United Republic of Tanzania
Ministry of Water, Energy
and Minerals

Kingdom of the Netherlands
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Morogoro Domestic Water Supply Plan

Volume IV

Hydrogeology - Annexes and Data

Final Report

August 1980

DHV

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ANNEXES

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ANNEX DA 1

THE GEO-ELECTRICAL METHOD

DA 1 THE GEO-ELECTRICAL METHOD

General

The geo-electrical method is described in many handbooks and reports, to which the reader is referred (see references sub-par. 2.4., No. 5, 11, 17, 27, 29 and 50). Here just some aspects will be mentioned.

All matter has the intrinsic property of an electrical resistivity (ρ), which is expressed in ohmm (=Ωm). Therefore each earth layer has also this property which is usually called the formation resistivity (ρ_f). When the pores of the formation contain water, the following relation between the formation resistivity and the resistivity of the pore water (ρ_w) has been found.

$$\rho_f = F \times \rho_w \qquad (1)$$

F is called the formation factor. Its value depends among other things on:

- porosity
- mineral content, e.g. clay and/or sand
- grain size, shape and arrangement of the particles.

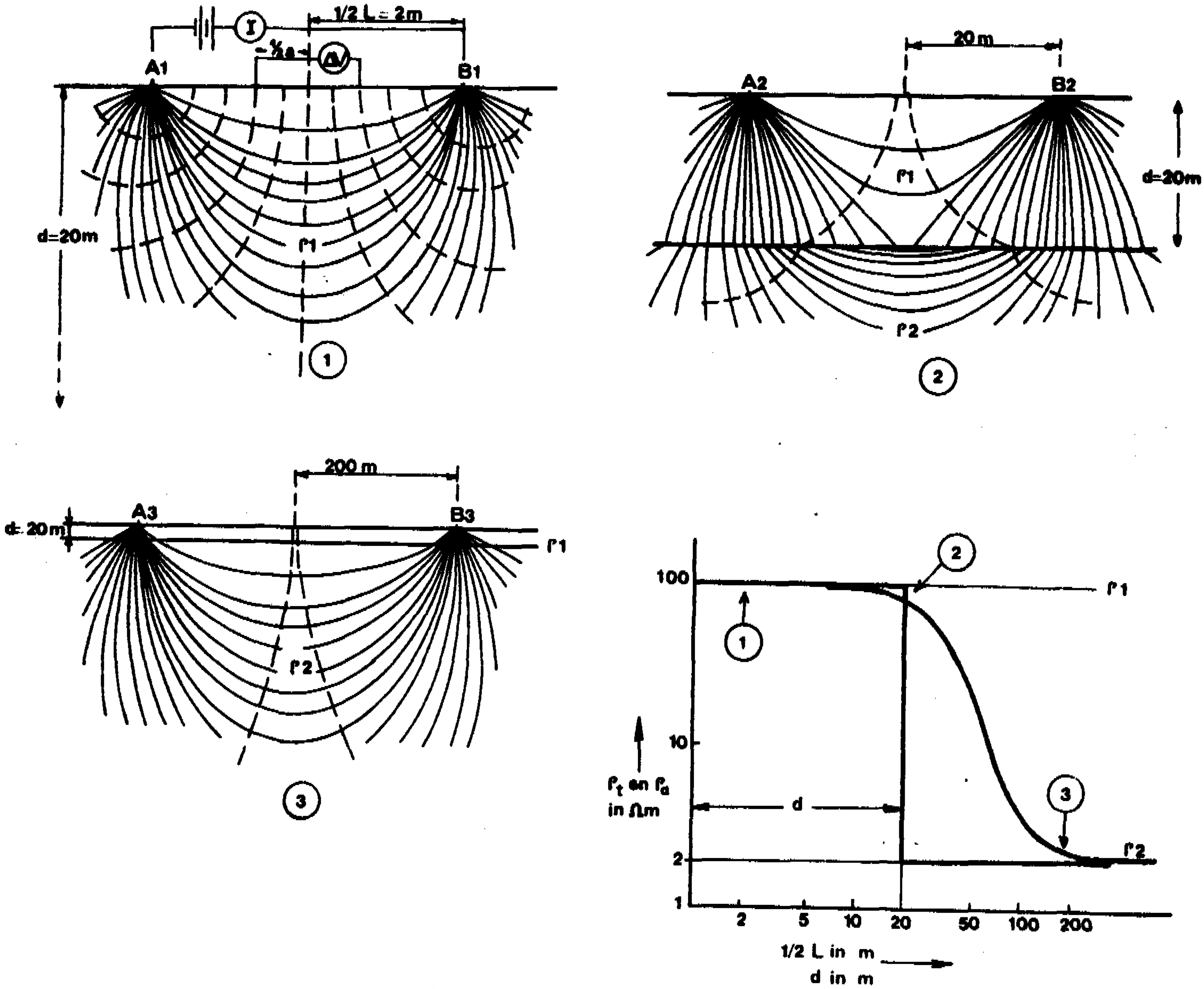
For clayey layers the formation factor depends also on the water resistivity.
The resistivity values of different formations can vary from less than 5 ohmm up to more than 1000 ohmm. Due to the occurrence of these high contrasts between the formation resistivities, the geo-electrical method is often very suitable to distinguish the different layers.

In general the conductivity of water (EC) is given. The relation between the conductivity (in mS/m) and resistivity (in ohmm) is:

$$EC = \frac{10^3}{\rho}$$

When there is no water in the formation the current conductivity is not electrolytic and the formation resistivity is always very high ($\rho_f > 500$ ohmm). In fissured bedrock the current conductivion takes place through the water in the fissures.

From formula (1) it is clear that when the salinity of the formation water increases, the water resistivity as well as the formation resistivity decrease. Moreover, if the clay content of a formation increases, the formation factor and with this the formation resistivity decrease. It has been found, just because of these two effects, that a distinction in the formation resistivities can be made between water-bearing layers with fresh water on the one hand and clayey layers or saline water-bearing layers on the other hand.



Geo-electrical sounding in Schlumberger arrangement of a subsurface built up by two layers with formation resistivities ρ_1 = 100 Ωm; ρ_2 = 2 Ωm.

1, 2 and 3: three steps of a sounding. Full curves indicate current lines; dashed curves indicate equipotential lines.

The 4th figure gives the resulting sounding graph, with the interpretation in the lower part.

Fig. DA 1-1: Principle of geo-electrical sounding technique.

As in hydrogeologic studies the occurrence of fresh water-bearing layers is very important, the geo-electrical method is often applied to trace these layers. It is also clear that it is very difficult or even impossible to distinguish clayey layers from saline aquifers.
By the execution of measurements on the groundlevel the true formation resistivity of the successive layers cannot be measured directly. Carrying out surface measurements (a sounding) only the so-called apparent resistivity (ρ_a) can be determined. Such a sounding has to be interpreted to true formation resistivities.

Field technique

A geo-electrical sounding is carried out by means of an arrangement comprising four electrodes. For the Schlumberger configuration used in the present survey, the electrodes are placed in a straight line, symmetrical in respect to a central point (fig. DA 1-1). Via the outer electrodes A and B an electrical current is passed through the soil. This generates a potential distribution inside the earth and therefore also a potential difference between the two inner electrodes M and N. This potential difference (V) and the strength (I) of the current applied is measured. The apparent formation resistivity value is calculated then by using the formula:

$$\rho_a = \frac{\pi}{4} \frac{L^2 - a^2}{a} \frac{V}{I}$$

where a and L are the spacings between M and N, respectively A and B. This calculated resistivity value is plotted against the value of L/2 belonging to it.
A sounding consists of a series of observations of current strengths and potential differences with varying electrode distances.
The distance between the current electrodes (L) is at first usually 3 metres. The potential electrodes are then placed at a distance (a) of 1 metre from each other. The distance between the current electrodes is subsequently increased in steps. As the arrangement expands, the current penetrates more and more deeply into the earth. As a result, more and more strata will influence the measurements. The distance between the potential electrodes remains unchanged, unless V becomes too small to be accurately read. Then the spacing between the potential electrodes is increased, after which the expanding of the AB-spacing is continued. The maximum distance between the current electrodes is determined by the depth to which information is desired.
In this way the relation between the horizontal distance L/2 and the apparent formation resistivity ρ_a is determined at several discrete points.

Interpretation

After a sounding is carried out a smooth line is drawn which fits the observation point as well as possible. It is often possible then to make immediately a qualitative interpretation of the soundings. This means that often a qualitative prediction can be given concerning the layer structure, i.e. the occurrence of clayey and/or saline water-bearing layers (low resistivities), prospects for sandy or gravelly aquifers with fresh water (medium to high resistivities), the depth to the bed-rock (very high resistivity) etc.
The quantitative interpretation of the soundings is a much more complicated problem. The interpretation is carried out in two stages.

- In the first stage the surface measurements have to be converted into a vertical sequence of layers with each a different formation resistivity, so:

  $$\rho_a\ (L/2) \rightarrow \rho(z)$$

- There upon these interpreted layers have to be translated in hydrogeological terms, so:

  $\rho(z) \rightarrow$ hydrogeological sequence of layers

The first stage of the interpretation is done by a curve-fitting method. For this purpose three-layer master curves 1) are used and a programmable pocket calculator (HP 97).
To execute the second stage, the relation between the formation resistivity values and the hydrogeological strata, which holds for the area under investigation has to be known.
The use of the geo-electrical method is limited, which is mainly caused by the following factors (see also sub-par. 3.2.3.):

- interpreting a sounding, it is assumed that the layers are horizontal and homogeneous over a rather large area;
- non uniqueness of interpretation; this means that one sounding may represent different sequences of resistivity layers (see the examples presented in sub-par. 3.2.3.);
- the actual sequence of layers has to be (strongly) schematized, due to the restricted resolution of the geo-electrical method;
- different hydrogeological strata may have the same value of formation resistivity (see table D 3.2.-2).

Due to these limiting factors, a sounding has not to be regarded as an isolated one. Interpreting a sounding all the available data of neighbouring boreholes and all the information of the nearby soundings have to be taken into account. Moreover, it is in general very helpful to have in advance a conception of the hydrogeological structure to start with. This conception has to be based on the available hydrogeological data, such as borehole data.

1) Rijkswaterstaat, the Netherlands (1969). Standard graphs for resistivity prospecting. European Association of Exploration Geophysicists, The Hague.

Approach of a geo-electrical investigation

In areas where little is known about the hydrogeological structure no final interpretation of the soundings can be given directly.
In the first instance the soundings can be interpreted then only tentatively into simple resistivity models. Because the interpretation is non-unique, the actual sequence of layers may be much more complicated than the simple models. In an interpreted model several actual layers are taken together and replaced by one "substitution" layer which has an "average" resistivity value.
After an evaluation of the tentative interpretations of all the soundings some locations are chosen where exploratory boreholes have to be drilled in which resistivity well logging measurements have to be executed. Based on these required informations the relation between the formation resistivity and the hydrogeological strata can be established. Moreover, on the ground of the boreholes and the tentative interpretations of the soundings a conception about the hydrogeological structure can be made. Backed with all this knowledge the final interpretation of the soundings can be made and finally a coherent model of the hydrogeological structure of the area and the prospects for the occurrence of fresh ground water can be presented.

ANNEX DA 2

GEO-ELECTRICAL INVESTIGATIONS TO SHALLOW DEPTH
SPECIAL STUDY

DA 2 GEO-ELECTRICAL INVESTIGATIONS TO SHALLOW DEPTH (special study)

CONTENTS

Figures

Tables

DA 2.1. SUMMARY

Within the scope of the hydrogeological survey detailed knowledge was required about the occurrence of shallow ground water and its quality. This information could be obtained from hand-drilled boreholes, the execution of which is time consuming.
Geo-electrical measurements have been carried out and compared with hand-drilled borehole data, to investigate the possibilities of using this method as an expedient in the investigations of shallow ground water and to optimize the selection of suitable shallow well sites.

The use of the geo-electrical method in the investigations for shallow ground water appeared to be possible, although with a low accuracy. By means of a qualitative interpretation of the sounding curves only a general impression can be obtained about the occurrence and water quality (fresh versus saline) of shallow ground water. Optimization of the selection of shallow well sites does not seem feasible with this method because of its low accuracy and the time required for execution and interpretation; this apart from the fact that this method requires a skilled geophysicist/operator, labourers, equipment and transport.

DA 2.2 INTRODUCTION

Within the scope of the hydrogeological survey of the MDWSP, detailed knowledge was required about the occurrence, the quantity and the quality of shallow ground water. The required data have been obtained from existing boreholes, shallow wells, pools and hand-dug holes.
It has been found, however, that often additional information is necessary. This information could be collected among other things from hand-drilled boreholes, the execution of which is time consuming.
In July 1978, the Morogoro Wells Construction Project (MWCP) started to operate in the Morogoro Region. Therefore, a skilled siting crew, from the Shinyanga Shallow Wells Project (SSWP), executed a survey to locate about fifty suitable shallow well sites in the period from May up to September 1978.
Owing to these circumstances it has been decided to study the following questions:

- to what extend is it possible, by means of the geo-electrical method, to predict the occurrence of shallow water-bearing layers, their thickness and the quality of the water;
- is it possible by means of the geo-electrical method to optimize (that is to speed up and to economize) the siting of shallow well locations.

This study has been integrated in the running programme of the siting crew. In this way the results of the geo-electrical measurements could be compared directly with the data of the hand-drilled boreholes such as sample descriptions, resistivity well-logging measurements and the quality of the ground water expressed in EC-values.

The survey area was situated in the northern part of the Morogoro Region along the northern border of the Wami valley. The investigations have been carried out near villages along the road between Dumila and Turiani (see e.g. map D1).
For a hydrogeological description of the survey area the reader is referred to par. 4.1.

DA 2.3 APPROACH TO THE STUDY

The investigations have been performed in two stages.
In the first one, which took place near the villages between Dumila and Mvomero, the geo-electrical group followed the SSWP siting crew. A geo-electrical sounding was carried out near most of the hand-drilled holes. In this way experience was gained concerning the types of stratification occurring in the investigated area and the corresponding sounding curves.
In the second stage the geo-electrical group preceded the hand-drillers. In this stage the villages between Mvomero and Turiani were visited together with the SSWP hydrogeological assistant. Pursuing the SSWP procedure (see DA 2.4.), in each village areas were located which showed good prospects for shallow well sites. In every promising area one or more geo-electrical soundings were executed. On the basis of these soundings the decision has been made whether the location should be considered for further investigations by means of hand-drillings or not. All these locations have been shown to the surveyor of the siting crew after which the siting has been completed with hand-drillings, EC measurements, well loggings and if necessary a yield test. Then the comparison between the geo-electrical soundings and the boreholes could be carried out and an evaluation could be made.

DA 2.4 THE EXECUTED STUDY

DA 2.4.1 Working method of the SSWP siting crew

Because one of the objectives of the study was to investigate the possibilities of optimizing the selection of shallow well sites and because the execution of the study has been integrated in the running programme of the SSWP siting crew, it is necessary to discuss the working method of this crew. This working method will be summarized below. For a comprehensive description the reader is referred to the booklet Shallow Wells 1).

The survey for selecting shallow well sites consists of two phases.
In the first one a hydrogeological assistant selects the areas near villages for further investigations. The following procedure is applied:
- gathering of information about the existing water supply (pools, springs, etc.) of the villages with the aid of ward heads and village-leaders;

1) DHV (1978): Shallow Wells, DHV Consulting Engineers, Amersfoort, the Netherlands

- establishing the number of the necessary well sites for the villages (one well for about 300 inhabitants);
- selections of promising areas on the ground of the hydrogeological prospects, based on the geology and topography.

The selected areas have to fulfil the following conditions:
- the distance to the village must be less than 1 to 2 km;
- they must be accesssible for the construction group;
- they must not be situated within 100 m of a source of contamination;
- they must be safeguarded against flooding.

These selected areas are successively numbered per 1:50.000 mapsheet (e.g. 165/4-7).

In the second phase a detailed investigation is carried out by the siting crew by making several hand-drilled boreholes. The following items have to be mentioned:
- the hand-drillings are carried out with light-weight equipment of small diameter; the maximum drilling depth is 10 metres;
- yield tests; if a water-bearing layer of reasonable thickness is found and if the EC of the water is less than 200 mS/m a yield test *is performed by means of a simple handpump* during one hour; drawdown and yield are measured every 10 minutes;
- water quality checks, mainly concerning EC values are carried out during drilling and yield test.

All hand-drillings are successively numbered per area (e.g. 165/4-7-3).

DA 2.4.2 <u>Equipment</u>

The geo-electrical soundings have been carried out with simple portable equipment. A Bison, type 2350A, earth resistivity meter has been used in combination with a special cable, normally used for "profiling" measurements. With this equipment soundings could be executed rapidly, with a maximum length (L/2) of 20 meter.
Resistivity well-logging measurements have been performed in the boreholes with a Geohm resistivity meter in combination with a self-made probe with an electrode distance of 0.2 m. These measurements have been carried out with depth intervals of 0.5 m.

DA 2.4.3 <u>Fieldwork and interpretation</u>

The actual fieldwork took two weeks, in which fifty two geo-electrical soundings have been carried out in thirty three promising areas. The soundings were numbered by adding successive letters to the site number, e.g. 165/4-7-b. Well logging measurements got the same number as the hand-drilled boreholes, e.g. 165/4-7-3.

The geo-electrical soundings, plotted on double logarithmic paper have been interpreted with the curve fitting method using three layer master graphs (see also annex DA 1). In table D 3.2.2 the relation between the formation resistivity values and the hydrogeological strata is presented.

The curves and their interpretations are given in figure DA 2.1. In the same figures the lithological profile of the corresponding borehole and the data of the resistivity well logging are given. The interpretation took about one week.

The SSWP siting crew carried out fifty three hand-drillings in the investigated area, which has taken six weeks. Thirty seven of these have been executed at the same location as a geo-electrical sounding.

A review of the hand-drillings, geo-electrical soundings and well-loggings per area and per village is presented in table DA 2.2. The results of the different interpretation methods as discussed in DA 2.5.1 and DA 2.5.2 are also given in this table.

DA 2.5 RESULTS

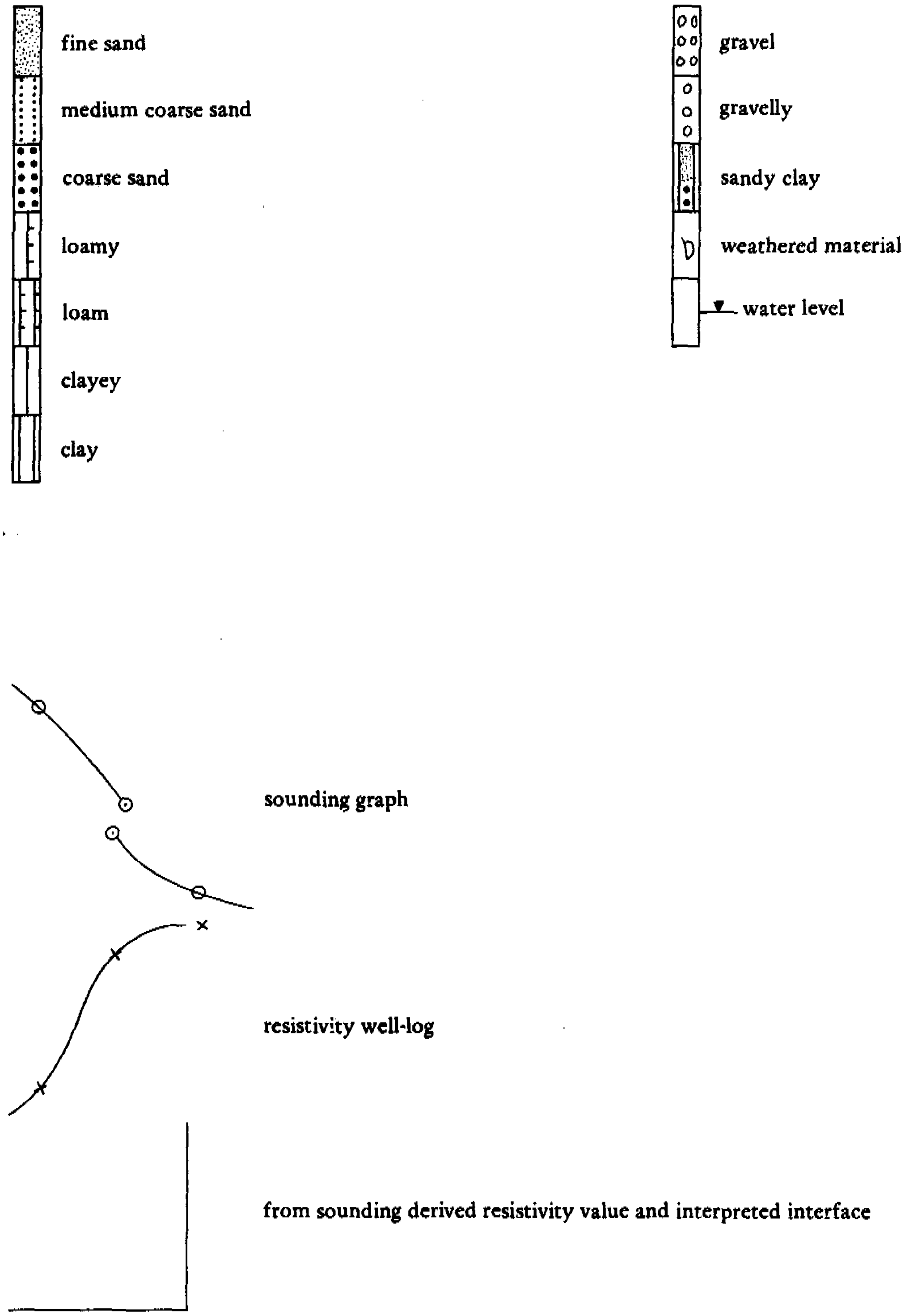
DA 2.5.1 Quantitative interpretation

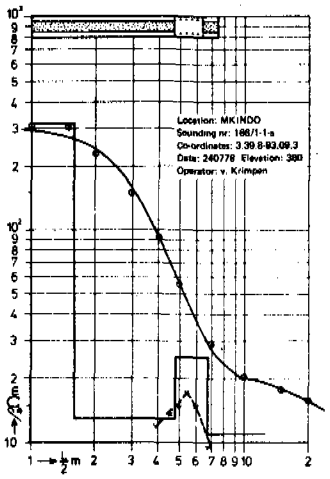
The geo-electrical soundings have been interpreted quantitatively into a hydrogeological model. These interpreted models have been compared with the lithological profile gathered from the borehole descriptions. A distinction has been made between a good, bad and "not clear" correspondence of the interpreted model with the hand-drilled lithological profile in view of depth, thickness and resistivities of the layers. These results are given in table DA 2.2. Ten soundings turned out to have an interpreted model that corresponds well with the drilled profile (e.g. 166/1-2-a). On the contrary the interpreted models of thirteen soundings had a bad correspondence with the borehole data (e.g. 166/1-3-a), while fourteen interpreted geo-electrical soundings have been indicated as "not clear" as compared with the lithological profile (e.g. 166/1-4-a). In some soundings only the top of a layer could be found while the bottom could not be indicated due to the limited length of the soundings. In many cases thin (water-bearing) layers could not be distinguished in the sounding curve due to the theoretical restrictions of the geo-electrical method as mentioned in sub-par. 3.2.3. These thin layers, however, are often of great importance for the exploitation of shallow ground water.
In general it can be said that the correspondence between the interpreted models an boreholes is not very good and the accuracy is low. Therefore it is concluded that a quantitative interpretation of the soundings is not suitable in shallow hydrogeological investigations, which do not exceed a depth of 10 to 15 m.

DA 2.5.2 Qualitative interpretation

The sounding graphs have also been interpreted in a qualitative way. On the ground of the measured (apparent) resistivities and the general shape of the sounding curves, predictions have been made concerning the possibilities for waterbearing layers with fresh ground water.

Fig. DA 2.1 Legend to geo-electrical soundings and corresponding lithologic bore hole profiles and well logs

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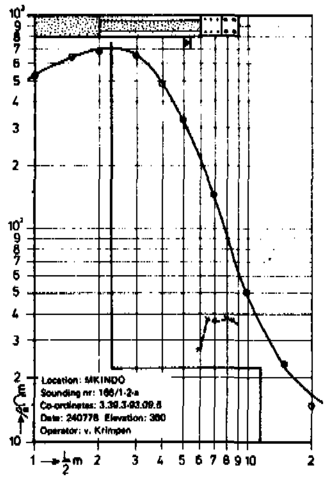
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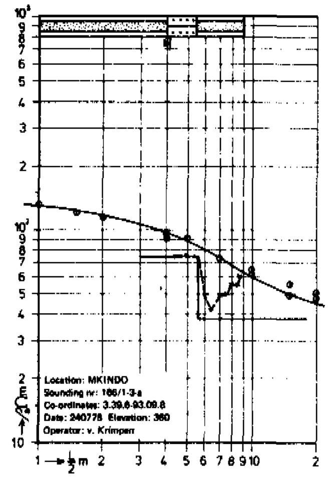
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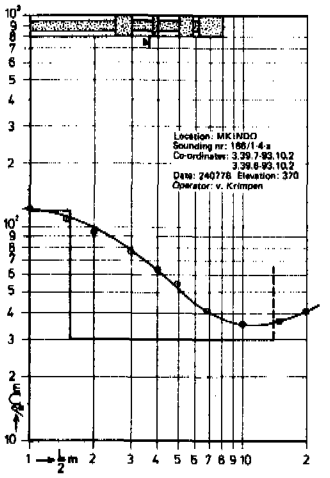
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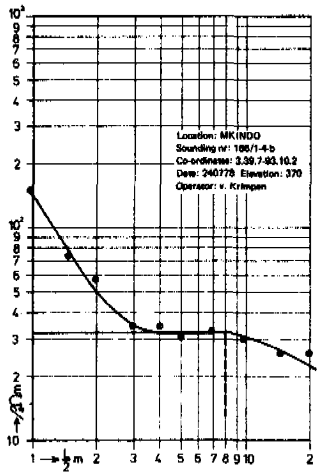
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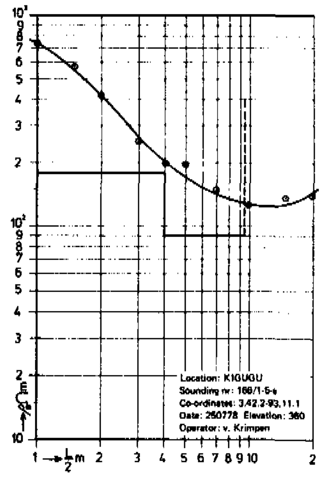
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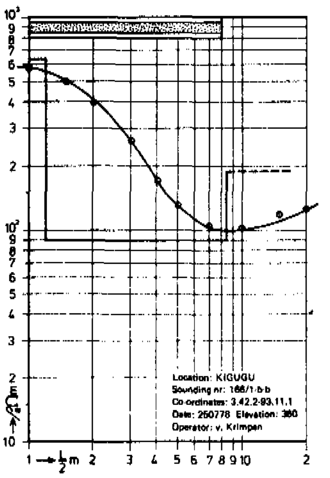
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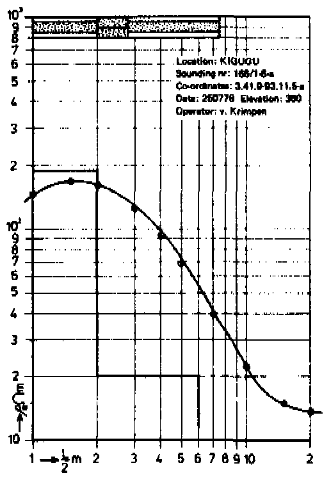
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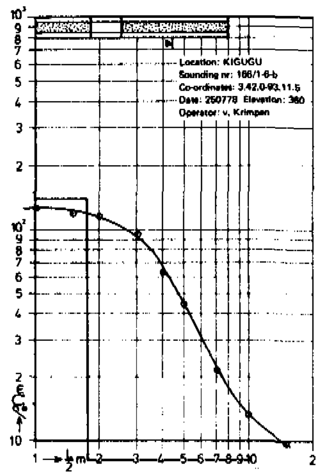
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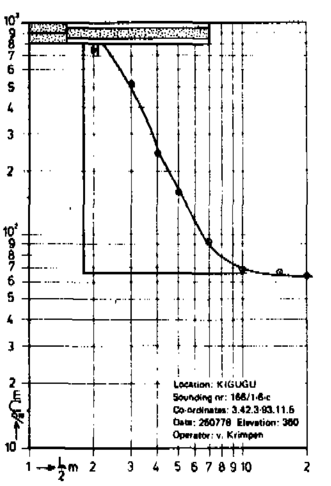
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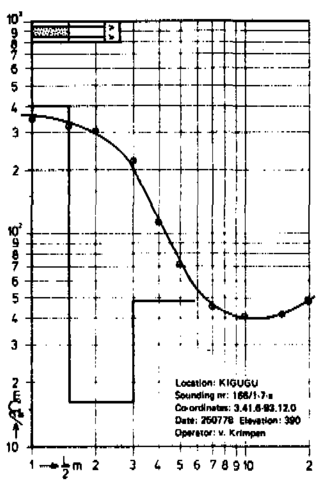
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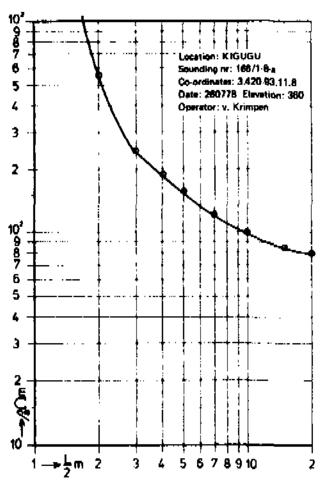
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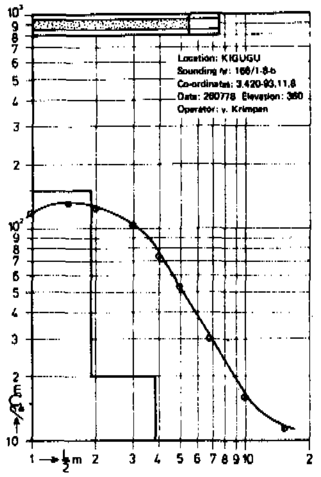
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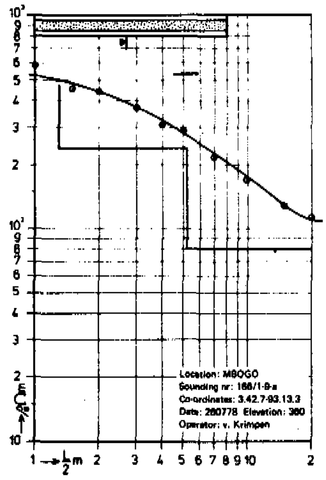
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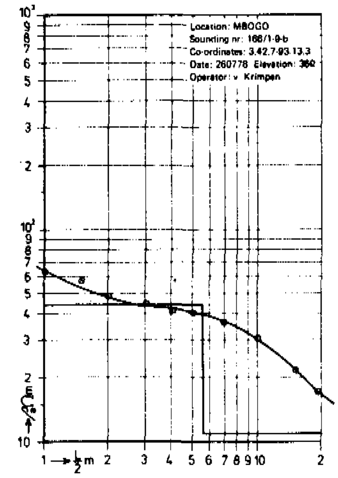
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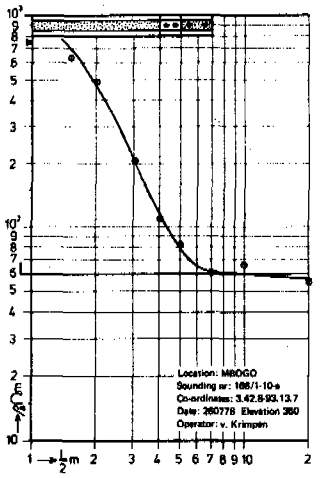
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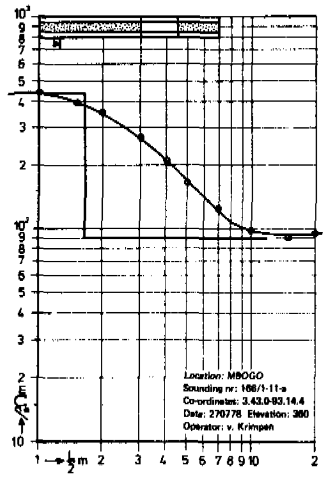
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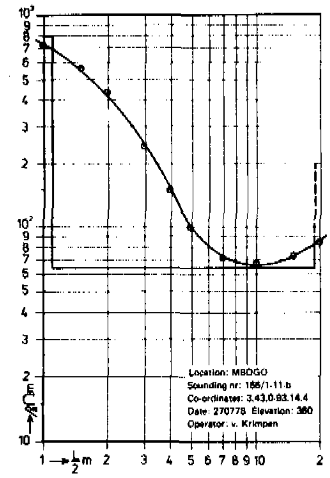
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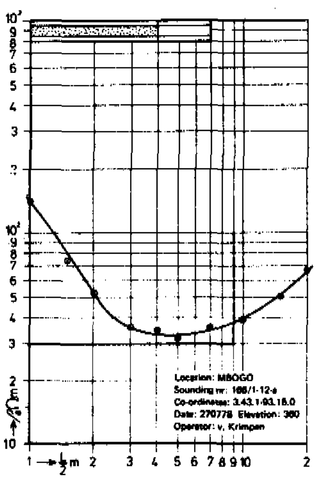
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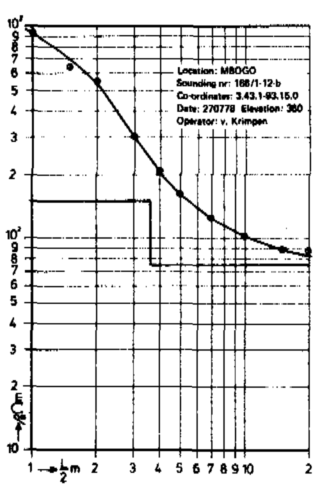
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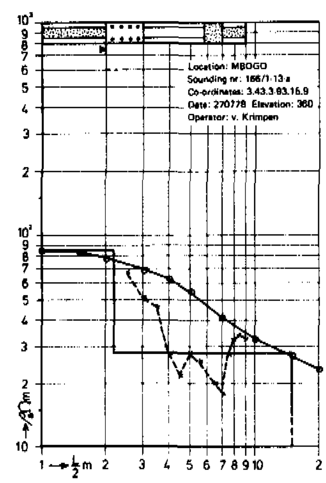
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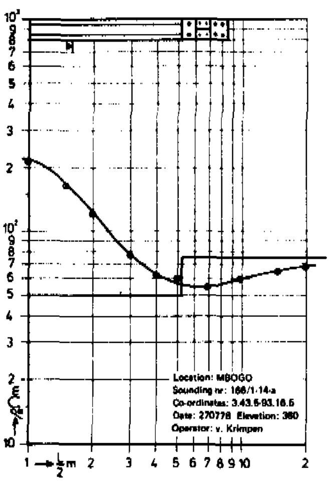
Date: 270778 Elevation: 360
Operator: v. Krimpen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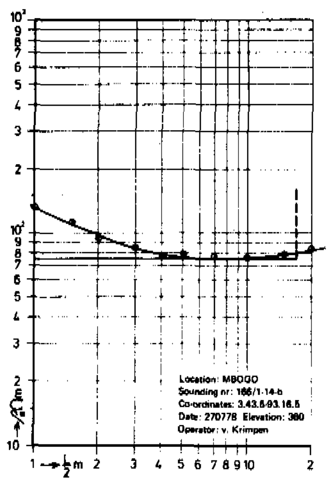
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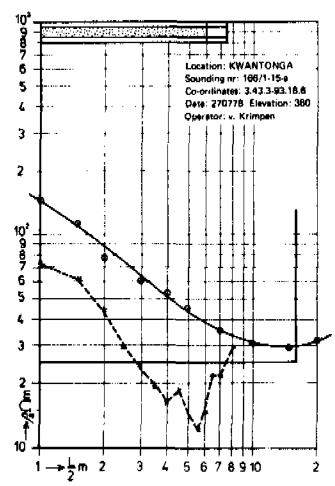
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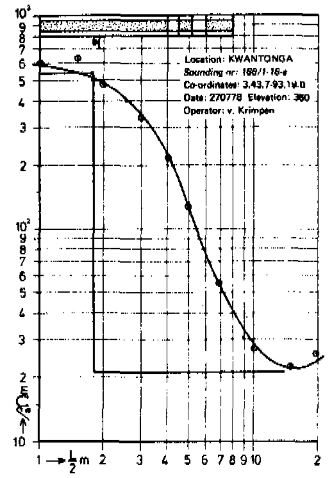
Operator: v. Krimpen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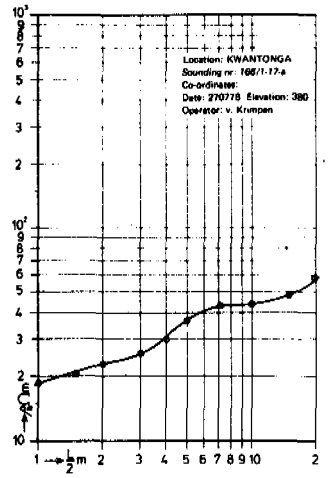
Date: 270778 Elevation: 380
Operator: v. Krimpen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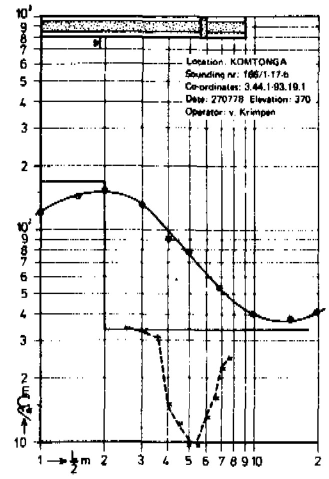
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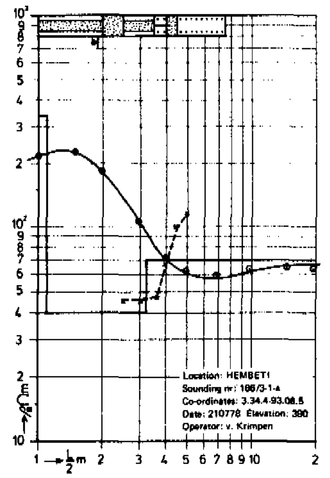
Operator: v. Krimpen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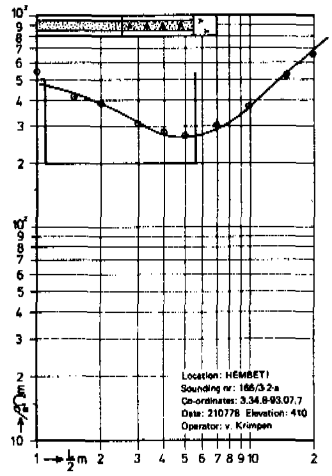
Date: 210778 Elevation: 390
Operator: v. Krimpen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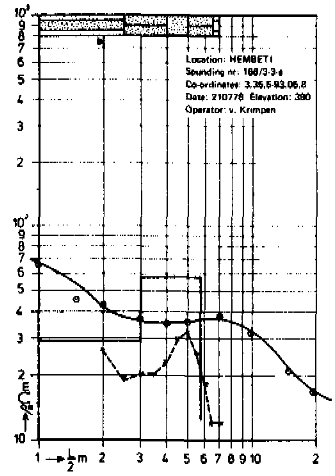
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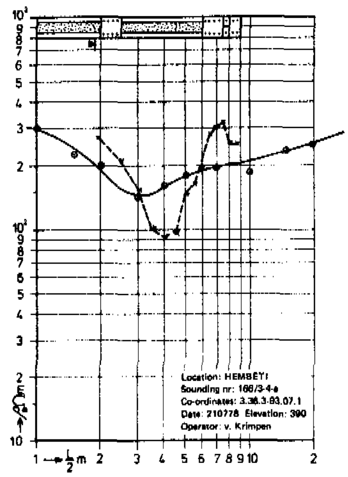
Co-ordinates: 3.36.6-93.06.8
Date: 210778 Elevation: 380
Operator: v. Krimpen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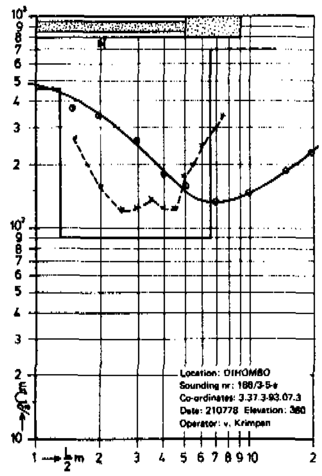
Operator: v. Krimpen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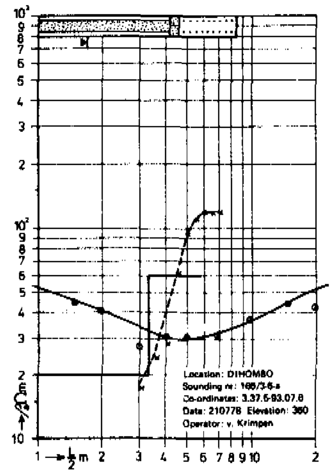
Date: 210778 Elevation: 360
Operator: v. Krimpen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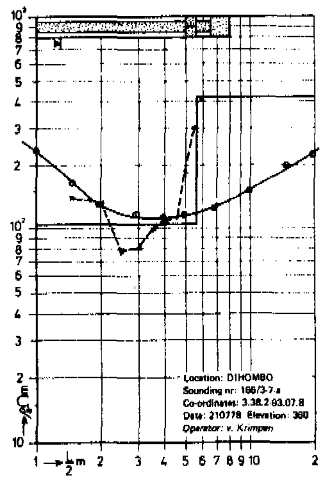
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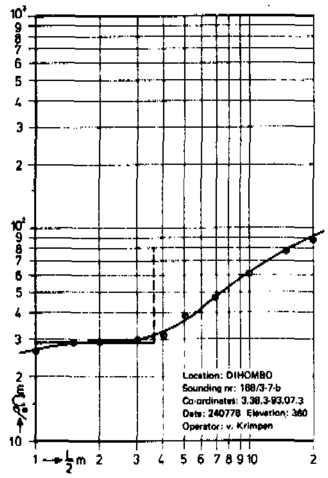
Operator: v. Krimpen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Date: 240778 Elevation: 360
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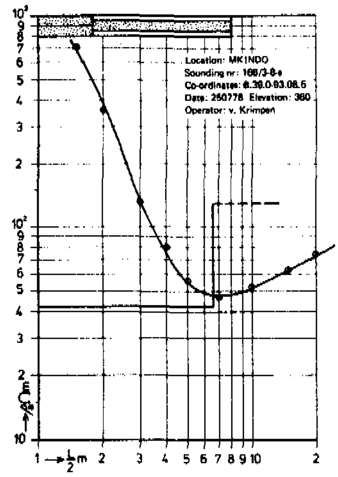
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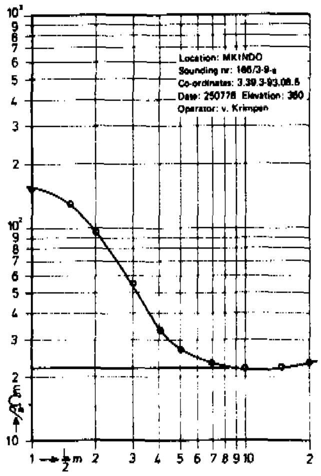
Sounding nr: 166/3-8-a
Co-ordinates: 6.39.0-93.08.6
Date: 250778 Elevation: 360
Operator: v. Krimpen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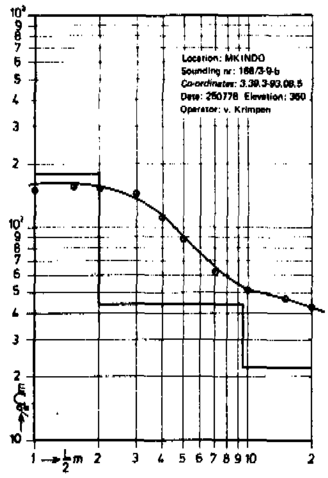
Sounding nr: 166/3-9-a
Co-ordinates: 3.39.3-93.08.5
Date: 250778 Elevation: 360
Operator: v. Krimpen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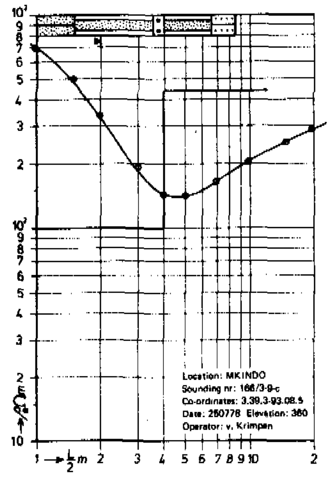
Date: 250778 Elevation: 360
Operator: v. Krimpen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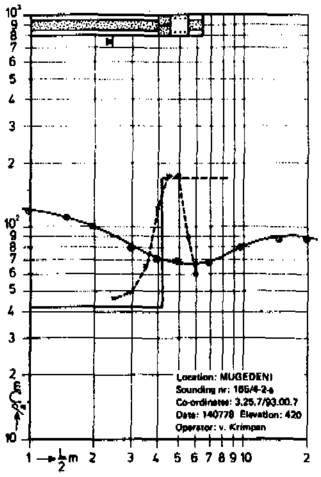
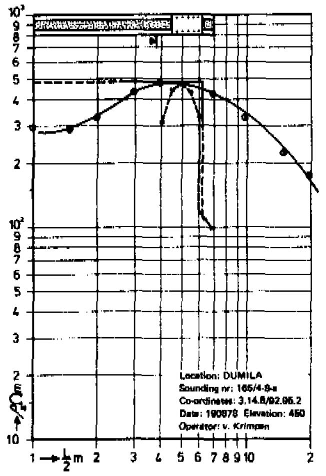
Date: 250778 Elevation: 360
Operator: v. Krimpen


Location: MUGEDENI
Sounding nr: 165/4-2-a
Co-ordinates: 3.25.7/93.00.7
Date: 140778 Elevation: 420
Operator: v. Krimpen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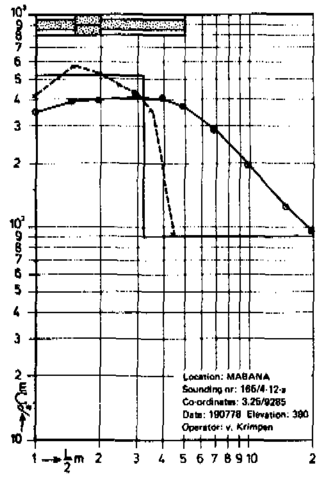
Sounding nr: 165/4-8-a
Co-ordinates: 3.14.8/92.95.2
Date: 190878 Elevation: 450
Operator: v. Krimpen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Co-ordinates: 3.25/9285
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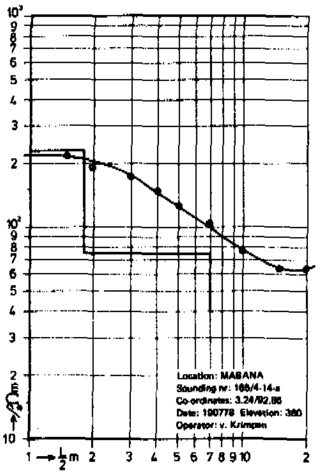
Operator: v. Krimpen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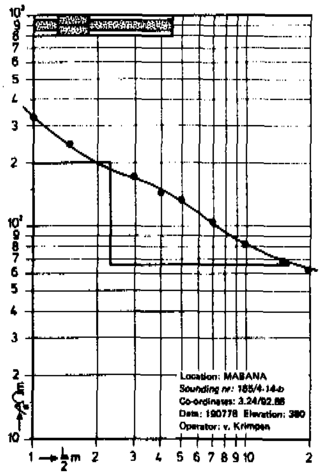
Operator: v. Krimpen


Location: MABANA
Sounding nr: 165/4-14-b
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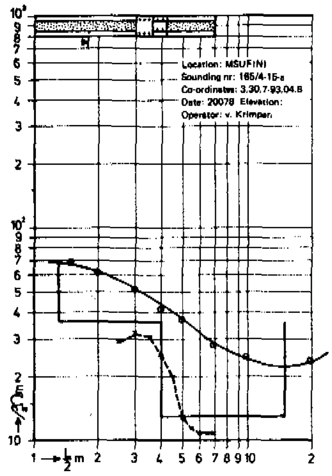
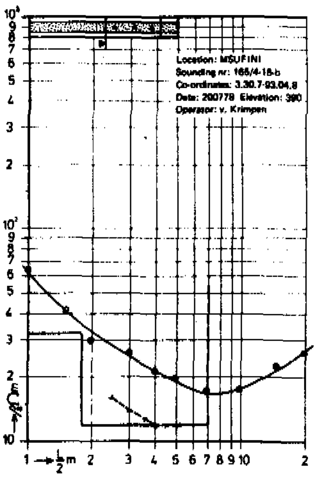
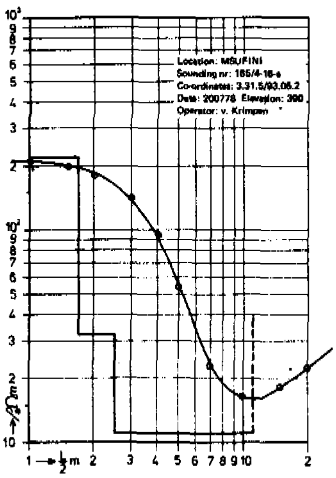
Date: 190778 Elevation: 380
Operator: v. Krimpen


Location: MSUFINI
Sounding nr: 165/4-15-a
Co-ordinates: 3.30.7-93.04.8
Date: 20078 Elevation:
Operator: v. Krimpen


Location: MSUFINI
Sounding nr: 165/4-18-b
Co-ordinates: 3.30.7-93.04.8
Date: 200778 Elevation: 390
Operator: v. Krimpen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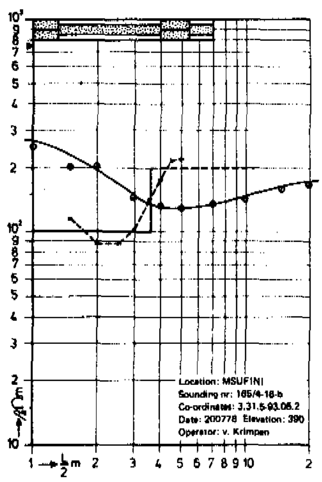
Co-ordinates: 3.31.5/93.06.2
Date: 200778 Elevation: 390
Operator: v. Krimpen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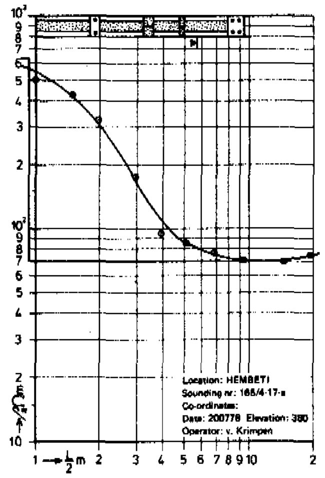
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Date: 200778 Elevation: 380
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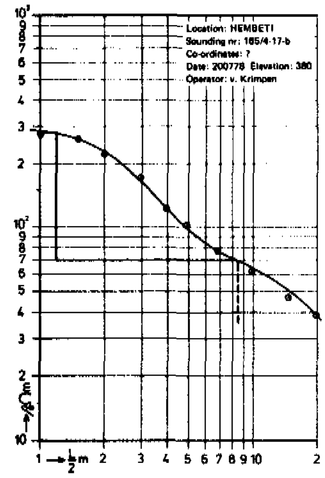
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Date: 200778 Elevation: 380
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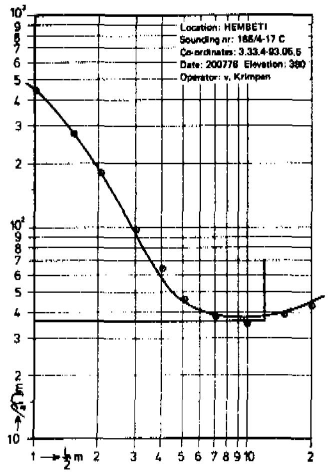
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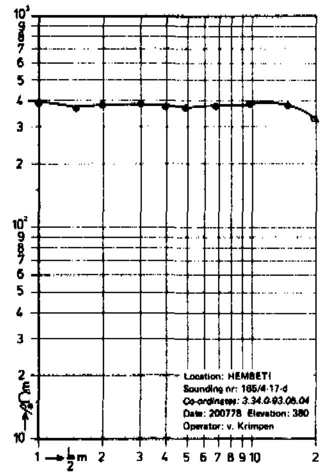
Date: 200778 Elevation: 380
Operator: v. Krimpen


Location: HEMBETI
Sounding nr: 165/4-17-d
Co-ordinates: 3.34.0-93.06.04
Date: 200778 Elevation: 380
Operator: v. Krimpen

So predictions, divided in good, bad and "not clear" prospects, have been made whether a suitable shallow well could be constructed or not. Later on, these predictions have been compared with the results of the siting crew, see table DA 2.2. If the prediction was in agreement with the drilling result it is indicated as positive, a disagreement is indicated as negative. The predictions of the qualitative interpretation, the results of the siting crew and their mutual correspondence are summarized in the table below.

