UNORTHODOX HYDROGRAPHY AT KARIBA

by R. T. Bailey (*)

Kariba — the dam — has been much in the news. With the dam completed, and the impounded waters of the Zambezi turning the hydro-electric turbines, attention is being focussed on the lake and its prospects of navigation.

175 miles long and 19 miles wide, and covering 2 000 sq. miles when full, it will be the largest manmade lake in the world. The 416-feet-high dam is 300 miles below the Victoria Falls. The bottom generally will be irregular, with a depth of about 280 feet near the dam, and the coastline will be intricate and indented. The flooding of this large tract of land, though sparsely populated, necessitated the resettlement of 50 000 primitive river dwellers, though this feat was given less publicity than the animal-rescue operations.

The lake offers exciting prospects of a tourist industry, fishing, sailing, and perhaps of commerce. To deal with the development of these aspects the Kariba Lake Coordinating Committee was formed, being a body with representatives of the Federal, Northern Rhodesia and Southern Rhodesia Governments.

Exactly what craft there will be on the lake is uncertain. Already there are a few yachts and motor launches. There will be fishing boats, yachts and pleasure craft. Cargo vessels may follow. There is provision for a dockyard and slipway where vessels larger than the limiting dimensions imposed by road transport can be assembled and launched.

*
* *

If there are to be ships, or even launches, they will require charts. A proposal that charts should be compiled from existing landmaps was accepted, and the author carried out this possibly unique task of dry-land hydrography.

The material on which the charts were based was a series of 1/25 000 maps covering the whole lake area, made by the Air Survey Company in 1952. The contour interval was 25 feet. Inaccuracies far in excess of those permissible in a properly sounded hydrographic survey were inevitable. They would occur not only in the interpolation of soundings between contours, but in the permitted error of the contours themselves, which was half the contour interval, or ± 25 feet. A further source of error was revealed when precise levelling was carried out right round the lake area,

(*) See biographical note in the January 1960 issue of the *International Hydrographic Review,* page 43.

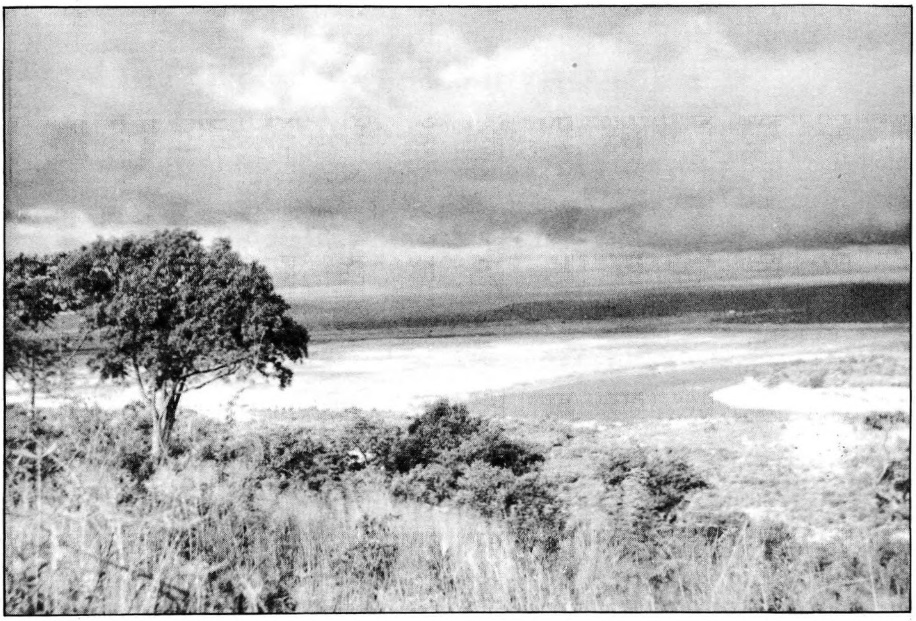


Fig. 1. — View of the Zambesi valley from the Native Commissioner's house at Binga.
The light area in the middle distance has been cleared of bush.

with connecting lines across the valley, and this showed a discrepancy of about 5 feet in the bench marks at the southwestern end of the lake.

