Bangazi Lake (23,2 ohm-m), the stream flowing past the Old Jetty (28,3 ohm-m) and the pool approximately 2 km south of the southern traverse alongside the main road (35,2 ohm-m) give an average resistivity of 28,8 ohm-m. The formation factor of the waterbearing sand is thus $\sim$ 10, and the effective porosity $\sim$ 22%. Unfortunately nothing specific can be said of the permeability or the storage coefficient without conducting pumping tests. As a general rule, however, aquifers with a fairly high porosity (as in this case) have a rather low permeability due to the presence of fine material. The logs of the boreholes drilled for Mr Ralph Reid and described in his report indicate the presence of relatively large amounts of fine material and thus support this contention.

4. THICKNESS OF WATERBEARING SAND AND BEDROCK TOPOGRAPHY

The results of the resistivity investigation are given in profile form in fig. 2 for the southern traverse. The gaps in the profile are unavoidable and are due to the fact that in the rugged dune terrain reliable measurements are not possible.

The western plain which is well covered by soundings shows firstly that the water level more or less follows the topography and secondly that the bedrock is everywhere below sea-level. Whether the latter condition holds true under the dune area as well is uncertain although the results of ES 15 (in the dune area) tend to support such a view. At any rate, the assumption that there is no ground water divide within the plain area seems valid for this traverse. The conditions to the north and south can only be established after more geophysical investigations have been carried out.

5. DISCUSSION

1. If we are to attempt to calculate how much groundwater flows into the lake then it is necessary

a) to conduct a number of pumping tests in the area to determine the permeability and storage coefficient of the waterbearing sands;

b) to conduct electrical sounding profiles (say every kilometre) to gain more information about the aquifer and the bedrock profile. These profiles can be selected to fit in with existing roads and topographical features.

2. To determine the bedrock profile under the dune area in the east does not seem a very practical proposition at present. The resistivity method is rather sensitive to topography although presumably one would be able to find a limited amount of sites where soundings could be performed. The seismic refraction method is also sensitive to topography since the superficial velocities tend to change with topographical relief but not nearly to the same extent as the resistivity method. Unfortunately there is another drawback when conducting any sort of geophysical work over the dunes viz., the loss in resolution with depth. An error of ± 10% on the plains where the bedrock is shallow is of no consequence; the same margin of error under 100 m of dune sand is ± 10 m which may be critical in deciding whether in fact the bedrock is above or below sea-level.

3. Since it is commonly felt among geologists that the sea is nearest its highest level ever, one would not expect that the bedrock would protrude

very far above sea-level anywhere on the eastern shores area. If we assume a bedrock below sea-level, a permeability value for the waterbearing sand of 5×10^{-4} m/s (a rather low value which indicates the presence of an appreciable amount of fine matter), an average hydraulic gradient of 1:200 as deduced from the electrical measurements and an average aquifer thickness (above sea-level) of 5 m then the flow through a kilometre stretch of aquifer $= 5 \times 10^{-4} \times \frac{1}{200} \times 5 \times 10^{3}$ m^3/s

$$\sim 1000 \; m^3/\text{day}.$$

As a comparison the rainfall per day on the same area (1,5 km x 1,0 km) is about 5000 m^3/day.

It should be emphasized that these calculations are purely speculative and are only meant to indicate the orders of magnitude for the different parameters involved.

To summarize, it is recommended that additional geophysical work in the form of pumping tests and sounding profiles be carried out over the entire eastern shores area. (Dune area excluded). Only after such an investigation will an accurate assessment of the amount of groundwater which flows into Lake St Lucia be possible.