Table DA 2.1 - Summary of the results

Qualitative predictions		Results hand-drillings		Correspondence	
		Approved	Disapproved	Good	Bad
Good	20	17	3	17	3
Bad	8	1	7	7	1
"Not clear"	9	5	4	-	-
Total	37	23	14	24	4

In 9 cases no predictions could be drawn from the soundings. From the remaining 28 cases only 4 predictions are in disagreement with the results of the siting crew. When only boreholes should have been drilled at the locations which were indicated as good or "not clear", just one shallow well site should have been missed. This demonstrates clearly that the geo-electrical method can be used in the surveys for suitable shallow well sites.
A qualitative interpretation takes only little time and can be done immediately after the execution and plotting of the sounding, although it requires some experience of the geophysical operator.

In spite of the above, the geo-electrical method appears not to be efficient in the investigations for shallow well sites. The time which will be saved by the siting crew as a result of the geo-electrical survey, is less than the time necessary for the geo-electrical crew. Moreover the geo-electrical investigations require a skilled geophysical assistant, labourers, equipment and transport. The siting crew cannot be replaced by a geo-electrical crew. First of all one quarter of the soundings did not give a decisive answer about the possibilities for shallow wells; in the second place a yield test is necessary and for construction reasons a sample description is required.
For general shallow hydrogeological investigations these qualitative interpretations are of little importance and therefore not useful.

Table DA 2.2. - Review of the soundings, hand-drillings and the results

Site number	Village	Sounding number	Borehole number	Well logging	Approved for construction	Correspondence between quantitative interpretation and hand-drillings	Correspondence between qualitative predictions and hand-drillings
165/1-2	Maqubike	a	1	yes	yes	?	-
8	Dumila	a	2	yes	yes	-	+
12	Mabana	a	3	yes	yes	+	+
14	Mabana	a			N		
	Mabana	b	1	no	no	-	+
15	Msufini	a	1	yes	yes	-	+
	Msufini	b	2	yes	yes	+	?
16	Msufini	a	-	-	N		
	Msufini	b	1	yes	yes	?	+
17	Hembeti	a	1	yes	yes	-	+
	Hembeti	b	-	-	N		
	Hembeti	c	-	-	N		
	Hembeti	d	-	-	N		
166/1-1	Mkindo	a	1	yes	yes	?	?
2	Mkindo	a	1	yes	yes	+	?
3	Mkindo	a	1	yes	yes	-	+
4	Mkindo	a	1	yes	no	?	-
	Mkindo	b	2	no	no	?	-
5	Kigugu	a	-	-	N		
	Kigugu	b	1	no	no	+	?
6	Kigugu	a	1	no	no	?	-
	Kigugu	b	1	no	no	-	+
	Kigugu	c	3	no	no	+	-
7	Kigugu	a	1	no	no	-	-
8	Kigugu	a	-	-	N		
	Kigugu	b	1	no	no	-	?
9	Mbogo	a	1	no	no	-	?
	Mbogo	b	-	-	N		
10	Mbogo	a	1	no	no	+	-
11	Mbogo	a	1	no	no	?	-
	Mbogo	b	-	-	N		
12	Mbogo	a	1	-	N	-	+
	Mbogo	b	-	-	N		
13	Mbogo	a	1	yes	yes	-	+
14	Mbogo	a	1	no	yes	?	+
	Mbogo	b	-	-	N		
15	Komtonga	a	1	yes	yes	?	?
16	Komtonga	a	1	no	no	?	?
17	Komtonga	a	-	-	N		
	Komtonga	b	1	yes	yes	-	+
166/3-1	Hembeti	a	1	yes	yes	?	+
2	Hembeti	a	1	no	no	+	-
3	Hembeti	a	1	yes	yes	?	+
4	Hembeti	a	1	yes	yes	?	+
5	Dihombo	a	1	yes	yes	+	?
6	Dihombo	a	1	yes	yes	+	+
7	Dihombo	a	1	yes	yes	+	+
8	Mkindo	a	1	no	no	?	+
9	Mkindo	a	-	-	N		
	Mkindo	b	-	-	N		
	Mkindo	c	1	no	yes	-	+

N = not drilled
\+ = correspondence is good
\- = correspondence is bad
? = correspondence is "not clear"

ANNEX DA 3

SEISMIC INVESTIGATIONS TO SHALLOW DEPTH

DA 3 SEISMIC INVESTIGATIONS TO SHALLOW DEPTH (special study)

CONTENTS

Figures

DA 3.1 INTRODUCTION

3.1.1 General

Within the scope of the hydrogeological investigations the seismic refraction method has been applied. Its main purpose was to study the usefulness of seismic refraction investigations with portable equipment in hydrogeological surveys to shallow depth (< 10 m). The objectives were mainly to determine the depth to the water table and/or to the bedrock. Moreover, it was examined whether this method was suitable in the siting for shallow well sites.

3.1.2 Principles of the seismic refraction method

For a detailed description of the seismic refraction method, i.e. the theory, the fieldwork, the interpretation method and the applications, the reader is referred to the literature (see also references sub-par. 2.4., No. 11, 17 and 50). To understand the seismic method, the following should be kept in mind:

- Refraction seismics is based on contrasts in propagation velocity of elastic waves through the earth, which depends upon its elastic properties.
- Seismic (= elastic) waves are bent (refracted) when they cross the boundary between two layers with different wave-velocities. The measure of bending is described by Snell's Law, as in optics.
- The function of a seismograph is to measure the time interval between the initiation of a seismic wave at the source and its arrival at a geophone. The seismograph does not indicate which path the wave followed.
- By measuring this time interval for different spacings between source and geophone a time-distance graph can be constructed.
- Interpreting these graphs, values of two parameters are deduced: the depth to the interface between the different layers and the wave velocities in these layers.

The deduced values for the wave velocities have to be translated into lithologic terms. The expected relation between the wave velocity and lithology, based on literature, is presented in table D 2.2-2.

The seismic refraction method has some limitations. Wrong depth values are obtained e.g. in the cases that:

- a layer is relatively thin (about less than ¼ of the depth to its top);
- the wave velocity does not increase with depth for each layer.

In these cases one or more layers cannot be distinguished with this method (hidden layer problem), and as a consequence wrong depth values will be interpreted.

DA 3.2 FIELDWORK

The measurements have been carried out with a portable Bison 1507 B Signal Enhancement Seismograph, which registered the time interval between the initiation of a seismic wave at the source and its arrival at the geophone. As impact source a 5 kg sledge hammer was used. The location of a geophone was fixed during the execution of a spread; the "shotpoint" was shifted successively.

Single spreads and profiles were made along a straight line with equally spaced "shooting" intervals of 2.5 m. The maximum length of a spread amounts to 50 m. If possible, all spreads have been shot "up" and "down". The execution of each spread took about one hour. The measurements have been executed in the period of June to August 1978.

The time distance graphs and the interpreted velocities and depths are given in fig. DA 3.1 up to 12 (at the end of this annex).

Because of the experimental character of the survey, the fieldwork was mainly carried out at locations where either the structure of the underground was well known from hand-drilled boreholes, or the depth to the water table was well known from nearby shallow wells. Most of these boreholes were executed by a MWCP-siting crew to locate suitable shallow well sites (see also DA 2).
All profiles have been numbered succesively per map sheet with the prefix S (e.g. 165/4-S1). Seperate spreads of a profile were succesively numbered per profile with the addition of a letter (e.g. 165/4-S1-a).
Two profiles were shot in terrace deposits of the Ngerengere River near Kihonda in order to assess the possibility of measuring the depth to the water table continuously along a profile.
In these terrace deposits single spreads have been made near a well-known borehole.
Most of the measurements have been made near the village of Manza in valleys, filled up with alluvial material, in the foothills of the Uluguru Mountains.
Profiles as well as single spreads have been carried out next to boreholes with clear succesion of clayey and sandy layers and the basement most probably at shallow depth.
Near Mirama single spreads have been made near an existing shallow well to establish the possibility of determining the water table depth.
In the Berega catchment area an attempt has been made to assess the depth to the ground-water table and to the bedrock in dry riverbeds.
No records could be made at these locations because the impact energy of the sledge hammer appeared to be too small in the loose sands of these riverbeds.

DA 3.3 INTERPRETATION

The readings belonging to one spread, measured with the seismograph, have been plotted on linear graph paper and a time-distance graph has thus been constructed. From this graph velocity values could be derived. After that the depths to interfaces could be calculated with the help of time-intercept formulas.
Later on the records have been interpreted once again according to the "Plus-Minus" method[1]). In this method the depth to the interfaces are derived from the "plus" values, i.e. the sum of the travel times from two symmetrical shot points. From the "minus" values, i.e. the difference between the same pairs of travel times the velocities of the refractor along the profile are calculated.

DA 3.4 RESULTS

The results of the seismic investigations will be discussed successively per location. A brief description will be given of the results with the different interpretation methods. Where the spreads were situated near hand-drilled boreholes or shallow wells the correlation between the results and the lithologic data or with the depth to the water table is dealt with.

DA 3.4.1 Kihonda: 183/3-S1 - fig. DA 3-1

This profile has been interpreted with the "plus-minus" method of which the "minus" graph indicates a rather constant velocity of the second layer (1400 m/sec), while the velocity of the upper layer varies widely (360-500 m/sec).
Using different velocities for the upper layer the calculated depths of the interfase vary between 1.5 and 5 m, which is rather unlikely for the ground-water table.
Possible causes of this might be:
- differences in the velocity v_1 of the first layer;
- the occurrence of an intercalated layer will an intermediate wave velocity (hidden layer).

The first possibility seems the most probable however. Especially in cases in which the velocity varies not only verticaly but also laterally (e.g. due to differences in compaction), considerable differences in the interpreted depths can be found.

DA 3.4.2 Kihonda: 183/3-S2 - fig. DA 3-2

From the "minus" graph an average velocity of the second layer has been derived of 1670 m/sec, but considerable differences occur per spread e.g. S2-a: v_2 = 1400 m/sec and S2-b: v_2 = 1900 m/sec.

1) Hagedoorn, J.G. (1959). The Plus-Minus method of interpreting seismic refraction sections. Geophysical Prospecting, vol. 7, n°2.

The "plus" graph shows depths to the first interface varying between 3 and 5,5 m, which is probably due to a sloping layer. This does not seem unlikely in these fluvial deposits of the Ngerengere River.

DA 3.4.3 Kihonda: 183/3-S3 and S4 - fig. DA 3-3 and 4

These measurements have to be mistrusted because the travel times between the source and geophone are not equal in the forward and reverse direction.
Nevertheless, S2 demonstrates a three layer structure with velocities of 390, 600-1000 and 1500-2400 m/sec respectively. This measurement clearly demonstrates that the (dry) upper layer has a higher velocity at greater depth. This velocity, however, is still too low to be correlated with a saturated zone. The calculated depths do not correspond with the hand-drilled lithological profile, nor with the depth of the watertable. Confined groundwater may be the cause of this difference.

DA 3.4.4 Manza: 201/1-S1 - fig. DA 3-5

The interpreted depth d_1 calculated with the time-intercept formula, varies between 3.4 and 2.2 m, which demonstrates that the interpreted depth is not very accurate. The apparent velocity v_1 of the first layer is rather constant (370 m/sec) and indicates a dry upper layer. The interpreted value of v_2 of the second layer varies between 1175 and 1860, which is a too wide range for a proper prediction about the concerning lithology.
The interpretation of the "minus" graph indicates a velocity of the second layer between 1300 and 1700 m/sec. A slight "undulation" in the vertical part of the graph suggests in most cases a lateral heterogeneity. The velocity differences might be the result of lithological transitions, e.g. from clay to sand.

DA 3.4.5 Manza: 201/1-S2 - fig. DA 3-6

These time-distance graphs seem to indicate that the vertical velocity distribution consists of many velocity values. In fact these graphs demonstrate an example of "diffraction" which is the result of a considerable lateral heterogeneity (see "burried step model" in Zohdy et al., 1974, references sub-par. 2.4. n°50).
The "minus" graph shows a s-shaped part which is a clear indication of a lateral inhomogeneity.
Because such a phenomenon is difficult to interpret it will not be discussed further.

DA 3.4.6 Manza: 201/1-S3 - fig. DA 3-7

This single spread has been carried out next to a hand-drilled borehole. The lithological profile shows a relatively thick sand layer between more clayey deposits.

The time-distance graph demonstrates a three layer structure. Two interfaces can be calculated at 3,1 m and at 8-11 m respectively of which the first one does not correspond with the drilled profile. The "minus" graph indicates a velocity v_3 of the third layer of 2500 m/sec which may be correlated with the weathered zone. The "plus" graph demonstrates clearly that the interface is slightly sloping.

DA 3.4.7 Manza: 201/1-S4 and S5 - fig. DA 3-8 and 9

These spreads have also been executed near a borehore. The time-distance graph of S4 demonstrates a three layer structure. The velocity of the middle layer can not be derived from the "minus" graph but the time distance graph indicates an apparent velocity of about 1400 m/sec. The "minus" graph indicates a velocity of 2500 m/sec for the third layer, probably weathered basement. This is in good correlation with the borehole data, moreover its calculated depth corresponds well with the second interface of 5 m.
The first calculated interface on the other hand does not correspond at all with the hand-drilled profile.
The graph belonging to spread S5 is strongly distorted and no further interpretation has been executed.

DA 3.4.8 Mirama: 165/4-S1, S2 and S3 - fig. DA 3-10, 11 and 12

These spreads have been made near an existing shallow well in order to assess the possibility of determining the depth to the water table. The time-distance graphs clearly demonstrate a wide variety in velocities in the upper layer. The calculated depths and velocities do not correspond at all with a water table of 1,80 m below groundlevel. The measured velocities indicate a saturated zone at greater depths (10 m). It is therefore concluded that the watertable in the shallow well is confined. As a consequence a (thin) clay layer has to be supposed on top of the aquifer, which however cannot be recognized in the time-distance graph due to its low velocity value (hidden layer).

DA 3.5 CONCLUSIONS

An interpretation of the derived velocity values gives reasonable results. Layers with an average velocity of 1500 m/sec can in most cases be correlated with saturated sediments, although moist clay layers may have the same values. Layers with velocities of about 2500 m/sec are probably semi-consolidated deposits or weathered basement; the second possibility seems the most likely one. This could be confirmed in one case (DA 3.4.7).

On the contrary, the comparison of the calculated depth to the water levels and those found in hand-drilled boreholes or wells was in general very disappointing. The calculated depths to interfaces are not accurate, due to lateral as well as vertical differences in velocity values which occur frequently in the top layers.

The determination of the depth to the bedrock (weathered or unweathered) seems possible with this method although this could be confirmed only once.

The application of the seismic refraction method in hydrogeological investigations for shallow ground water (< 10 m) seems not to be very feasible in the project area, because of its low accuracy in determining the depths to the several interfaces, in particular the depth to the water tables, i.e. water-bearing layers.
For the same reason this method is also not suitable in the surveys for shallow well sites.
Apart from this, the execution of seismic refraction measurements and especially their interpretation according to the "plus-minus" method is rather time consuming in comparison with the execution of hand-drillings.

Figure DA 3–1 Kihonda : 183/3–S1

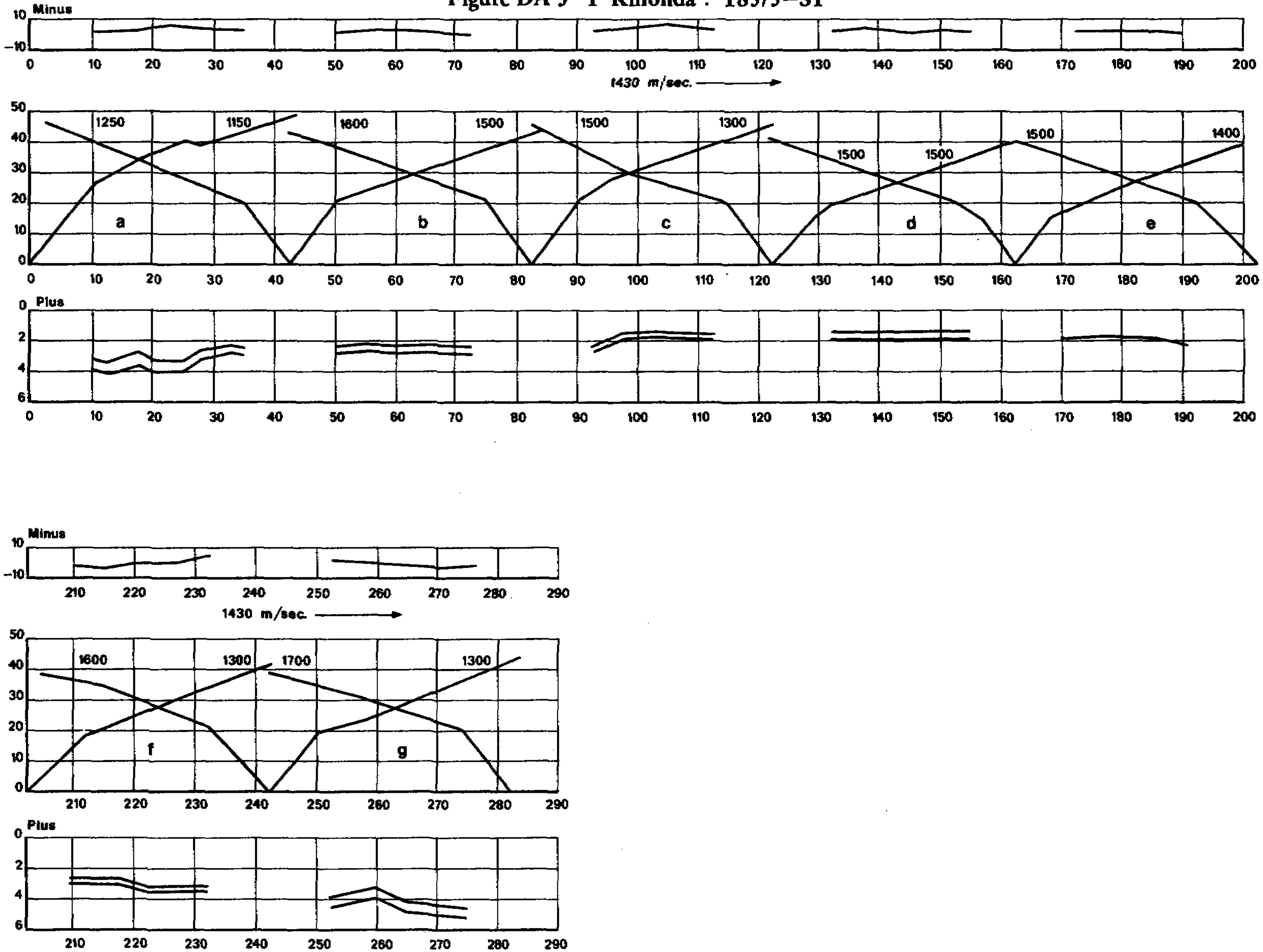


Figure DA 3–2 Kihonda : 183/3–S2

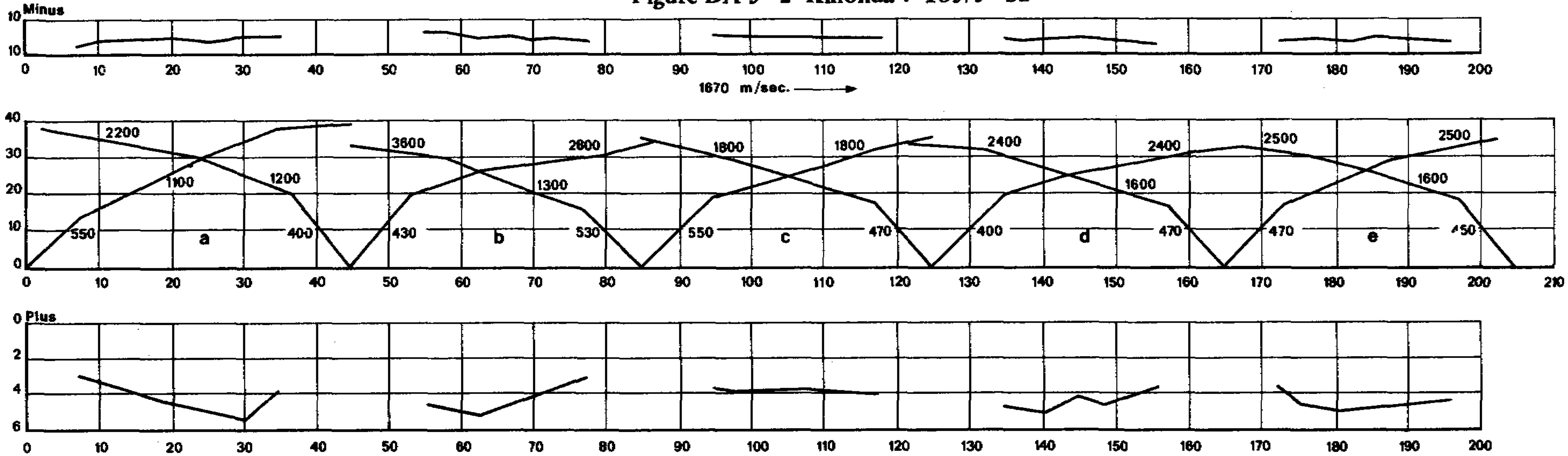


Figure DA 3–5 Manza : 201/1–S1

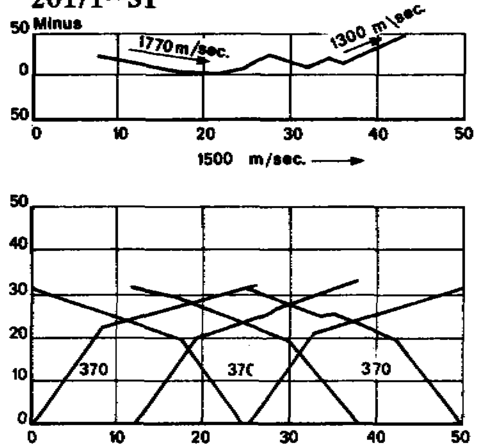


Figure DA 3–6 Manza : 201/1–S2

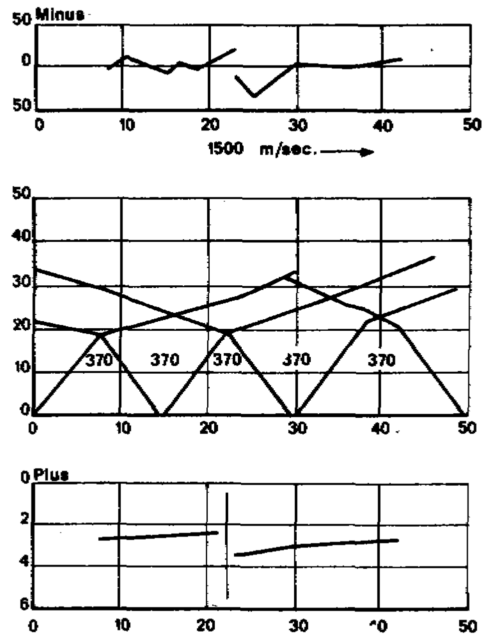


Figure DA 3–3 Kihonda : 183/3–S3

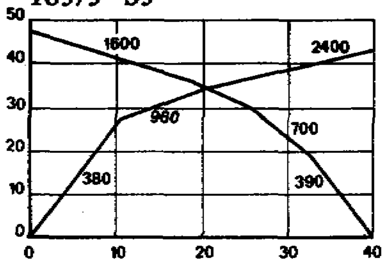


Figure DA 3–4 Kihonda : 183/3–S4

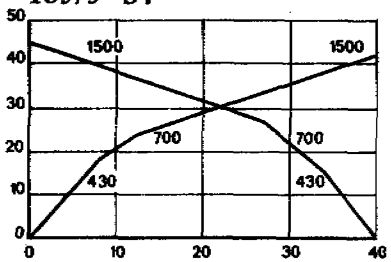


Figure DA 3–7 Manza :
201/1–S3

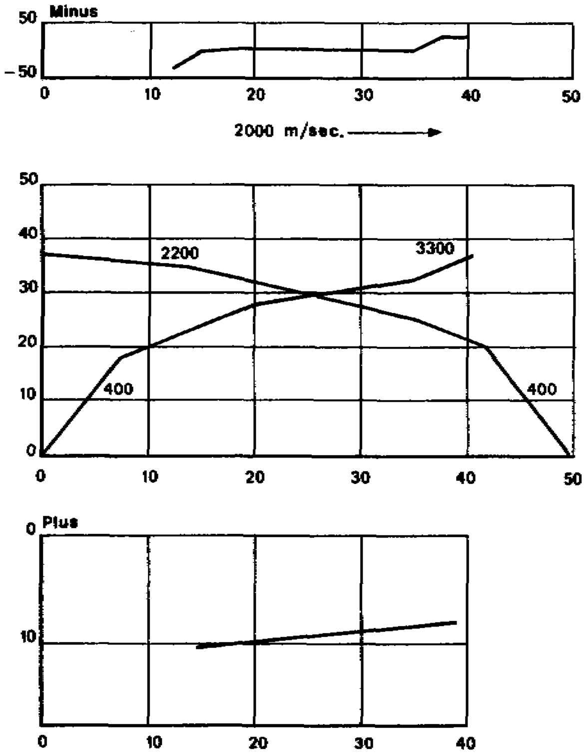


Figure DA 3–8 Manza :
201/1–S4

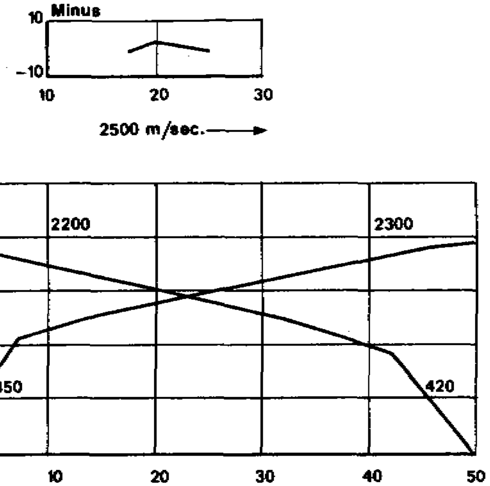


Figure DA 3–9 Manza :
201/1–S5

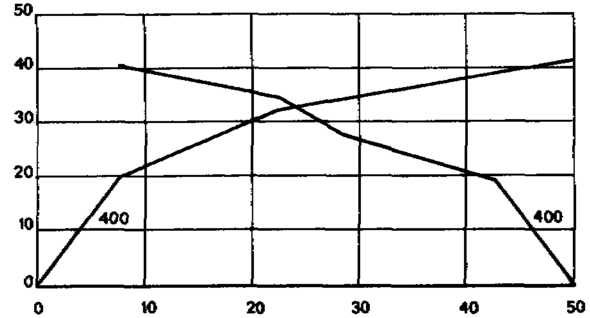
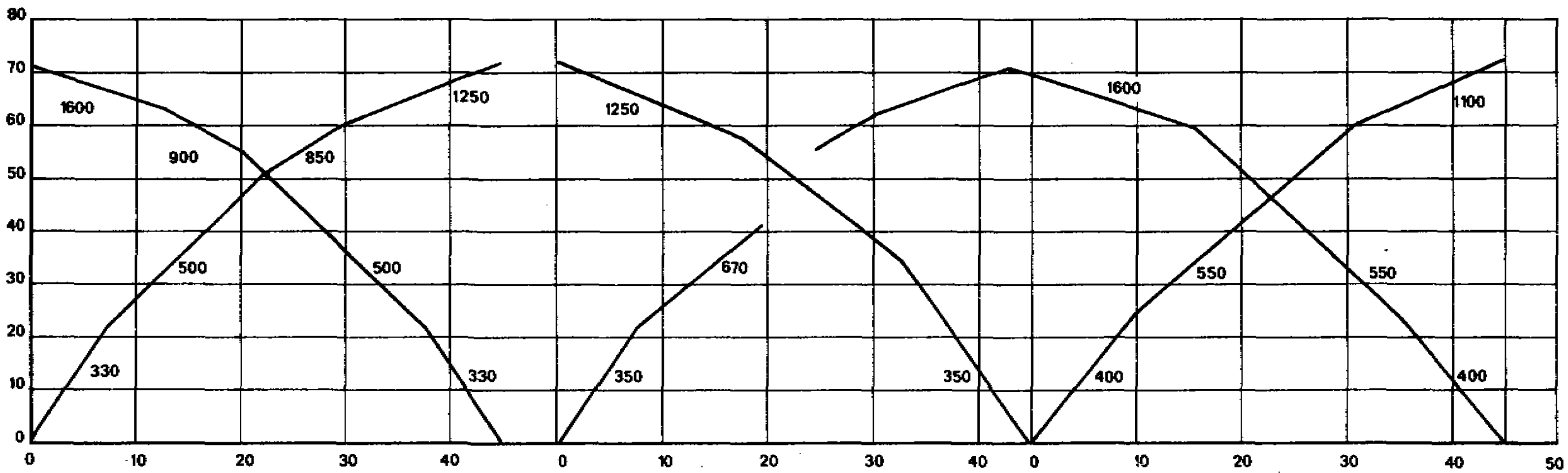


Figure DA 3–10 Mirama : 165/4 –S1 Figure DA 3–11 Mirama : 165/4–S2 Figure DA 3–12 Mirama : 165/4–S3



ANNEX DA 4

GROUND WATER IN THE NGERENGERE AREA
SPECIAL STUDY

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DA 4 GROUND WATER IN THE NGERENGERE AREA

DA 4.1 Identification of problems

In the First Report of the MDWSP the Ngerengere area was identified as an area where a large number of villages experience major difficulties in obtaining sufficient drinking water.
The area does not have sufficient surface water to supply all villages with water throughout the year and ground water sources - tapped mainly by means of handdug holes and some shallow wells - give low yields during the dry season.
The chemical quality of part of the ground water in the area was reported to be very poor.

During the hydrogeological survey of the Ngerengere area, carried out between August and November 1978, the water supply problems of this area were quantified and qualified in terms of ground water availability and salinity (table DA 4.6.1). The results of the hydrogeological survey were too general however, to enable the assessment of definite recommendations on the development of potable ground water sources.

Hence the aim of this special study was:
- to study in detail the availability of ground water in the Ngerengere area and near its problem villages in particular.

DA 4.2 Approach to the Study

Evaluation of borehole data, drilled in the Ngerengere area (see table DA 4.4-3) showed that the ground water at greater depth is highly mineralized and unsuitable for domestic purposes.
Hence the study was focussed on the occurence of shallow ground water. Because the geological and consequently also the hydrogeological situation throughout the area varies considerably (see D 4.2), each problem village had to be studied separately.

The field investigations can be split up into three parts:
- study of existing shallow wells and hand-dug holes during the last part of the dry season, when ground water levels decline to a minimum and salinities are increasing accordingly;
- execution of geo-electrical soundings;
- drilling of exploration holes with hand-drilling equipment.

Further activities included the examination and evaluation of water sample analyses results (see table D 10) and the study of aerial photographs.

DA 4.3 Description of the area

DA 4.3.1 General (fig. DA 4.3-1)

The Ngerengere area is the catchment area of the Ngerengere River which takes its rise in the NW Uluguru Mountains and flows around the northern Ulugurus in an eastern direction.
From its sources till the point where it leaves the project area, near Seregete, the Ngerengere River is about 100 km long.
The area is approximately 2210 km^2 and contains 42 villages with a total population of more than 50,000. Morogoro town, with 74,000 inhabitants, which is also situated in the Ngerengere catchment area, is not included in this study.

DA 4.3.2 Topography and geology (fig. DA 4.3-2 and map D 2)

The Ngerengere River takes its rise at elevations between 1200 and 1600 m in the Ulugurus and descends steeply into the 14 km wide valley SW of Morogoro, situated at elevations between 520 and 500 m above sealevel.
From here, down to the junction with the Ruvu River, the slope of the main course is 0,25%, with two knick points caused by lithological differences of the rocks underlying the valley.

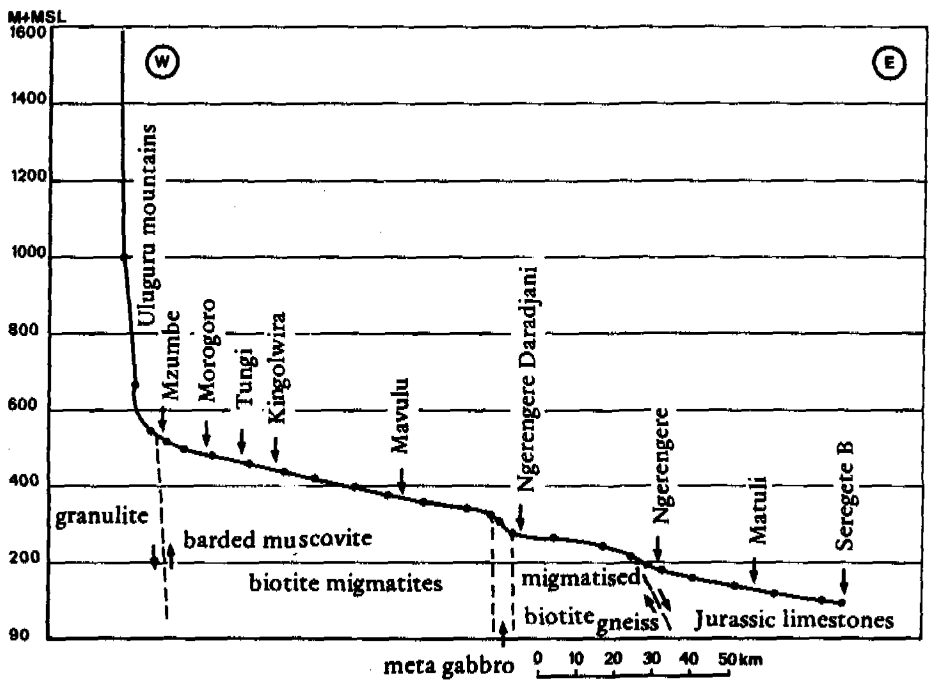


Fig. DA 4.3-2 - Longitudinal profile of Ngerengere valley

West of the Uluguru Mountains the Ngerengere River follows SW-NE oriented faults that separate the Uluguru granulites from banded migmatites. North of the mountains, the river follows the SSW-NNE oriented Kingolwira Fault, which separates the migmatites in the West from a biotite gneiss complex in the East. In this part of the catchment area, the Precambrian rocks are covered with red soil of varying thickness. Between Mzumbe and Mavulu the Ngerengere River has deposited alluvial material in a 500-1000 m wide and 10-25 deep valley.
East of the Kingolwira Fault, the catchment is underlain by biotite gneiss, intruded by a migmatised gabbro body just east of Ngerengere Darajani.

At Ngerengere the river crosses the Kiwege Fault which separates the biotite gneiss in the West from Jurassic sandstones and limestones in the East.

DA 4.3.3 Meteorology and river flow

In the catchment area, rainfall data have been collected from 31 raingauge stations.
The mean annual rainfall in 95% of the catchment area is about 900 mm; in the Ulugurus the annual rainfall exceeds 1500 mm.

The annual potential evaporation (Penman) calculated from evaporation data collected at Morogoro, is 1800 mm. Actual annual evaporation may be in of order of 0.4 times the annual potential evaporation, thus 720 mm.

The mean annual discharge at Utari Bridge, near the mouth of the Ngerengere River is 144,000.000 m^3. The catchment area here is 2840 km^2 hence the annual discharge equals an annual rainfall of 51 mm.

Water from the Ngerengere River is being used by some sisal estates and factories.
The present potential consumptive use is estimated at 0.5 m^3/sec.

A very rough annual water balance over the catchment area may thus be calculated.

Rainfall	=	discharge + evaporation ± change in ground water storage + underground outflow of ground water runoff
900 mm	=	56.5 mm + 720 mm + 0 mm (average annual change in groundwater storage is zero) + underground outflow.

The approximate amount of ground water that probably leaves the catchment area underground thus equals an annual rainfall of 123.5 mm.
As explained in 4.2., the only rocks with a high (secondary) permeability in the Ngerengere area, are the Jurassic limestones. The area underlain by the limestones is a karst area and considerable amounts of ground water may flow through subsurface solution channels, and leave the catchment area of the Ngerengere. The figure of 123.5 mm is, however, certainly much too high due to inaccuracies in the mean figures used in the tentative water balance. The occurrence of water losses in the karst area is highly probable but they cannot be quantified.

DA 4.4 Medium-depth and deep ground water

Since 1931, 47 registered boreholes have been drilled in the Ngerengere area.
Some borehole data are listed in table DA 4.4-3; additional information is presented in DD 1,2 and 3 (data-part of this report). At present at least 43 out of these 47 boreholes are abandoned because of high salinity of the ground water, or a very low yield at the time of drilling or after some time of operation.
Nineteen boreholes were drilled in Jurassic sandstones and limestones in the eastern part of the catchment area. The electrical conductivity of the ground water varied from 42 mS/m to 1050 mS/m and was 335 mS/m on an average.

Table DA 4.4-1 - Summary of Ngerengere boreholes drilled in Jurassic

N° of boreholes	EC mS/m	Classification
1	< 75	good
0	75 - 125	fair
4	125 - 200	poor
9	> 200	beyond acceptable limits

Chemical data of 5 boreholes are lacking.

Tested yields varied from 0.3 to 2.4 l/s and were 1 l/s on an average.

The remaining 28 boreholes were drilled in Precambrian gneiss.
The electrical conductivity varies from 17 mS/m to 950 mS/m with an average of 420 mS/m. Borehole 9/49, 21/49 and 90/75, drilled between Tungi and Kihonda, had extremely high salinities (EC 1300-1770 mS/m). Although they were drilled into gneiss, the saline water probably originated from the overlying alluvial deposits.

Table DA 4.4-2 - Summary of Ngerengere boreholes drilled in Precambrian gneiss

N° of boreholes	EC mS/m	Classification
3	< 75	good
0	75 - 125	fair
3	125 - 200	poor
15	> 200	beyond acceptable limits

Although the EC of 6 boreholes was lower than 200 mS/m, the yield of only one of those boreholes was sufficient for exploitation.

The conclusion of this review is, that it is very risky to try to drill boreholes in the Ngerengere area because yields would probably be very low and the quality of the water would be very poor.

Table DA 4.4-3 - Summary of boreholes, drilled in the Ngerengere area

Number	Location	EC mS/m	Tested yield l/s	Total depth (m)	Aquifer(s)	Remarks
1/31	Ngerengere Railway st.	130	0.4	73.14	Jura	abandoned
2/34	Fatemi S.E.	130	2.4	146.31	Jura	abandoned
4/34	Kizuki S.E.	42	1.3	145.70	Jura	abandoned
6/34	Kiwege S.E.	250	2.5	119.48	Gneiss	abandoned
7/34	Kiwege S.E.	190	5.0	50.90	Gneiss	abandoned
8/34	Mgugo S.E.	950	9.3	118.26	Gneiss	abandoned
14/34	Pangawe S.E.	460	3.8	68.57	Gneiss	abandoned
1/35	Morogoro town	950	0.4	48.77	Gneiss	abandoned
3/35	Kingolwira Farm		0.01	150.67	Gneiss	abandoned
6/35	Ngerengere S.E.	240	4.6	63.09	Gneiss	abandoned
2/36	Fatemi S.E.	400	0.4	145.70	Jura	abandoned
7/38	Tungi S.E.	170	0.4	86.26	Gneiss	abandoned
5/39	Kizuka S.E.	500		80.15	Jura	abandoned
8/47	Kingolwira Prison	490	0.2	142.65	Gneiss	abandoned

Number	Location	EC mS/m	Tested yield l/s	Total depth (m)	Aquifer(s)	Remarks
17/47	Kingolwira Prison	Saline	0.3	76.20	Gneiss	abandoned
9/49	Tungi S.E.	15.15	0.1	121.92	All/ Gneiss	abandoned
21/49	Tungi S.E.	17.70		33.53	All/ Gneiss	abandoned
3/53	Ngerengere	300		117.09	Jura	abandoned
23/53	Kidugallo	180	1.3	121.92	Jura	abandoned
52/55	Kidugallo Prison		dry	39.62	Jura	abandoned
6/56	Kidugallo	400	2.2	111.66	Jura	abandoned
21/56	Kihonda S.E.	17	0.03	74.07	Gneiss	abandoned
18[a]/59	Pangawe		0.3	85.04	Gneiss	abandoned
18[b]/59	Pangawe		0.6	49.07	Gneiss	abandoned
23/59	Pangawe	94	8.8	56.08	Gneiss	abandoned
7/62	Sanga sanga	10.50	10.50	121.92	Jura	abandoned
8/62	Mhulazi school	227	227	107.90	Jura	abandoned
9/62	Gomero	500	0.4	111.56	Jura	abandoned
5/63	Mgugu	650	2.2	37.19	Gneiss	abandoned
31/64	Kingolwira		2.3	76.20	Gneiss	abandoned
41/67	Mikese	300	0.6	60.69	Gneiss	abandoned
49/67	Pangawe	Saline		22.25	Gneiss	abandoned
17/68	Ngerengere		Noyield	67.36	Jura	abandoned
46/71	Kidugalo	150	1.2	201.78	Jura	in production
38/72	Magadu	650	1.3	135.33	Gneiss	abandoned
79/72	Morogoro	800	0.1	16.80	Gneiss	abandoned
265/74	Kizuka	Saline		122	Jura	abandoned
5/75	Kizuka	680		136	Gneiss	abandoned
23/75	Sanga sanga	360		52	Jura	no data, restricted area

Number	Location	EC mS/m	Tested yield l/s	Total depth (m)	Aquifer(s)	Remarks
70/75	Sanga sanga	Good		85.34	Jura	no data, restricted area
79/75	Sanga sanga	Good		108	Jura	no data, restricted area
80/75	Sanga sanga	Good		136	Jura	no data, restricted area
90/75	Kihonda	1300		30.48	All/ Gneiss	abandoned
77/77	Sanga sanga ujama		1.3	36.58	Gneiss	abandoned
149/77	Fulwe	23	0.5	25.60	Alluvium	abandoned
104/78	Mikese		No yield		Gneiss	abandoned
117/78	Mikese	162			Gneiss	not yet in production

DA 4.5 Selection of villages to be studied in detail

DA 4.5.1 General

In order to select priority villages, existing water supply systems, proposed water supply systems as well as systematically collected hydrogeological data have been taken into consideration and are referred to briefly.
Additional information on these subjects can be found in B 3.1, E 3.4.4 and D 3.1 respectively.