Soundings interpolated between contours were based on the assumption that the gradient was even. If it was not so, then an error amounting almost to the contour interval was possible, which might be increased or decreased by the permitted contour error of $\pm$ 12.5 feet. On steep slopes, with closely spaced contours, the error would be immaterial, but over flat country, with contours far apart, the error would be considerable.

The charts were planned to cover the lake with five overlapping sheets on a scale of 1/75 000. A general sheet on a scale of 1/250 000 shows the whole lake, and certain harbor sites and approaches are covered by 1/25 000 plans.

*
* *

The top operating level of the lake is designed to be 1 590 feet above MSL Beira. During the dry season there is likely to be a draw-down of 15 feet, and a succession of unusually dry seasons might result in a draw-down of 30 feet. Thus 1 560 feet above MSL, being the probable lowest lake level, was selected as chart datum. A possible increase of 10 feet *above* top operating level was not taken into consideration for the charts, though it had to be reckoned on in the engineering designs for harbor works and shore installations.

Both soundings and heights were referred to chart datum, and the high-water line at 1 590 was not regarded in the same way as mean high-water springs on a marine chart. Negative soundings were shown in the

Fig. 2. — Aerial view of the dam in course of construction, showing the impounded waters of the Zambesi, Kariba township on the south side, and the new lake forming in the distance.

conventional form, or in the case of small drying features, as a height. This gives rise to the anomaly that features shown with a height of, say, 10 or 20 feet will in fact become submerged during much of the year.

Being at 25-foot intervals, the contours on the maps in the vicinity of the coastline were at 1 550, 1 575, and 1 600. Low-water level at 1 560 and high water at 1 590 had to be interpolated by eye, and in places where the contours are widely spaced a considerable lateral displacement of the coastline is possible. The low-water and high-water lines were indicated by a thick firm line and a thin firm line respectively, pecked where doubtful. A blue wash below the low-water line, and a green wash above the high-water line left the area of drying soundings in between conspicuous.

Isolations were a matter of intelligent guesswork. An isolation of, say, 1 550 ft (10-ft sounding) might rise almost to 1 575 (15-ft negative sounding) or on the other hand might flatten off at 1 555. Such isolations were generally shown as drying, their indicated height above datum depending on the size of the isolation and on the spacing on the contours surrounding it. It is possible that certain features shown on the charts as islands may not in fact exist *as* islands at any lake level.