DA 4.5.2 Villages to be excluded from the detailed study

The eleven villages, situated in the upper part of the Ngerengere catchment, south-west of Morogoro Town, have been excluded from this detailed study because of the reasons listed below:

- Mlali and Kipera are connected to a piped supply, pumped from a riverbed infiltration well.

- Mzumbe, Changarawe and Kauzeni are connected to a small piped gravity system.
- Sufficient shallow well sites have been found by the MWCP survey department, in Manza and Konga.
- With very little effort and low costs, the other four villages, Tangeni, Vikenge, Sanga Sanga and Mindu can be supplied with gravity piped water (E 3.4.4).
- Construction of the Mindu Dam will start in 1980, therefore, construction of shallow wells in the Ngerengere Valley within the boundaries of the future reservoir would only be a very temporary solution.

A second group of villages, excluded from this special study are those, directly east of Morogoro Town, in the foothills of the Northern Ulugurus, because Misongeni, Legezamwendo, Kitungwa, Pangawe and Kisinga are all connected to a piped gravity system.
Bigwa also has a small gravity supply.
Both Ngerengere and Kidugalo have pumped, piped supplies from a riverbed infiltration well and a borehole respectively. The riverbed well at Ngerengere, however, dries up in the course of the dry season.

DA 4.5.3 First priority villages

First priority is given to ground water investigations in the villages:

Diguzi	Mkambarani
Fulwe	Mkonowarama
Kihonda	Muhugamkola
Kinonko	Ngerengere
Kiwege	Ngerengere Darajani
Lubungu	Seregete A
Maseyu	Seregete B
Mikese	Tungi
Mlilingwa	

These villages experience major difficulties in obtaining sufficient drinking water throughout the year and the water of many holes and wells contains high concentrations of salt.

DA 4.5.4 Second priority villages

The villages Visarake, Magela, Lubuma, Matuli, Lulongwe and Kwamba are situated along the Ngerengere River and some of its main tributaries.
River water is used during the wet season and the main part of the dry season.
Hand-dug holes in the riverbeds give sufficient water during the short periods when there is no surface flow.
Construction of shallow wells along or in the riverbeds will probably not offer serious problems.

Table DA 4.6-1 - Hydrogeological field data Ngerengere area

Village	Nr. and types of ground-water supplies (Nov. 1978)					Type of supply[1])	Total depth (m-GL)	Aquif. type	Water level (m-GL)	EC mS/m	Date	Regular Measurement Programme				Remarks
	hh	hhrb	sw	psw	pbh							Min. WL (m-GL)	Max. WL (m-GL)	Min. EC mS/m	Max. EC mS/m	
Fulwe			4			sw	6.3		2.4	26		16.06.78				
						sw	3.5		1.3	400						
						sw	3.4		2.1	32						
Kihonda			1			sw	2.8			200						not used
Kinonko		5				hhrb	1.5	sand	1.0	120	09.10.78					
Kiwege	6					hh	2.0	loam	2.0	9						very small
								sand								yields
Kwaba		4				hhrb	0.4	sand	0.4	125	18.10.78					
Lubungo	2		2			sw	4.1	loam	3.7	53	29.09.78					dry out
						sw	3.4		3.1	82						
Lukobe	3		1			sw	3.5		3.1	142	28.09.78		0.0			basement at 5.0 m
Maseyu	4		1			sw										dry out
Matuli		6				hhrb	0.4	sand	0.3	75	18.10.78	1.5				
Mikese			4	1		pbh				820	16.06.78					abandoned
						sw	6.6		1.1	73						
						sw	7.0		1.8	80		7.0	1.0	80	100	
Milingwa	10					hh	0.7	laterite	0.5	5	09.10.78	3.0				very low yields
Mkambarani	8					hh	1.5	loam	1.0	80-180	25.08.78					
Muhugam-	3					hh	0.9		0.5	80	19.09.78					low yield
kola						hh	2.6		2.5	18						
						hh	1.2		1.0	125						
Ngerengere			1			psw				58	09.10.78					
Ngerengere-	no ground-water supplies										09.10.78					
Daradjani																
Sanga	2					hh	2.5		2.5	40	20.10.78					very low
Sanga																yields
Seregete A	no ground-water supplies															
Seregete B	no ground-water supplies															
Tungi	no ground-water supplies															

[1]) hh = hand-dug hole
hhrb = hand-dug hole in river bed
sw = shallow well
psw = shallow well with pumped piped supply
pbh = borehole with pumped piped supply

DA 4.6 Hydrogeological field survey

Between July and October 1978, hydrogeological fieldwork was carried out in the Ngerengere area.
The existing ground water supplies of more than 20 villages in this area were examined, the hydrogeology of the area as a whole was studied in the field and locations were selected where the occurrence of ground water could be studied by means of geo-electrical investigations and hand-drilling.
Data on existing ground water supplies collected during the field work are presented in table DA 4.6-1.
In 16 out of the 20 villages, ground water is being exploited by means of hand-dug holes or shallow wells.
However most of the holes and wells dry up during the dry season and some of them have saline ground water and are not being used therefore.

DA 4.7 Geo-electrical investigations

In the Ngerengere area, 37 geo-electrical soundings have been executed; their locations are given on fig. DA 4.3-1.
The numbers of these soundings are:
183/1-17, -18, -19, -20, -21, -22, -23, -24, -25
183/2-1
183/3-1, -2, -3, -4, -5, -6, -7, -8, -9, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19.

The sounding curves and their interpretation are presented in DD 7.

With the exception of soundings 183/3-2, -9 and -16, all soundings show weathered basement at shallow depth.
From these soundings, information on the occurrence of ground water in the weathered zone, and its salinity, cannot be detected because the degree of weathering of the basement varies considerably form place to place and the resistivities vary accordingly.
Only the depth to the fresh bedrock can be found from these soundings.
Soundings 183/3-2, -9 and -16 were located in the alluvium of the Ngerengere River.
Up to a depth of 25 m, very low resistivity values (2-3 Ohmm) occur in these soundings, indicating the presence of highly saline ground water.

DA 4.8 Execution of the hand-drillings

Between mid-January and the end of April, 1978, 101 exploration holes were drilled at various locations, across the valleys of the Ngerengere River and some of its tributaries.

Due to lack of time, not all priority villages, listed in the previous paragraph, could be studied. The collected data have been sufficient however, to gain insight into the hydrogeology of the Ngerengere area and the prospects for shallow ground water for the villages that were not studied may be deduced from this knowledge. Profiles were drilled near the following villages:

Village 1-	N° of hand-drillings	Profile
Kihonda	14	A
Tungi	20	B
Mkambarani	11	C^1, C^2
Mkonowarama	4	D^1, D^2
Mikese	5	E^1, E^2
Lubungo	5	F^1, F^2
Ngerengere Darajani	6	G
Kinonko	4	H
Muhungamkola	6	I
Vidaraka	8	J
Masimbu	12	(K)
Mkundi	6	(L)

The borehole data are presented in DD 9.
The drilled profiles are described in the next paragraph.

DA 4.9 Description of hand-drilled profiles

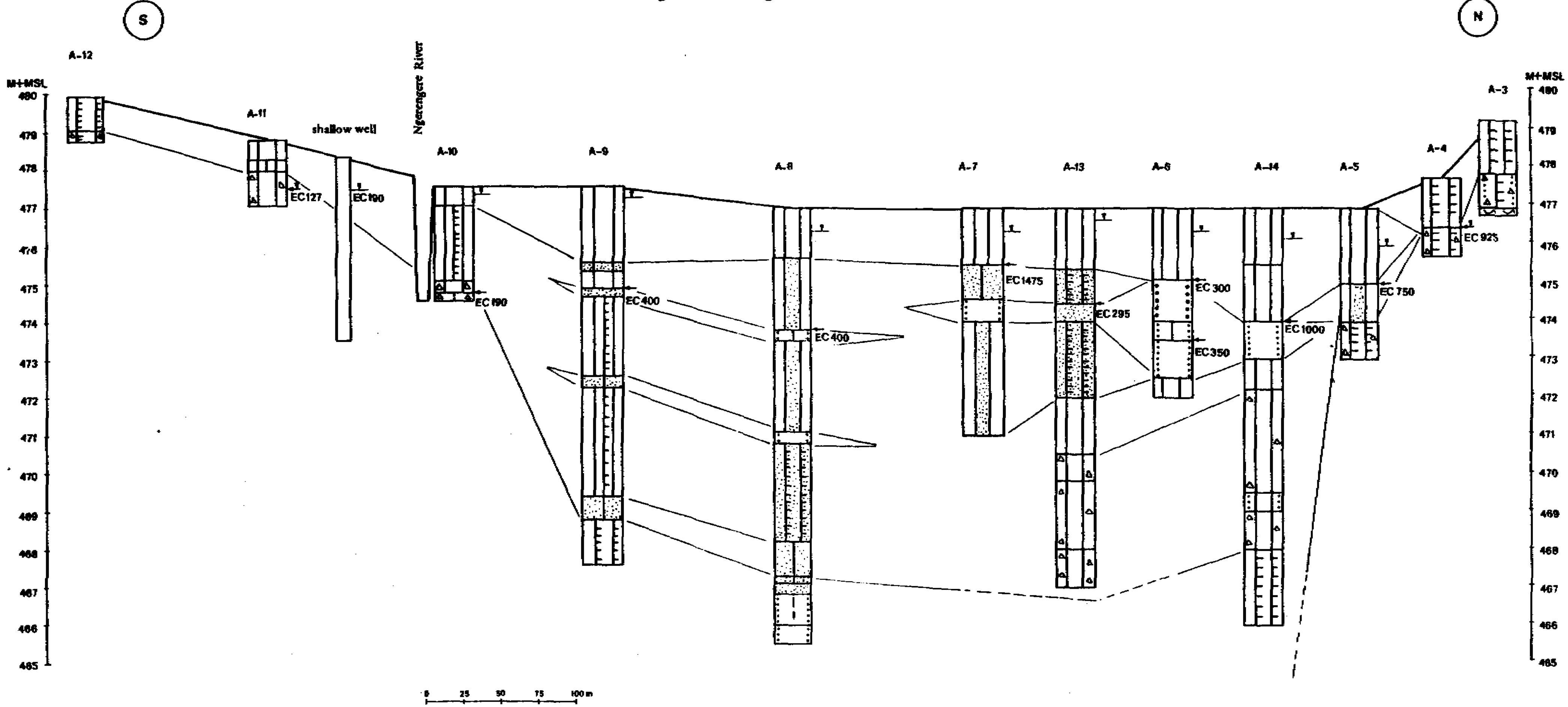
DA 4.9.1 Profile A at Kihonda (fig. DA 4.9-1)

At Kihonda, profile A_1-A_{12} was drilled, north-south accross the Ngerengere Valley.
Boreholes A-1 to A-4 presented the same sequence.
From top to bottom the following layering was found:

- a 1.0 to 1.5 m thick top layer of orange/red loamy soil;
- a 1.0 m thick layer consisting of a mixture of angular quartz stones and calcrete and ferrite nodules in a matrix of orange/red loam;
- weathered biotite gneiss; this basement material was proved only in borehole A-3, at a depth of 2.3 m.

The orange/red loam probably is residual soil material.
There is no single theory explaining the formation of calcrete, different mechanisms can be active under different circumstances.
In drilling A-4, ground water was struck in the loamy gravel layer. The electrical conductivity of this water was 925 mS/m.

Figure DA 4.9-1 Hand-drilled profile across Ngerengere Valley, at Kihonda
Legend: see Fig. D 3.3-18



Alluvial deposits of the Ngerengere River were encountered in boreholes A-5 to A-11, over a distance of 750 m. Boreholes A-5 to A-7 more or less showed the same sequence.

- A 1.5 to 3.0 m thick top layer of very tough darkbrown-black swamp clay; this clay layer also occurred in drillings A-8 to A-11.
- A water-bearing sand layer, varying in thickness from 0.6 m to 2.6 m and in texture from fine to very coarse.
  The EC of the ground water in this sand channel varies from 1475 to 295 mS/m.

Below the sand, there is a gravelly brown/grey mottled clay, down to about 10 m below surface, followed by a bluish loam.

Drillings A-8 and A-9 show an identical layering.
Below the 1.4 - 2.0 m thick blackish clay, there is a 7 m thick sequence of brown/grey mottled loam and fine sandy clay, alternated with 3 thin water-bearing sand layers.
The EC of the ground water in these layers is 400 mS/m.

At a depth of 9 m, the same bluish loam as present in A-14 was encountered.

In borings A-10 and A-11, ground water was struck in an orange/red loamy gravel, identical to the residual material found in A-1 to A-5.
Some infiltration of water from the Ngerengere River into this layer occurs since the EC is between 127 and 190 mS/m. A 5 m deep shallow well, constructed just south of the river, is not being used by the villagers of Kihonda, because of the salty taste of the water (EC 190 mS/m).

DA 4.9.2 <u>Profile B, at Tungi</u> (fig. DA 4.9-2)

At Tungi, a profile of 20 boreholes (B-1 to B-20) was drilled across the Ngerengere Valley.
The profile resembles the Kihonda profile.

Borings B-1 to B-8 on the northern slope of the valley and B-17 and B-18 on the southern flank present identical sequences: a 1.0 to 2.5 m thick orange/red loam on top of an orange coloured loamy gravel.
The gravel consists of angular quartz pieces and lumps of calcrete.
Evidence of basement material was not found in these borings but from other drillings it is known that the gravel zone with quartz and calcrete invariably rests on basement rock.
Ground water in the gravel layer was only encountered in borings B-6 and B-17; the EC of the water was 525 to 800 mS/m, which is about the same as the ground water in this gravel layer near Kihonda.

Alluvial deposits were met with in borings B-9 to B-20, over a width of 1000 m across the valley.
The upper layer in these borings is a 1.2 to 3.0 m thick blackish swamp clay, which occasionally is sandy in its lower parts.

Covered by this clay, a sand channel was found in drillings B-9 to B-15. The salinity of the ground water in the sand body is very high; up to 3800 mS/m.

Much fine to coarse-textured, water-bearing sand was present in borings B-19 and B-20; both near the present riverbed.
The EC of the water here was 500 to 800 mS/m, almost the lowest of the profile.

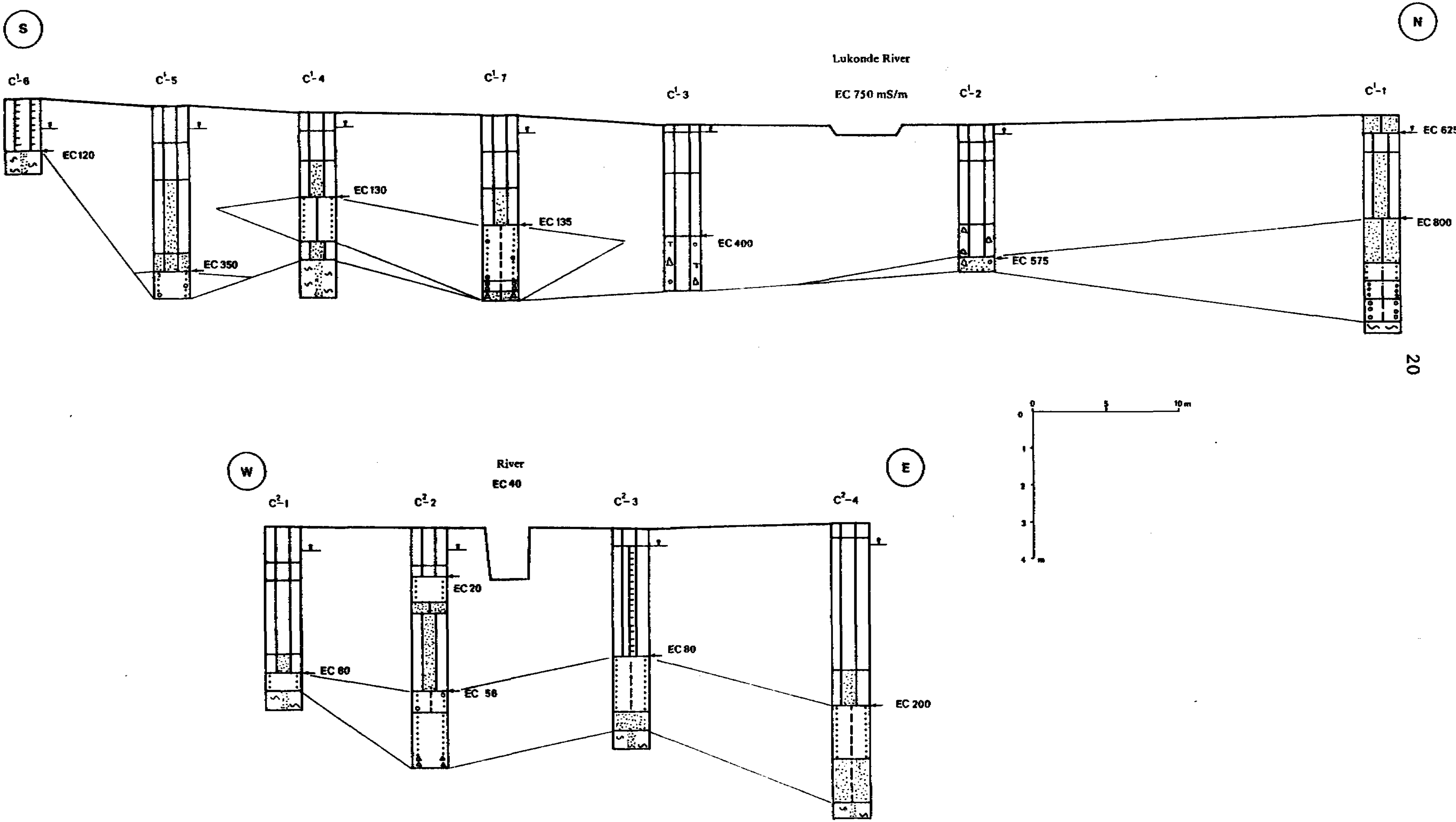
The lower parts of the drillings are made up of brown/grey mottled, sometimes loamy or fine sandy clay with some quartz pieces.
In Maji borehole 41/49, drilled down to 34 m, weathered gneiss was struck at a depth of 10.5 m.

DA 4.9.3 Profiles C^1 and C^2 at Mkambarani (fig. DA 4.9-3)

As can be seen in profile C^1, the alluvium deposited by the Lukonde River in the neighbourhood of Mkambarani, is more than 100 m wide and 4 - 5 m thick.
The uppermost 2 - 4 m of the alluvium, is a sticky, brown coloured clay which confines the sand layers that occur between this clay and the weathered gneiss.
In the profile three different sand lenses were encountered. These lenses probably are cross-sections through old channels and therefore the sand bodies may have a considerable length.
In two of the three channels, saline ground water is present under confined conditions. The EC varies from 350 to 800 mS/m.
In the sand, encountered in borings C^1-4 and C^1-7, ground water with an EC of 135 mS/m was found. It is possible that some recharge of this aquifer takes place, the EC of the ground water in boring C^1-6 (upper parts of weathered basement) was 120 mS/m.
There may be a hydraulic connection between the outcropping wheathered basement south of boring C^1-6, and the aquifer of C^1-4 - C^1-7.
In boring C^1-7 a pumping test will have to be carried out to see whether salt water is attracted by pumping this aquifer.
If this doesn't occur, than there are some possibilities for exploitation of this aquifer by means of shallow wells with hand pump.

Profile C^2 is drilled across the valley of a small tributary of the Lukonde River.
The alluvial deposits are more than 50 m wide.
Confined ground water occurs in a 0.5 - 2.5 m thick sand layer, at depths between 3.5 and 6.5 m below ground level.

Figure DA 4.9-3 Hand-drilled profiles at, Mkambarani



Below the sand, weathered basement was found.
The salinity in most part of the aquifer is relatively low: 56 - 80 mS/m; in boring C^2-4 an EC of 200 mS/m was found.
Location C^2-2 seems an attractive site for constructing a shallow well with hand pump. The sand is coarse and free of clay particles; the bottom of the sand layer is gravelly here. Again a pumping test will have to be carried out first, to assess the yield and the quality of the ground water after some time of pumping.

DA 4.9.4 Profiles D^1 and D^2 at Mkonowarama (fig. DA 4.9-4)

Near the village of Mkonowarama, 5 boreholes were drilled at three different locations along the Ngerengere River.

In boring D^1-1, water-bearing sand was found below 3.5 m of sticky brown clay. The sand layer is only 0.5 m thick and rests on weathered basement. The ground water was unconfined; the water level is the same as the water level of Ngerengere River.
The ground water is extremely saline; the EC was 1900 mS/m.

In boreholes D^2-1, -2 and -3, predominantly sandy material occurs. The water levels correspond with the water level of the Ngerengere River. Close to the river, the EC is 650 mS/m; further from the river, EC's up to 1900 mS/m occur.

DA 4.9.5 Profiles E^1 and E^2 at Mikese (fig. DA 4.9-5)

Although the Mikese River is only a very small stream, it has deposited a considerable volume of alluvium.
North of the river, only clays were encountered on top of the weathered basement.
Just south of the river, in boring E^1-4, two water bearing sand layers were found. The EC of the ground water was 120 mS/m. The total thickness of the aquifer, 3.0 m and its coarse texture make it interesting for the construction of a shallow well at the location of E^1-4.

Profile E^2 shows the presence of a 4 - 5 m thick slightly clayey sand body, below 2 meters of clay. Confined ground water with an EC of 88 to 120 mS/m, occurs in this aquifer. Because of the fact that neither in profile E^1 nor in profile E^2, saline ground water was present, the prospects for shallow ground water seem fair in this valley.

Figure DA 4.9-4 Hand-drillings in Ngerengere River Valley, at Mkonowarama

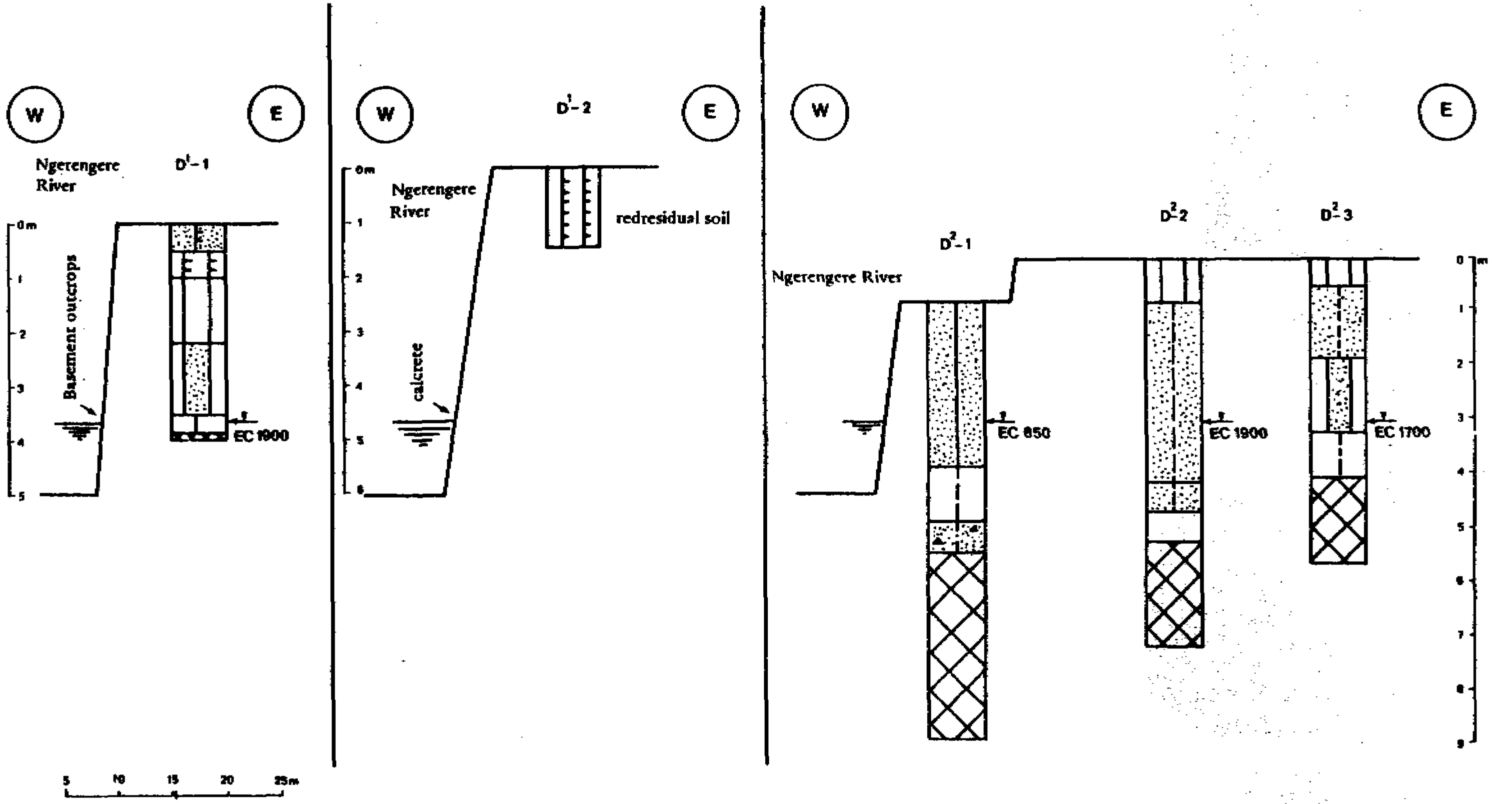
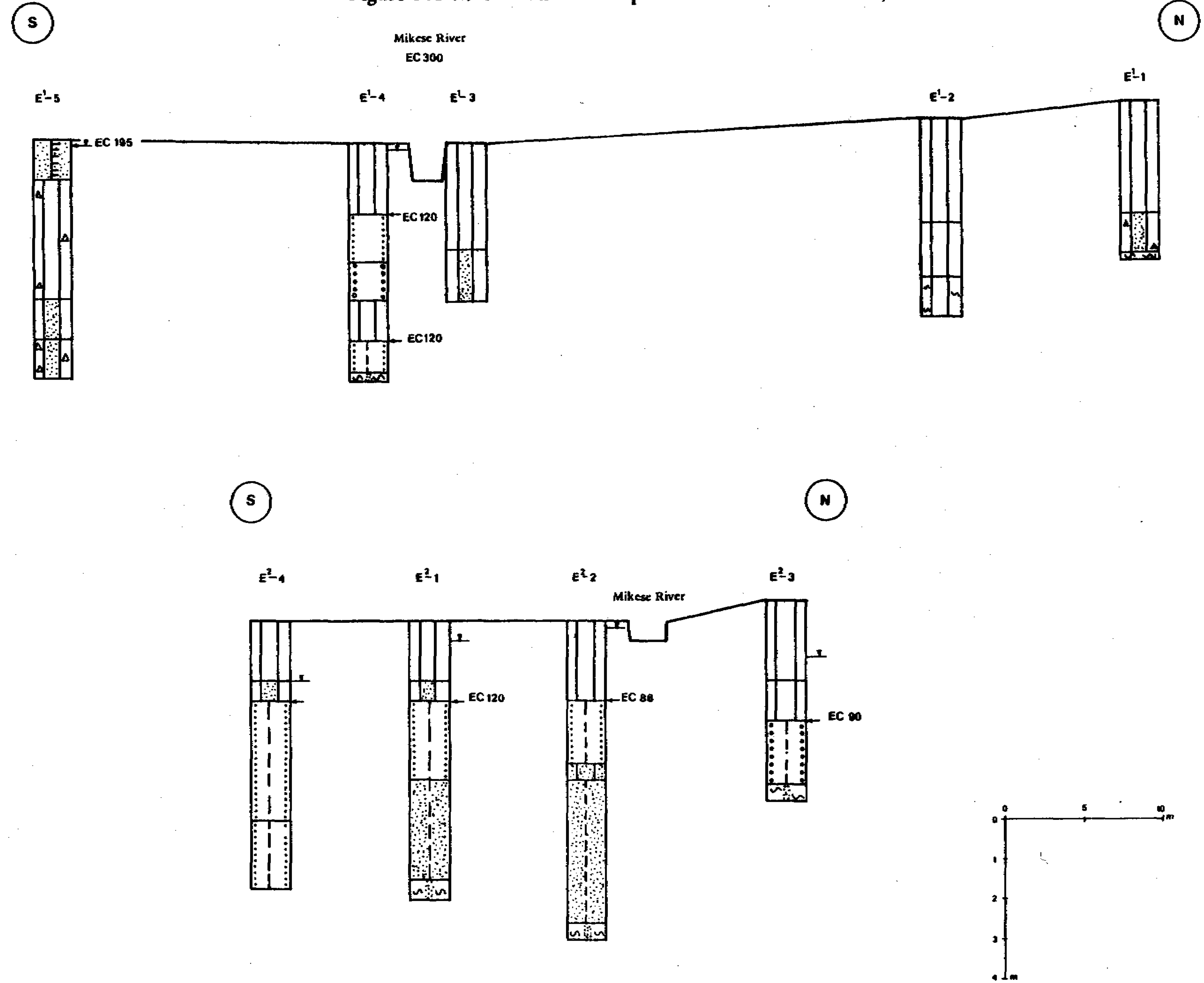


Figure DA 4.9-5 Hand-drilled profiles across Mikese River, at Mikese



DA 4.9.6 Profiles F^1 and F^2 at Lubungo (fig. DA 4.9-6)

As can be seen on profile F^1, alluvium occurs only west of the present course of the Lubungo River.
East of the river, orange/red loamy soils were found on top of the weathered basement.
A small isolated pocket of ground water with an EC of 45 mS/m was found in boring F^1-2; it offers no possibilities however.
The alluvium of the Lubungo River is about 80 m wide.
Below 3 - 4 m of sandy clay, there is a sand body that wedges out against the basement in a western direction.
In boring F^1-5 the EC was 147 mS/m, but in F^1-4, very saline ground water occurs (EC 577 mS/m).
Because of this, there seem to be no possibilities for exploitation of shallow ground water here.

In profile F^2, predominantly clays were encountered.
Ground water occurs in a thin sand layer in boring F^2-3 and in the gravel layer on top of the weathered basement in boring F^2-2.
Because of the presence of highly saline ground water, there seem to be no possibilities here for shallow wells.

DA 4.9.7 Profile G, at Ngerengere Darajani (fig. DA 4.9-7)

In Ngerengere Darajani, the Ngerengere River has incised itself relatively deeply into the basement.
Alluvial deposits of limited extend have locally been sedimented along the river. In borings G-4 to G-7, such alluvium was encountered. Borings G-1 to G-3 and G-8 were drilled in orange/red loamy soils.
Ground water of a low salinity (EC 50 up to 150 mS/m) occurs in an aquifer with considerably varying thickness and texture from borehole to borehole.
No saline ground water was found at this location and therefore there seem to be possibilities for exploitation of shallow ground water.
Wells should preferably be constructed as close to the river as possible so that pumping of a well will induce a ground water flow from the riverbed into the sandy aquifer.

DA 4.9.8 Profile H, at Kinonko (fig. DA 4.9-8)

At Kinonko, ground water was found to occur in a 60 m wide 2 m thick, slightly clayey coarse sandlayer, confined by 2 - 3 m of sandy clay.
The low salinity of the ground water, and the coarse texture of the sand offer some prospects for the exploitation of this aquifer.
Pumping tests will have to be carried out to find out if the EC does not increase after some time of pumping, and also to determine the possible yield of a shallow well in this aquifer.

Figure DA 4.9-6 Hand-drilled profiles at, Lubunga

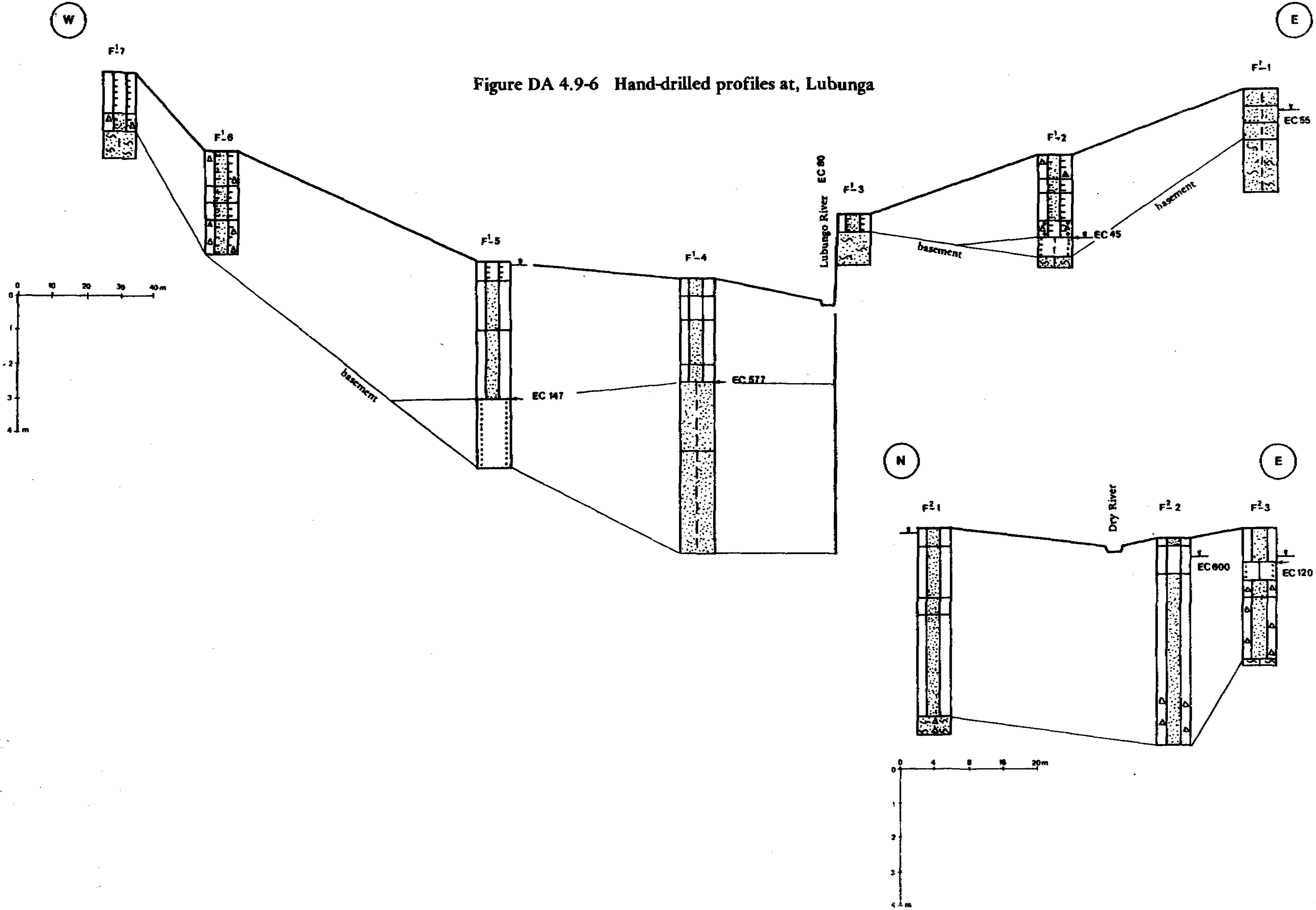


Figure DA 4.9-7 Hand-drilled profile across Ngerengere Valley, at Ngerengere Darajani

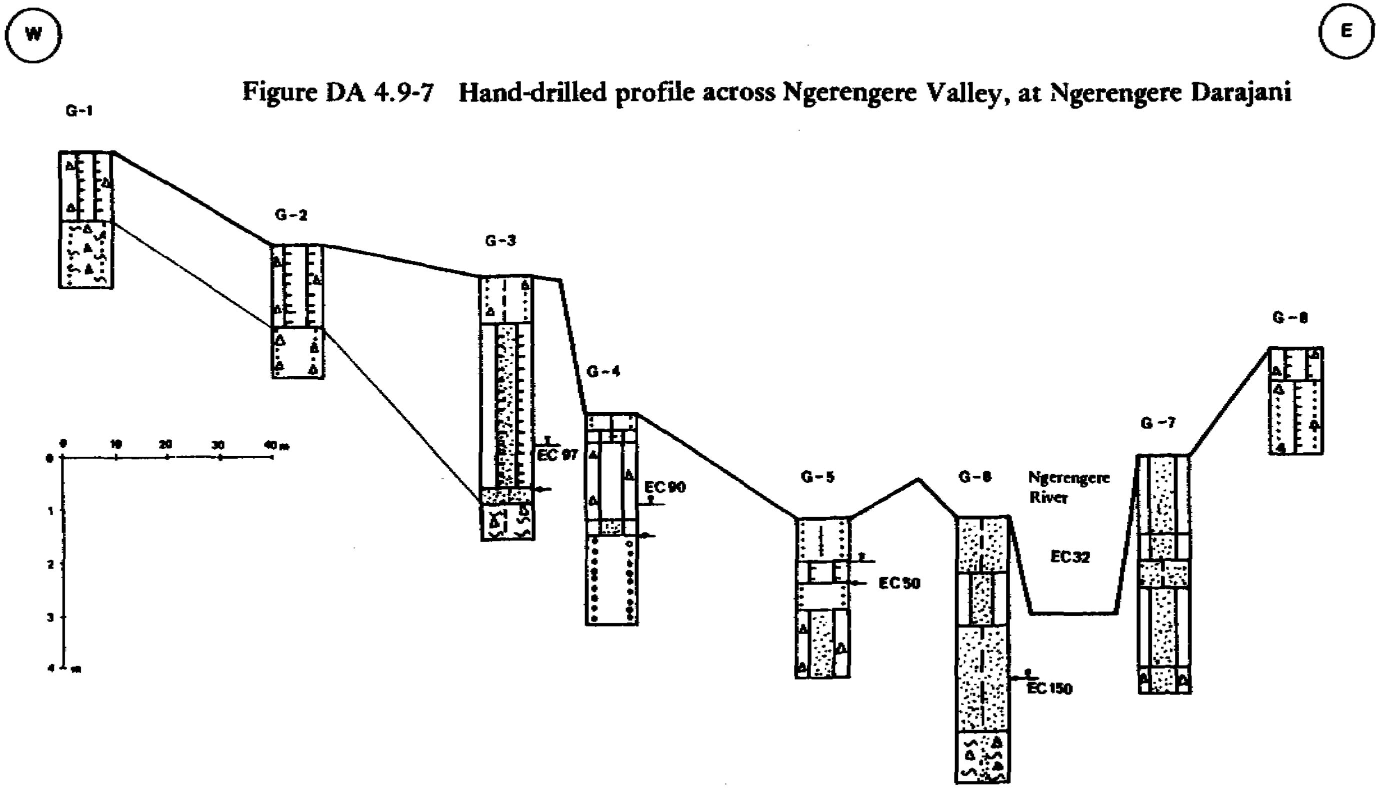
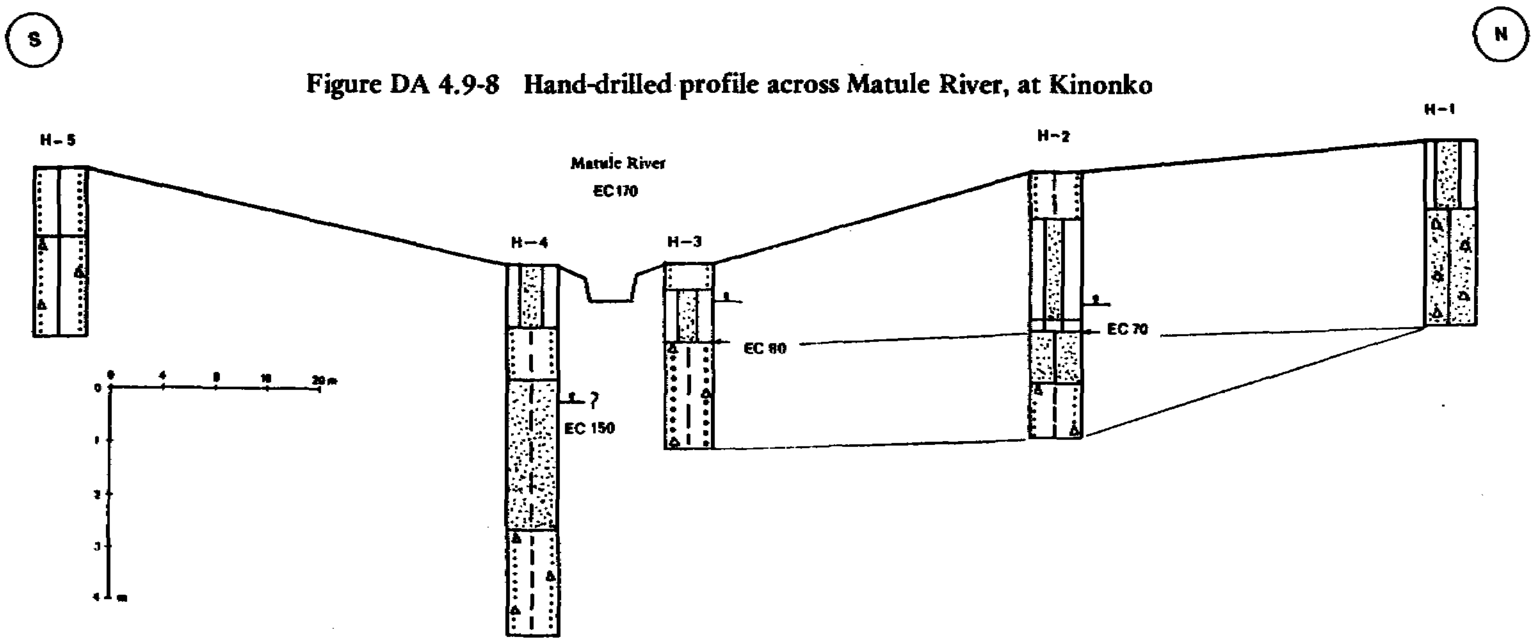


Figure DA 4.9-8 Hand-drilled profile across Matule River, at Kinonko



DA 4.9.9 Profile I, at Muhungamkola (fig. DA 4.9-9)

The alluvium deposited by the Muhungamkola River at the village Muhungamkola, is about 60 m wide and 6 - 8 m thick.
Below sandy clay which is 1 - 2 m thick, water bearing sand is present.
The ground water is confined and its EC varies in the different borings from 75 up to 220 mS/m.
A second aquifer in boring I-6, contains saline ground water.
Location I-4 seems to offer some prospects for shallow well construction.
However, pumping tests are necessary to be able to decide if this tentative conclusion is justified.

DA 4.9.10 Profile J, at Visaraka (fig. DA 4.9-10)

This profile, drilled across the valley of the Ngerengere River, downstream from the village Ngerengere, differs from the profiles described thus far. In boring J-1 to J-4, an up to 9 m thick sand layer occurs below 1 - 2 m of sandy clay and clayey sand. The sand is coarse to very coarse and only occasionally slightly clayey.
The sand is water-bearing: the ground water seems to be unconfined, and the EC is low: 65-75 mS/m.
In borings J-5 to J-8 predominantly clay was found alternated with thin sand or gravel layers. Here saline ground water occurs (EC up to 350 mS/m).
The best prospects for shallow ground water are therefore present, near the river.
The aquifer is certainly thick and permeable enough, to install shallow wells with motor pumps but it is possible that after some time of pumping saline ground water will flow towards the well.

DA 4.9.11 Profile K, at Masimbu (fig. DA 4.9-11)

Masimbu is not a village, but a camp, Schools for people from of a Liberation Movement are being built here. A request was made to the MDWSP to assess the ground water potential of the area around Masimbu. To this end, 12 holes were drilled along the Ngerengere River, at intervals of approximately 50 m.

Fig. DA 4.9-11 shows that the individual boreholes are lithologically very different from each other. The thickness of aquifers and the salinity of the ground water varies also considerably. Generally, most boreholes have very clayey sequences, alternating with sands containing saline ground water (EC's up to 1200 mS/m). Locations that probably are suitable for construction of shallow wells with handpump are: K-7 and K-11.

Figure DA 4.9-9 Hand-drilled profile across Muhumgamhola Valley, at Muhumgamhola

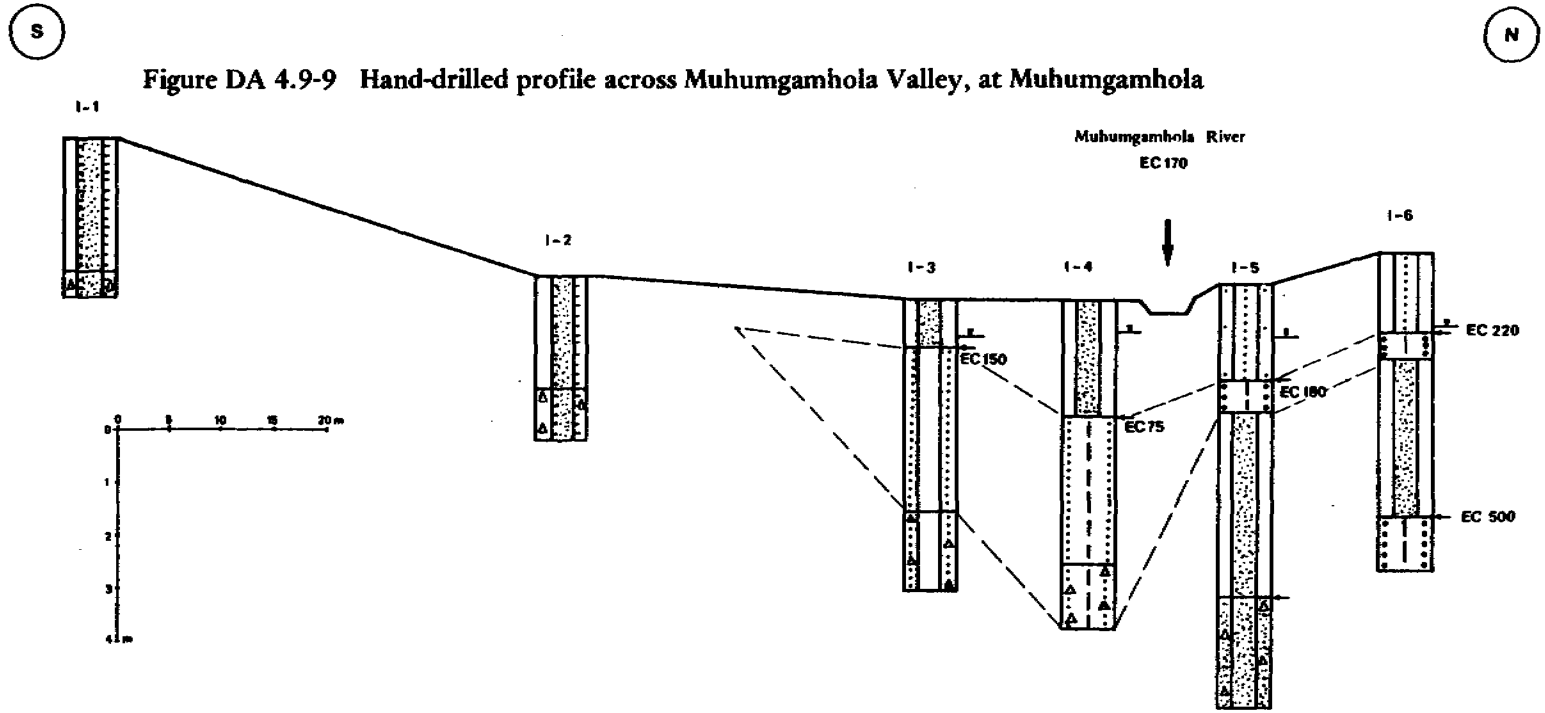


Figure DA 4.9-10 Hand-drilled profile across Ngerengere Valley, at Visaraka

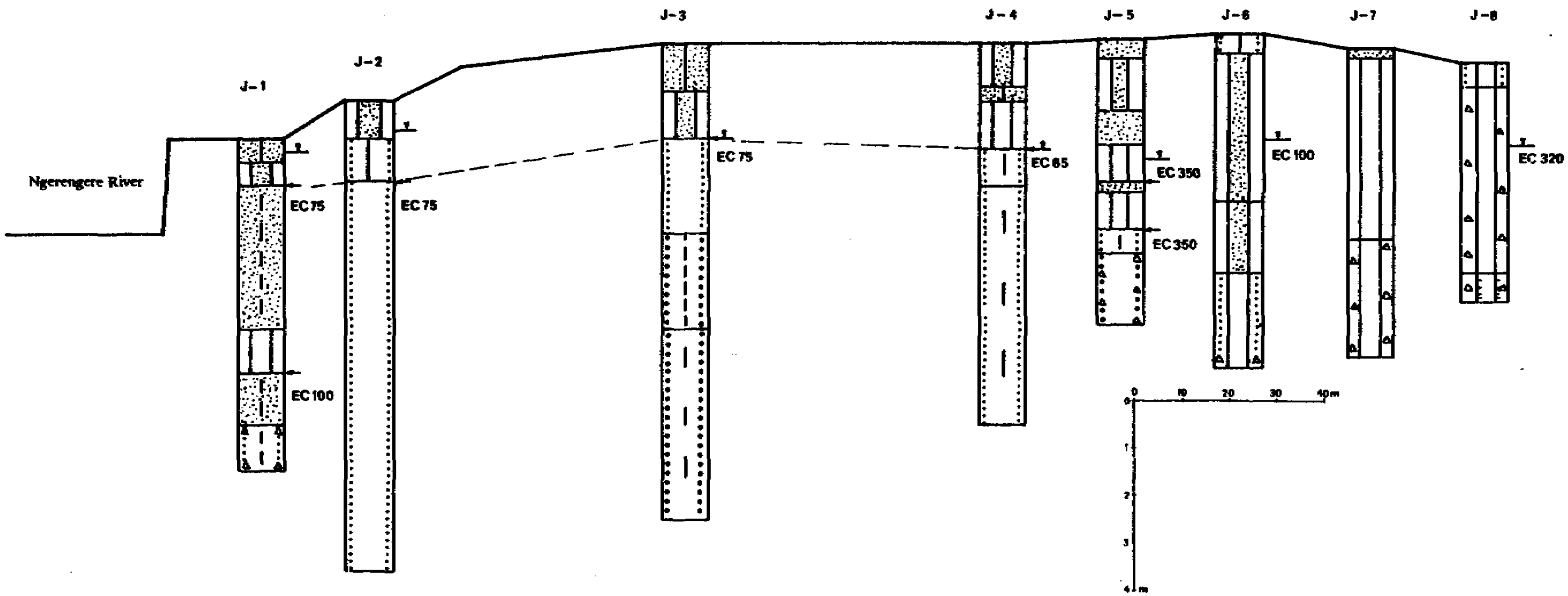
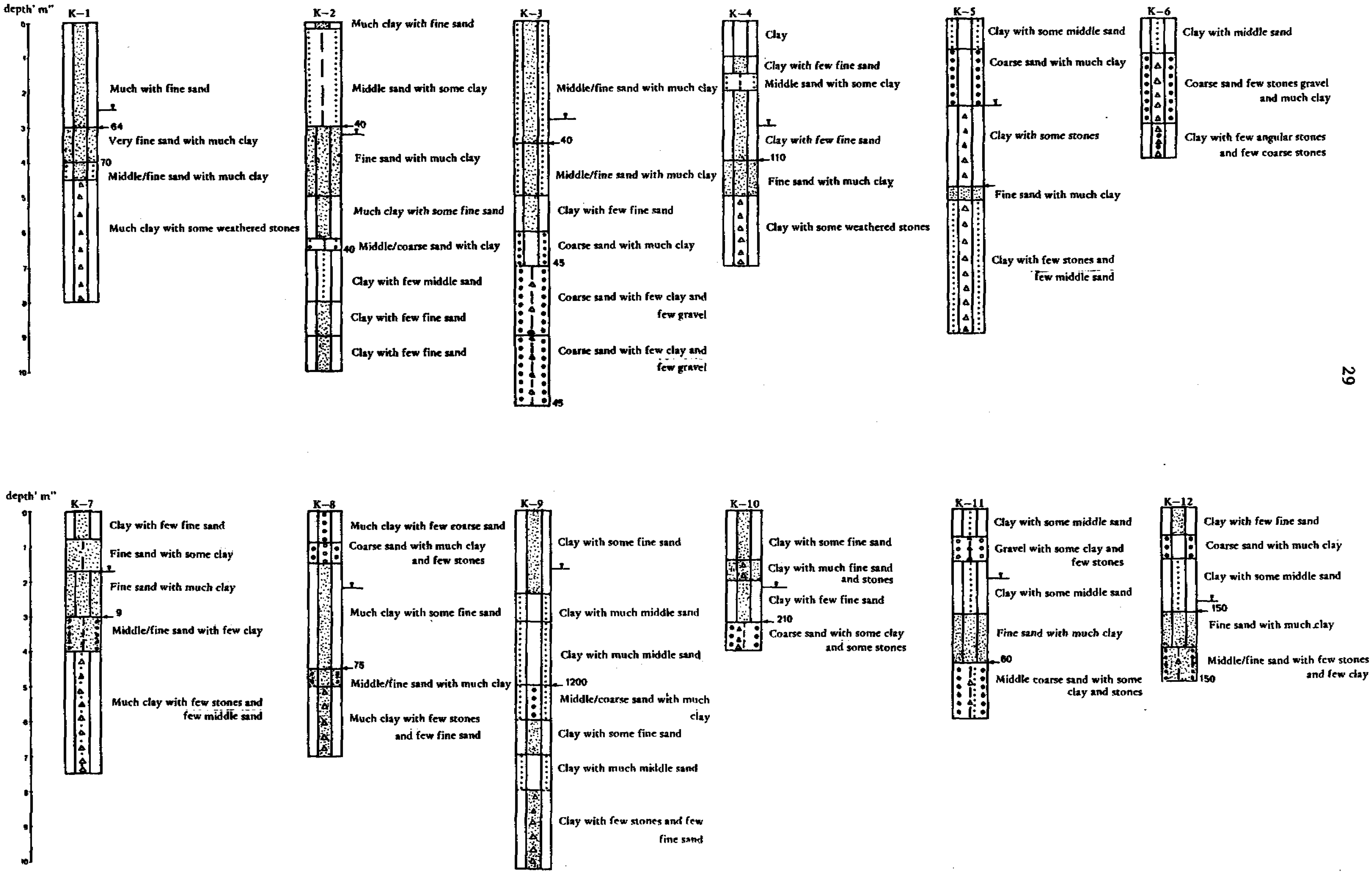


Figure DA 4.9-11 Hand-drilled holes at Masimba, along the Ngerengere River



Pumped supplies from shallow ground water in this area is not possible because of the clayey character of the aquifers and the presence of saline ground water.

DA 4.10 Conclusions

A. Examination of data from borehores drilled in the Ngerengere area proves, that the prospects for medium-depth and deep ground water in most parts of the Ngerengere area are poor to extremely poor. The yield of boreholes generally is low (< 3 l/s) to very low (< 1 l/s) and almost everywhere the ground water is saline. EC's up to 3800 mS/m have been measured. Fair prospects for exploitation of medium-depth to deep ground water are only present in the narrow (2 - 3 km wide) N-S orientated zone, underlain by Jurasic limestones (see D 4.2.7.).

B. In the Ngerengere valley upstream from Sanga Sanga settlement (fig. DA 4.3-1) 10 m up to 30 m thick and up to 900 m wide alluvial deposits occur. Since downstream from Sanga Sanga the Ngerengere River cuts relatively deeply into the basement and no alluvium is present there, the valley upstream from Sanga Sanga must have undergone a relative subsidence. Clays and sandy clays make up more than 90% of the upper 12 m of the sediments. Sands are usually water-bearing, the ground water being confined, but the salinity of the ground water is extremely high so that there are no prospects for shallow ground water in this part of the area. Only close to the river, shallow wells may locally be possible.

C. Between Sanga Sanga settlement and Ngerengere, the Ngerengere River is incised into the Precambrian gneiss and almost no alluvium has been deposited here.
As can be seen on Map D 4, this part of the catchment area is bounded by NE-SW running major faults, and is relatively uplifted. Alluvium occurs only locally in the valley of the Lukonde, Matule and Mikese Rivers, and some other streams. The alluvium is up to 100 m wide and 5 - 10 m thick. Approximately 80% of the deposits are clays; sands and clayey sands make up 20% of the alluvium. The ground water is confined and the EC's are mostly below 200 mS/m although saline ground water was found locally also.

Exploitation of shallow ground water by means of shallow wells with handpump might be possible in the villages: Mkambarani, Mikese, Muhungamkola and Kinonko.
No data are available yet on the water level fluctuations in these aquifers; some aquifers probably will run dry during the dry season.

Also the presence of saline ground water very close to the areas where fresh ground water was found, forms a potential danger. Pumping of ground water might induce the saline ground water to flow towards the wells.

D. Downstream of Ngerengere, the river has deposited alluvial sediments which are more than 12 m thick and 500 m up to more than 1000 m wide. This area is not underlain by Precambrian gneisses, but mainly by Jurassic sandstones and this probably is the reason for the abundance of sands in the alluvial deposits. At Visaraka, medium to very coarse sands make up more than 75% of the alluvial sediments. The sands are water-bearing and the EC is low (< 75 mS/m). Saline ground water was found to occur in clays and loams on the slopes of the valley. Shallow wells therefore will have to be located close to the river. Because of the high permeability of the sands, and the considerable thickness and extend of the aquifer, it is possible to withdraw a few l/s from a well. Larger yields however will increase the chances of salinisation of the aquifer. Careful planning and testing of aquifers is recommended before pumped supplies from shallow wells are taken into consideration.

E. By extrapolation of the collected and evaluated hydrogeological data, predictions can also be made concerning the prospects for shallow ground water in other problem villages.
The summary below describes the prospects for shallow ground water of all problem villages in the Ngerengere area.

Diguzi

No field data were collected on the occurrence of shallow ground water near Diguzi.
The valley, approximately 1 km south of this village was visited and alluvium was found to occur here over a width of 100 m across the valley. Possibilities for shallow ground water are present here.
Since the EC's of the ground water in Kiwege, upstream from Diguzi, and Visaraka, downstream from Diguzi are low, low salinity of the ground water near Diguzi is expected also.

Fulwe

The topographical location of Fulwe is very unfavourable; the village is situated almost on the watershed between the Ngerengere and Lukonde Rivers.
Ground water is present in small valleys in and near the village. However during the dry season the wells and holes dry out and the ground water is saline.

Approximately 1.5 km south of the village there is a small alluvial valley, where ground water of a low salinity (25 mS/m) occurs. The two shallow wells in this valley are hardly being used however, because of the distance. If shallow wells with handpump are to be constructed in this valley, a road will have to be constructed first.
A borehole was drilled in Fulwe (149/77), but its yield is very low, 0.4 l/s with a drawdown of 9.3 m.

Kinonko

At Kinonko shallow wells can be constructed in the valley of the Matule River. Average depth of the wells will be 7.0 m; the aquifer thickness is approximately 1.6 m. The EC of the ground water generally is below 200 mS/m but saline ground water occurs also and salting up of the aquifers during the dry season may be expected.

Kiwege and Mlilengwa

These villages are situated on water sheds.
Small quantities of shallow ground water occur in a few very small alluvial valleys around the villages. The yield of hand-dug holes in these valleys is extremely low; the EC of the ground water is only 9 mS/m, which points to very "young" water. There may be small possibilities for concrete ring wells.
Yields will still be very low and during the dry season there may be a shortage of ground water.

Lubungo

Near Lubungo there are two small valleys where alluvium was deposited. The ground water in these alluvial sediments is saline. There are no possibilities for shallow wells.

Maseyu

This village is situated on a water shed.
Ground water of low salinity occurs in very small valleys, filled with sandy alluvium. The ground water occurs in pockets and many of these pockets dry up during the dry season.

A detail study of the aquifers around this village will have to be carried out, to find out whether there are possibilities for shallow wells here.

Mikese

Shallow wells can be constructed in the valley of the Mikese River. The EC of the ground water is 100 mS/m on an average.
The seasonal water level fluctuations in this valley are considerable. Water levels vary from 1.5 to 7.0 m below ground level.

Mkambarani

Small amounts of ground water can be withdrawn from aquifers in valleys south and east of the village.
Because of the presence of saline ground water in the same valleys, the wells may become more saline during the dry season.

Mkonowarama, Kihonda, Tungi

All ground water occurring in the alluvium of the Ngerengere Valley is extremely saline.
There are no possibilities for shallow wells therefore.

Muhungamkola

Shallow wells with handpump can be constructed in a small valley, east of the village.
There is danger that the aquifer becomes more saline during exploitation, however.

Ngerengere

Shallow wells can be constructed along the Ngerengere River in sandy alluvium. The EC is low; 75 mS/m.

Ngerengere Darajani

Narrow isolated patches of alluvium occur along the Ngerengere River.
There are some possibilities of exploitation of shallow ground water from the alluvium, especially close to the river, where hydraulical connections exist between the riverbed and the alluvium along the river. Because of the presence of saline ground water, there is danger of salinisation of the aquifers.

Seregete A and B

There are no possibilities for extraction of shallow ground water within a distance of 1.5 km from these villages.
The nearest source of ground water is the riverbed and the alluvium of the Ngerengere River, at a distance of respectively 5 and 3 km from these villages.

Kwamba Lubumu, Lulogwe, Magela, Matuli, Visakara

Shallow wells can be constructed in the extensive alluvium of the Ngerengere River and its main tributaries.
There is an abundance of sandy material in the alluvium.
Yields of shallow wells will be high and the EC of the ground water is between 75 and 125 mS7m.
Because of the presence of saline ground water on the higher slopes of the valley, in weathered basement material, wells will have to be constructed quite close to the river.

ANNEX DA 5

GROUND WATER IN THE BEREGA AREA
SPECIAL STUDY

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DA 5. GROUND WATER IN THE BEREGA AREA

DA 5.1. INTRODUCTION

In the First MDWSP Report, the northern part of the Kilosa district was identified as an area experiencing most serious domestic water supply problems. Hence priority was given to the setting up of a study to assess the availability of ground water in this area, corresponding with the Berega Catchment and shown in fig. DA 5.1-1.
In a separate study (Volume III), the surface hydrology section of the MDWSP established the quantity of surface water available for domestic use.

Activities started in June 1978, with a hydrogeological reconnaissance survey of the area.
During this survey, data collected within the scope of the identification of conditions and problems of rural water supply in the northern part of the Kilosa district, dealt with in the First MDWSP Report, were quantified and qualified.
Hydrogeological fieldwork was carried out in 40 villages in the area.
Hydrogeological field data were systematically collected between June and July 1978, and are tabulated in DD 4.

An evaluation of data on deep boreholes drilled in this part of the project area is presented in D 3.1.1.
On the basis of the hydrogeological survey, the evaluation of boreholes data and the geological maps of the area, a general description of the hydrogeology of this area could be outlined in D 4.2.4. and D 4.2.13.

Three different waterbearing formations could be distinguished.

Shallow ground water occurs in:
- alluvial sands and gravels that fill up the riverbeds of the Berega river and its main tributaries
- sands and gravels of higher level fluvial terraces

Ground water at greater depth is occasionally present in:
- weathered zones, faults and shear zones of the gneissic basement rocks

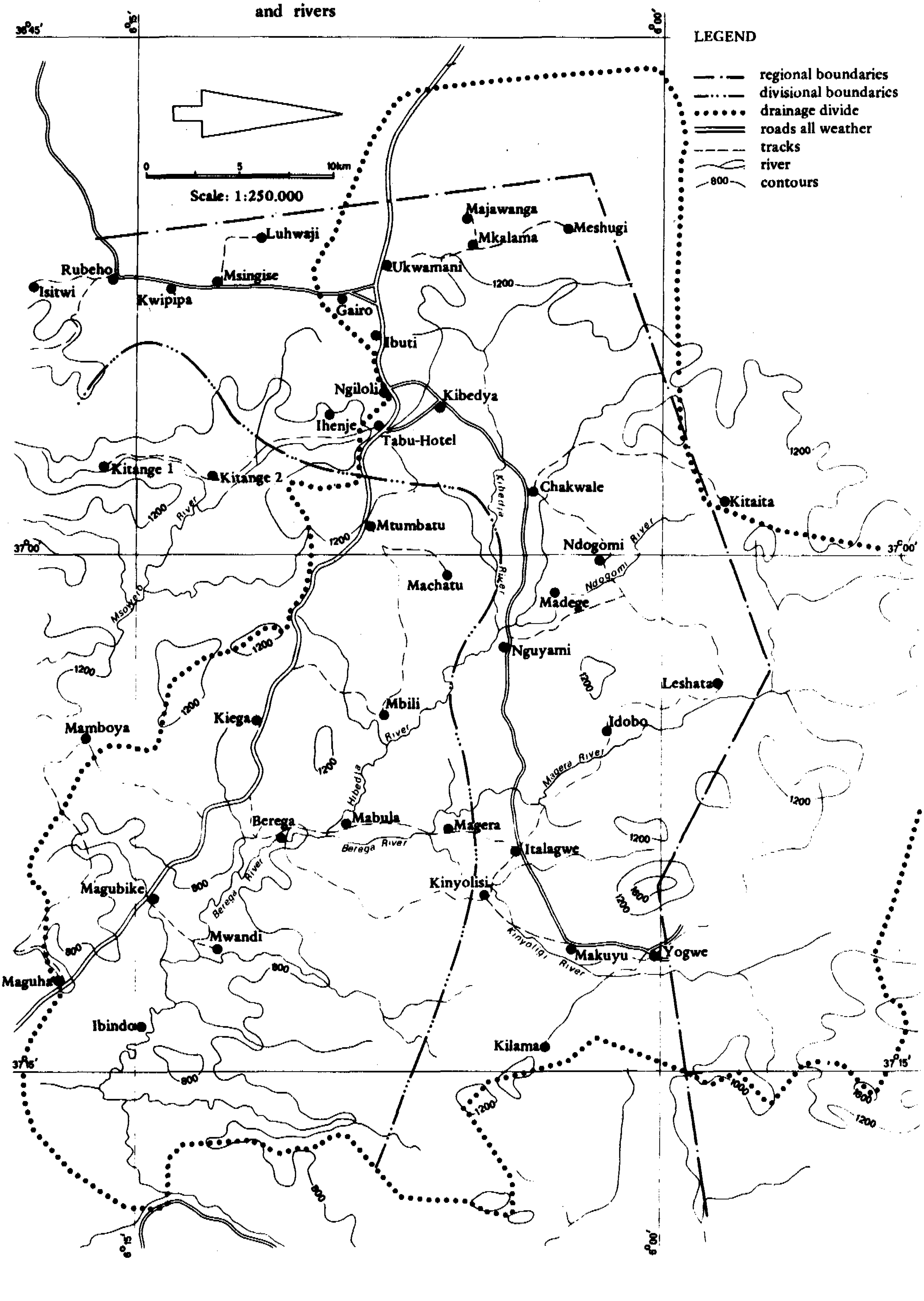
Table DA 5.4.6-1 shows that ground water in the basement rocks is invariably highly mineralized and unsuitable for domestic use. In addition, yields of boreholes are very low.
For this reason it was decided to concentrate this detailed study on the occurrence of shallow ground water.
Since all problem villages are situated within the catchment area of the Berega River, it has been found logical from a hydrogeological point of view to confine the investigations to this basin.

Thus, the aim of this detailed study was:

- to assess the quantity of potable ground water at shallow depth (0-12 m) available for domestic water supply throughout the year
- to find hydrogeological reasons for the occurrence of saline ground water in the basin
- to locate suitable shallow well locations

Fig. DA 5.1-1

The Berega Catchment Area; Location of villages and rivers



DA 5.2. APPROACH TO THE STUDY

DA 5.2.1. General

A reconnaissance survey, carried out at the beginning of the dry season by the MDWSP-hydrogeological section showed that the ground water quality and potential varied widely over the area.

As a result of this survey two sub-areas could be distinguished within the Berega River Basin (fig. DA 5.2.1-1).

Sub-area I, the western part of the catchment, has been characterized as one with poor prospects for the construction of shallow or river wells, due to a considerable salinity of the ground water and insufficient ground water potential of the riverbed aquifers.
Ground water quality and potential of sub-area II, the eastern half of the catchment, seemed much better although considerable differences in salinity were measured at relatively short distances.

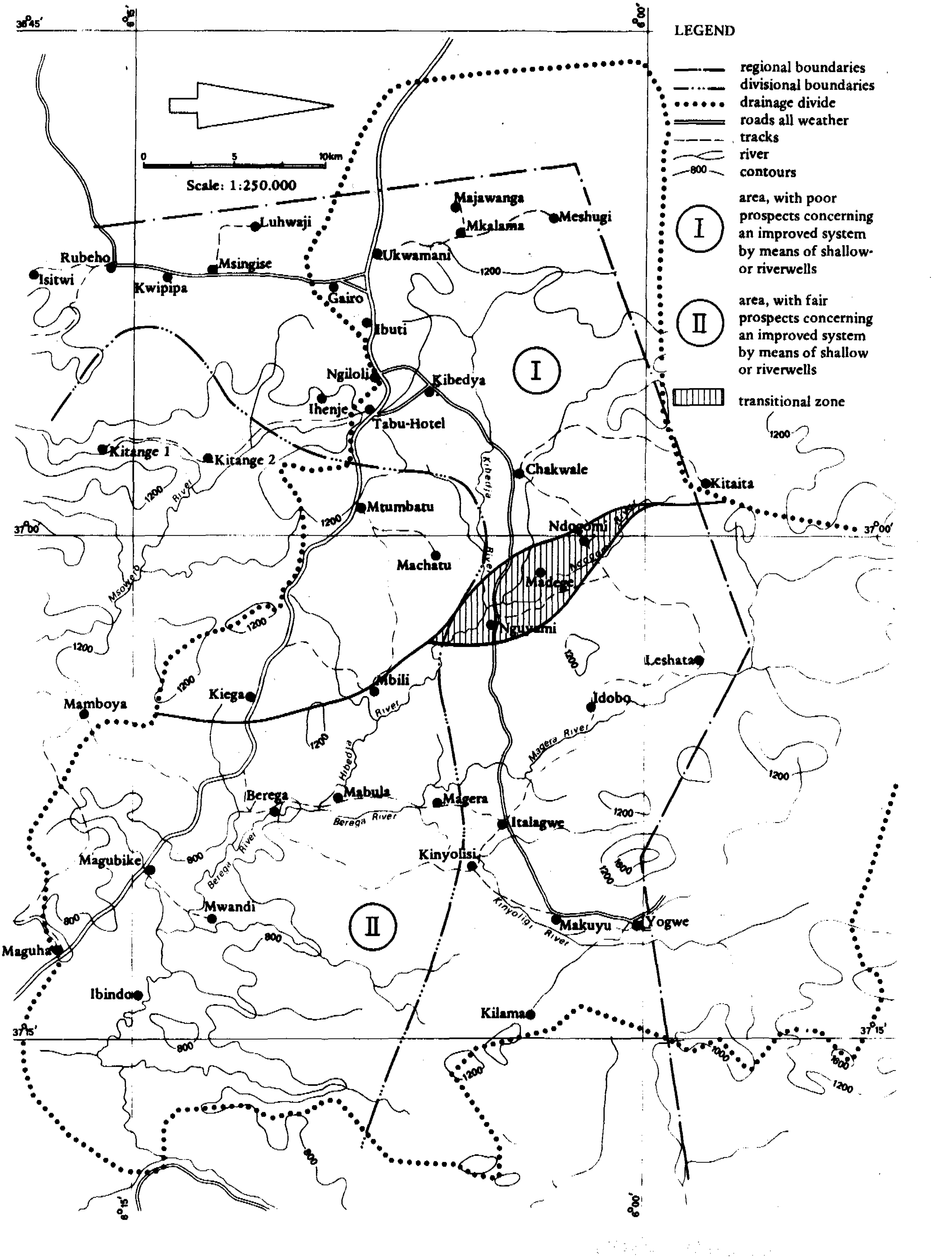
Because prospects for the construction of shallow or river wells seemed fair in sub-area II, a detailed study was set up to establish the ground water potential of the riverbed aquifer during the dry season and to find an explanation of locally high salt contents.

The main purpose was:
- to determine the thickness of the riverbed aquifer
- to find out if a vertical and/or horizontal layering of ground water with different salinity content exists
- to estimate the hydraulic permeability
- to measure the water table and salinity changes regularly during the dry season
- to locate good river well sites

At those locations where older terrace deposits occupy part of the valley, the cross-sections have also been extended to cover these. The aim of this was:
- to find out whether a hydraulic connection exists between the riverbed aquifer and other waterbearing zones
- to examine the chemical quality of ground water in these deposits
- to locate good shallow well sites

Fig. DA 5.2.1-1

Sub-areas based on fieldwork



DA 5.2.2. Fieldwork

To determine the ground water potential of the riverbed aquifer the following fieldwork was executed:

- as close as possible to a problem village, hand borings were drilled along cross-sections in the riverbeds
- samples were taken for examination from every drilled metre and the salinity of the ground water, expressed in EC-values, was measured
- 1 inch diameter PVC piezometer tubes were installed in every borehole

Geo-electrical soundings, covering the hand drilled profiles, were carried out in the riverbeds themselves and on the older terrace deposits, if present. The soundings were made in order to get more information about thickness of the weathered zone and to establish the depth to the unweathered bedrock.

Boreholes, drilled in the vicinity of geo-electrical soundings were well-logged, in order to gather resistivity data that could be of use during the interpretation of the geo-electrical sounding curves.

All profiles, drilled boreholes, locations of geo-electrical soundings and installed piezometer tubes were levelled.

Water samples were taken to get an impression of the chemical quality of the ground water. Extracting water samples from the observation wells was not possible, therefore water samples were taken from hand-dug holes near the cross-sections.

DA 5.2.3. Equipment

The boreholes were drilled with light equipment, manufactured in the Netherlands (Eykelkamp).
This lightweight set comprises the following items:

- 2 handles + 10 extension rods of one metre each
- 2 Edelmann combination bits of 7 cm diameter
- 2 Edelmann combination bits of 10 cm diamter
- 2 riverside bits of 7 cm diameter
- 2 riverside bits of 10 cm diameter
- 1 screw auger of 4 cm diameter
- 1 bailer of 63 mm diameter
- 2 1 m slotted galvanized casing pipes of 3 inch diameter
- 8 1 m unslotted PVC casing pipes of 3 inch diameter
- 10 extra extension rods of one meter each
- 1 complete set for pumping (hand pump)

Geo-electrical soundings were carried out with portable equipment comprising the following items:

- Bison 2300A earth resistivity meter

- 2 reels with 250 m cable each
- 4 40 cm iron pens (current and potential electrodes)
- 8 connection cables

Conductivity measurements in the observation wells were carried out with:
- Bison 2300A earth resistivity meter
- resistivity probe of 2 cm diameter
- reel

Well-loggings were carried out with simple, partly self-made, portable equipment which comprises the following items:
- geohm resistivity meter
- probe with an electrode distance of 0.2 m and 10 m cable

Levelling was performed with:
- Wild NAK 2
- 4 meter staff

EC-values during drilling were measured with:
- VU-IVA conductivity meter

DA 5.2.4. Elaboration of data

Fifteen sections across the riverbeds of the Berega, Kibedya, Magera, Kinyolisi and Dogomi Rivers were hand drilled and geo-electrically investigated.

These cross-sections have been numbered successively per map sheet e.g. 165/1-1. A total of 65 holes were hand drilled; the total drilling depth was 299.50 metres. The borings have been numbered per cross-section with the addition of a number e.g. 165/1-1-3. Because several holes turned out to be dry, only 57 were used to install piezometer tubes which have been given the number of the hand drilled boreholes in which they are installed.

A total number of 37 geo-electrical soundings were carried out. They are also numbered per cross-section, but with the addition of a letter. Well-loggings are numbered as the boreholes they have been made in.

DA 5.3. DATA COLLECTION AND ELABORATION

DA 5.3.1. Hand drilling

The samples have been described by the MDWSP hydrogeology section. Grain size, colour and mineral content have been determined. The lithological profiles were reconstructed together with the surveyor's borehole descriptions.

These lithological profiles were worked out in cross-sections, together with the levelled measuring points.

Water levels and the EC-values measured during drilling are also given in these sections.

DA 5.3.2. Geo-electrical soundings and well-loggings

Geo-electrical soundings were plotted on double logarithmic paper and interpreted with the curve-fitting method using 3-layer mastergraphs; the sounding curves and their interpretations are given in DD 11.
For more theoretical background information about geo-electrical soundings and interpretation methods reference is made to D 3.2.4.
Well-loggings together with the corresponding lithological profile are given in DD 12.

The results of the interpreted sounding curves are also given in the previously mentioned cross-sections. The depths of geo-electrically uniform layers as well as their average resistivities are indicated.

DA 5.3.3. Water quality

Taking water samples out of the piezometer tubes failed due to lack of a suitable pump. Therefore water samples were taken from hand-dug holes in the vicinity of the cross-sections. All samples were chemically analyzed by the MDWSP water supply section. The results are summarized in table DA 5.7.2-2.

DA 5.3.4. Ground water flow

Ground water flow within the alluvial aquifers can hardly be calculated for the whole river basin. Many small tributaries had not been incorporated in this study and it proved to be difficult to determine the real extention of the riverbed aquifers.
To get an impression of the ground water potential, however, a rough estimation was made of the minimum ground water flow in the riverbed.

A longitudinal profile of the Berega River and its main tributaries was reconstructed (Fig. DA 5.3.4-1) to determine the hydraulic gradient, assuming that this is equal to the gradient of the riverbed. It appeared that the gradient is rather constant over the river bed and varies between 0.013 and 0.021 (see Fig. DA 5.3.4-1).

Minimum saturated vertical sections of the aquifers have been estimated from the cross-sections. The actual extention of the aquifer was not established exactly in all cases, as drillings often had to be stopped at limited depth due to hard layers or caving in of the boreholes. Minimum sections have been established for situations at the beginning of a dry season (ground water table at ground level), the end of the dry season of 1978 (mid-November), and an extremely dry year (beginning of the rainy season mid-December).
To this end, the decline of the ground water levels, measured during the dry season of 1978, has been extrapolated from the figures presented in DD 13.
Ground water flow through the different sections has been calculated using permeabilities estimated from the borehole samples.
Minimum calculated ground water flows vary between 4110 m^3/day downstream at Ibondo, to 535 m^3/day upstream at Ndogomi.

The area is 1760 km^2, hence, assuming an average annual rainfall of 650 mm (see DA 5.4.5.), the total amount of precipitation that falls yearly in the catchment area is about 1144 x 10^6 m^3. The average ground water discharge of the Berega riverbed near the junction of the Berega with the Chogowale River (Ibindo) is approximately 4500 m^3/day (Table DA 5.7.1-1) or 1.643 x 10^6 m^3/year, which is only 0.15% of the annual precipitation. The remaining part of the rainfall evaporates or is discharged as surface water.

DA 5.3.5. Measurement programme

From July up to December 1978, measurements were executed of water levels in piezometers installed by MDWSP.
At the same time, the EC's of the ground water in many hand-dug holes were measured.
The data are presented in DD 13.
During the course of the dry season, the ground water table in the alluvial aquifer did not decline more than 0.5 m on an average.
At most locations where the EC was measured at regular intervals during the dry season, there was hardly any change in salinity.
An increase in salinity was only measured at Mabula, Magera, Ndogomi, Nguyomi and Mbili.

DA 5.4. DESCRIPTION OF THE SURVEY AREA

DA 5.4.1. Topography

The Berega River Basin drains the central part of the eastern Ukaguru Mountains. The basin is about 80 kilometres long down to the junction with the Chogowale River, one of the main tributaries of the Mkindu River (see Fig. DA 5.1-1).
The basin drains moderately to semi-arid terrain between elevations of 1500 and 600 metres above sea level.
The drainage area is about 1760 km^2 of which roughly 5% is the main valley floor, 15% is rugged mountains and the remaining 80% is upland terrain.

Slopes are moderate, 4-10%, with some inselbergs reaching elevations of 300 to 800 metres above their surroundings.

The valley is a NW-SE orientated depression bounded by faults.
To the NE the Nguru Mountains rise steeply, forming a drainage divide at elevations up to 1500 metres. To the SW the divide follows elevations up to 1400 m of the Kaguru Mountains.

DA 5.4.2. Geology (Map D 2)

The catchment area is situated between two mountain ranges; the Nguru Mountains in the NE and the Kaguru Mountains in the SW.
The Nguru Mountains mainly consist of granulites. The Kaguru Mountains are composed of tightly folded gneiss, amphibolite, meta-gabbro and quartzite, locally intruded by granite.

The Berega River Basin itself is underlain by pre-Cambrian biotite gneiss of sedimentary origin, folded into a NW-SE strikingly broad syncline.
In many places the weathered or unweathered bedrock is covered with some metres of red-brown sandy soil, derived mainly from the biotite gneiss.

Remnants of fluvial and colluvial depositional terraces, locally up to several hundred metres wide and a few metres thick are found in the main valleys.
These sediments are well bedded, consisting of dark-brown sandy loams, loamy sands and coarse sands to fine gravels, most probably deposited during early Quaternary times.
The top of these terraces is situated at elevations of a few metres above the present riverbeds.
The present riverbeds of the Berega River itself and its main tributaries, the Kibedya, Magera and Kinyolisi River, are from 5 to 50 metres wide.
They are cut into the old terraces or bedrock and filled up with some metres of coarse to very coarse sand. Geoelectrical measurements carried out during this study indicate the presence of a fairly thick weathered zone beneath these alluvial deposits.

DA 5.4.3. Hydrology

The catchment boundaries and the main rivers are given in fig. DA 5.1-1. None of the rivers in the Berega catchment area are perennial; they only flow after heavy rains.
The occasional floods do not occur more than a few times a year and the inundations of the terraces are limited to a few days a year.
During these floods a considerable amount of water is discharged, carrying a heavy sand load.
After the rain stops, rivers flow intermittently for some time and from about halfway through the dry season no more surface discharge takes place. During the dry season drainage takes place only through the aquifer formed by the alluvial sands and gravels that filled up the riverbeds of the Berega River and its main tributaries.

DA 5.4.4. Land use and vegetation

Agriculture is limited to small local farms (mashamba) in the vicinity of the villages. The main food crops are maize and sorghum.
Cash crops are very rare and consist mainly of cotton and sunflowers and to a lesser extent of beans. No large farms or estates occur in this area.

Most of the cultivated fields are situated on the older terraces. Sometimes very recent lower terraces bordering the present riverbeds are also used for cultivation.

The vegetation of the remaining upland terrain mainly consists of open forest, scrub and scattered trees. The slopes of the Nguru Mountains and the inselbergs are bare or support light forests.

Stock herding activities are extensive throughout the area.
Lifestock units for the different villages in the Berega area are given in Volume II, Table BD 3-1.

DA 5.4.5. Meteorology

Rainfall data were collected from two stations within the Berega River catchment area. The mean annual rainfall in Berega (Station Berega Mission), with reasonably reliable records, amounts to 781 mm. Rainfall data from a station in Gairo are less reliable and show a mean annual rainfall of about 505 mm (records from 1970). Rainfall data have been summarized in table DA 5.4.5.-1.

Evaporation data have been derived from records of the stations Kongwa and Morogoro. Mean annual potential evaporation measured at these stations amounts to 1967 mm and 1760 mm respectively.

Evaporation in the Berega area will probably be somewhat lower because of its higher elevations.
The evaporation may possibly be less than 100 mm in May, June and July and will only exceed 150 mm in October, November and December.

Table DA 5.4.5.-1 Rainfall data

Monthly Rainfall (mm) for Station: BEREGA MISSION Registration Number: 96.3703

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	103.1	150.1	143.5	159.0	59.7	4.3	8.4	0.0	0.0	18.0	16.8	99.1	762.0	*
1951	51.8	198.4	68.8	55.4	70.1	4.8	8.6	0.0	0.0	29.2	49.8	125.5	662.2	603.1
1952	227.1	128.3	100.1	135.4	82.6	2.8	0.0	0.0	30.0	0.0	54.9	25.4	786.4	881.1
1953	144.8	12.4	136.7	101.3	92.5	12.4	14.7	12.2	0.0	0.0	2.5	104.1	633.7	607.4
1954	158.2	191.8	39.9	95.5	53.1	1.0	0.0	0.0	0.0	21.3	5.1	77.7	643.6	667.4
1955	56.1	219.5	24.9	108.7	111.3	40.4	5.1	0.0	0.0	0.0	24.6	166.1	756.7	648.8
1956	215.9	124.5	83.3	175.0	44.2	17.3	0.0	0.0	5.1	0.0	54.6	100.6	820.4	855.9
1957	178.1	45.7	141.0	264.9	154.4	11.7	0.0	0.0	3.0	25.4	27.4	245.6	1097.3	979.5
1958	58.2	174.8	189.7	116.1	52.3	35.3	0.0	0.0	0.0	0.0	14.2	99.3	739.9	899.4
1959	133.1	218.9	191.0	94.2	32.8	0.0	0.0	30.5	0.0	0.0	0.0	77.0	777.5	814.0
1960	149.6	62.7	99.8	139.2	38.4	25.9	25.7	0.0	1.3	1.5	0.0	0.0	544.1	621.1
1961	15.2	200.7	52.1	147.3	59.7	0.0	77.5	0.0	0.0	104.1	150.4	184.4	991.4	656.6
1962	315.0	97.0	83.3	81.3	30.5	0.0	25.4	0.0	0.0	0.0	3.0	148.6	784.9	968.1
1963	100.5	136.6	99.6	71.8	15.1	12.7	0.0	0.0	0.0	0.0	231.2	88.1	755.6	587.9
1964	198.6	172.7	206.3	85.8	55.8	55.7	28.0	0.0	0.0	20.3	0.0	218.7	1041.9	1142.5
1965	238.8	194.5	78.7	35.6	35.6	0.0	0.0	0.0	0.0	20.4	63.4	104.1	771.2	822.4
1966	25.5	27.9	111.8	139.7	73.6	53.3	40.6	0.0	0.0	0.0	38.1	(50.0)	(560.5)	639.9
1967	27.9	94.3	30.5	250.7	207.1	2.3	33.0	12.7	10.2	0.0	43.1	230.3	942.1	(756.8)
1968	150.7	139.5	286.0	135.1	51.6	25.4	0.0	0.0	0.0	0.0	58.4	20.3	967.0	1161.7
1969	57.9	186.0	128.2	69.0	33.5	10.5	2.8	6.8	8.9	9.4	36.8	41.7	591.5	591.7
1970	284.5	179.8	121.1	53.6	62.3	0.8	0.0	0.0	0.0	2.8	7.4	84.2	796.5	783.4
1971	129.5	111.3	60.6	157.0	57.4	19.3	0.0	0.0	0.0	12.9	1.4	61.2	611.8	640.8
1972	63.0	162.8	197.2	92.5	127.6	2.1	24.7	0.0	45.1	40.3	29.5	137.7	922.5	817.9
1973	267.6	218.7	30.3	217.0	24.4	12.8	0.0	5.1	0.0	1.6	18.5	115.9	911.9	944.7
1974	64.8	55.2	28.7	278.7	75.7	3.1	14.0	0.0	0.0	17.1	10.0	53.9	501.2	571.7
1975	160.4	38.9	177.6	160.2	62.6	9.9	2.9	1.6	9.9	1.0	1.3	88.5	714.8	688.9
1976	66.9	164.6	86.3	107.3	71.7	18.9	15.4	0.2	0.5	0.0	2.5	54.5	588.8	621.6
1977	195.6	188.8	96.1	105.6	123.1	1.1	21.1	14.9	19.4	11.0	81.3	127.0	985.0	833.7
1978	114.0	112.2	216.9	136.0	67.1	15.6	3.4	1.0	0.0	0.0	111.6	309.1	1086.9	874.5
n(1953-77)	25	25	25	25	25	25	25	25	25	25	25	25	25	25
m	138.3	136.8	111.2	131.3	69.9	14.9	13.2	3.4	4.1	11.1	36.2	107.2	778.1	773.0

Monthly Rainfall (mm) for Station: GAIRO Registration Number: 96.3626

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1970	251.2	59.1	98.7	15.4	7.4	0.0	0.0	0.0	0.0	0.0	0.0	102.2	534.0	*
1971	57.3	97.1	50.7	64.9	28.3	15.0	15.3	0.5	3.0	3.3	2.5	30.8	388.9	437.6
1972	77.9	177.4	121.8	39.5	95.9	0.0	0.0	*	*	*	*	118.4	*	*
1973	121.2	184.9	90.0	51.5	53.3	0.7	0.0	0.0	0.0	0.0	0.0	108.8	610.4	*
1974	57.3	15.6	31.1	114.9	45.1	1.0	4.0	1.1	0.7	21.0	28.7	45.7	366.2	430.6
1975	138.0	75.0	103.1	74.4	28.8	0.0	0.0	0.0	13.2	16.9	30.1	143.7	623.2	523.8
1976	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1977	303.0	*	29.1	26.2	11.1	0.0	*	0.0	13.2	13.7	86.3	87.1	*	*
1978														

DA 5.4.6. Ground water

The area's main aquifer is formed by alluvial sands and gravels of recent age that filled up the riverbeds of the Berega River and its main tributaries. Phreatic conditions seem to exist everywhere. Ground water is also present in the older sedimentary terraces and residual soils that occupy parts of the main valley and its smaller tributaries.

Ground water level measurements, executed in piezometer, installed during this special study, indicated a ground water flow from the older terraces and residual soils towards the riverbed aquifer, during the course of the dry season.

The salinity of the shallow ground water varies widely over the river basin; ground water in the Kibedya riverbed has a salinity frequently exceeding the maximum acceptable value of 200 mS/m, while the water in the Kinyolisi riverbed is of a much better quality (EC values up to 65 mS/m).

The gneiss of the pre-Cambrian basement complex is virtually impervious and the occurrence of deep ground water appears to be restricted to the weathered zone, fault lines and shear zones.
Table DA 5.4.6-1 shows that yields of deep boreholes are very low and the ground water is strongly mineralized. Therefore chances to find suitable deep well sites with sufficient yield and acceptable quality must be considered very poor.

Table DA 5.4.6-1 - Boreholes drilled in the Berega area and surroundings

number	location	EC mS/m	Q lit/sec.	total depth	remarks
2/53	Gairo	198	0.5	73.8	abandoned
41/54	Chakwale	249	0.9	42.1	abandoned
15/60	Rubeho	-	dry hole	75.3	abandoned
16/60	Meshugi	saline	0.2	62.8	abandoned
34/60	Rubeho	240	0.5	68.9	abandoned
37/60	Kisitwe	-	dry hole	68.0	abandoned
18/65	Magubike	490	1.3	76.2	
33/65	Gairo	255	0.7	90.2	abandoned
41/76	Mtumbatu	-	dry hole	91.4	abandoned
282/77	Mtambatu	175	1.1	62.5	

DA 5.4.7. River flow and ground water recharge

During the wet season, when rivers and streams are flowing continuously, the riverbed aquifer is saturated with water of relatively low salinity.

After the main rainy season, rivers flow intermittently for some time and about halfway through the dry season no more surface discharge takes place.

During the part of the dry season that the riverbed aquifer is no longer recharged by infiltration of stream runoff, ground water seepage from alluvial and colluvial material on the valley and mountain slopes gradually becomes the only source of recharge. Later in the dry season recharge may stop entirely.

Recharge of the terrace deposits, colluvium and eluvium, as well as the weathered and fissured parts of the basement rocks takes place during the wet season, when parts of the valley floor are flooded and water can percolate down to greater depths.

DA 5.5. PRESENT WATER SUPPLY SITUATION

DA 5.5.1. Introduction

The water supply situation in the Berega area, as described below, is based on data collected for the First MDWCP Report, supplemented with data collected by the hydrogeological as well as the hydrological sections during their respective field surveys in this area.

As stated before, the northern part of the Kilosa District was identified as an area experiencing most serious water supply problems during the dry season. The present water supply situation (1978) during this season may be summarized as follows:

- about 34,000 people (66%) in the area depend on hand-dug holes in the riverbeds
- seven villages (about 7750 people) do not have any domestic water supply within 2 km walking distance
- eight villages (about 12,000 people) use water of very poor quality
- two villages, at the end of a gravity scheme, only receive water for a few days per week
- the pumped, piped water supply of one village suffers from regular breakdowns

The different types of domestic water supply in the Berega area and their specific problems will be discussed separately.

DA 5.5.2. Gravity piped water supply (5 villages; 12,000 people)

Five villages, Gairo, Ukwamani, Majawanga, Kibedya and Chakwale, with about 12,000 inhabitants are connected to a gravity piped water supply that also provides water to five villages outside the basin (Gairo gravity scheme).
The water is diverted from two small perennial streams in the mountains south-east of Kisitwe by means of gravity flow through pipes.
The water is distributed through public taps in the villages.

Only Gairo, Ukwamani and Majawanga are certain of a supply throughout the year. During the dry season, however, the villages Kibedya and Chakwale (about 4700 inhabitants), at the end of the pipeline, only receive water for a few days per week.