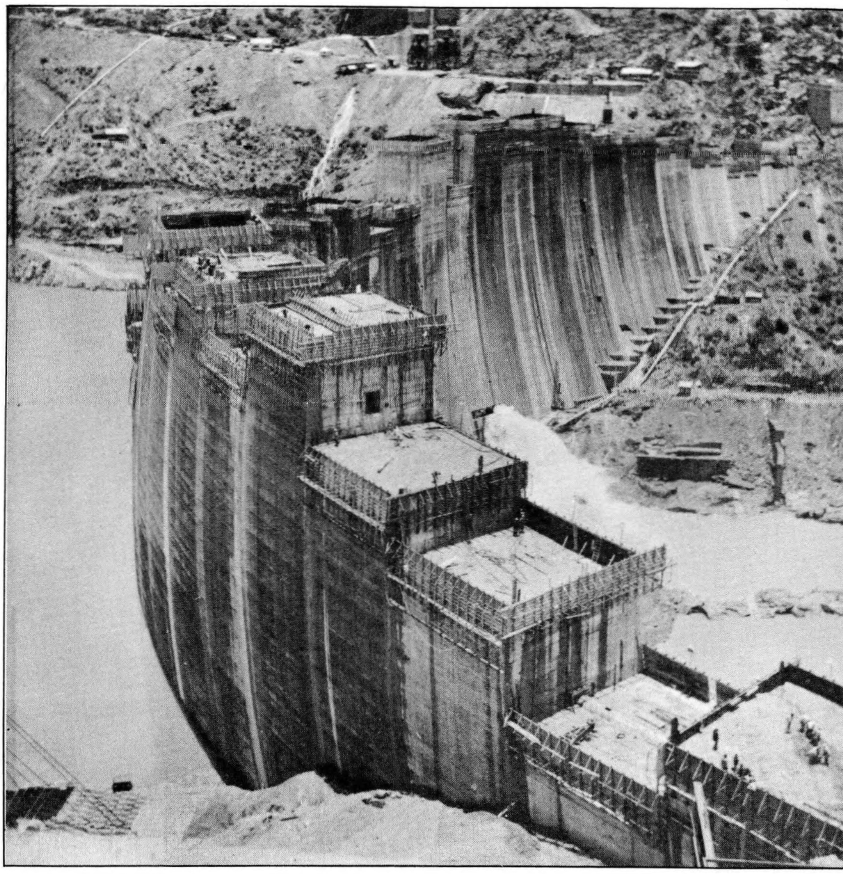


Fig. 3. — Kariba dam in course of construction, as viewed from the south bank in February 1959.

*
* *

The method of compiling the charts was as follows :

The coastline (1 560) and the high-water line were drawn direct on to the 1/25 000 sheets. The water area was then filled with soundings from a careful scrutiny of the contours, spaced according to the intricacies of the ground and the depth of water. Soundings, in feet and not in fathoms, were generally shown to an even 5 feet. Underwater contours, indicated by fathom symbols, were drawn at depths of 10 feet, 50 feet, 100 feet and 200 feet. With a view to reduction to 1/3rd scale, drawing was done free-hand with a No. 3 UNO pen, and each sheet, covering 15 minutes of latitude and longitude, was photoreduced, background detail being eliminated as far as possible. The transparent photopositives were then waxed onto a sheet of astrafoil on which the graduation had been drawn. With compass roses stuck on, and title and other details added, the compilation drawings were complete.

For the 1/250 000 sheet a similar process was applied to each of the

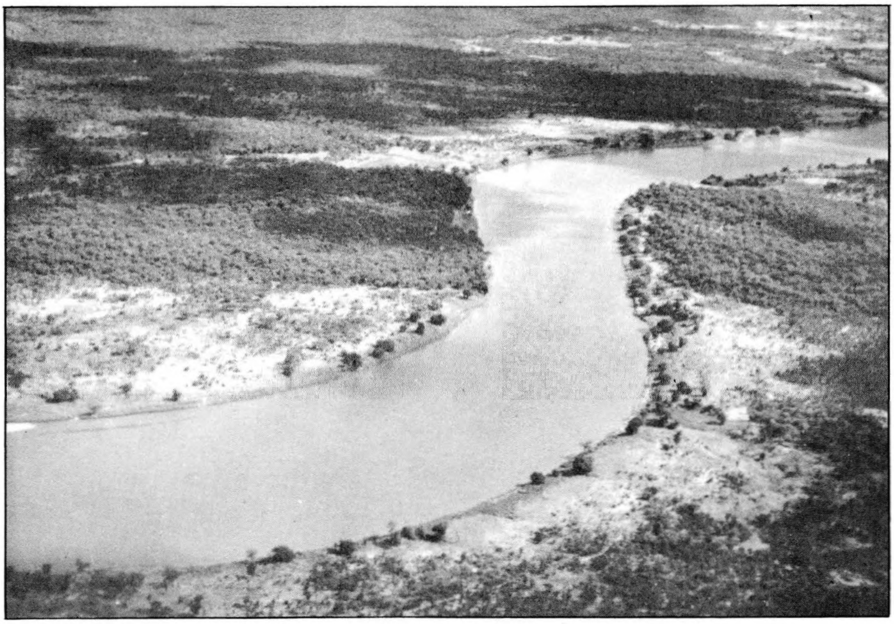


Fig. 4. — A view of the Zambesi from the air, showing the tree-covered nature of the bottom of the new lake in areas where bush has not been cleared.

1/75 000 sheets. The coastline and underwater contours were drawn, — simplified where too intricate for reduction, — and selected soundings traced. Reduced photopositives were then waxed onto a graduated transparent sheet as for the others.