DA 5.5.3. Pumped, piped water supply from a river well (1 village; 2650 people)

Only Berega and its two sub-villages Chirihara and Berega Mission are connected to a pumped water supply. The water is pumped from a concrete river well in the Berega riverbed into 3 storage tanks that have to be refilled every day. The water is distributed to public taps.

Apart from occasional breakdowns of the pump and lack of diesel oil, this system works properly for about 8 months a year.
During the last months of the dry season, when the ground water table is much lower, the storage capacity of the river well is not sufficient, consequently it takes several days of intermitted pumping to fill the storage tanks.

DA 5.5.4. Pumped, piped water supply from a spring (1 village; 1350 people)

The whole year round, the village of Maguha receives water from a small spring (0.3 lit/sec).
This spring has been developed by means of a small dam and two storage wells. From the wells the water is pumped to seven public taps and one cattle dip.

This system shows, that even with a very small amount of water, not varying much throughout the year many people can be served.

DA 5.5.5. Pumped, piped water supply from a deep borehole (1 village, 2800 people)

Only one village, Magubike (about 2800 inhabitants), is connected to a pumped water supply from a deep borehole. In the past more boreholes were drilled in this area, but most of them have been abandoned (see table DA 5.4.6-1). The main reasons are a very low yield and strongly mineralized ground water (EC values up to 500 mS/m.

The borehole in Magubike is connected to public taps and in spite of the very high EC value (490 mS/m) these taps are still used. For drinking water purposes, however, the villagers collect water from the river in the wet season and from hand-dug holes during the dry season.

DA 5.5.6. Non-improved water supply (22 villages; 32,550 people)

DA 5.5.6.1. Water supply within walking distances

The villages Ibindo, Mwandi, Kiegeya, Mabula, Nguyami, Madege, Iogwe, Makuyu, Ndogomi, Idibo, Leshata, Magera, Italagwe and Kinyolisi, with a total of about 18,000 inhabitants, all fall into the same category; during the wet season people use water from the Berega River, its tributaries and temporary pools, while during the dry season the only sources of water are hand-dug holes in the riverbeds.

There are no major supply problems since the hand-dug holes give water the whole year around, provided that one digs deep enough. The main problem, however, is not the quantity but the quality of the water in these hand-dug holes. Especially the villages along the Kibedya River suffer from saline water (Nguyami EC up to 450 mS/m).

The people of Kiegeya (900 inhabitants) have to dig holes in alluvial and residual loamy soils during the dry season.
Due to the low permeability of this waterbearing material, people have to wait a long time before they can fill their buckets.
Moreover, the ground water is of a very poor quality (EC > 200 mS/m).

DA 5.5.6.2. No water supply within walking distance

The villages Mkalama, Meshugi, Ngiloli, Tabu Hotel, Mtumbatu, Mbili, Machatu, Kitaite and Kilama (about 9700 inhabitants) have the most serious water supply problems.

During the wet season people from these villages may collect water from nearby temporary pools, but for more than six months a year the villagers have to collect water at considerable distances.

People from Mkalama and Meshugi go to the public taps in Majawanga (Gairo gravity scheme) at respectively 2 and 5 kilometres distance.

The villagers from Ngiloli and Tabu hotel go to the public taps in Kibedya at distances of 3 and 4 kilometres respectively.
If, during the last months of the dry season, the tap in Kibedya does not work these people have to walk to Gairo at 6 and 8 kilometres respectively.
The people of Ibuti go to public taps in Gairo at 2.5 kilometres distance.

The villagers of Mbili, Mtumbatu and Kilama have to walk more than 7 kilometres to reach their water supply at the end of the dry season, when ground water in small streams close by the villages dries up.

DA 5.6. DESCRIPTION OF CROSS-SECTIONS AND INDIVIDUAL HAND DRILLINGS

DA 5.6.1. General

The results of the field investigations will be discussed separately per village. A brief description is given of the lithological situation of the cross-sections and individual hand drillings, drilled in the vicinity of the villages in question. Fig. DA 5.6-1 shows the location of the cross-sections. A summary of the ground water salinity and prospects for the construction of river or shallow wells is given per village as well.
Ground water quality and potential are discussed separately per village in DA 5.7.1. and DA 5.7.2.

DA 5.6.2. Cross-sections

Fig. DA 5.6-2 gives the legend to the cross-sections presented in Fig. DA 5.6.2-1 to -18.

Fig. DA 5.6-1

Location of the cross-sections

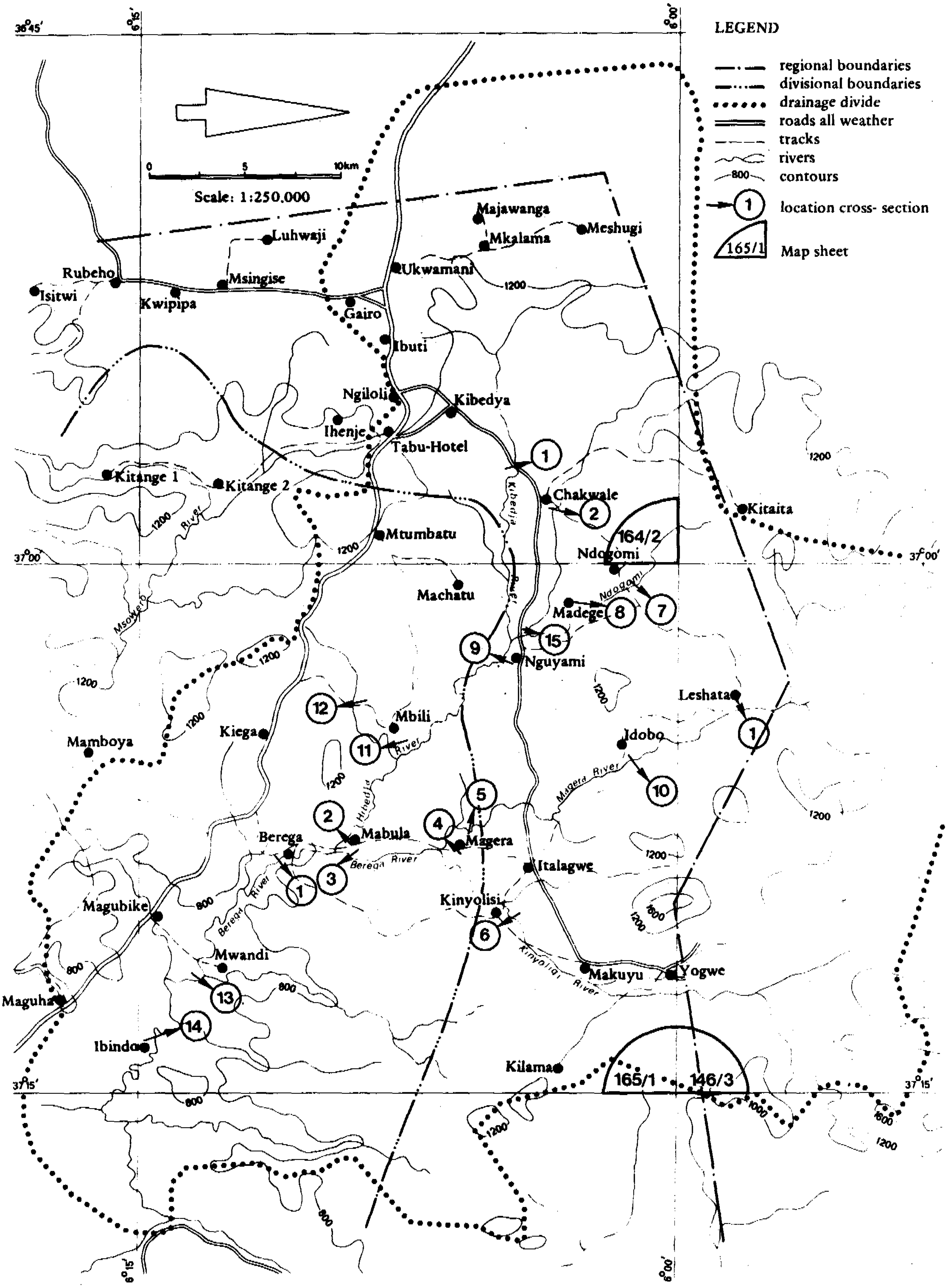
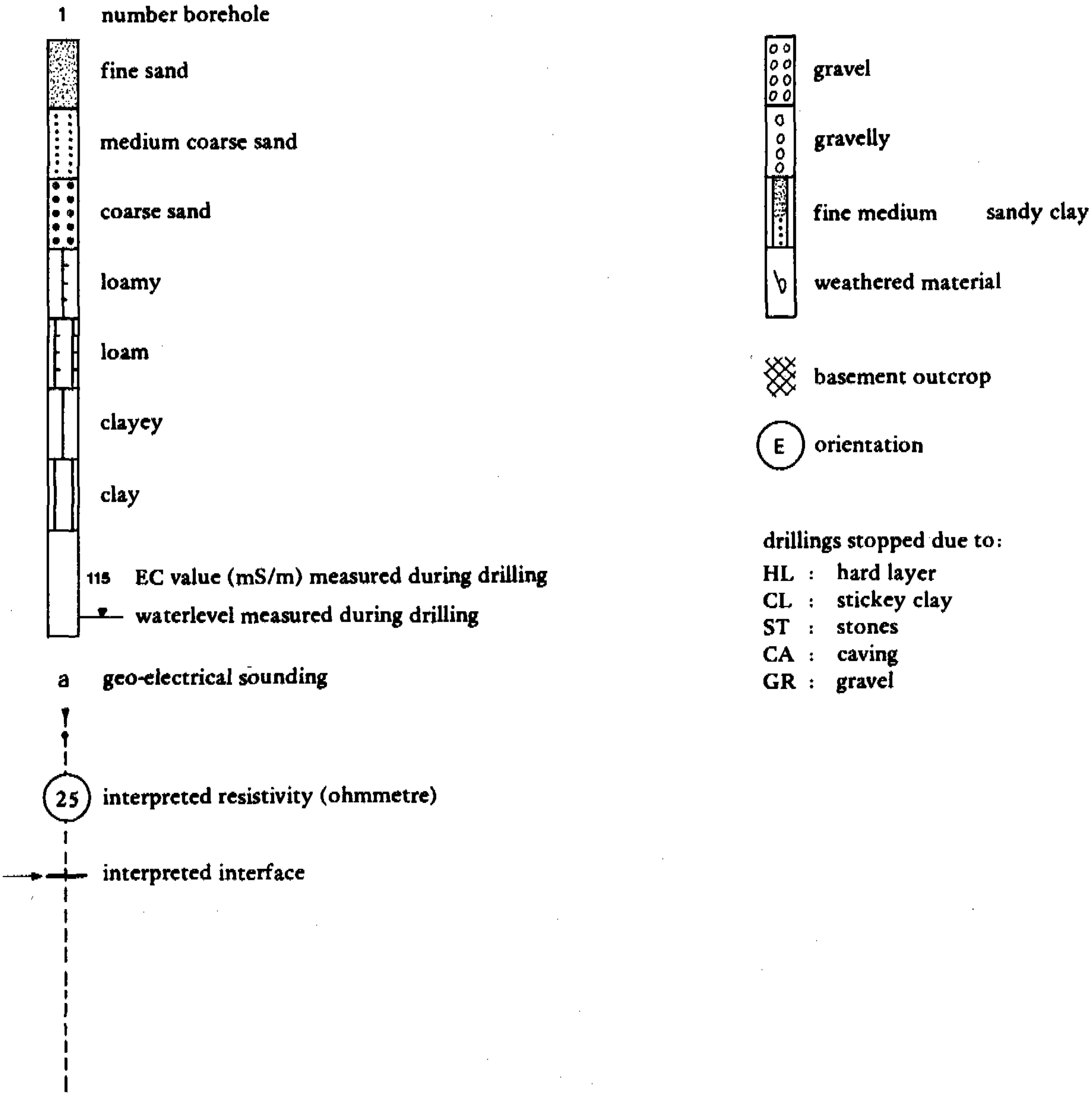


Fig. DA 5.6-2 : Legend to cross sections



DA 5.6.2.1. Berega, Berega River (165/1-1)

The existing water supply and its problems in the village Berega have been discussed in DA 5.5.3.
The villagers depend on hand-dug holes in the riverbed of the Berega River during the times that the pumped piped system is out of order or insufficient, therefore this village has also been involved in the study.

The profile is situated along the track between the sub-villages Berega Mission and Chirihara.
The whole profile shows clean coarse gravelly sands. Drillings had to be stopped at limited depth, however, due to gravel layers and boreholes caving in.
Geo-electrical measurements failed at this location, probably due to lateral heterogeneity indicated by bedrock outcrops in the vicinity of the spot.
The NE situated terrace consists entirely of weathered basement (borehole 165/1-1-5) without a hydraulic connection with the riverbed aquifer.
Coarse, gravelly sands underly some finer deposits of the SW situated terrace. A hydraulic connection exists between this terrace and the riverbed and because its EC value is about 100 mS/m prospects for the construction of a shallow well seem favourable.
EC values gradually increase in NE direction; this is probably due to inflow of mineralized water from weathered material of the SW situated terrace.

DA 5.6.2.2. Mabula, Kibedya River (165/1-2)

This cross-section is situated about 500 m SW of the village.
The riverbed itself consists of coarse sand with occasional gravels, underlain by sandy clay of fluvial origin. The more clayey deposits of borehole 165/1-2-4 on the other hand are underlain by sandy clay, probably weathered basement material.
The NE situated terrace shows a gradual increase of more clayey deposits, probably also weathered basement material.
A hydraulic connection exists between the riverbed and both terraces, but because of its higher topographical level and its position with regard to the village, the NE terrace is the most suitable for the construction of shallow wells.
The cross-sectional diagram shows rather high EC values (190 mS/m) but measurements carried out later indicated much lower values of about 140 mS/m, which is permissible for a temporary solution.

Geo-electrical soundings indicate a layer with high resistivities representing bedrock at an average depth of 25 metres.
The top layer on the other hand shows resistivities of about 14-18 m which indicates (clayey) sands or weathered bedrock with saline ground water. The latter possibility seems the most probably.

FIGURE DA 5.6. 2-1 Cross-section 165/1-1 Berega Valley at BEREGA

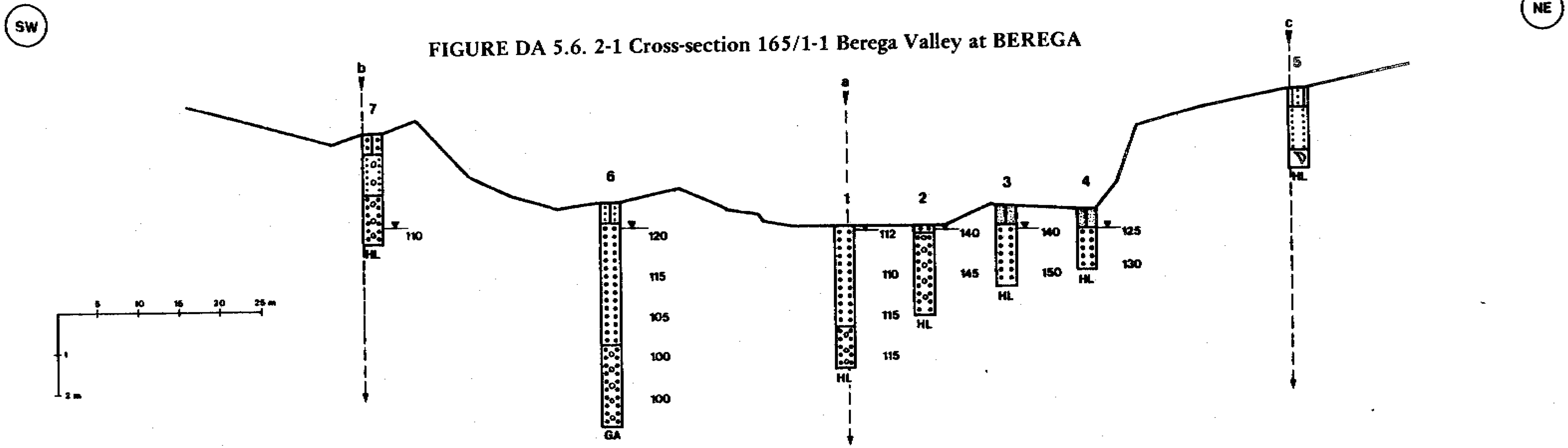
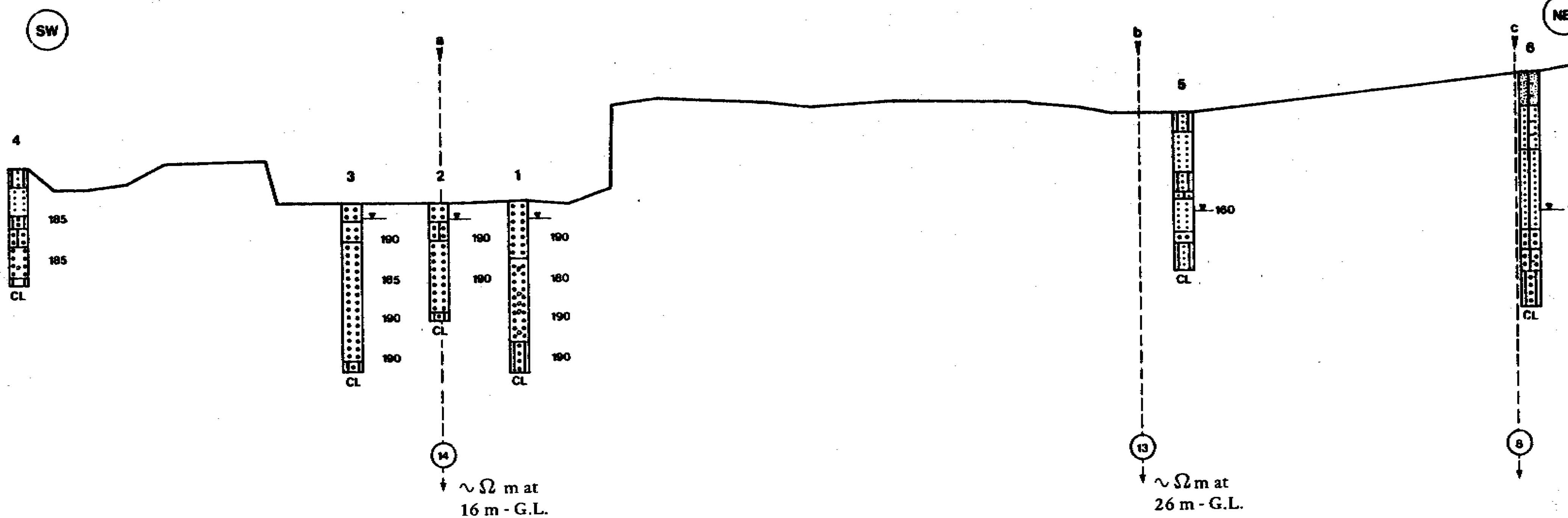


FIGURE DA 5.6. 2-2 Cross-section 165/1-2 Kibedya Valley at MABULA



DA 5.6.2.3. Mabula, Berega River (165/1-3)

This profile is situated about 500 metres SE of the village and covers only one terrace. The first three boreholes in the riverbed encountered coarse sand underlain by sandy clay which is probably weathered material from the higher older deposits.

This cross-section clearly demonstrates that high EC values of ground water in riverbeds is often due to inflow of highly mineralized water from older terraces and weathered basement material.
Boreholes 165/1-3-5, 6 and 9 demonstrate a clear layering in water salinity, not only laterally but vertically also and a gradual increase in salinity (up to 800 mS/m) in NW direction.
Therefore prospects for the construction of shallow wells are very poor on this terrace. The quality of the water in the riverbed is reasonable, although EC values tend to be high next to the terrace. EC measurements show values of about 130-150 mS/m which makes prospects for the construction of river wells fair.

Geo-electrical soundings indicate the average depth to bedrock to be about 17 metres. The middle layer shows a resistivity decrease from 34 to 8 Ωm in NW direction; this clearly corresponds with an increasing EC value in that direction.
Drillings show that this layer probably consist of weathered basement with saline ground water.

DA 5.6.2.4. Magera, Magera River (165/1-4)

This cross-section is situated along the track between Mabula and Magera about 500 m south of the village. The profile shows medium coarse to coarse sands interbedded with some clay layers. The northern terrace is overlain by clayey fine sands while the other terrace consists entirely of weathered basement material.

A hydraulic connection exists between both terraces but, because of the water quality, prospects for the construction of shallow wells are good only on the northern terrace.
Ground water quality of the riverbed is in general good (EC < 125 mS/m) although some inflow of mineralized water occurs from the weathered material of the southern riverbank.

Geo-electrical soundings show a middle layer with resistivities varying between 32 and 60 Ωm, which probably indicates a weathered zone with fresh ground water (EC < 150 mS/m).
Depth to bedrock (resistivity < 100 Ωm) gradually increases in northern direction up to 16 metres below ground level.

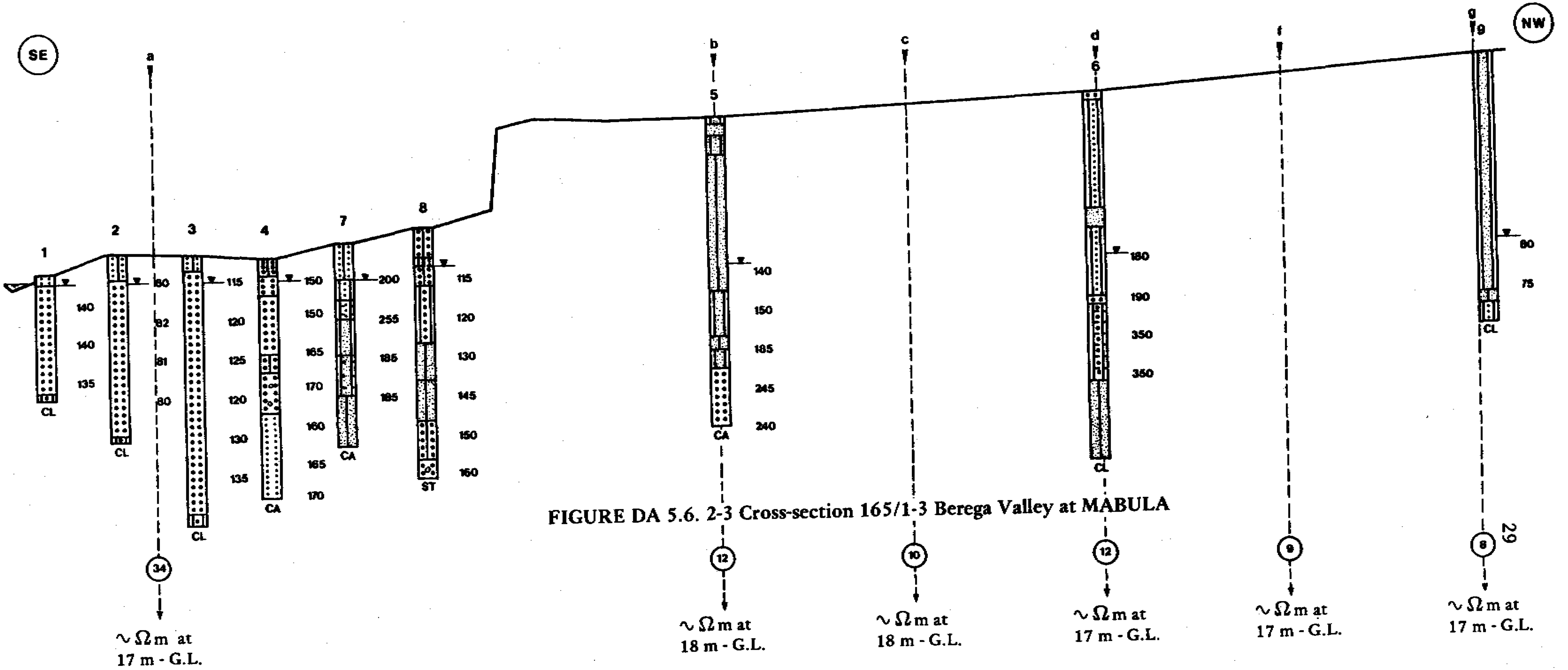
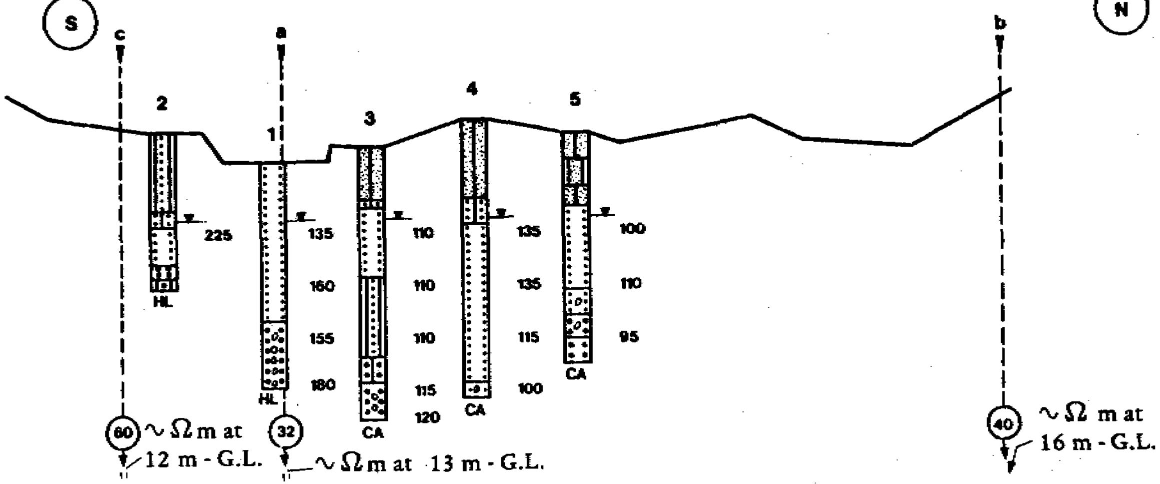
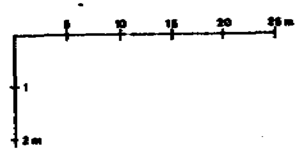


FIGURE DA 5.6. 2-3 Cross-section 165/1-3 Berega Valley at MABULA

FIGURE DA 5.6. 2-4 Cross-section 165/1-4 Magera Valley at MAGERA





DA 5.6.2.5. Magera, Magera River (165/1-5)

The profile is located about 500 metres west of the village near a hand-dug hole. The riverbed itself shows very coarse sand with gravel, underlain by weathered basement (clay). The eastern terrace is overlain by sandy clay and clayey sand, probably weathered basement material. Because of a medium coarse sand layer of reasonable thickness and good quality (EC < 125 mS/m) of the ground water, prospects for shallow well construction are satisfactory on this terrace.

Geo-electrical soundings failed at this location because of a considerable lateral heterogeneity indicated by bedrock outcrops in the vicinity of this cross-section.

DA 5.6.2.6. Kinyolisi, Kinyolisi River (165/1-6)

The cross-section is situated about 600 metres north of the village near temporary hand-dug holes in the riverbed.
The riverbed itself, only 8 metres wide, consists of very coarse sands underlain by gravels. Drillings had to be stopped at limited depths probably due to these gravel layers.
The northern terrace consists of coarse sands of fluvial origin overlain by some finer loamy material. Due to the general good quality of the ground water, prospects for the construction of shallow wells are good on this terrace.
This cross-section clearly demonstrates that the Kinyolisi River is one of the tributaries of the Berega River system with a considerable better ground water quality; EC values vary between 40 and 80 mS/m.

FIGURE DA 5.6. 2-5 Cross-section 165/1-5 Magera Valley at MAGERA

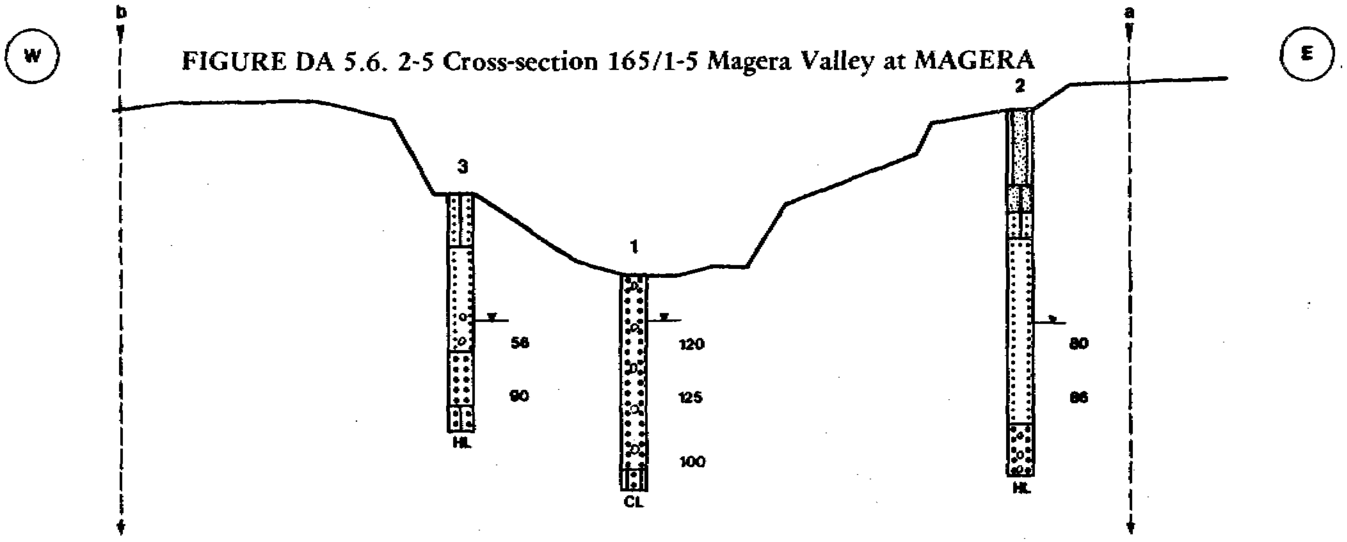
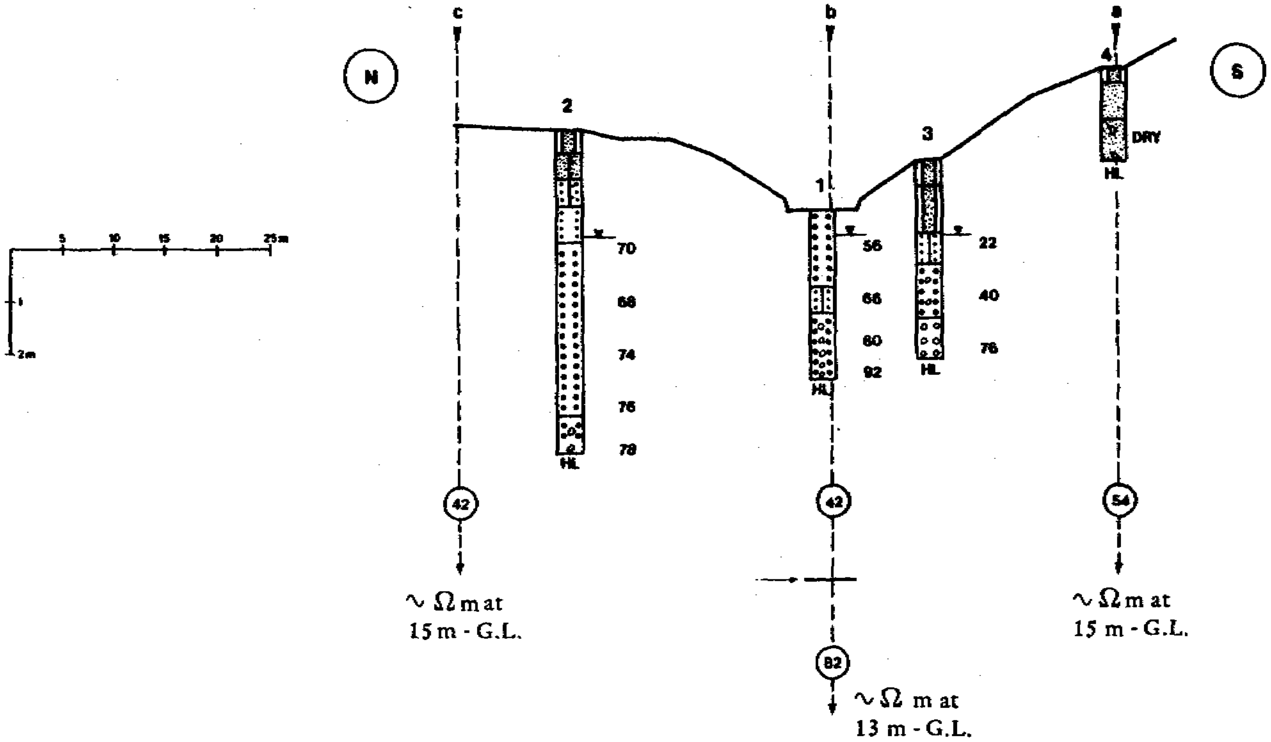


FIGURE DA 5.6. 2-6 Cross-section 165/1-6 Kinyolisi Valley at KINYOLISI



DA 5.6.2.7. Ndogomi, Ndogomi River (165/1-7)

The profile is located about 1300 metres NE of the village centre. Hand-dug holes in the riverbed are the only source of water supply for the villagers and cattle during the dry season.
The riverbed itself is filled up with clayey medium coarse sand with rather low permeabilities. The north eastern terrace consists entirely of weathered basement material while the more flat south western terrace is of fluvial origin.
Although a hydraulic connection exists between both terraces, the south western one is most suitable for the construction of shallow wells. Salinity content seems reasonable, but salinity checks carried out later showed higher values (up to 170 mS/m), which make shallow or river wells only temporarily permissible.

Geo-electrical soundings in the narrow bed failed. Sounding 165/1-7-a, however, indicates the average depth to bedrock to be about 7 metres which correlates with the drilling results.

DA 5.6.2.8. Madege, Ndogomi River (165/1-8)

This cross-section is situated about 700 metres NE of the village. The riverbed itself consists of medium coarse to coarse sands underlain by sandy clay of fluvial origin. The sloping south-western terrace consists of weathered basement material without a hydraulic connection with the present riverbed.
The other side becomes more clayey in north-eastern direction and is obviously of fluvial origin, so that prospects of the construction of shallow wells are good (location of borehole 165/1-8-3) on this terrace, although it must be realized that salinity contents tend to be high (> 150 mS/m).
The analysis of a water sample taken from a hand-dug hole in the river-bed shows that the manganese content exceeds the maximally acceptable limits of the WHO-standards.

According to geo-electrical sounding results, layers with high resistivity (weathered bedrock) are present from a depth of 14 metres approximately. The middle layer shows resistivities of about 20 Ωm which indicates a high clay mineral content or weathered basement material with saline ground water.

FIGURE DA 5.6. 2-7 Cross-section 165/1-7 Ndogomi Valley at NDOGOMI

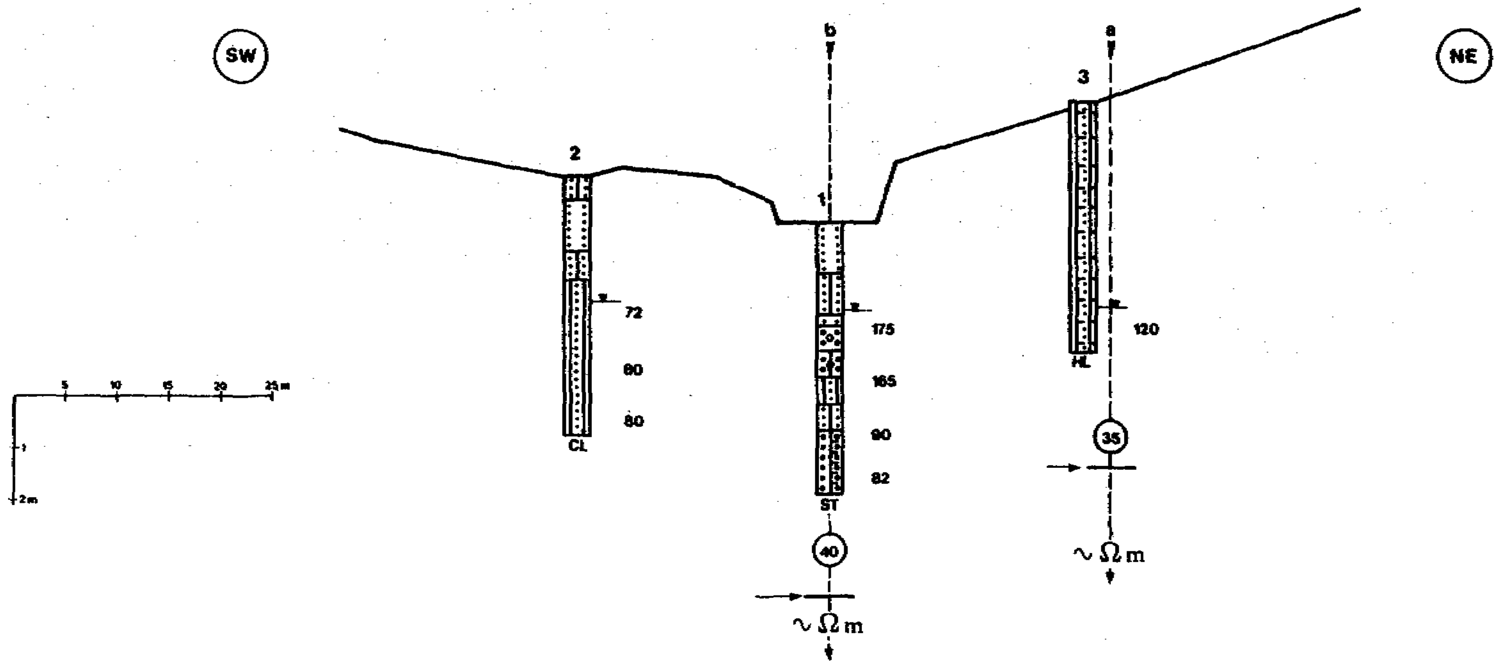
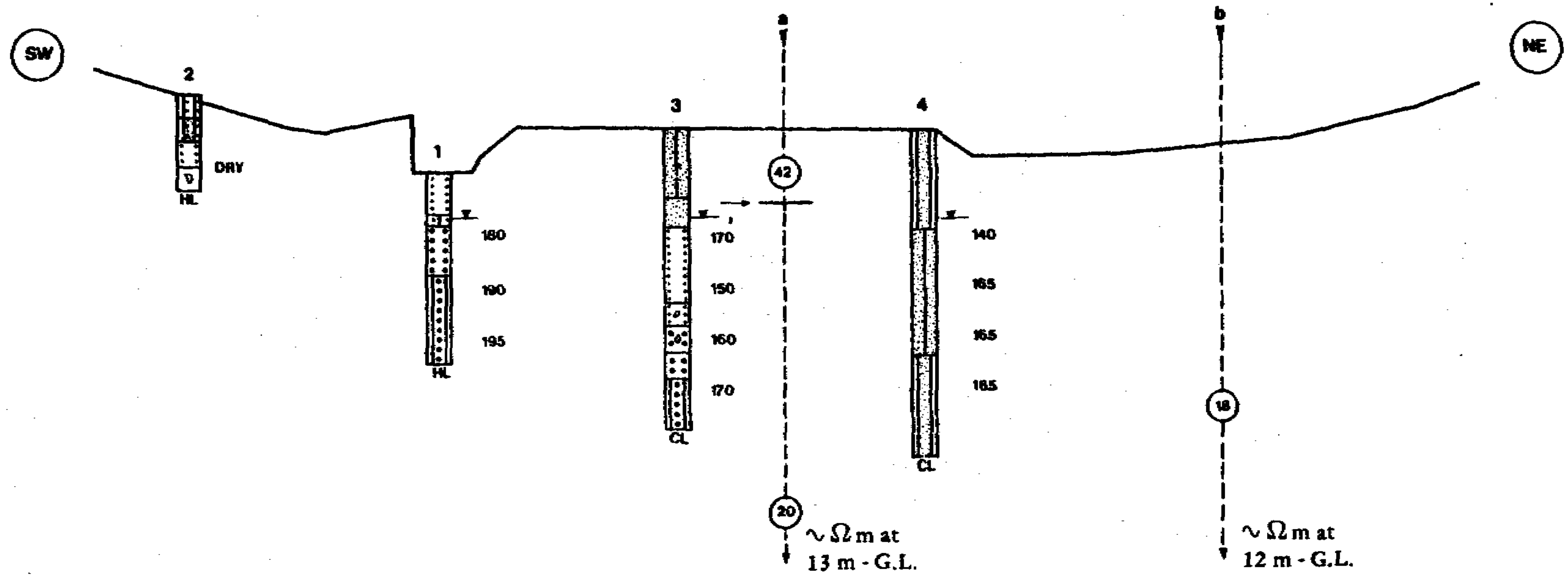


FIGURE DA 5.6. 2-8 Cross-section 165/1-8 Ndogomi Valley at MADEGE



DA 5.6.2.9. Nguyami, Kibedya River (165/1-9)

The cross-section is located about 700 metres south of the village centre along the track to Machatu. The riverbed consists of medium to coarse sands underlain by gravelly layers.
The northern terrace also consists mainly of coarse sands underlain by gravels.
Preliminary surveys showed that the Kibedya River is one of the tributaries with ground water of poor quality. This profile clearly demonstrates that salinity content of the ground water in the riverbed as well as in the terrace exceeds the maximum acceptable level of 200 mS/m. Therefore this location in unsuitable for the construction of river or shallow wells.

Geo-electrical soundings indicate an increasing depth to basement in northern direction up to 11 metres.
The middle layer shows an interpreted resistivity of 24 Ω m which probably indicates weathered basement material with saline ground water.

DA 5.6.2.10. Idibo, Magera River (165/1-10)

The cross-section is located about one kilometre east of the village. The western terrace consists of weathered basement material and prospects for the construction of shallow wells are poor.
The eastern terrace on the other hand is obviously of fluvial origin and consists of clayey sands and medium coarse sands underlain by sandy clay. The ground water quality of this terrace as well as that of the riverbed is good (E.C. values about 70 mS/m) and because a hydraulic connection exists prospects for shallow well construction are favourable.

Geo-electrical soundings show an increasing depth to basement in eastern direction, the maximum being about 20 metres below ground water level (165/1-10-a).
The resistivity value of the middle layer varies between 15 and 36 Ω m which indicates fresh waterbearing sandy layers or weathered basement with saline ground water. The first possibility, however, seems the most probable one.

FIGURE DA 5.6. 2-9 Cross-section 165/1-9 Tribedya Valley at NOUYAMI

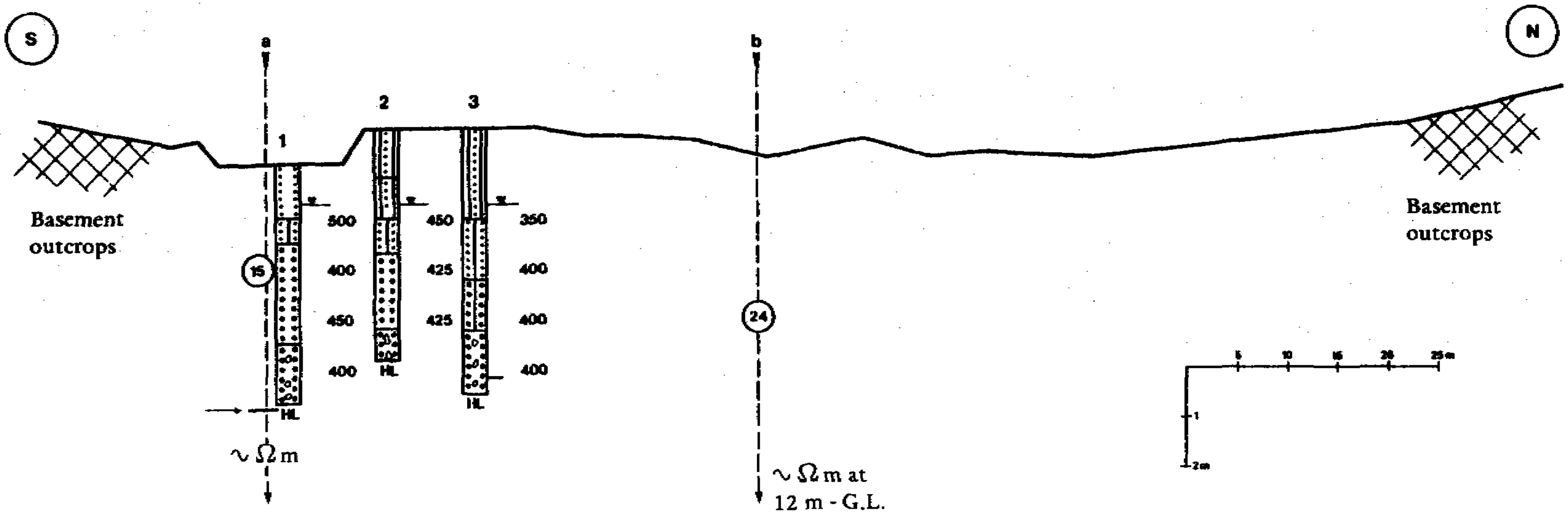
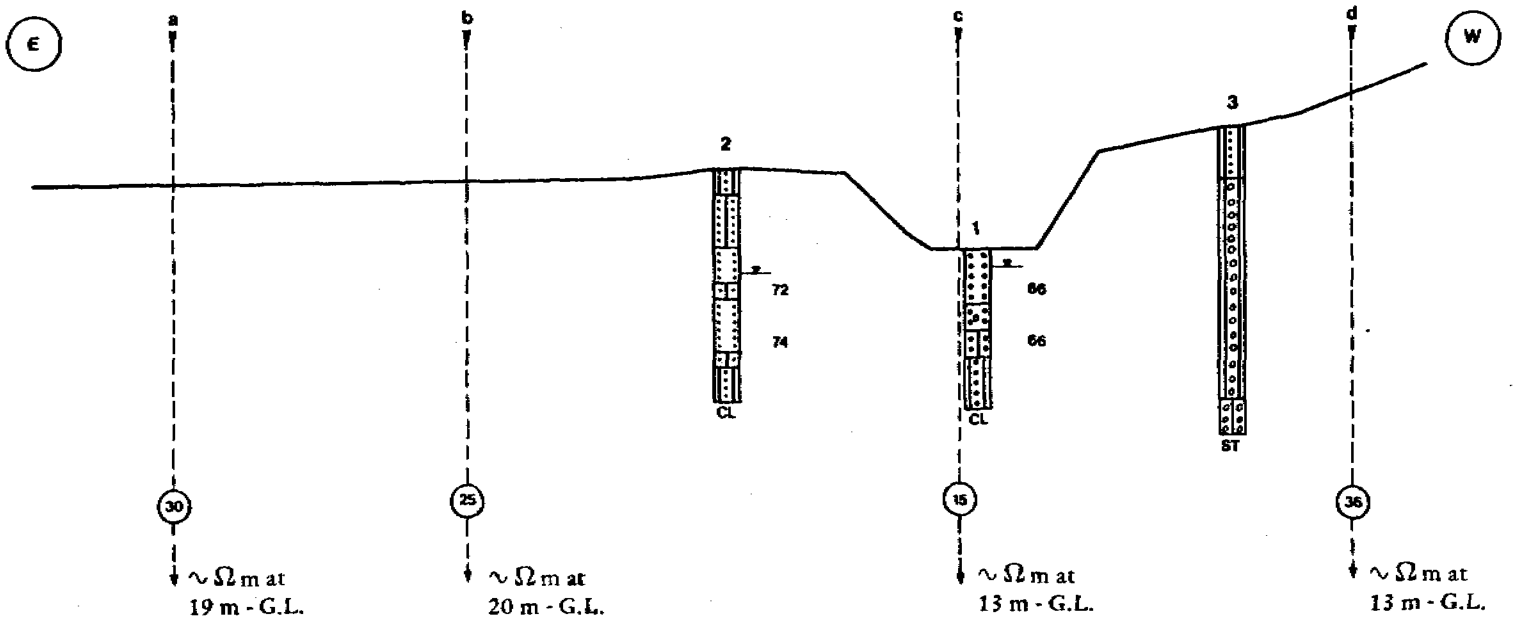


FIGURE DA 5.6. 2-10 Cross-section 165/1-10 Magera Valley at IDIBO



DA 5.6.2.11. Mbili, Mbili River (165/1-11)

This cross-section is located about 400 metres SE of the village centre. The riverbed itself consists of coarse sands underlain by gravels and depth to bedrock varies from nil up to a few metres and therefore hand-dug holes can only be found in deeper filled up parts. Because of evaporation and lack of recharge, ground water quality is very poor (EC > 250 mS/m) and unsuitable for exploitation, apart from the fact that most parts of the riverbed fall dry halfway through the dry season.

No geo-electrical soundings were carried out at this location because of bedrock outcrops.

DA 5.6.2.12. Mbili, Mbili River (165/1-12)

This profile is located about 2 km south of the village along the track to the main road Morogoro-Dodoma.
The cross-section shows a situation like the previous one.
The riverbed is situated between bedrock outcrops and the profile covers a deeper filled up part. Only one drilling was carried out and bedrock was struck at a depth of 1.5 m.
The observation well fell dry in mid-October so that this location is unsuitable for the construction of a shallow or river well.

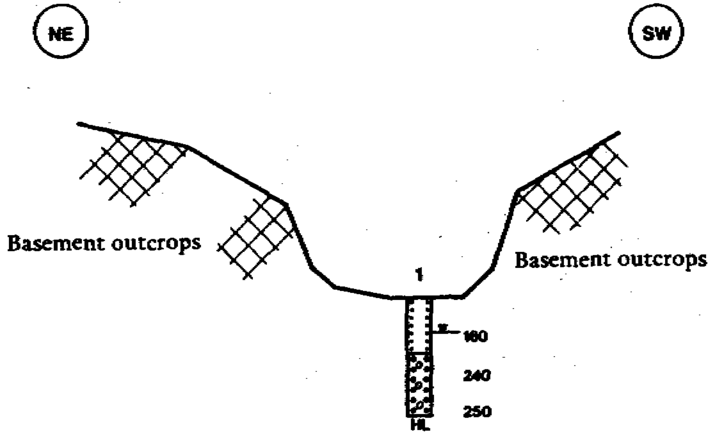
No geo-electrical soundings were carried out.

DA 5.6.2.13. Mwandi, Berega River (165/1-13)

The profile is situated between Mwandi and its subvillage Mugambo, about 1200 metres south of Mwandi.
The riverbed consists of coarse to medium coarse sand underlain by gravelly layers. The southern terrace consist of coarse sands overlain by finer material, probably weathered basement.
The northern terrace consists of thick, coarse sand and gravelly sand layers overlain by clayey deposits. Because of a hydraulic connection with the riverbed, prospects for the construction of shallow wells are good on this terrace, although salinity contents tend to be high (about 125 Ω mS/m).
Likewise cross-section 165/1-3, this profile clearly demonstrates inflow of saline water from the southern terrace into the riverbed.

No geo-electrical measurements were satisfactory due to lateral heterogeneity caused by bedrock outcrops in the vicinity of this profile.

FIGURE DA 5.6. 2-11 Cross-section 165/1-11 Mbili Valley at MBILI



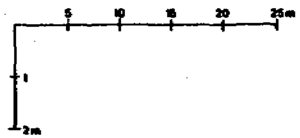


FIGURE DA 5.6. 2-12 Cross-section 165/1-12 Mbili Valley at MBILI

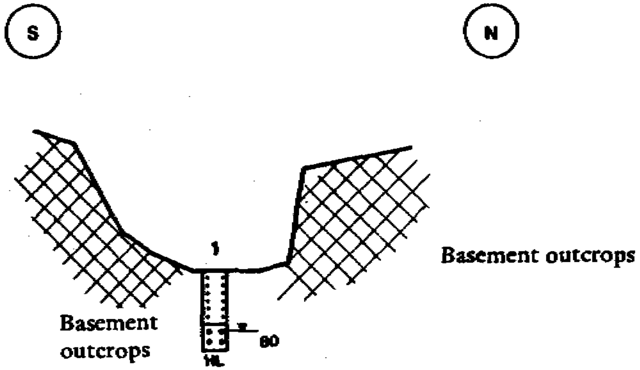
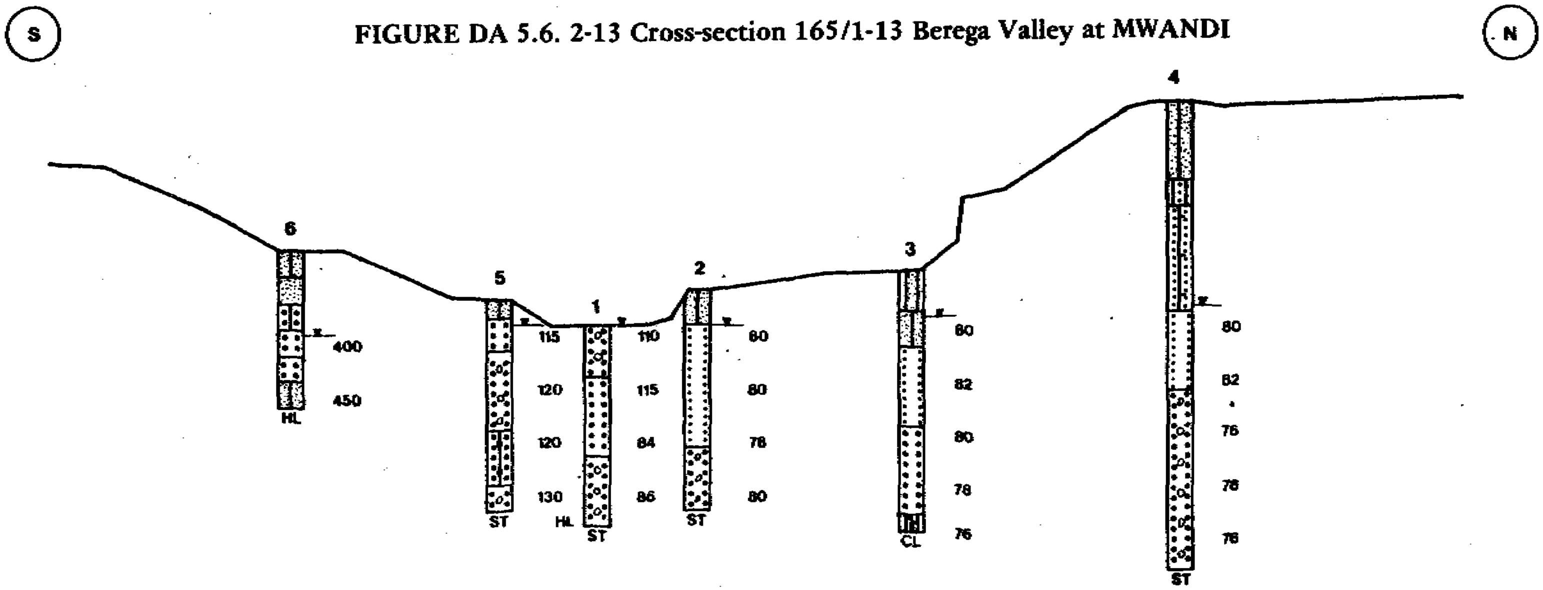


FIGURE DA 5.6. 2-13 Cross-section 165/1-13 Berega Valley at MWANDI



DA 5.6.2.14. Ibindo, Berega River (165/1-14)

The cross-section covers the riverbed of the Berega River and its terraces downstream.
The whole riverbed consists of medium coarse and coarse gravelly sands. Hand drillings had to be stopped due to hard layers, probably gravels. The eastern terrace consists entirely of weathered basement without a hydraulic connection and is thus an unsuitable location for the construction of shallow wells.
The western terrace, on the other hand, consists mainly of medium coarse sand layers of reasonable thickness and, in spite of higher E.C. values (125-150 mS/m), prospects for the construction of shallow wells are satisfactory in comparison with ground water of the riverbed.

Geo-electrical soundings indicate a V-shaped filled up valley with a maximum depth to bedrock of about 20 metres (165/1-14-b). The middle layer of the interpreted model shows resistivities of about 45 Ω m which probably indicates a weathered zone with fresh gound water.

DA 5.6.2.15. Leshata, Magera River (146/3-1)

The cross-section is located 400 metres east of the village centre. The western terrace consists of weathered basement material without a hydraulic connection with the present riverbed and is therefore unsuitable for the construction of shallow wells.
The riverbed itself consists of medium coarse to coarse sands underlain by clayey sand with some gravels. The eastern terrace is good but slightly decreasing in western direction, probably due to inflow of saline water from older deposits or weathered material.

According to geo-electrical sounding results, depth to bedrock is slightly increasing in eastern direction up to 28 metres approximately. Interpreted resistivities of the middle layer vary between 38 and 70 Ω m which indicates weathered basement with fresh ground water.

FIGURE DA 5.6. 2-14 Cross-section 165/1-14 Berega Valley at IBINDO

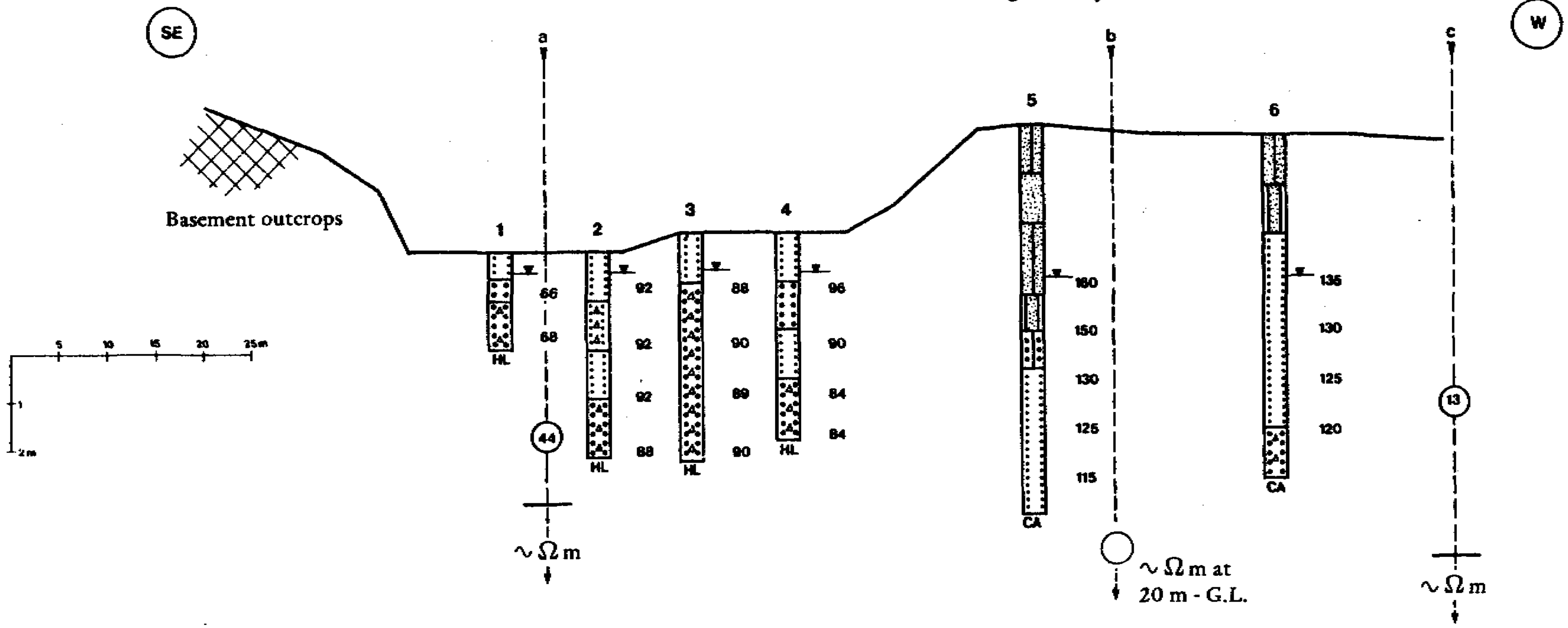
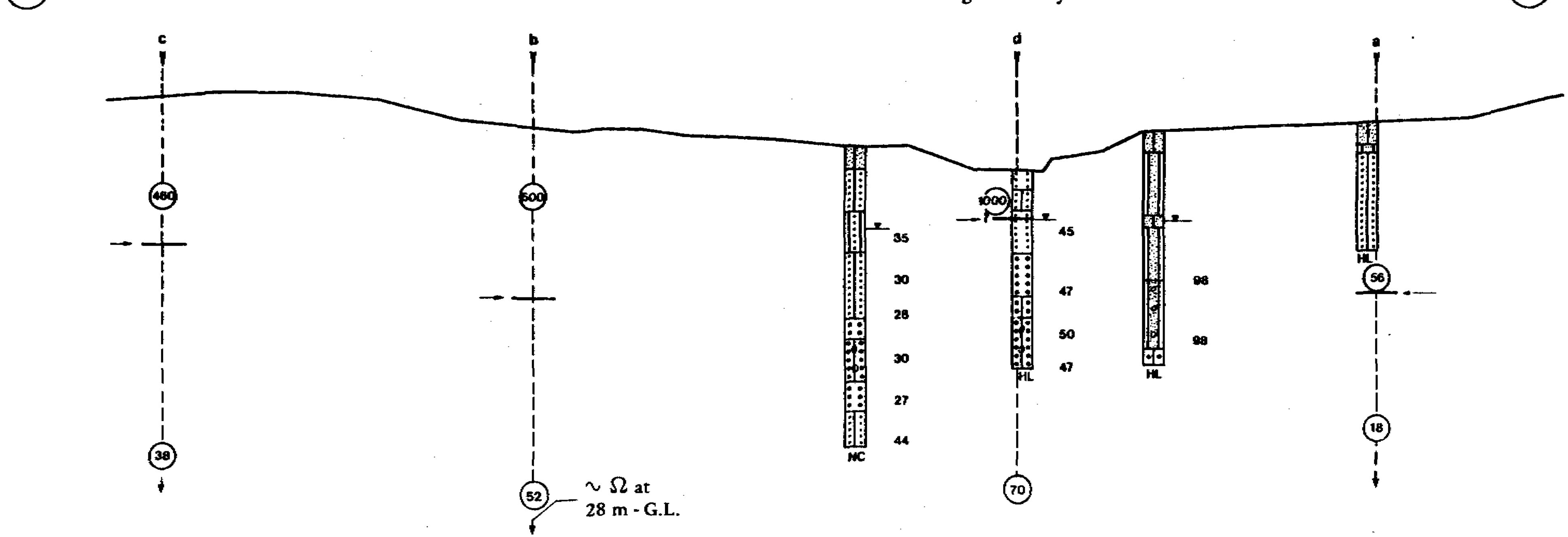


FIGURE DA 5.6. 2-15 Cross-section 146/3-1 Magera Valley at LESHATA



DA 5.6.2.16. Nguyami, Ndogomi River (165/1-14)

The location of the profile is west of the village, where the Ndogomi River crosses the road to Chakwale. Five boreholes were drilled across the approximately 80 m wide alluvial valley.
No geo-electrical soundings were carried out here. The alluvial deposits are mainly coarse, angular sands and clayey fine sands.
Because the salinity of the ground water is very high, E.C's up to 450 mS/m having been measured, it is not possible to exploit the ground water.

DA 5.6.2.17. Chakwale, Chakwale River (164/2-1)

The profile was drilled in the northern part of the village, along the road to Ndogomi.
Two boreholes were drilled in the riverbed of the Chakwale River and one on each of the two terrace deposits along the riverbed.
The profiles showed mainly coarse, gravelly sands.
No ground water was present in this profile.

DA 5.6.2.18. Chakwale, Kibedja River (164/2-2)

The profile is situated south-west of the village, along the road to Kibedja.
Highly saline ground water, EC's up to 750 mS/m were found in both the riverbed deposits as well as the terraces along the river.

FIGURE DA 5.6.2-16 Cross-section 165/1-15 Ndogomi Valley at Nguyami

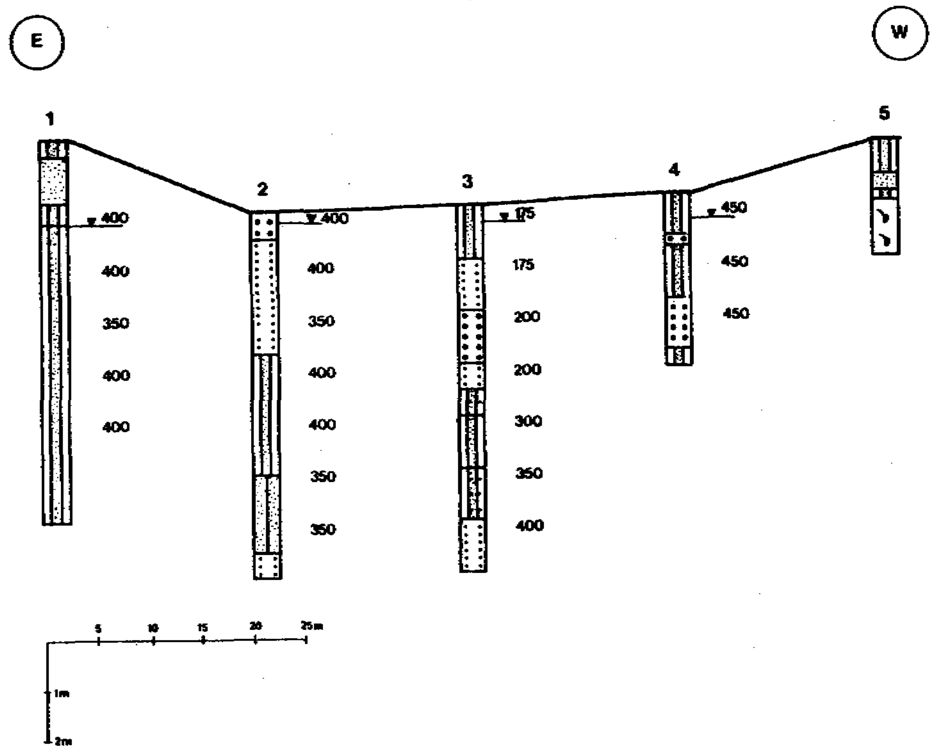


FIGURE DA 5.6.2-17 Cross-section 164/2-1

Kibedya Valley at Chakwale

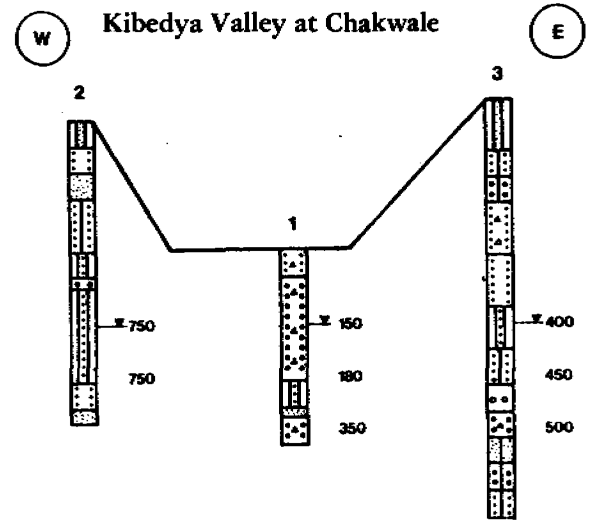
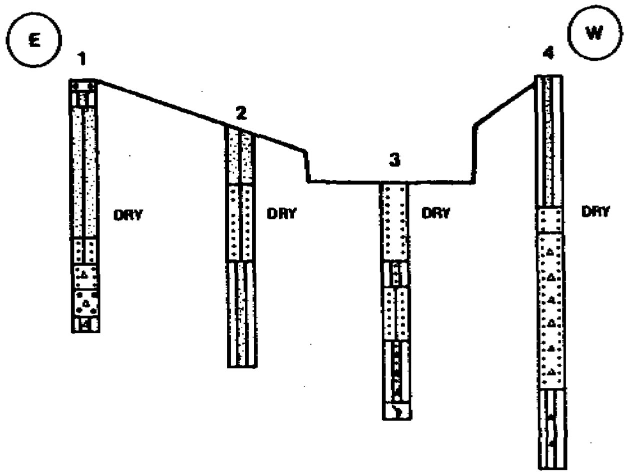


FIGURE DA 5.6.2-18 Cross-section 164/2-2 Chakwale Valley at Chakwale



DA 5.7. WATER POTENTIAL

DA 5.7.1. Ground water potential

It was not always possible to establish the exact thickness and extension of the riverbed aquifer. Drillings often had to be stopped at limited depth because of caving in of the boreholes due to loose sandy material, or because hard layer (gravels, stones) were encountered in the boreholes. Most ground water will flow through the riverbed aquifer because of its very high permeability. However, ground water also flows through the terrace deposits bordering the riverbed aquifer and even through the weathered zone of the basement in the valleys.

The calculation of the ground water flow through the different cross sections presented in Fig. DA 5.6.2-1 to -18 was based on the areas of the ground-water saturated cross-sections through the riverbed and coarse textural terrace deposits.
Because of the limitations mentioned above, these areas are minimum areas and therefore the calculated ground water flow through the cross-sections, are minimum flows.

The areas of the cross-sections were determined for situations at the beginning of the dry season (ground water levels equal to the ground surface), the end of the dry season of 1978 (beginning of the rainy season in mid-November), and a hypothetical extremely dry year (beginning of the rainy season mid-December).

Ground water flow through the cross sections, presented in Table DA 5.7.1-1, was calculated according to the formulae:

$Q = K.i.A$

Q	=	ground water flow	m^3/day
i	=	hydraulic gradient	
K	=	permeability	m/day
A	=	minimum area of cross section	m^2

The hydraulic gradients was estimated, using Figure DA 5.3.4-1; the longitudinal profile of the Berega river and its tributaries and assuming that the hydraulic gradient is equal to the gradient of the surface of the riverbed.

The permeability of the cross sections have been estimated by examination of the drilling samples.

Assuming a water demand of 40 l/day/capita, and an average growth rate of the population of 5% a year, the water demand per village has been determined for 1978, 1988 and 1998.
The water demand figures are give in Table DA 5.7.1-1, together with the water potential data.

The water demand of the twelve listed villages in 1978 is 862 m^3/day, 1296 m^3/day in 1988 and 1724 m^3/day in 1998.

The minium ground water flow through the cross section at Ibindo, which location is close to the junction of the Berega river with the Chogowale River, is 2055 m^3/day.
Hence the total flow through the riverbed aquifer is sufficient to meet the total demands up to the year 1998.

The ground water potential near the individual villages is ample; only the Mbili riverbed near Mbili offers no prospects for exploitation of ground water because the aquifer dries up during the dry season.

Table DA 5.7.1-1 - Ground water potential and water demand

cross-section	village	population 1978	population demand 1978 m³/day	population demand 1988 m³/day	population demand 1998 m³/day	k m/day	i	A m² BDS	A m² EDS	A m² EEDS	Q m³/day BDS	Q m³/day EDS	Q m³/day EEDS
165/1-1	Berega	2890	116	174	232	450	.014	340	300	290	2150	1880	1825
165/1-2	Mabula	1069	43	65	86	300	.015	225	170	160	1010	765	720
3						225	.014	360	320	310	1135	1000	875
165/1-4	Magera	1567	63	95	126	200	.014	260	145	125	725	406	350
5						250	.014	190	120	95	800	420	332
165/1-6	Kinyolisi	800	32	48	64	350	.015	72	50	40	378	263	210
165/1-7	Ndogomi	1434	57	86	114	275	.015	65	43	38	267	177	157
165/1-8	Madege	2050	82	123	164	300	.015	89	68	63	400	306	283
165/1-9	Nguyami	1792	72	108	144	350	.015	138	167	100	725	562	525
165/1-10	Ibido	2715	109	164	218	400	.015	110	80	60	660	480	360
165/1-11	Mbili	821	33	50	66	400	.026	10	7	-	104	72	-
12						300	.026	7	-	-	55	-	-
165/1-13	Mawandi	2558	102	153	204	400	.014	390	370	350	2185	2075	1960
165/1-14	Ibindo	1558	62	93	124	350	.014	475	435	420	2327	2130	2055
146/3-1	Leshata	2285	91	137	182	250	.016	150	105	90	600	420	360
total			862	1296	1724								

BDS beginning dry season
EDS end dry season
EEDS end extreme dry season

DA 5.7.2. Ground water quality

Ground water salinity, expressed in EC values (mS/m), varies widely over the area; not only per tributary but also locally. In general ground water of the riverbeds appeared to be of a better quality than that of its terraces. It could be proved that inflow occurs of mineralized water from older deposits or weathered basement material into the present riverbed which results locally in an increasing salinity (DA 5.6.2.1, -6.2.3, -6.2.13, -6.2.14). Salinity probably increases in these deposits because of evaporation and a longer detention time.
On the basis of the salt content a decision can be made whether the ground water is suitable for the construction of a shallow or river well (EC < 200 mS/m).
The table below reviews of the suitable shallow or river well sites per cross-section as mentioned in DA 5.6.2; a distinction has been made whether the site can be considered a long term or a temporary solution.

Table DA 5.7.2-1 - Average EC values of the ground water in different cross sections

village	river	well* location	average EC value mS/m	classification**
Berega	Berega	T	105	fair, permissible
Mabula (2)	Kibedya	T	150	doubtful, temp. perm.
(3)	Berega	R	150	doubtful, temp. perm.
Magera (4)	Magera	T	100	fair, permissible
(5)	Magera	T	85	fair, permissible
Kinyolisi	Kinyolisi	T	75	good, permissible
Ndogomi	Ndogomi	T	130	doubtful, temp. perm.
Madege	Ndogomi	T	150	doubtful, temp. perm.
Nguyami	Kibedya	-	300	poor, not permissible
Idibo	Magera	T	70	good, permissible
Mbili (11)	Mbili	R	250	poor, not permissible
Mbili (12)	Mbili	R	80	doubtful
Mwandi	Berega	T	76	fair, permissible
Ibindo	Berega	T	120	fair, permissible
Leshata	Magera	T	40	good, permissible

* T = terrace
R = riverbed
** temp. perm. = temporarily permissible

This table clearly demonstrates that the ground water quality of the Kibedya River and its tributaries, the Ndogomi and Mbili rivers is of poor quality (EC values > 150 mS/m), while ground water quality of the Magera and Kinyolisi Rivers on the other hand are of reasonable quality. Ground water quality of the Berega River itself is reasonable, although considerable differences occur locally due to inflow of mineralized water from older deposits or weathered basement material.
The high salinity content of the Kibedya River may be due to recharge of highly mineralized water from the residual soils of weathered basement material of which its catchment area mainly consists. Hardly any terrace of fluviatile origin occurs along this river.

Only the locations in the Kibedya and Mbili Rivers near Nguyami and Mbili respectively, appeared to be unsuitable for the construction of shallow wells because of inadmissible salt contents, while four locations (Mabula 2x, Ndogomi and Madege) turned out to be suitable for the construction of shallow or river wells as a temporary solution.

Chemical analyses of ground water from 13 different locations are given in table DA 5.7.2-2.
A complete analysis was made of the two samples with an EC higher than 200 mS/m.
Main constituents are chloride, bicarbonite, calcium and magnesium (sodium and potassium were not analyzed).
In the other samples, only iron, fluoride and nitrate were analyzed. Fluoride and iron contents are very low.
In Magera a high nitrate content of the ground water was found.
Bacteriological contamination of the ground water in the riverbed aquifers is undoubtly present, because of the abundance of cattle in the Berega area.
A bacteriological test, carried out on a surface water sample from the Berega River, showed serious contamination by Faecal Coliforms.
It is recommended therefore, that shallow wells be constructed on the terraces and as far as possible from the riverbed.
The filters in shallow wells in both the riverbed aquifers and on the terraces will have to be placed as deep as possible.

Table DA 5.7.2-2 - Chemical analyses of ground water

location cross-section no. date of sampling		Berega 165/1-1 24-10-78	Mabula 165/1-2 23-10-78	Mabula 165/1-3 23-10-78	Magera 165/1-4 23-10-78	Magera 165/1-5 23-10-78	Kinyolisi 165/1-6 25-10-78	Ndogomi 165/1-7 24-10-78	Madege 165/1-8 24-10-78	Idibo 165/1-10 23-10-78	Mbili 165/1-11 17-11-78	Mwandi 165/1-13 18-11-78	Ibindo 165/1-14 17-11-78	Chakwale 25-10-78
water analysis	unit													
EC	mS/m	140	160	140	75	110	60	175	190	70	325	110	90	300
pH		8.0	8.3	7.8	8.1	8.1	8.0	7.8	7.7	7.8	7.5	7.2	7.3	7.8
calcium	mg/l CA^{++}										8.8			23.2
magnesium	mg/l Mg^{++}										95			68
total hardness	mg/l $CaCO_3$										610			860
iron	mg/l Fe	0.03	0.03	0.04	0.04	0.05	0.04	0.16	0.07	0.23	0.9	0.31		0.06
manganese	mg/l Mn	-	-	-	0.1	-	0.3	0.8	2.5	1.8				0.1
fluoride	mg/l F	0.8	0.6	0.8	0.3	0.7	0.5	0.3	0.4	0.4	0.7	0.8	0.8	0.7
chloride	mg/l Cl^-										730			500
bicarbonate	mg/l HCO_3^-										586			488
nitrate	mg/l NO_3^-	3.1	3.0	3.1	2.1	28.8	2.0	6.2	6.6	0.4	12.4	3.1	3.0	
sulfate	mg/l SO_4^{--}										68			
phosphate	mg/l PO_4^{---}										0.17			

DA 5.7.3. Summary of conclusions

The recommendations for an improved water supply by means of shallow or river wells within the investigated sub-area are summarized in the following table.

Table DA 5.7.3-1 - Recommendations for improved water supply by means of shallow wells

village	temporary solution	long term solution	possibilities of a pumped, piped water supply	no possibilities
Berega		x	x	
Mabula	x			
Magera		x	x	
Kinyolisi		x	x	
Ndogomi				x
Madege	x			
Nguyami				x
Idibo		x		
Mbili				x
Mwando		x	x	
Ibindo		x	x	
Leshata		x		

Shallow or river wells may not be possible in Ndogomi because of an insufficient ground water potential of the riverbed aquifer, while the Kibedya River has inadmissibly saline ground water near Nguyami (the riverbed of the Ndogomi River west of the village was investigated by the MWCP siting crew; considerable salt contents up to 400 mS/m were found there).
The Mbili River near Mbili suffers from insufficient ground water potential as well as high salinity. Because of the salt content (> 125 mS/m) of the rivers near Mabula and Madege, shallow or river wells can serve only as a temporary solution.
The MWCP siting crew carried out some additional drillings and complete sitings in villages which were not involved in this study; the results are summarized in the following table.

Table DA 5.7.3-2 - Results of the MWCP hand drilling in the Berega area

village	siting completed sufficient sites	siting not yet completed	unsuccessful siting	
			insufficient yield	EC > 200 mS/m
Magubike		x		
Kiegeya			x	x
Italagwe	x			
Makuyu	x			
Iyogwe	x			
Kilama			x	
Chakwale				x

Chakwale was surveyed in order to establish the possibility of shallow or river wells near the village which could serve as a temporary solution during the occasional breakdowns of the Gairo gravity scheme. It appeared, however, that salinity contents of the Kibedya River exceed the maximum level of 200 mS/m (even up to 400 mS/m).

The water supply of the villages Kiegeya and Kilame cannot be improved by means of shallow or river wells, because no suitable sites could be found in the alluvial deposits near these villages. Riverbeds fell dry halfway through the dry season while near Kiegeya high salt contents were found (> 500 mS/m).
These villages may be served by shallow or river wells as a temporary solution during part of the dry season; otherwise resettlement will have to be considered, especially for Kilama, because of its remote location in case of an improved water supply by means of a gravity scheme.
The domestic water supply of the villages Italagwe, Makuyu and Iyogwe can be improved by shallow wells. The MWCP siting crew has selected sufficient sites to serve these villages.

Improved domestic water supply for the villages within the other sub-area, mentioned in DA 5.2.1., is not possible by means of shallow wells, mainly because of the insufficient ground water potential of the riverbeds near by these villages during the dry season. Shallow or river wells may serve as a temporary solution during part of the dry season, however.
The only possibilities for an improved domestic water supply are gravity schemes.
In a separate study, the surface hydrology section of the MDWSP established the quantity of surface water available for domestic use in this area (Volume III).
Part of the area can be served by an improved and extended Gairo gravity scheme, while new gravity schemes also appear to be possible.

In this case, the villages Mbili, Nguyami and Ndogomi would also be connected to such schemes, instead of having their supply improved by means of shallow or river wells, as initially suggested.

DATA

DATA

DD

DATA (tables and figures)

DATA DD 1

BOREHOLE DATA

DD 1 - Borehole data (see last sheet of data for explanation of abbreviations)

well no.	date	location	drill	type of well	elev. GL above SL m	elev. GL above GL m	depth drill m BGL	depth finish m BGL	geological formations pierced	casing dia inches	casing depth m BGL	screen dia inches	screen depth m BGL	length	type
BH 1/31	11-04-'31	Ngerengere	Perc.	exploit.	188		73.14		P.C.	8	0-25.91				
BH 2/33	1933	Chakwale							P.C.						
BH 2/34	24-02-'34	Fantami S.E. Kidugallo	Perc.	exploit.			146.31		Jurassic	6	0-62.48				
BH 4/34	10-08-'34	Kizuk S.E. Ngerengere	Perc.	exploit.			145.70		Jurassic	8	0-11.58				
										6	11.58-33.53				
BH 6/34	28-06-'34	Kiwege S.E. Ngerengere	Perc.	exploit.			119.48		Jurassic	6	0-30.48				
BH 7/34	23-07-'34	Kiwege S.E. Ngerengere	Perc.	exploit.			50.90		Jurassic	6	0-24.69				
BH 8/34	24-10-'34	Mgugo S.E. Kingolwira	Perc.	exploit.			118.26		P.C.	6	0-32.96				
BH 14/34	9-12-'34	Pnagawe S.E. Kingolwira	Perc.	exploit.			68.57		P.C.	6	0-29.87				
BH 1/35	9-02-'35	Morogoro	Perc.	exploit.			48.77		P.C.	6	0-11.89				
BH 3/35	14-06-'35	Kingolwira Farm	Perc.				150.67		P.C.		no casing left				
BH 6/35	13-08-'35	Ngerengere S.E.	Perc.	exploit.			63.09		Jurassic	8	0-17.52				
BH 2/36	2-06-'36	Fatemi S.E. Kidugallo	Perc.	exploit.			145.70		Jurassic	8	0- 9.14				
BH 7/38	25-06-'38	Tungi S.E. Morogoro	Perc.	exploit.			86.26		P.C.	6	0-25.52				
BH 9/38	9-08-'38	Rudewa S.E. Kimamba	Perc.	explor.	435		50.30		Q/T		no casing left				
BH 12/38	11-10-'38	Rudewa S.E.	Perc.	explor.	435		51.82		Q/T		no casing left				
BH 14/38	21-11-'38	Ilonga S.E. Kimamba	Perc.	exploit.	495		39.62		P.C.	8	0-12.19				
										6	12.19-44.20				
BH 5/39	27-09-'39	Kizuha Ngerengere	Perc.	exploit.			80.15		P.C.	6	0-25.91				
BH 10/39	12-01-'40	Mkata	Perc.	explor.	400		86.58		Q/T-P.C.		no casing left				
BH 1/40	13-06-'40	Railway St. Mazimba	Perc.	exploit.	540		54.56		P.C.	6	0-39.62				
BH 8/47	2-10-47	Prison Kingolwira	Perc.	explor.			142.65		P.C.		no casing left				
BH 17/47	6-01-'48	Prison Kingolwira	Perc.	explor.			76.20		P.C.		no casing left				
BH 9/49	31-03-'50	Tungi S.E. Morogoro	Perc.	explor.	460		121.92		All.-P.C.		no casing left				
BH 21/49	12-11-'59	Tungi S.E. Morogoro	Perc.	explor.	470		33.53		All.-P.C.		no casing left				

EC*: EC values calculated from TDS values according to: EC = TDS x 0.7

well no.	water struck at m BGL	Swl m GL	Swl m GL	Q l/sec	S m	Q/S l/sec/m	KD m²/day	Av.K m/day	quality TDS ppm	EC* mS/m	F ppm	remarks	co-ordinates
BH 1/31	10.67	8.84		0.4					900	130		ab.	
BH 2/33												ab.	
BH 2/34	92.66	0.00		2.4					900	130		free flowing	
BH 4/34	45.72											ab.	
	134.11	6.10		1.3					314	45		ab.	
BH 6/34	18.29	8.23		2.5					1883	27		ab.	
BH 7/34	24.38	16.76		5.0					1427	200		ab.	
BH 8/34	74.68	24.69		9.3					7150	1020		ab.	
BH 14/34	48.16	24.69		3.8					3575	510		ab.	
BH 1/35	16.76	11.28		0.4					762	110		ab.	
BH 3/35	73.15	60.96		0.01								ab. '35	
	94.48												
BH 6/35	11.58	4.27		4.6					1783	256		ab.	
BH 2/36	10.76	+0.30		0.4					2946	420		free flowing	
BH 7/38	45.42	39.62		0.4					1301	185		ab.	
	63.09												
BH 9/38	14.32								1070	153		ab. '38	
	22.56								458	65			
	28.65								458	65			
	34.75								642	92			
	45.42												
BH 12/38	14.32											ab. '38	
	22.56												
	28.04												
	34.75												
	45.42												
	50.90												
BH 14/38	17.68	3.05		0.8					856	122		ab.	282.5-9249.7
BH 5/39	45.00								3830	550		ab.	
	65.84								2496	357			
BH 10/39	25.91	24.38		3.0								ab.	318.4-9253.1
BH 1/40	30.48	16.46		0.8					1255	180		ab.	339.4-9252.8
BH 8/47	35.05	27.13		0.2					3590	513		ab. '47	
BH 17/47	6.71	6.40		0.3					salty			ab. '47	
BH 9/49	7.62	3.05		0.1					11064	1580		ab. '49	358.5-9252.7
BH 21/49	7.62	1.22							12980	1850		ab. '49	356.6-9253.7
	21.34												

Continued 1

well no.	date	location	drill	type of well	elev. GL above SL m	elev. GL above GL m	depth		geological formations pierced	casing		screen			
							drill m BGL	finish m BGL		dia inches	depth m BGL	dia inches	depth m BGL	length	type
		Dam site													
BH 21/51	18.09-'51	Tungi		explor.			12.43		All.-P.C.		no casing left				
BH 28/52	15-11-'52	Mkata, Vet.		exploit.	415	0.30	35.36		Q/T	6	0-35.66				
		Camp 3	perc												
BH 37/52	17-11-'52	Mkata, Vet.	perc	explor.	415		40.84		P.C.	8	0-28.04				
BH 2/53	25-01-'53	Gairo	perc	exploit.	1260		73.76		P.C.	8	0-19.40				
		Minor Settlem.	perc												
BH 3/53	10-05-'53	Ngerengere	perc	exploit.	180		117.39		Jurassic	8	0-2494				
BH 23/53	25-07-'53	Kidugallo	perc	exploit.			121.92		Jurassic	6	0-30.48	6	30.48-35.66	5.18	grsp
BH 37/54	2-10-'54	Lloyds ridge	perc	exploit.	488	0.30	31.69		Q/T	8	0-31.39				
BH 41/54	4-10-'54	Chakwale	perc	exploit.	1080		42.06		P.C.	8	0-13.72				
BH 43/54	16-11-'54	Wami Prison	perc	exploit.	324		47.50	43.50	Q/T						
BH 43A/54	24-12-'54	Wami Prison	perc	exploit.	384		46.55	44.81	Q/T	8	0-44.81				
BH 30/55	15-09-'55	Madoto S.E.	perc	exploit.	430		49.07		Q/T	8	0-48.46				
BH 40/55	5-10-'55	Madoto S.E.	perc	exploit.	430		33.53	33.53	Q/T	8					
BH 52/55	5-01-'55	Kidugallo	perc	exploit.			39.62		Jurassic		no casing left				
BH 2/56	22-05-'56	Kidugallo	perc	exploit			122.23		Jurassic	8	0-29.93				
BH 6/56	19-03-'56	Kidugallo	perc	exploit.			111.56		Jurassic	6	0-56.38				
BH 19/56	4-10-'56	Antorion S.E.	perc	exploit.	440		47.85	47.85	Q/T	8					
BH 21/56	11-08-'56	Kihonda S.E.	perc	exploit.	525		74.07		P.C.	6	0- 6.40				
BH 23/56	6-09-'56	Kimamba town	perc	exploit.	435		40.23	40.23	Q/T	6	0-40.23				
BH 34/56	6-11-'56	Kimamba	perc	exploit.	440	0.52	53.43	53.43	Q/T	8	0-53.43				
BH 37/56	7-12-'57	Kimamba	perc	exploit.			52.73	35.97	Q/T	8	0-35.97				
BH 42/56	24-01-'57	Kimamba S.E.	perc	exploit.			53.64	53.34	Q/T	8	0-53.34				
		Sentari S.E.	perc												
BH 2/57	28-02-'57	Kimamba	perc	exploit.	440	0.60	52.43	52.43	Q/T	8	0-52.43				
		Antorion S.E.	perc												
BH 10/57	29-05-'57	Kimamba	perc	exploit.			56.39	51.82	Q/T	8	0-22.25	8	22.25-51.82	29.57	grsp
		Madoto S.E.	perc												
BH 19/57	9-07-'57	Kimamba	perc	exploit.	435	0,71	64.92	64.61	Q/T	10	0-12.19	8	12.19-64.63	52.42	grsp

well no.	water struck at m BGL	Swl m GL	Swl m GL	Q l/sec	S m	Q/S l/sec/m	KD m³/day	Av.K m/day	quality TDS ppm	EC* mS/m	F ppm	remarks	co-ordinates
BH 21/51	3.96	2.44										13 boreholes	
BH 28/52	29.87	16.76		2.5					726	104			322.6-9252.7
BH 37/52	no water											abandoned '52	322.6-9252.7
BH 2/53	32.31 57.91	54.25		0.5					1696	198	0.1	ab.	264.4-9320.8
BH 3/53	10.67	7.92							2320	330	6.0	ab.	
	22.86			1.0					1790	256			
BH 23/53	30.48 51.82 106.68	16.76		1.3					1340	190		ab.	
BH 37/54	17.68	15.85		3.8					1220	174	1.2	EC840 in 1978	276.4-9243.3
BH 41/54	23.77	19.20		0.9					2490	356	1.9	ab.	274.8-9329.8
BH 43/54	18.53	15.54		2.0									329.8-9292.8
BH 43A/54	11.28	15.54		2.0	6.86	0.29	30		810	116	1.1		329.8-9292.8
BH 30/55	14.63 27.73 47.24	8.23		3.8	3.05	1.25	130		520	75	0.3	ab.	
BH 40/55	18.90	12.80		3.2					420	60	0.2	abandoned	
BH 52/55												ab. '55	
BH 2/56	65.74	53.34		2.2	25.30	0.09	10		746	106	1.0	(1956 lab.)	
									635	119	nil	(1957 lab.)	
BH 6/56	19.81	13.41		2.2					3042	435	1.0	ab.	
BH 19/56	9.45	9.41		7.6					720	103	1.0	ab.	295.6-9249.9
BH 21/56	57.91	57.30		0.03					128	18	0.2	ab.	350.7-9255.6
BH 23/56	9.14	9.14		1.9	12.19	0.16	15		1160	166	4.0	(1956 lab.)	294.7-9250.0
	14.63 25.91								383	62	0.4	(1963 lab.)	
BH 34/56	10.97	10.06		3.8	12.19	0.31	30		490	70	1.0	ab.	292.9-9249.7
BH 37/56	9.14	7.32		0.6	0.30	2	210					ab.	
BH 42/56	31.70	29.57		2.8					540	77	1.0	ab.	
BH 2/57	12.19	9.45		5.1	11.58	0.44	45		490	70	1.0		293.2-9250.0
BH 10/57	11.58 21.34 31.39	10.06		10.1	9.45	1.07	110		400	57	0.6	ab.	
BH 19/57	11.58 39.01 56.08	9.14		1.6					766	110	0.4		