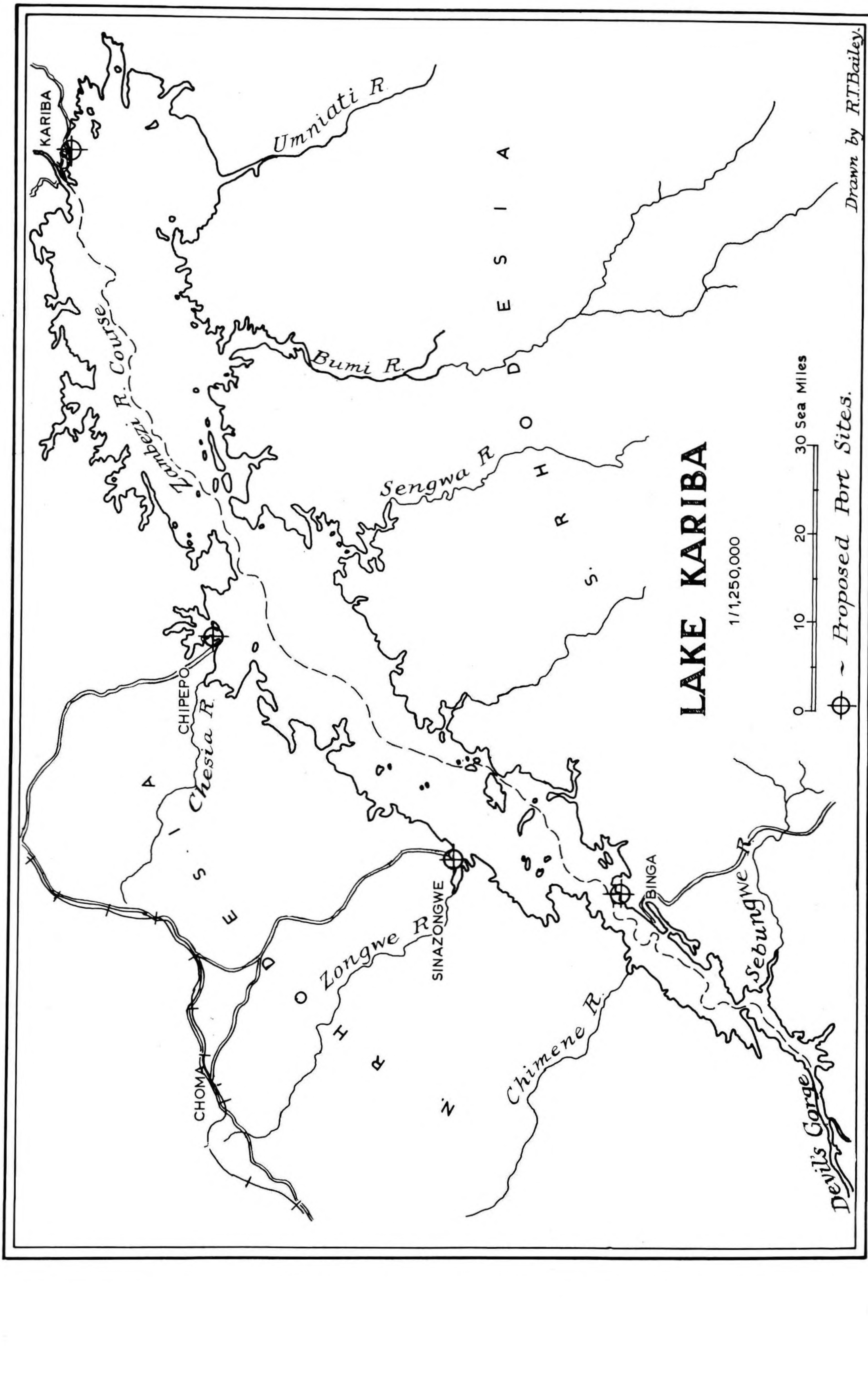
The whole task took 3 ½ months. A hydrographic survey of Lake Kariba would have taken 10 years or more, and in any case could not have been carried out until the lake was full, which will not be until 1962 at the earliest. Sounding of certain areas will have to be carried out in the future, depending on the trend of shipping development and navigational requirements. At least the charts show the areas of deep water which may safely be left without further survey, and they have already been useful for planning requirements.