Continued 2

well no.	date	location	drill	type of well	elev. GL above SL m	elev. GL above GL m	depth drill m BGL	depth finish m BGL	geological formations pierced	casing dia inches	casing depth m BGL	screen dia inches	screen depth m BGL	screen length	screen type
BH 23/57	28-08-'57	Kilosa	perc	exploit.			32.93		Q/T	8					
		East Africa	perc												
		Sisal plant	perc												
BH 28/57	7-09-'57	Kilosa	perc	exploit.	488		32.61	32.61	Q/T	8	0-32.61				
BH 31/57	18.09-'57	Kilosa	perc	exploit.	478	0.30	32.61	32.61	Q/T	6	0-32.61				
BH 32/57	2-10-'57	Kilosa	perc		480		33.53	32.92	Q/T	8	0-32.92				
BH 15/59	30-12-'59	Mikumi	perc	exploit.	515		92.05	92.05	Karroo	8	0-64.92				
										6	64.92-92.05				
BH 17/59	19-05-'59	Kimamba town	perc	exploit.	435	0.15	35.36	35.36	Q/T	6	0-35.36				
BH 18A/59	5-06-'59	Pangawe	perc	explor.			85.04		P.C.		no casing left				
BH 18B/59	24-08-'59	Pangawe	perc	explor.			49.07		P.C.		no casing left				
BH 19/59	17-10-'59	Mikumi	perc	exploit.	515	0.90	71.63	68.58	Karroo	6					
BH 23/59	18-09-'59	Pangawe	perc	exploit.	535		56.08		P.C.	8	0-19.81				
BH 15/60	17-09-'60	Rubeho	perc	explor.	1335		75.29		P.C.	8	0-19.20				
BH 16/60	2-11-'60	Meshugi	perc	explor.			62.79		P.C.	6	0-26.82	6	26.82-	35.97	gpsp
BH 17/60	28-10-'60	Magole	perc	exploit.	425		48.77	46.33	Q/T	6	0-30.48	6	30.48-46.33	15.85	gpsp
BH 31/60	3-04-'61	Kimamba town	perc	exploit.	440		69.50		Q/T						
BH 34/60	2-12-'60	Rubeho	perc		1305	0.60	68.88		P.C.	6	0-68.88				
BH 37/60	22-01-61	Kisitwe	perc		1350	0.2	67.97	67.97	P.C.	6	0-67.97				
BH 23/61	2-10-'61	Kimamba town		explor.			189.59	185.32	Q/T	6					

well no.	water struck at m BGL	Swl m GL	Swl m GL	Q l/sec	S m	Q/S l/sec/m	KD m³/day	Av.K m/day	quality TDS ppm	EC* mS/m	F ppm	remarks	co-ordinates
BH 23/57	5.18	3.96		12.6					1970	280	1.0	ab.	271.7-9213.0
	29.26								2130	305		ab.	
BH 28/57	9.14	5.49		3.5					990	140	2.0		276.7-9241.5
	10.67												
BH 31/57	11.89	4.27		2.3					1520	217	0.5		
	16.15												
BH 32/57	3.35	1.83		16.7					546	78	1.0	ab.	280.2-9240.0
BH 15/59	6.10	3.96		3.1					1070	153	0.3	10 m from BH 19/59	
BH 17/59	10.36	9.14		1.8					1880	269	2.0	ab.	294.7-9250.0
	14.32								2232	316	0.5		
	18.89								2232	316	0.5		
	31.99								2250	238	0.5		
BH 18A/59		15.24		0.3								ab. '59	
BH 18B/59		17.07		0.6								ab. '59	
BH 19/59	6.10	3.35		3.1					917	150	0.6	10 m from BH 15/59	
BH 23/59	15.85	13.41		8.8					700	100	2.0		365.6-9247.0
	41.15												
BH 15/60	no water											ab. '60	262.2-9308.4
BH 16/60	34.75	29.26		0.2					saline	water		ab. '60	
BH 17/60	19.81	18.59		2.1					445	71	0.3		319.5-9295.5
		18.73		1.9	8.40	0.23	24	1.5					
BH 31/60	10.67	10.06		4.6	5.49	0.84	90		455	65	0.4	ab. '61	295.0-9249.9
	31.09	12.19											
	46.33	23.77											
	52.43	12.19											
	59.74												
BH 34/60	64.92	52.37		0.5									261.2-9306.6
	67.05											ab.	
BH 37/60	56.39	52.22		0.1					659	94	0.6	ab. '61	264.3-9302.4
BH 23/61	10.67	12.80		13.9					760	110	1.2	ab. '61	295.1-9249.8
	18.90								1477	210	0.8		
	34.44								691	99	0.6		
	44.20												
	62.48												
	109.73												
	132.59												

Continued 3

well no.	date	location	drill	type of well	elev. GL above SL m	elev. GL above GL m	depth drill m BGL	depth finish m BGL	geological formations pierced	casing dia inches	casing depth m BGL	screen dia inches	screen depth m BGL	length	type
BH 30/61	28-01-'61	Sentari S.E. Kimamba	perc	exploit.	440	0.35	62.80	62.80	Q/T	6	0-37.80	6	37.80-62.80	25.00	gpsp
BH 6/62	31-03-'62	Mvomero	perc	exploit.	410	0.50	62.48	61.56	Q/T	6	?	6	every other 3 m	30.78	gpsp
BH 7/62	8-12-'62	Saga Saga					121.92		Jurassic	6 6 6 6	0-10.67 15.24-36.58 39.62-60.96 64.62-68.58	6 6 6	10.67-15.24 36.58-39.62 60.96-64.62	4.57 3.04 3.66	gpsp gpsp gpsp
BH 8/62	8-04-'63	School Mkulazi			165		107.90		Jurassic		no casing left				
BH 9/62	7-11-'62	Gronero			210	0.58	111.56	106.58	Jurassic	6	0-30.48	6	30.48-106.68	76.2	gpsp
BH 5/63	21-02-'63	Mguzi Mgugu	perc		435		37.19		P.C.	6	0- 9.14	6	9.14-20.73	11.59	gpsp
BH 18/63	24-12-'63	Wami Prison	perc	exploit.	381		62.48	62.48	Q/T	6 6 6	0-29.0 35.7 -51.5 61.6 -62.5	6 6	29.0-35.7 51.5 -61.6	6.7 10.1	gpsp gpsp
BH 4/64	30-05.'64	Kikiboga Hotel	perc		580		75.18		Karroo	8	0-33.83	8	33.83-47.55	13.72	gpsp
BH 13/64	31-07-'64	Kigoboga	perc		560	1.58	43.28		Karroo	6	0-31.39	6	31.39-44.80	13.42	gpsp
BH 31/64	30-01-'65	Kingolwira	perc	exploit.	440		76.20		P.C.	8	0-13.41	8	13.41-23.16	9.75	gpsp
BH 18/65	19-09-'65	Magubike	perc	exploit.	740	0.86	76.20		P.C.			6	0-61.57	61.57	gpsp
BH 33/65	31-02-'65	Gairo	perc	exploit.	1270		90.22	90.22	P.C.	6		6		58.52	gpsp
BH 14/66	28-08-'66	Turiani	perc	exploit.	380		36.60	36.60	P.C.	8	0- 6.00	6	6.00-36.00	30.00	gpsp
BH 41/67	1-11-'67	Mikese	perc		430	1.06	60.69	60.69	P.C.		0- 2.74 12.50-22.56		2.74-12.50	9.76	gpsp
BH 49/67	1967	Pangawe	perc		480		22.25		P.C.						
BH 17/68	1-07-'68	Ngerengere	perc	exploit.	384		122.00		Q/T	6		6			
BH 72/68	28-01-'69	Kilosa		exploit.	488	1.74	27.12		Q/T	6	0-21.03 24.08-27.12	6	21.03-24.08	3.05	gpsp

well no.	water struck at m BGL	Swl m GL	Swl m GL	Q l/sec	S m	Q/S l/sec/m	KD m^3/day	Av.K m/day	quality TDS ppm	quality EC* mS/m	quality F ppm	remarks	co-ordinates
BH 30/61	13.72	9.45		9.1					1467	210	0.6		293.2-9249.9
	38.10												
BH 6/62	6.10	5.48		3.8	1.52	2.49	260		542	62	0.5	ab. '70	328.0-9302.8
								1650	259	0.2	ab.		
BH 7/62	9.14	7.01										ab.	
	36.58												
				0.3	76.2	0.004	1		7008	1058	0.6	/7-6-'62)	
									5442	580	2.0	/17-8-'62)	
BH 8/62	62.48	52.73		0.4					1150	277	nil	ab.	
BH 9/62	37.19	30.48		0.4					3751		0.6	(9-7-'62) ab.	
									1290	504	nil	(17-8-'62)	
									1245	117	4.0	18-12-'67	
BH 5/63	10.67	7.32		2.2	19.51	0.11	10		good water			ab.	372.4-9248.0
	33.53								4810	687	0.2		
BH 18/63	32.00	20.73		1.0	12.80	0.08	8		2007	287	1.2	ab.	330.5-9292.0
	53.34	19.81		1.4	18.90	0.07	8	0.5	1630	233	2.0		
BH 4/64	22.86	0.96		3.1	6.40	0.48	50		604	151	0.9		298.6-9187.6
	41.13								816	112	0.6		
BH 13/64	33.53	25.00		2.5	6.10	0.41	45		1232	225	1.0		296.2-9187.9
BH 31/64	3.05	1.67		2.3	26.82	0.09	10					"good water"	365.5-9256.5
	12.19												
	70.10												
BH 18/65	13.72	0.61		1.3					2935	488	2.0	(27-8-'65)	297.3-9309.6
									3331		nil	(28-8-'76)	
BH 33/65	51.82	47.65		0.7	12.19	0.06	5		1991	220	nil	(2-2-'66)	264.5-9320.5
									1800	285	0.5	24-6-'71	
BH 14/66	35.05	1.82		3.2	15.69	0.20	21	0.7	450	88	0.4		346.4-9321.8
				3.2	14.02	0.23	24						
BH 41/67	6.10	7.62			30.48	0.6			848	264	2.0	(1967)	379.0-9250.4
									800			(1978) ab.	
BH 49/67	10.67	3.66										"saline water"	366.0-9248.8
	18.29												
BH 17/68	65.84	16.80		1.3								pumped dry ab.	
	60.09	15.13		1.5	71.06	0.02	2		886	127	0.1		330.2-9293.3
	79.24												
	89.91												
BH 72/68	3.35	0.26		5.6	2.44	2.30	240		1100	150	1.3	ab.	277.5-9244.2

Continued 4

well no.	date	location	drill	type of well	elev. GL above SL m	elev. GL above GL m	depth		geological formations pierced	casing		screen			
							drill m BGL	finish m BGL		dia inches	depth m BGL	dia inches	depth m BGL	length	type
BH 75/68	1968	Kilosa	perc	exploit.	488		38.00		Q/T						
BH 78/68	1968	Kilosa	perc	exploit.					Q/T						
BH 17/69	1969	Mtibwa	perc	exploit.	375		33.60	33.60	Q/T	6	0- 9.70	6	9.70-33.60	23.90	gpsp
BH 26/69	1969	Mtibwa	perc	exploit.	375	0.66	47.90		Q/T	6	0- 8.40	6	8.40-47.90	40.30	gpsp
BH 46/69	1969	Mikumi	perc		500		86.60		Karroo						
BH 47/69	1969	Mtibwa							Q/T						
BH 56/69	19-09-'69	Wakwari	perc		345		76.50	44.80	Q/T	8	0-35.10	8	35.10-44.80	9.70	gpsp
BH 58/69	20-09-'69	Wakwari	perc		350		71.30	71.30	Q/T	6	0-33.80	6	33.80-52.70	18.90	gpsp
									Q/T	6	52.70-66.80	6	66.80-70.10	3.30	gpsp
BH 4/70	1970	Mibigili Prison	perc	exploit.	384	43.60	43.60		Q/T	6	0-35.10	6	35.10-39.60	4.50	gpsp
											39.60-43.60				
		Lomo, Kimamba													
BH 21/70	1970	Usagara Est.	perc	exploit.	478		24.00		Q/T						
BH 22/70	21-01-'70	Usagara Est.	perc	exploit.	478		22.86	22.86	Q/T						
BH 97/69	1969	Sentari Kilosa	perc	exploit.			43.00		Q/T						
BH 46/70	1970	Ilonga							Q/T						
BH 46/61	14-07-'71	Kidugallo	perc	exploit.	255		201.78		Jurassic				64.62-70.72	63.70	gpsp
BH 73/71	14-08-'71	Mtibwa	perc	exploit.	310		106.70	34.40	Q/T	8	0-28.30	8	28.30-34.40	6.10	gpsp
BH 75/71	14-09-'71	Mikumi	perc	exploit.	520	0.91	76.20		Karroo	6	0-15.84	6	15.84-40.23	24.39	gpsp
BH 111/71	1971	Mikumi	perc		560										
BH 112/71	8-11'71	Mikumi	perc	exploit.	550		46.93		Karroo			6	9.14-21.37	12.0	gpsp
BH 123/71	1971	Kidatu S.E.	perc	exploit.			69.80		Q/T-Karroo						
BH 136/71	1971	Mikumi	perc	exploit.			62.48		Q/T-Karroo	6	0-34.78	6	34.78-46.94	12.19	gpsp
BH 14/72	12-05-'72	Mtibwa	perc	exploit.	375		198.10	36.60	Q/T-P.C.	8	0- 9.10	8	9.10-21.30	12.2	gpsp
											21.30-27.40		27.40-35.50	6.1	
											35.50-36.60				gpsp
BH 38/72	1972	Magadu	perc		540		135.33		P.C.		no casing left				
		Saba Saba													
BH 79/2	7-07-'72	Morogoro	perc		520		16.80		P.C.		no casing left				
BH 95/72	10-11.'73	Kimamba town	perc		440		137.16		Q/T	8	0-110.00				
										6	110.0-120.20	6	120.20-129.70	9.50	J.S.

well no.	water struck at m BGL	Swl m GL	Swl m GL	Q l/sec	S m	Q/S l/sec/m	KD m^3/day	Av.K m/day	quality TDS ppm	EC* mS/m	F ppm	remarks	co-ordinates
BH 75/68	2.00	0.91		4.9	1.83				400	63	0.2	ab.	277.5-9244.2
BH 78/68									510	47	0.2	ab.	
BH 17/69		2.44		2.7	18.00	0.15	16		400	57		ab.	349.7-9320-8
BH 26/69	9.14	3.50		4.2	48.46	0.09	9		288	41	0.4	ab.	349.6-9320.9
				2.5	25.00	0.10	11						
BH 46/69	34.40	17.30		5.4								ab.	
BH 47/69												no data	
BH 56/69	22.86	21.64		1.0	28.96	0.03	4		1574	225	0.8	ab.	341.5-9303.2
	38.09	21.64		1.2	2.13	0.56	59						
	71.63	21.95		2.1	6.10	0.34	36						
BH 58/69	61.00	17.07		0.9	36.27	0.02	3		153	210	1.0	ab.	340.5-9299.6
				1.9	21.03	0.09	10						
BH 4/70	19.81	8.84		1.9	2.13	0.89	94	20.9	290	41	0.5	ab.	
	37.00												
												ab.	
BH 21/70	12.10	7.90		0.8								no further data	
BH 22/70	12.19	10.60		0.6	8.53	0.07	10					ab.	
BH 97/69	8.00			7.6								no further data	
BH 46/70												no data	283.0-9251.3
BH 46/61	63.70	36.27		1.2	59.44	0.02	5			150	1.4		
BH 73/71	18.00	14.00		0.5	73.20	6.83	1		590	84	0.4	ab.	349.2-9319.0
BH 75/71	24.38	18.59		2.1	26.52	0.08	10						
	66.00												
												ab.	
BH 111/71												no data	
BH 112/71	21.34	5.79		2.7	4.34	0.62	65			92			
BH 123/71	15.85	5.49		1.9	49.38	0.04	5						
	29.87												
BH 136/71	20.30	8.70		3.4	2.00	1.7	180						
BH 14/72	21.00	2.75		0.1	17.0	6.88	nil		310	44		abandoned	348.5-9320.2
	30.50												
	178.00												
BH 38/72	13.72	8.53		1.3	55	0.02	5		4250	650	0.2	abandoned	350.5-9242.5
	16.76												
BH 79/2	12.60	12.00		0.1								abandoned	351-4-9245.8
BH 95/72									4680	669		at 18.00 m	293.8-9250.0
	8.50	4.00		8.0	5.18	1.54	160		1125	160		at 30.00 m	
	18.29								350	59	0.2	at 120 m	
	39.93												

Continued 5

well no.	date	location	drill	type of well	elev. GL above SL m	elev. GL above GL m	depth		geological formations pierced	casing		screen			
							drill m BGL	finish m BGL		dia inches	depth m BGL	dia inches	depth m BGL	length	type
		Ngerengere	perc												
BH 265/74		Kizuka	perc				122.00								
BH 5/75		Kizuka	perc				136.00								
BH 23/75		Sanga Sanga	perc				52.00								
BH 70/75		Sanga Sanga	perc				85.34								
BH 79/75		Sanga Sanga	perc				108.00								
BH 80/75		Sanga Sanga	perc				136.16								
BH 90/75		Kihonda	perc		480		30.48		P.C.						
BH 41/76	11-12-'76	Mtumbatu	perc				91.44	48.66	P.C.	6		6	13.20-34.50	21.30	gpsp
BH 282/76		Mtunbatu	perc			0.9	62.48	55.47	P.C.	6	0-23.50	6	23.50-55.50	32.00	gpsp
		Sanga Sanga													
		Ujamaa													
BH 77/77		Kingolwira	perc		420	0.48	36.58		P.C.	6	0- 4.88	6	4.88-36.58	31.70	gpsp
BH 149/77	11-09-'77	Fulwe	perc		420	0.75	25.60	25.60	P.C.	6	0- 4.27	6	4.27-25.60	21.33	gpsp
BH 175/77	4-12-'77	Msowero	perc	exploit.	435		51.21	51.21	P.C.	6	0- 5.5	6	5.5 -16.8	11.3	gpsp
										6	16.8 -35.0	6	35.0 -47.2	12.2	gpsp
										6	47.2 -51.2				
BH 226/77		Dumila	perc		430	0.60	61.11	61.11	Q/T	6	0-30.48	6	30.48-48.77	18.70	gpsp
											48.77-61.11				
BH 246/77		Kidogo basi	perc	exploit.			30.0	30.0	Karroo	6	0-13.4	6	13.4 -26.8	13.4	gpsp
		Ujamaa													
BH 33/78		Kitete	perc	exploit.	455		80.77		Q/T						
BH(46/78)		Mbigili	perc	exploit.			36.60	36.60	Q/T	3		3			
BH 95/78	13.12-'78	Cahnzuru	perc		455		66.00	66.00	Q/T						
		Mikese	perc	exploit.	400		40.0	40.0	P.C.	8		8			
BH 117/78		Mikese	perc	exploit.	380		18.0		P.C.	8	0- 6.0	8	6.0 -18.0	12.0	gpsp
BH		Dakawa Ranch					46.5		P.C.						
BH		Wami Prison							Q/T						

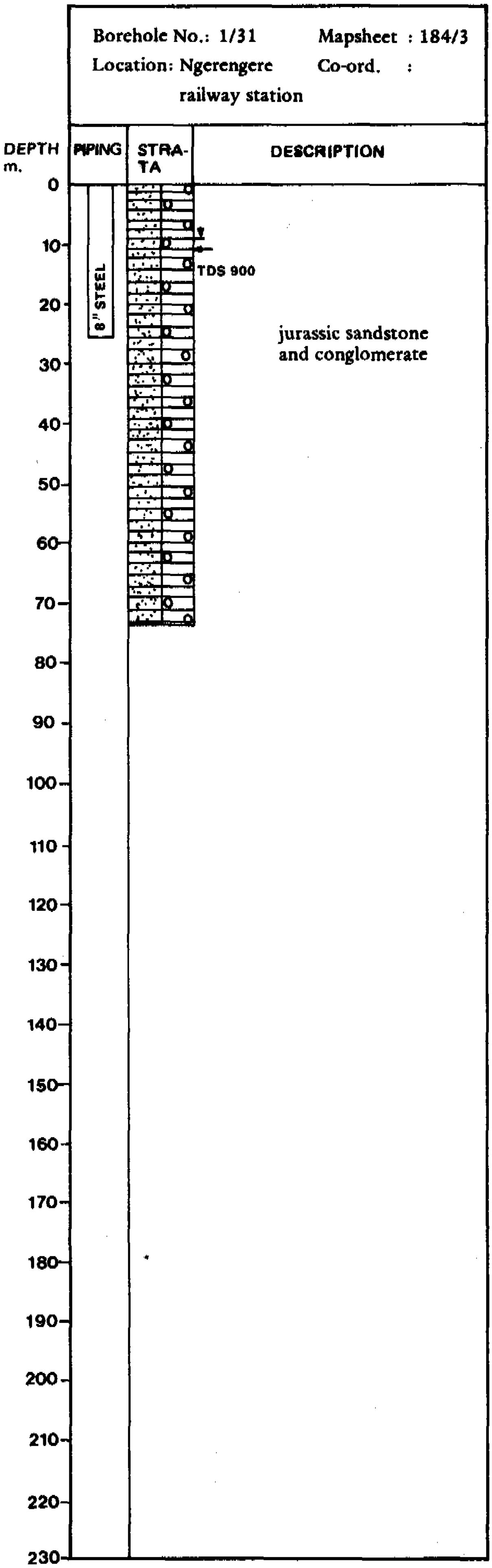
Perc = Percussion drill
P.C. = Precambrian
Q/T = Quarternary-Tertiair
All = Alluvium
S = Screen length
KD = Transmissivity
TDS = Total dissolved solids

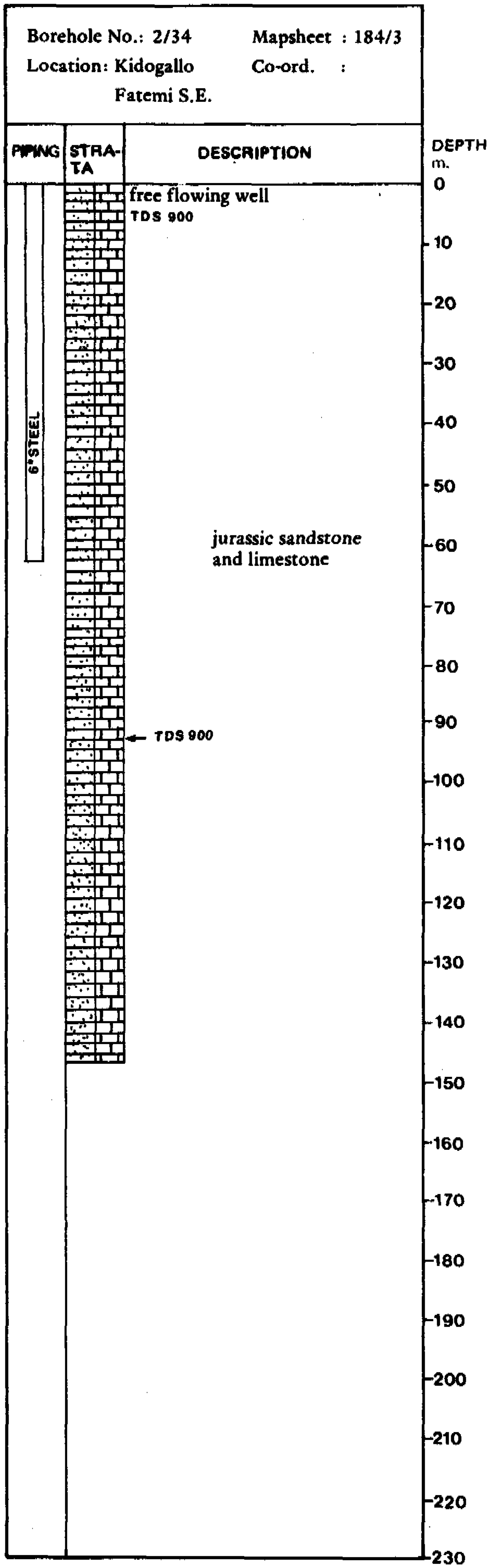
GL = Ground level
SL = Sea level
BGL = Below ground level
Swl = Standing water level
Q = Discharge
Av.K = Average hydraulic conductivity
EC = Electrical conductivity
F = Fluor

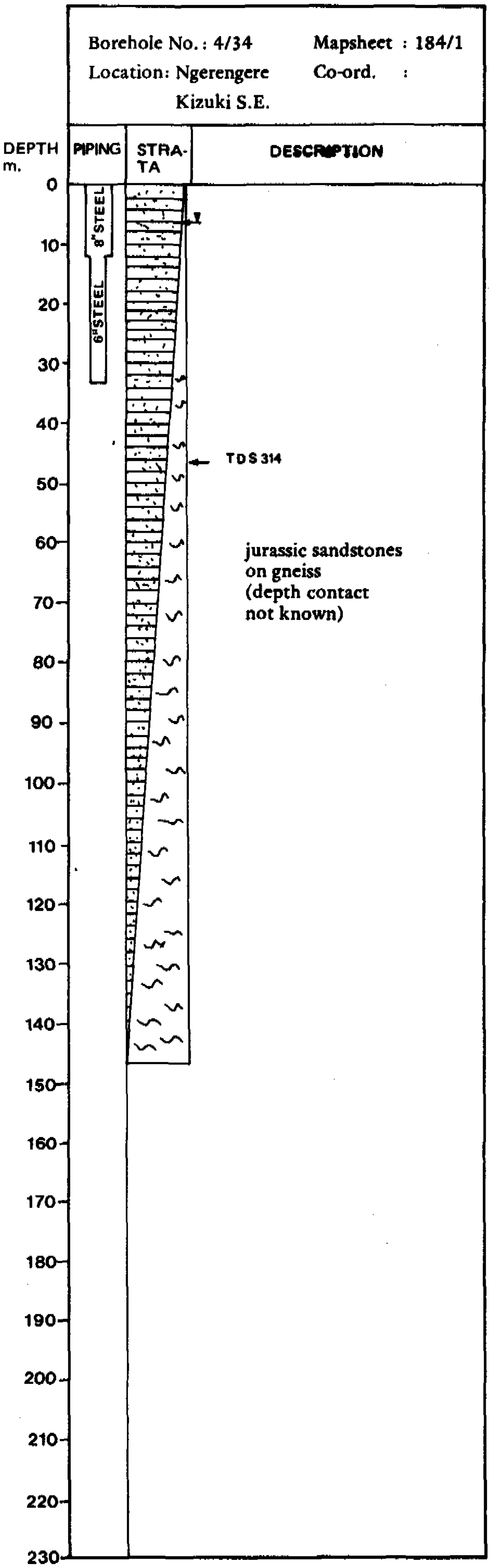
well no.	water struck at m BGL	Swl m GL	Swl m GL	Q l/sec	S m	Q/S l/sec/m	KD m^3/day	Av.K m/day	quality TDS ppm	EC* mS/m	F ppm	remarks	co-ordinates
BH 265/74	14.00	6.00			17.00							saline water	
BH 5/75	25.00	3.00			24.00				5090	727		saline water	
BH 23/75	35.00	10.36							2650	379	0.4		
BH 70/75												no data	
BH 79/75	88.39	30.48									2.4	good water	
BH 80/75	38.09				44							good water	
BH 90/75	3.05	0.61			8.53							saline water	354.0-9251-5
												saline water	
BH 41/76		19.81										no yoeld	
BH 282/76		22.86		1.1	25.91	0.04	5			175			
BH 77/77		4.88		1.3	2.21	0.59	60						370.0-9264.9
												not yet in production	
BH 149/77	7.62	7.62		0.4	9.31	0.04	5					1977	376.0-9252.8
		1.31								23		20-6-'78	
												not yet in	
BH 175/77		3.66		0.6					1200	155	1.9	production	302.8-9278.5
BH 226/77		9.14		3.0	39.82	0.08	8	0.4	712	102	2.5	not yet in pr.	317.0-9274.4
BH 246/77		1.0		8-6	6.5	1.3						"good water"	
BH 33/78										125		not yet in pr.	308.5-9291.5
												old well, new number	
BH(46/78)		10.50		6.7	23.00	0.29	31					not yet in pr.	
	9.0												
BH 95/78	45.0	42.0		16.0	12.0	1.33	140					not yet in pr.	287.4-9248.9
												ab. 1978	379.2-9252.0
	5.0												
	7.5												
BH 117/78	15.0	2.4		6.0	7.5	0.8	85					not yet in pr.	379.3-9252.8
BH				2.0								no data yet	
BH													

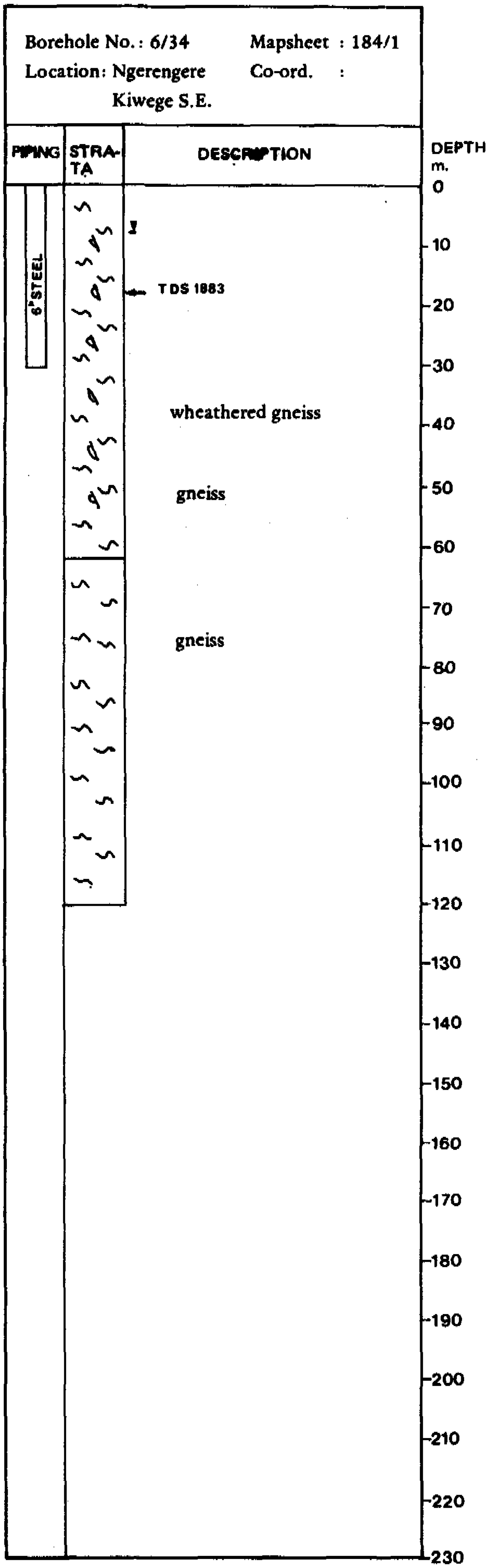
DATA DD 2

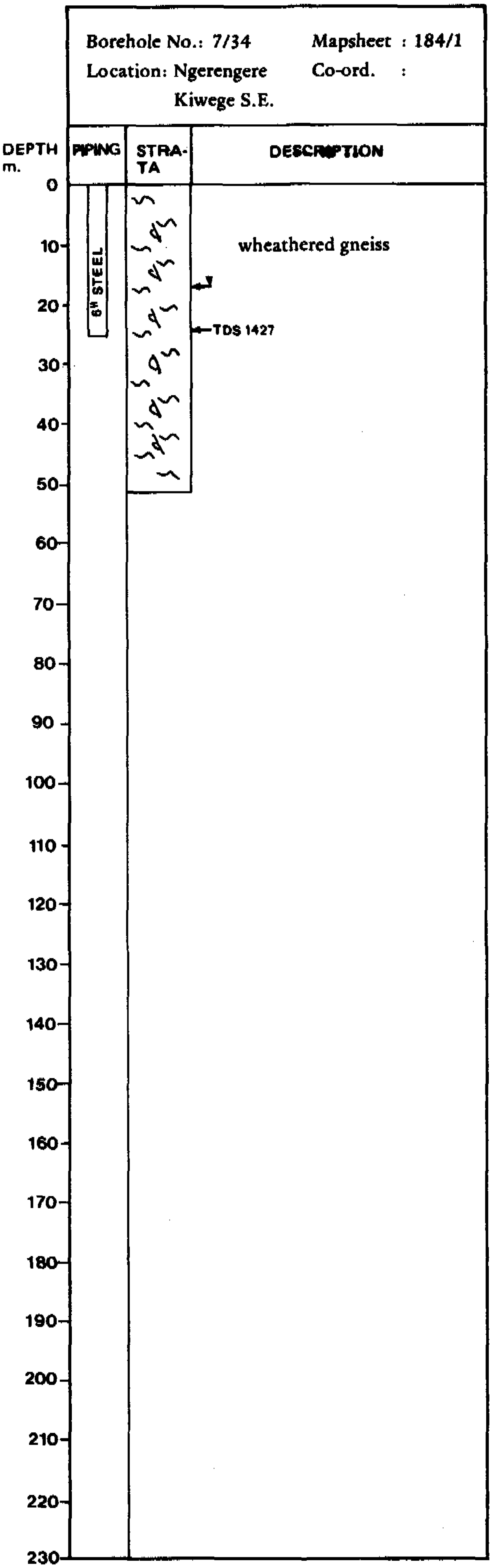
SAMPLE LOGS FROM EXISTING BOREHOLES

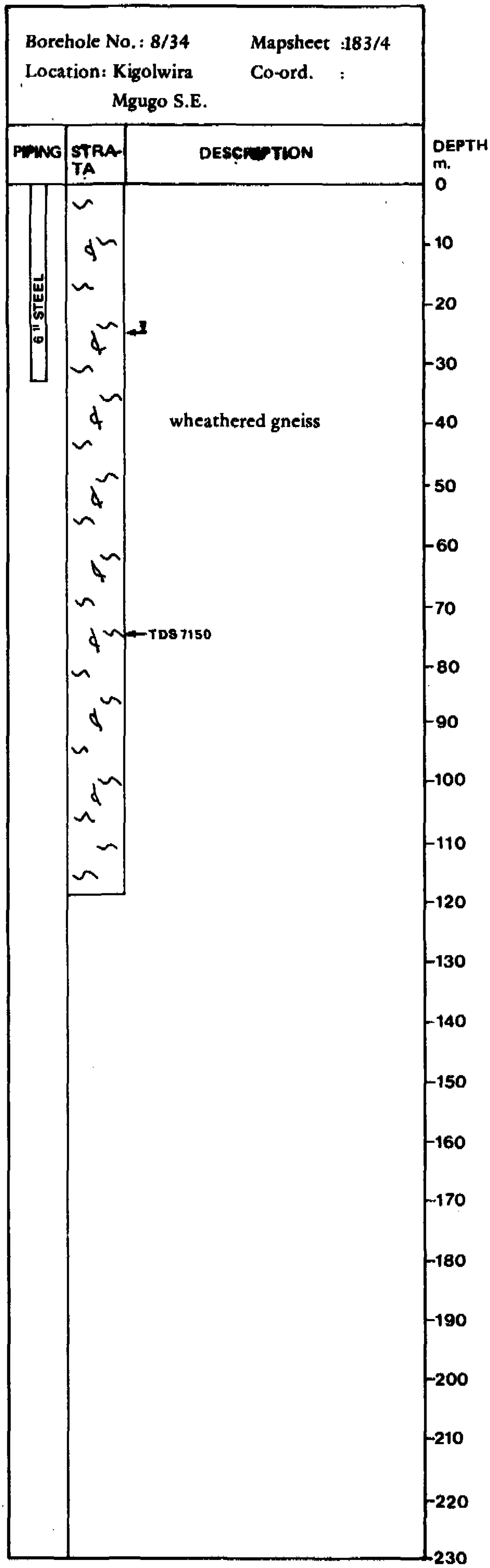

Borehole No.: 1/31
Mapsheet : 184/3
Location: Ngerengere railway station
Co-ord. :
DEPTH m.
PIPING
STRA-TA
DESCRIPTION
8" STEEL
TDS 900
jurassic sandstone and conglomerate
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230


Borehole No.: 2/34
Mapsheet : 184/3
Location: Kidogallo Fatemi S.E.
Co-ord. :
PIPING
STRA-TA
DESCRIPTION
DEPTH m.
free flowing well
TDS 900
6" STEEL
jurassic sandstone and limestone
TDS 900
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

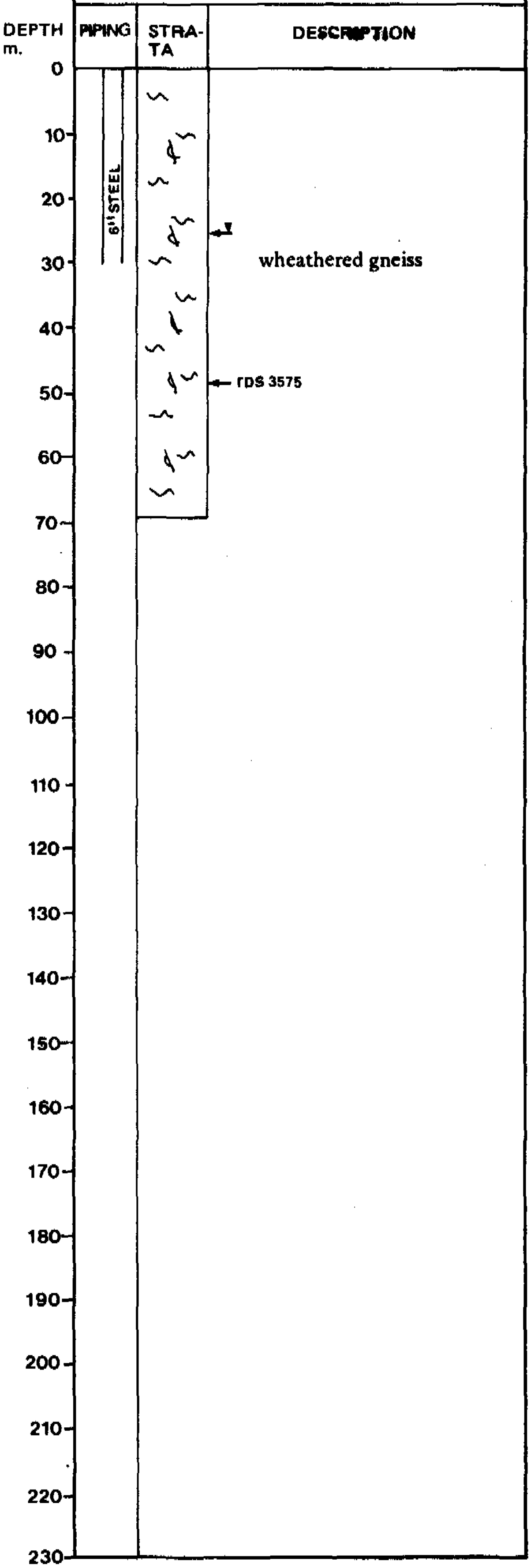

Borehole No.: 4/34
Mapsheet : 184/1
Location: Ngerengere
Kizuki S.E.
Co-ord. :
DEPTH m.
PIPING
STRATA
DESCRIPTION
8" STEEL
6" STEEL
TDS 314
jurassic sandstones
on gneiss
(depth contact
not known)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230


Borehole No.: 6/34
Mapsheet : 184/1
Location: Ngerengere
Kiwege S.E.
Co-ord. :
PIPING
STRATA
DESCRIPTION
DEPTH m.
6" STEEL
TDS 1883
wheathered gneiss
gneiss
gneiss
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

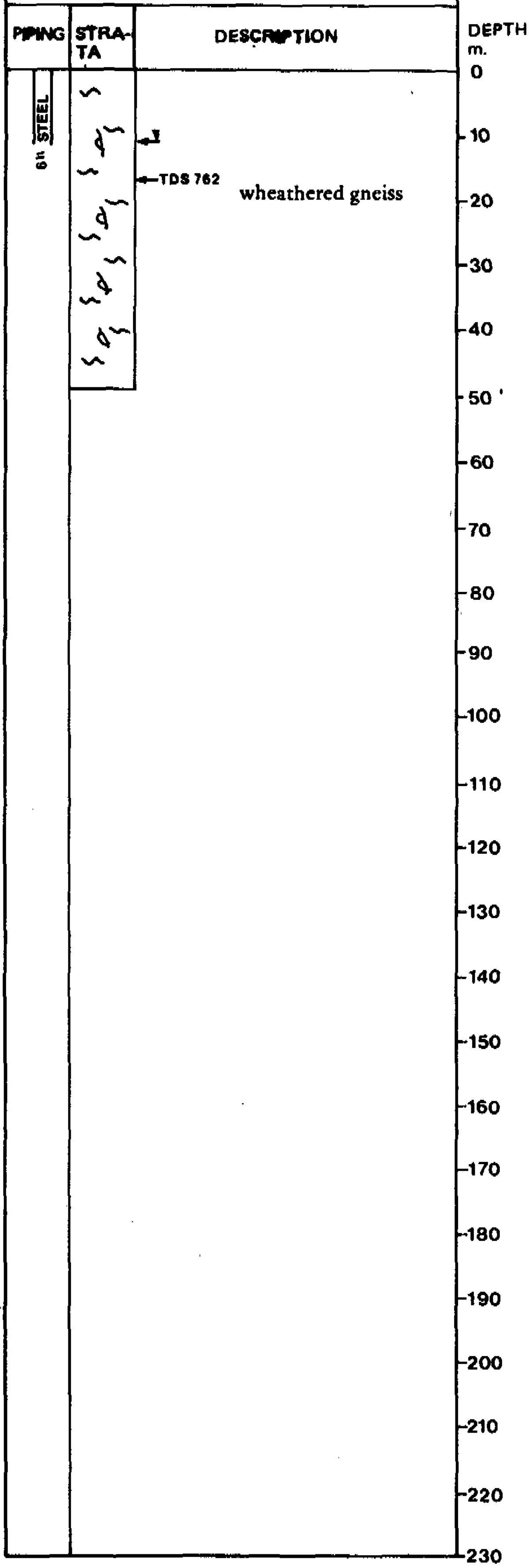

Borehole No.: 7/34
Mapsheet : 184/1
Location: Ngerengere Kiwege S.E.
Co-ord. :
DEPTH m.
PIPING
STRA-TA
DESCRIPTION
6" STEEL
wheathered gneiss
TDS 1427
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

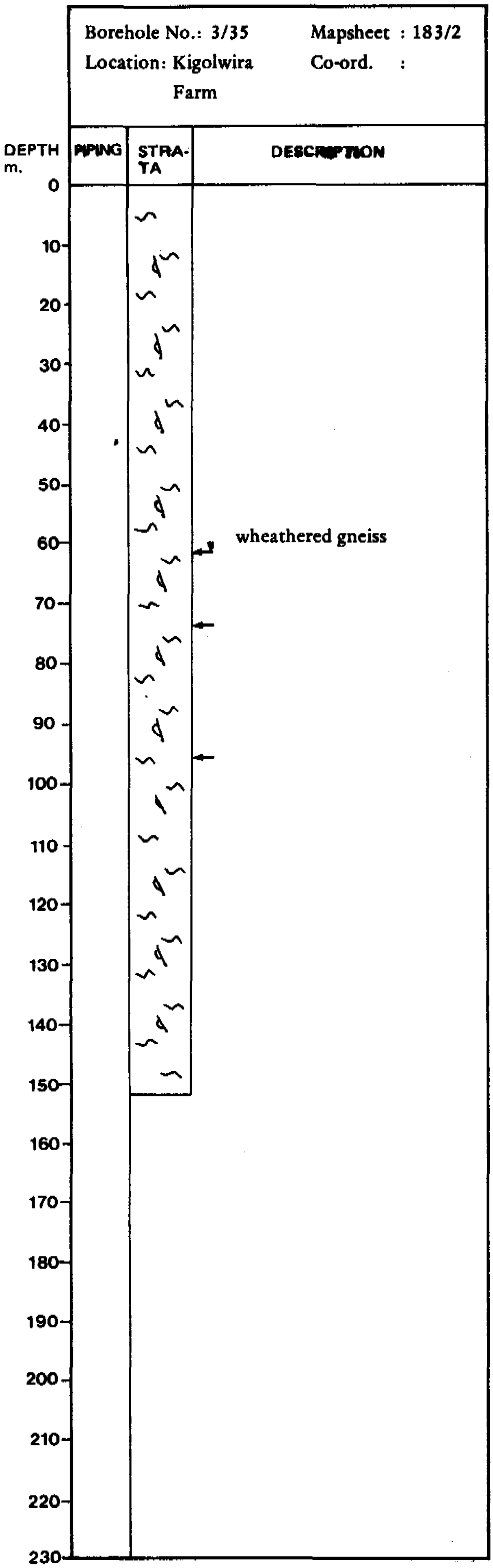

Borehole No.: 8/34
Mapsheet :183/4
Location: Kigolwira Mgugo S.E.
Co-ord. :
PIPING
STRA-TA
DESCRIPTION
DEPTH m.
6" STEEL
wheathered gneiss
TDS 7150
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

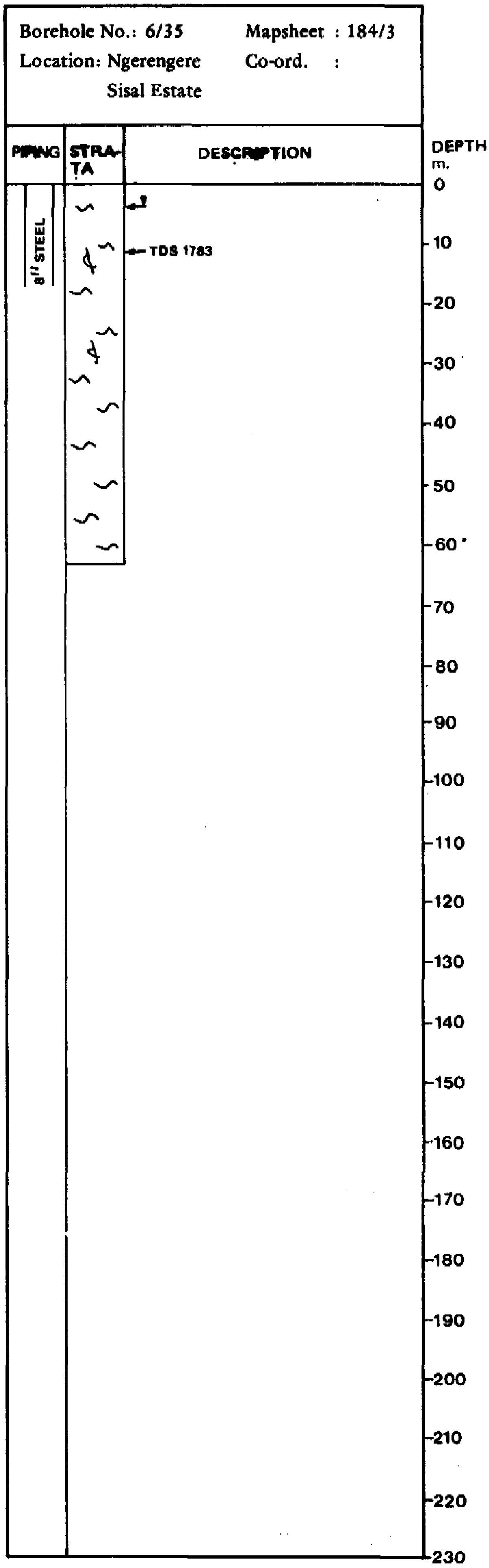
Borehole No.: 14/34 Mapsheet : 183/4
Location: Kigolwira Co-ord. :
Pangawe S.E.