The charts were produced under the supervision of the Director of the Federal Department of Trigonometrical and Topographical Survey, and will be published by that department.

*
* *

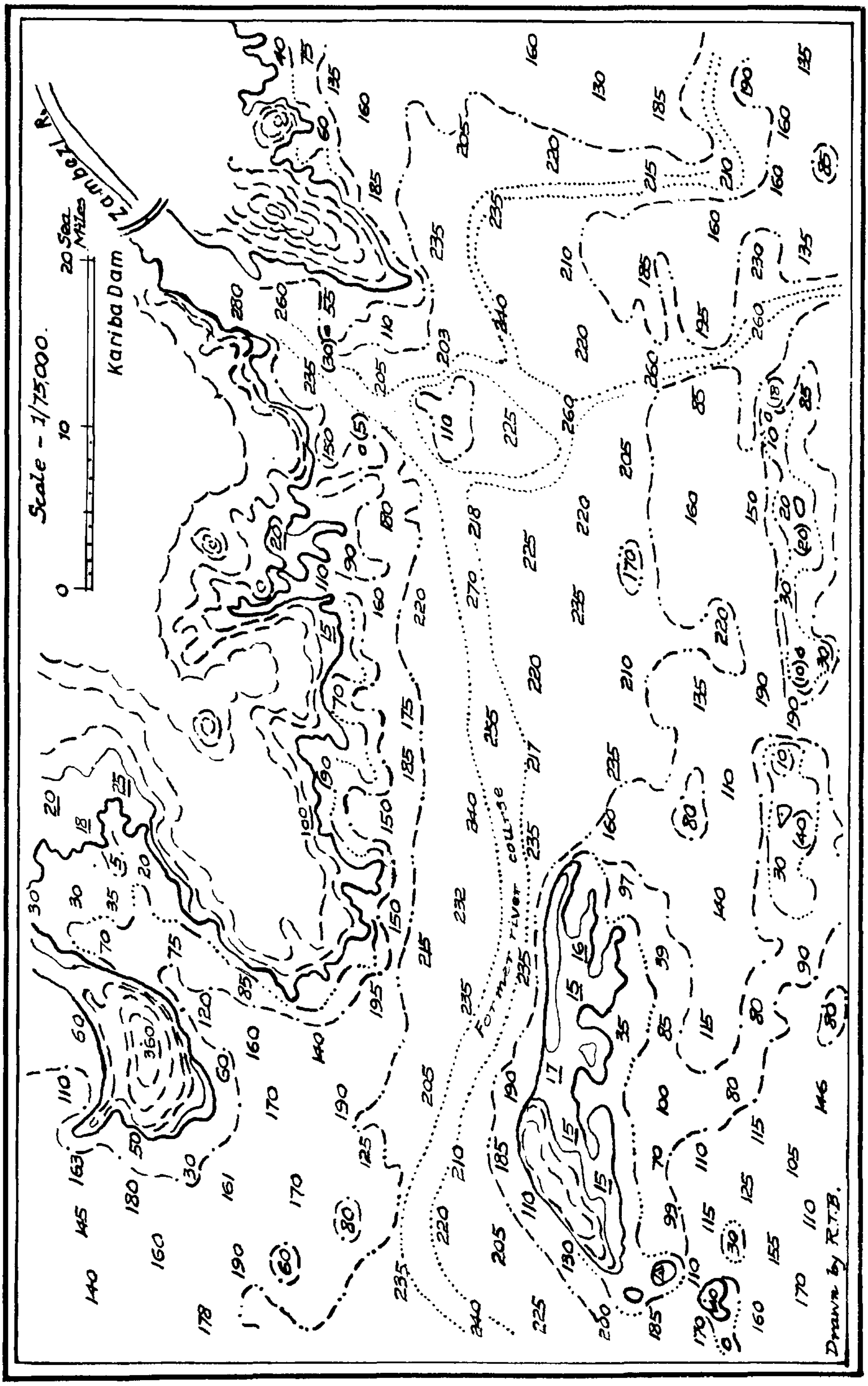
The whole of the Zambesi valley is tree-covered except for the old cultivations. Much of it is characteristic mopani bush, with trees generally between 25 and 40 feet, but there are larger trees such as the elephantine baobab, and it is inevitable that sooner or later some craft will find itself perched in the upper branches of one of these submerged trees.

If fishing was to be developed — and an estimate puts the yield at 10 000 tons a year — it was necessary to clear vast areas of bush down to



Pl. 1. — General map of Lake Kariba as it will be when full.

Reproduced by permission of the Government of the Federation of Rhodesia and Nyasaland.



Pl. 2. — Portion of chart of Lake Kariba in vicinity of the dam.

Reproduced by permission of the Government of the Federation of Rhodesia and Nyasaland.

ground level to leave the bottom free of snags for fishermen's nets. Before inundation 375 sq. miles of bush will have been cleared in selected areas, generally from the high-water line to 50 feet below chart datum. No economic method of using the timber could be found, and the felled trees were bulldozed into rows and burnt. These areas had, of course, to be shown on the charts, which bear a rather unusual caution :

> *Soundings, interpolated from contours, may be in error by ± 10 feet. Trees and boulders are likely to exist in uncleared areas, and vessels should avoid navigating in shoal water except in cleared areas.*

The charts are weak in three matters other than those referred to :

1. Features for use in navigation are few and far between, and navigation will have to be very much by eye.

2. The charts will not form a stable basis for further sounding, as they include very few identifiable and securely plotted points. Future hydrographic work will have to start with a local triangulation. As for the laying of buoys, whereas it is quite easy to indicate positions on the charts where they would be desirable, the task of actually laying them *in* those positions would be quite another matter. For marking the limits of areas cleared of bush it is proposed to lay marker buoys on the ground *before inundation,* and indeed this is the only way of doing it accurately.

3. The charts are almost entirely lacking in names. Many new marine features are in the process of being formed — bays, straits, narrows, channels, shoals and points — for which names will have to be invented. This is one of the rare legitimate opportunities for commemorating individuals, though if every feature were given a mere surname, romantic places would be endowed with a civil-service prosiness.

* * *

The search for harbor sites was another matter in which the author found himself engaged in unorthodox hydrography — in the bush and amongst the mealies with a level and stave instead of sounding in a boat.

The services of Sir Alexander Gibb and Partners (Africa), Consulting Civil Engineers, had been engaged to investigate the whole problem of harbors, to recommend sites, and to draw up detailed plans of port installations. Four harbors were envisaged : at Kariba itself, at Sinazongwe and Chipepo on the Northern Rhodesian shore, and at Binga, far up the lake on the Southern Rhodesian shore. The basic requirements of sites were (*a*) shelter, especially from the northeast and east, from which quarter the prevailing wind is expected, (*b*) deep-water approaches, (*c*) a reasonably shallow area for use as an anchorage, and (*d*) ground rising at a suitable gradient and high enough for jetties or hards and the shore installations. Likely-looking places were selected from a close scrutiny of the land maps, but reconnaissance in the field — sometimes carried out in country heavily populated with elephant — ruled many of these out on account of the nature of the ground or of some other feature which was not apparent on the maps.

It must be admitted that too much reliance was placed at first on the 1/25 000 maps, which were in any case on too small a scale for basing designs on. This was especially the case at Chipepo, where an island site seemed to offer advantages, but which would require a causeway apparently about ½ mile long and not more than 20 feet high to connect with the mainland. A survey on the ground based on a nearby precise bench mark revealed that heights as shown on the map were as much as 20 feet too high, and that the causeway would have to be a mile long and over 40 feet high in places. This ruled out that site on the grounds of expense, and some rapid revision of plans was necessary.

The very large predicted range of lake level (40 feet) made for unusual problems in the design of port installations. Clearly a normal type of jetty would be impracticable; it would be alternately high and dry or submerged at low and high lake levels. The installations are likely to be in the form of a sloping hard or jetty with a gradient of not more than 1 in 10. Even these will have to be some 500 feet in length, though only about 60 feet will be available for vessels to secure alongside at any one lake level. There are to be facilities for passenger landings and cargo handling, and for local fishing craft. The jetties and hards will be constructed *dry*, and will await the rising waters of the lake to bring them into service, which is unlikely to be before 1964.