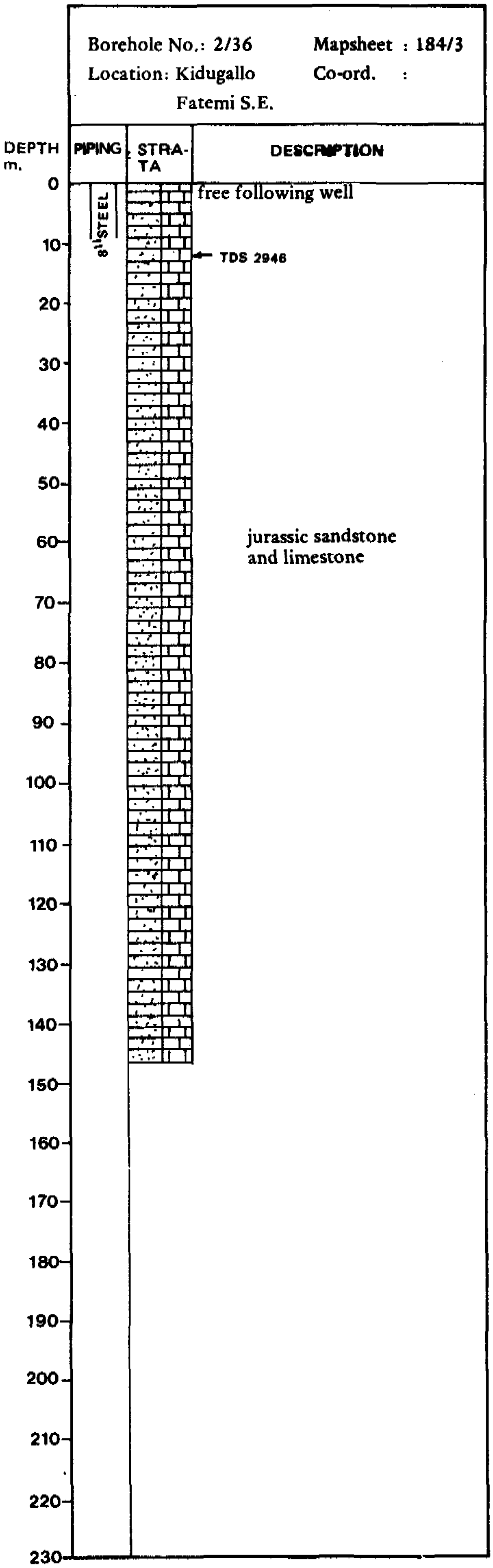


Borehole No.: 1/35 Mapsheet : 183/3
Location: Morogoro Co-ord. :

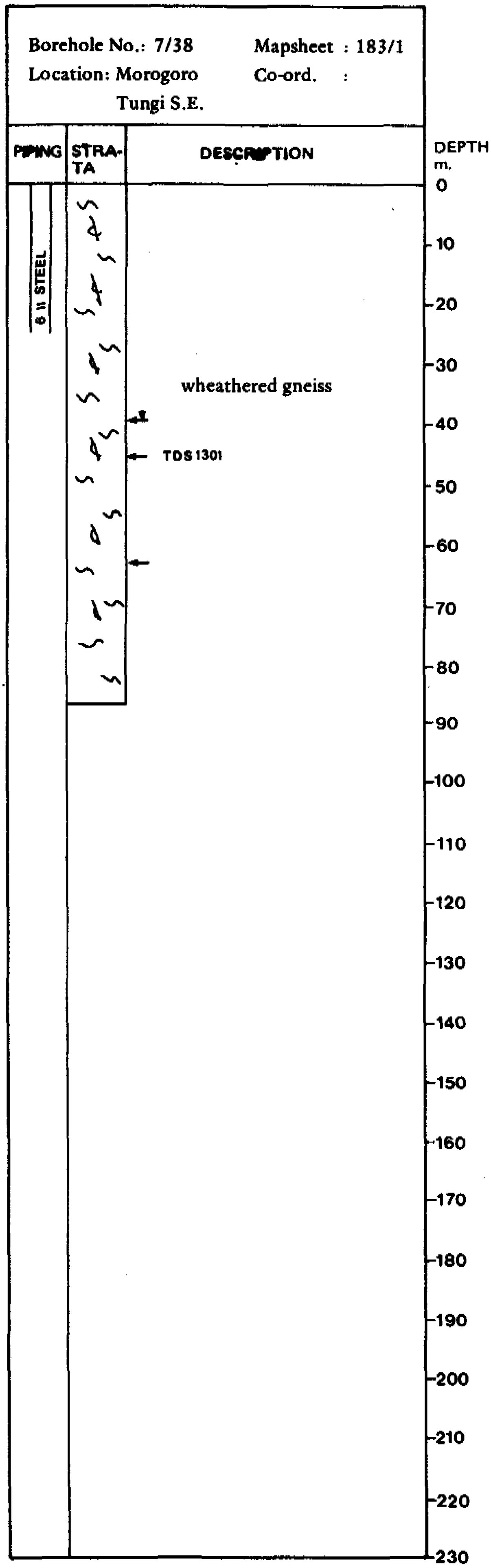



Borehole No.: 3/35
Mapsheet : 183/2
Location: Kigolwira Farm
Co-ord. :
DEPTH m.
PIPING
STRATA
DESCRIPTION
wheathered gneiss
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

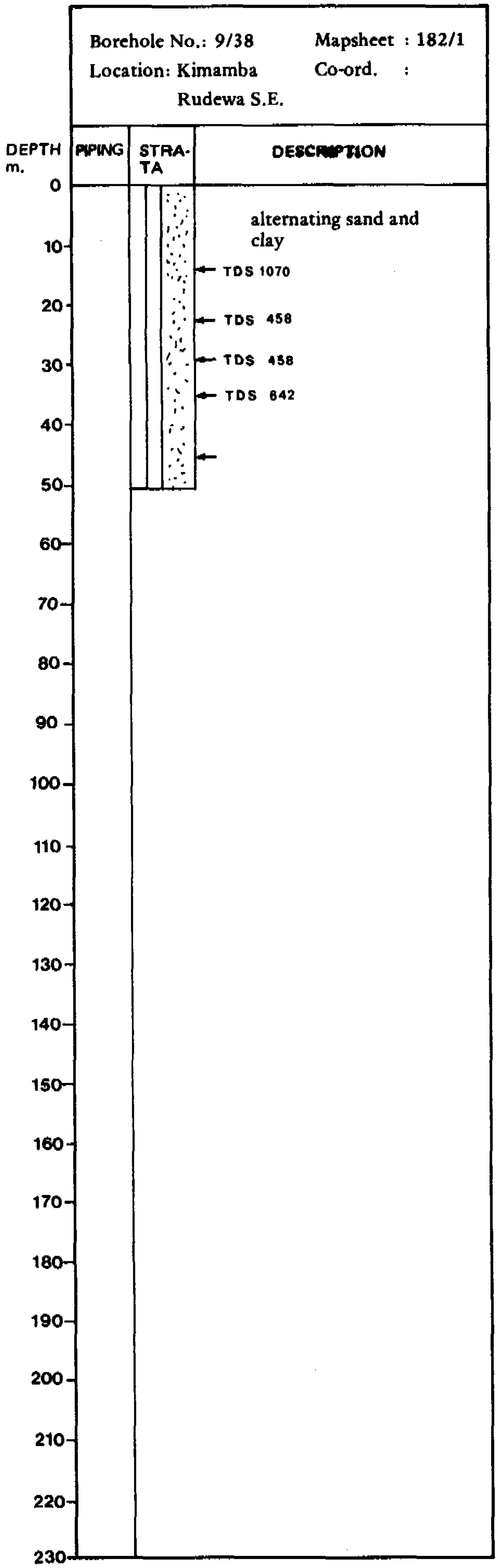

Borehole No.: 6/35
Mapsheet : 184/3
Location: Ngerengere Sisal Estate
Co-ord. :
PIPING
STRATA
DESCRIPTION
DEPTH m.
8" STEEL
TDS 1783
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

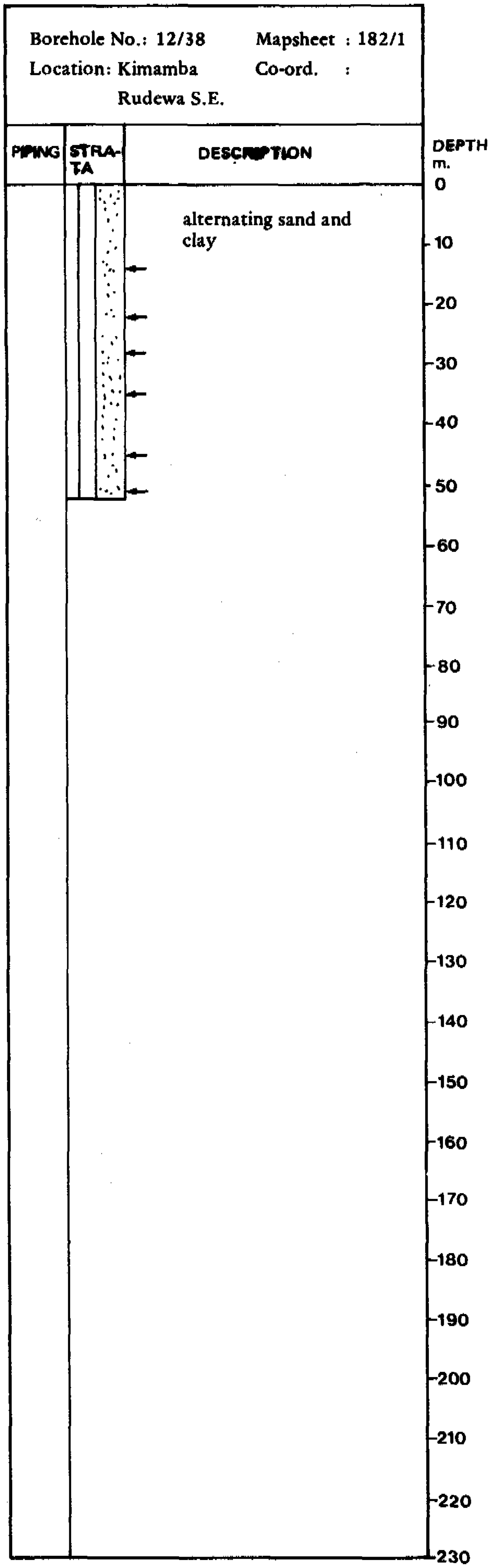


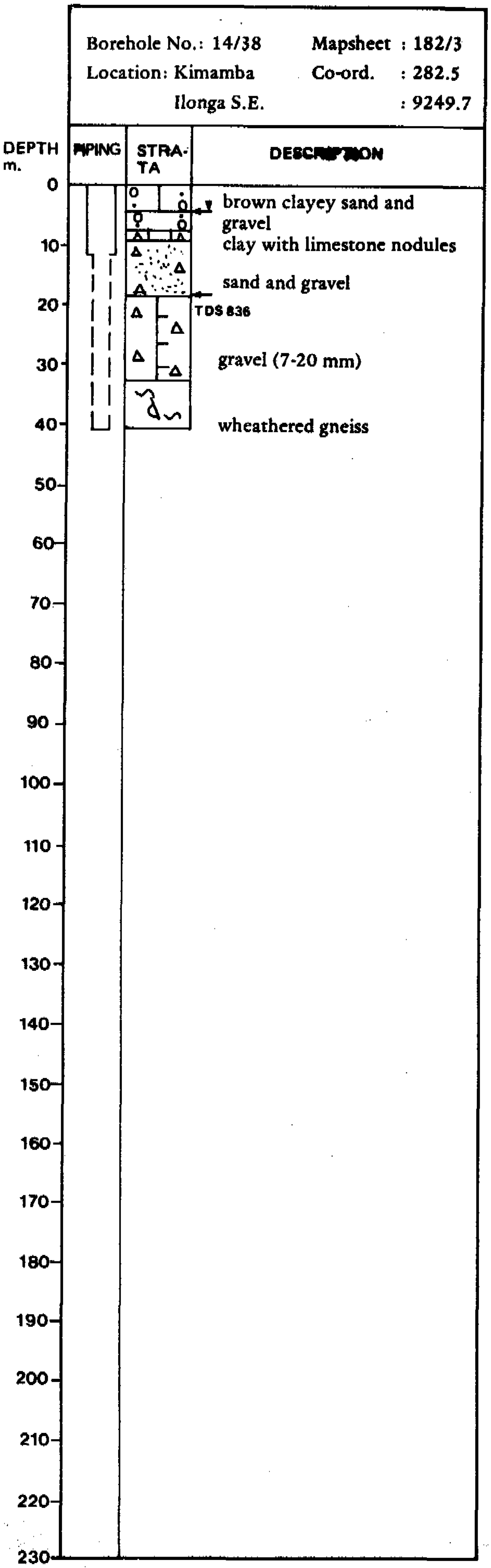
Borehole No.: 2/36
Mapsheet : 184/3
Location: Kidugallo Fatemi S.E.
Co-ord. :
DEPTH m.
PIPING
STRATA
DESCRIPTION
8" STEEL
free following well
TDS 2946
jurassic sandstone and limestone
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

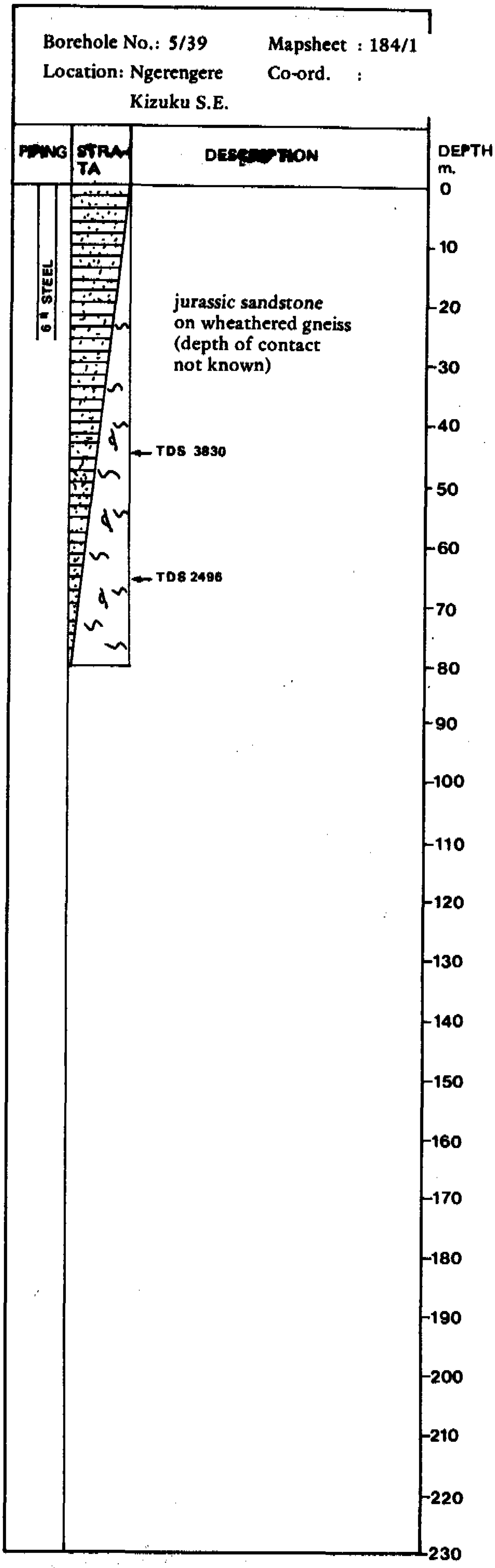


Borehole No.: 7/38
Mapsheet : 183/1
Location: Morogoro Tungi S.E.
Co-ord. :
PIPING
STRATA
DESCRIPTION
DEPTH m.
8" STEEL
wheathered gneiss
TDS 1301
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

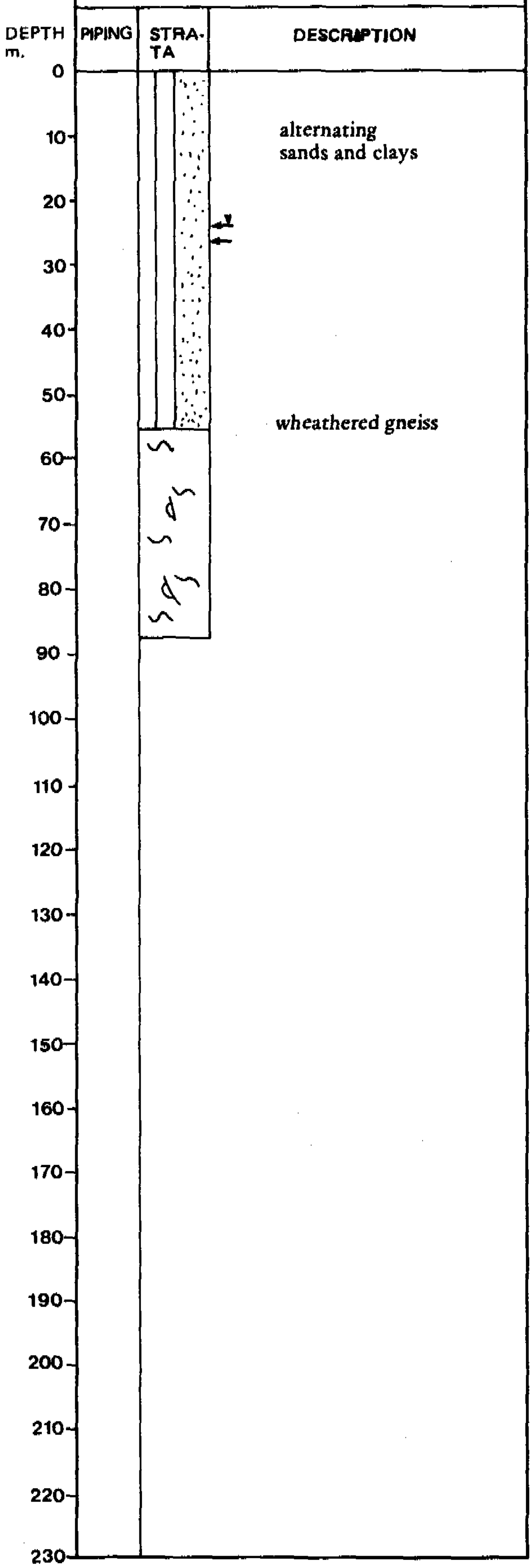

Borehole No.: 9/38
Mapsheet : 182/1
Location: Kimamba
Rudewa S.E.
Co-ord. :
DEPTH m.
PIPING
STRA-TA
DESCRIPTION
alternating sand and clay
TDS 1070
TDS 458
TDS 458
TDS 642
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230


Borehole No.: 12/38
Mapsheet : 182/1
Location: Kimamba
Rudewa S.E.
Co-ord. :
PIPING
STRA-TA
DESCRIPTION
DEPTH m.
alternating sand and clay
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

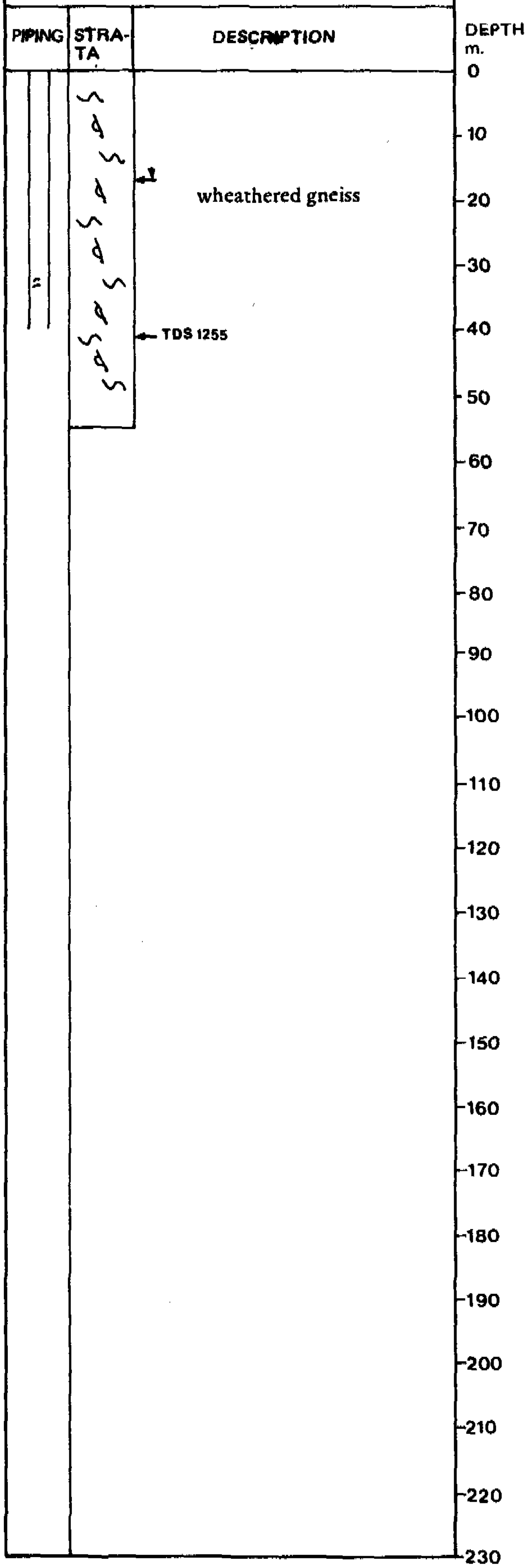

Borehole No.: 14/38
Mapsheet : 182/3
Location: Kimamba
Ilonga S.E.
Co-ord. : 282.5
: 9249.7
DEPTH m.
PIPING
STRATA
DESCRIPTION
brown clayey sand and gravel
clay with limestone nodules
sand and gravel
TDS 836
gravel (7-20 mm)
wheathered gneiss
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

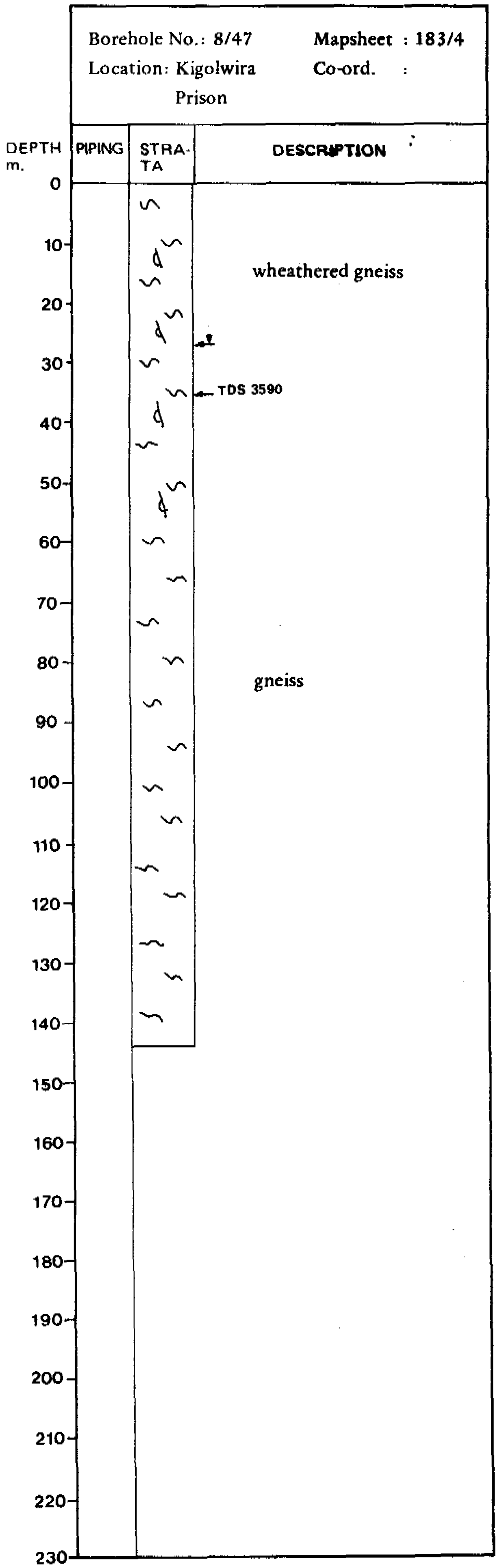

Borehole No.: 5/39
Mapsheet : 184/1
Location: Ngerengere
Kizuku S.E.
Co-ord. :
PIPING
STRATA
DESCRIPTION
DEPTH m.
6" STEEL
jurassic sandstone
on wheathered gneiss
(depth of contact
not known)
TDS 3830
TDS 2496
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

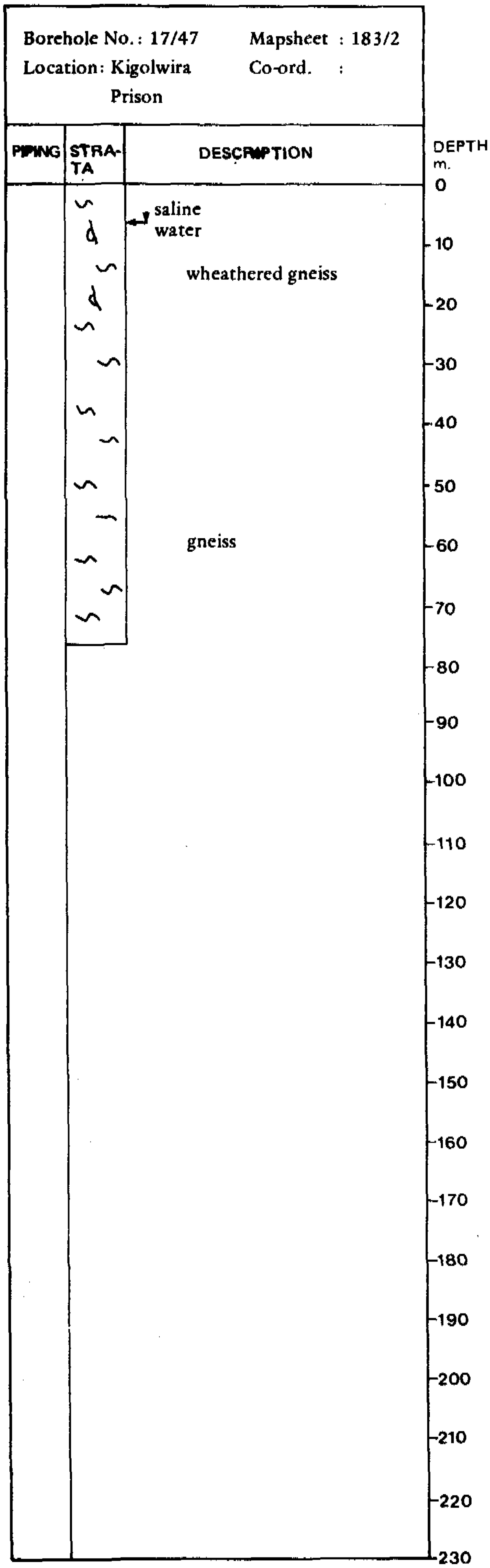
Borehole No.: 10/39 Mapsheet : 182/4
Location: Mkata Co-ord. : 318.4
Railway station : 9253.1

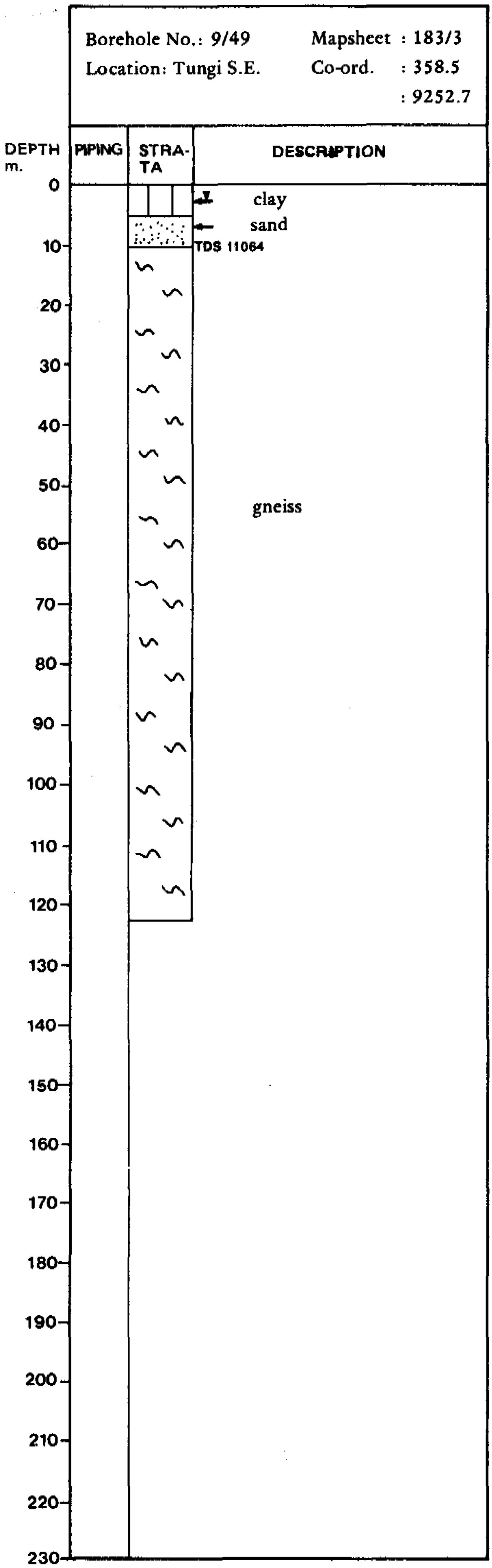


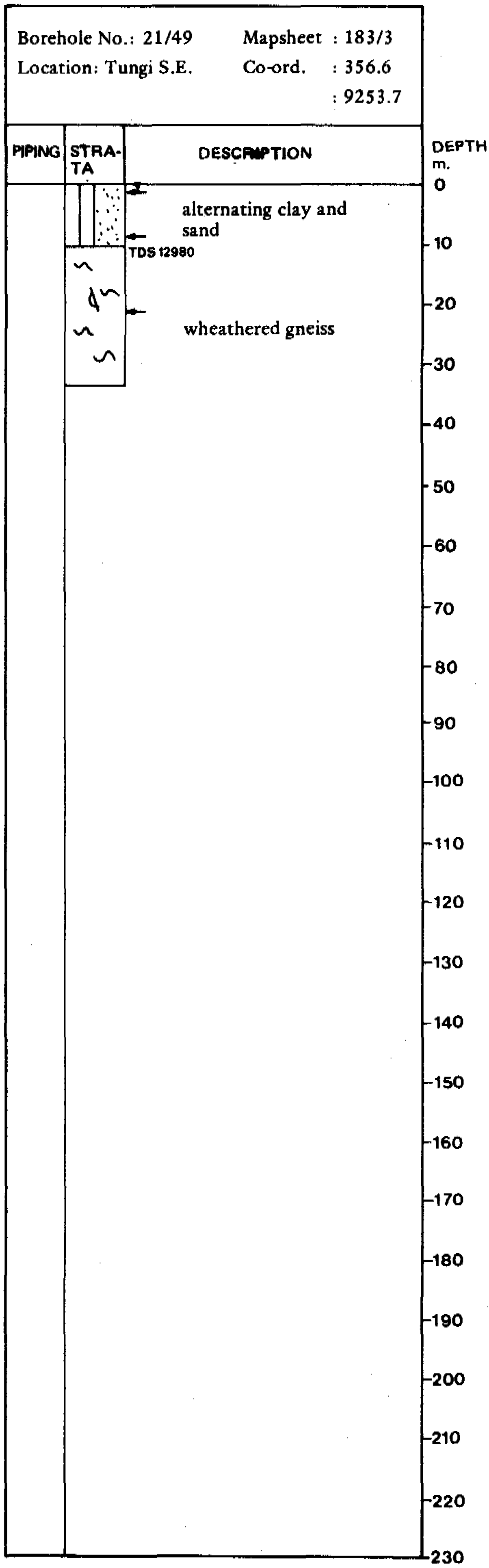
Borehole No.: 1/40 Mapsheet : 183/3
Location: Masimbu Co-ord. : 339.4
Railway station 9252.8




Borehole No.: 8/47
Mapsheet : 183/4
Location: Kigolwira Prison
Co-ord. :
DEPTH m.
PIPING
STRATA
DESCRIPTION
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
wheathered gneiss
TDS 3590
gneiss


Borehole No.: 17/47
Mapsheet : 183/2
Location: Kigolwira Prison
Co-ord. :
PIPING
STRATA
DESCRIPTION
DEPTH m.
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
saline water
wheathered gneiss
gneiss


Borehole No.: 9/49
Mapsheet : 183/3
Location: Tungi S.E.
Co-ord. : 358.5
: 9252.7
DEPTH m.
PIPING
STRATA
DESCRIPTION
clay
sand
TDS 11064
gneiss
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

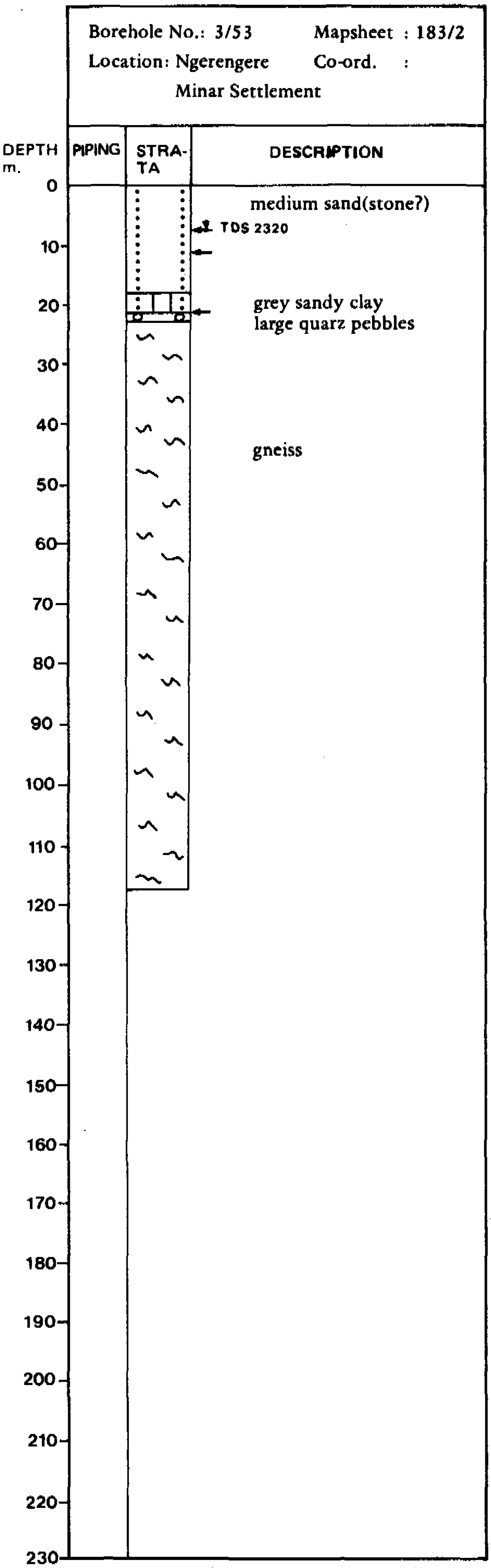

Borehole No.: 21/49
Mapsheet : 183/3
Location: Tungi S.E.
Co-ord. : 356.6
: 9253.7
PIPING
STRATA
DESCRIPTION
DEPTH m.
alternating clay and sand
TDS 12980
wheathered gneiss
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

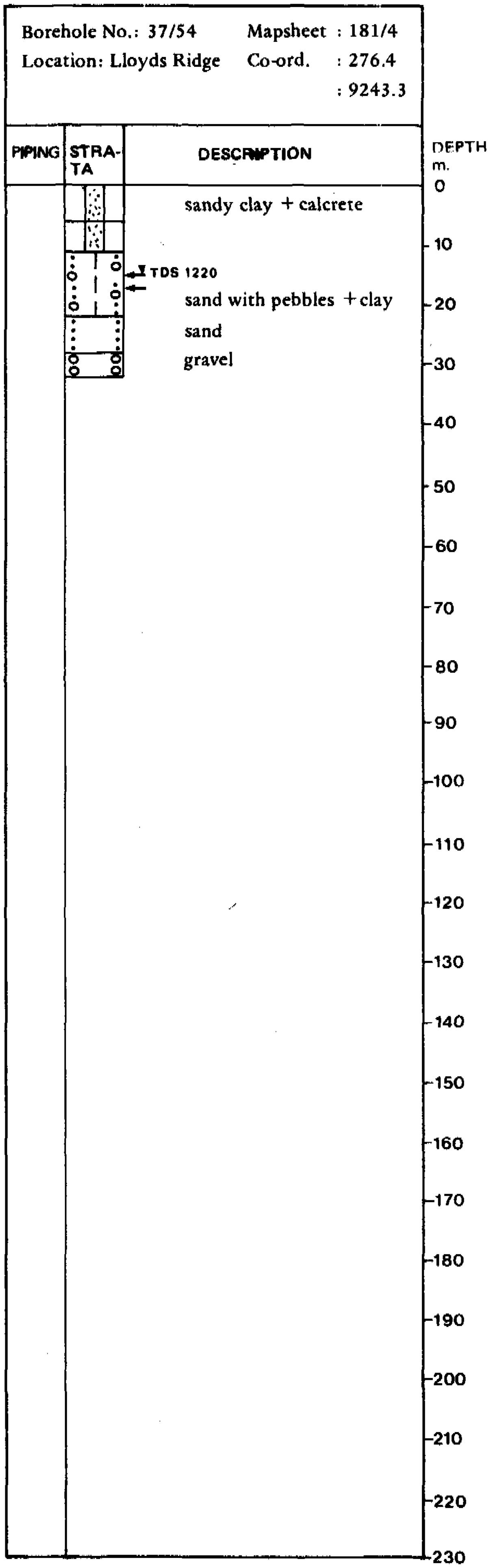
Borehole No.: 28/52 Mapsheet : 182/4
Location: Mkata Co-ord. : 322.6
Vet Camp : 9252.7

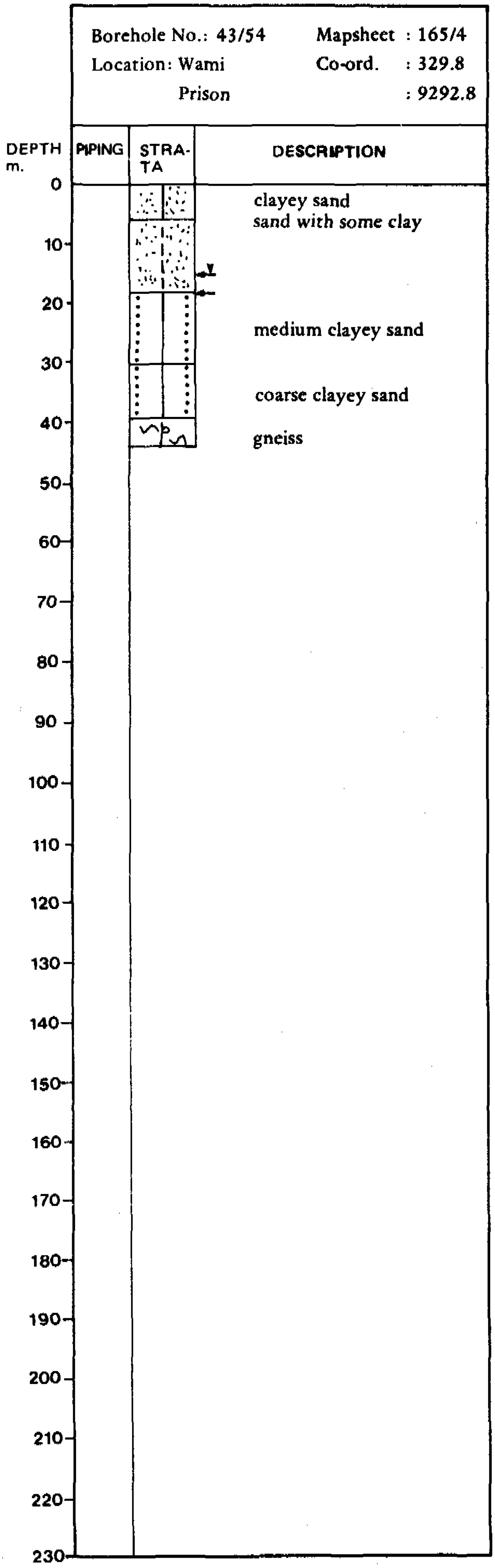
DEPTH m.	PIPING	STRATA	DESCRIPTION
0	6" STEEL		grey sandy clay
			fine sand
10			sand and gravel
20			sandy clay with calcrete
			fine sand
30		TDS726	gravel
			fine sand
40			
50			
60			
70			
80			
90			
100			
110			
120			
130			
140			
150			
160			
170			
180			
190			
200			
210			
220			
230			

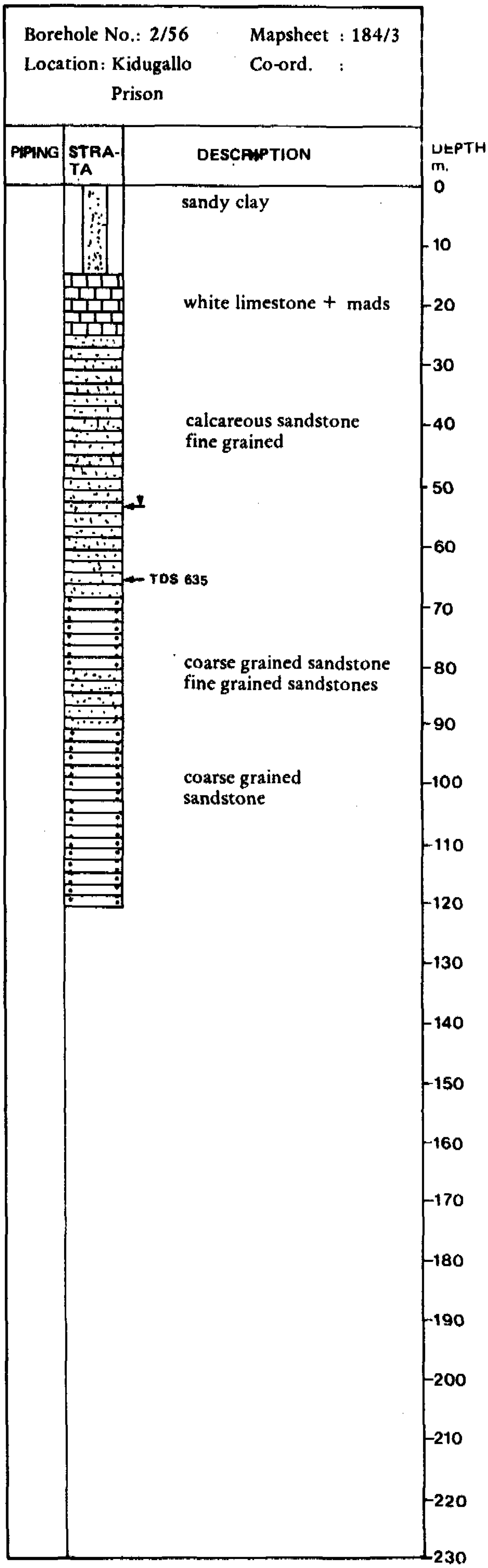
Borehole No.: 37/52 Mapsheet : 182/4
Location: Mkata Co-ord. : 322.6
Vet Camp : 9252.7

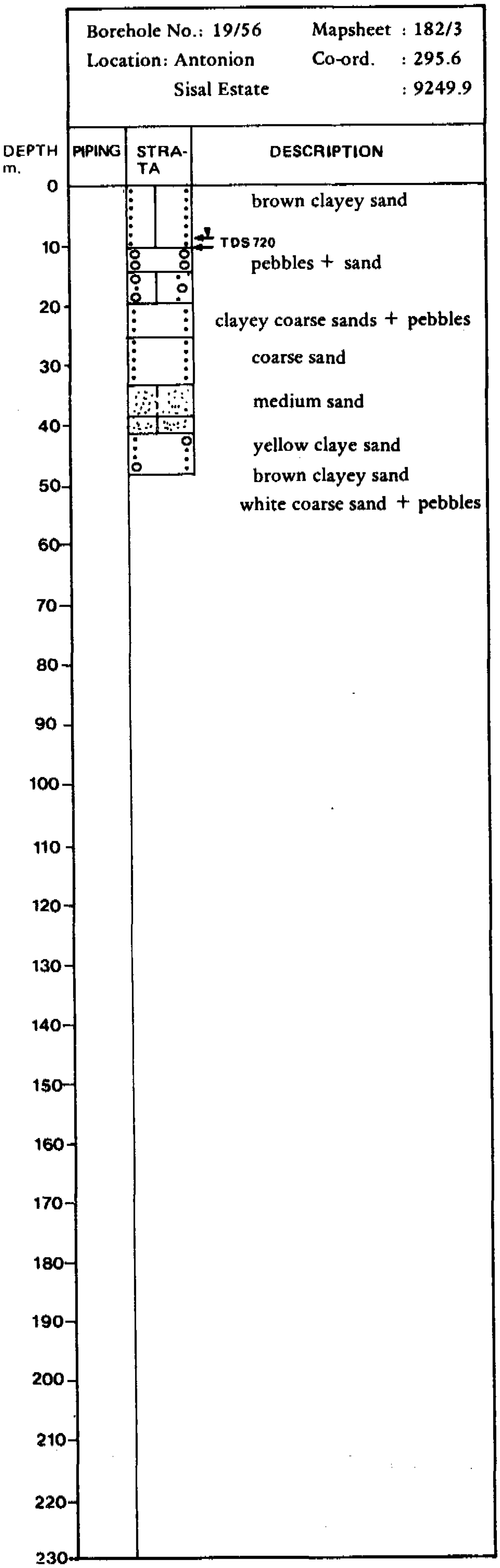
DEPTH m.	PIPING	STRATA	DESCRIPTION
0			orange/red sandy loam
			stones
10			soft, clayey wheathered gneiss
20			decomposed gneiss
30			very hard gneiss
40			
50			
60			
70			
80			
90			
100			
110			
120			
130			
140			
150			
160			
170			
180			
190			
200			
210			
220			
230			

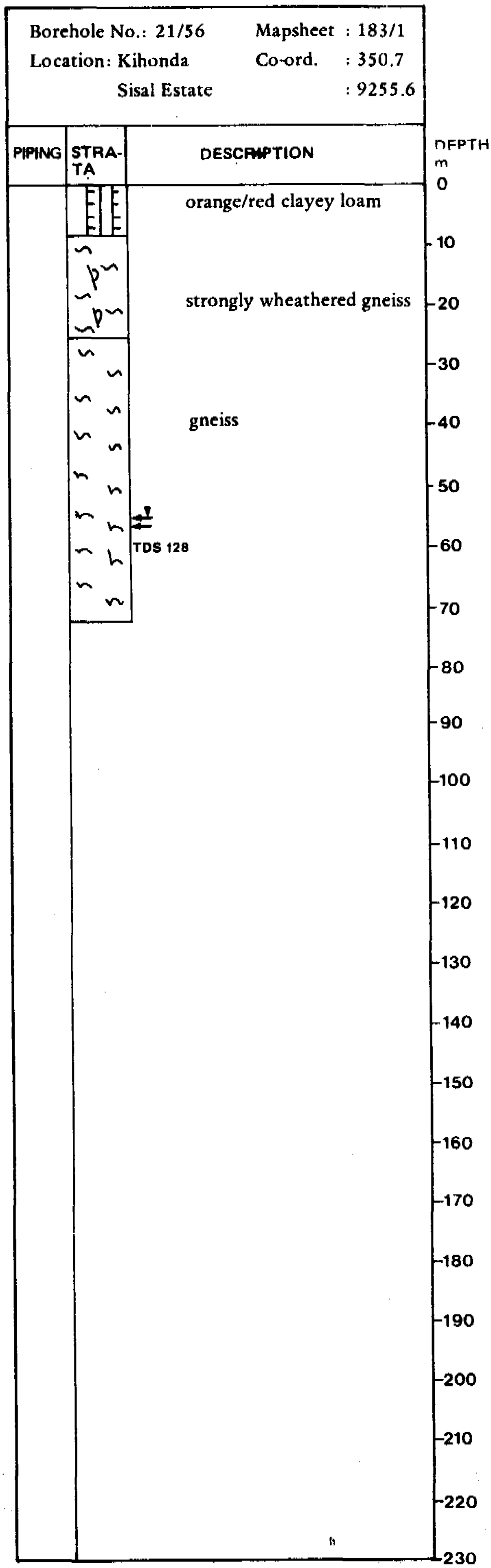

Borehole No.: 3/53
Mapsheet : 183/2
Location: Ngerengere Minar Settlement
Co-ord. :
DEPTH m.
PIPING
STRA-TA
DESCRIPTION
medium sand(stone?)
TDS 2320
grey sandy clay
large quarz pebbles
gneiss

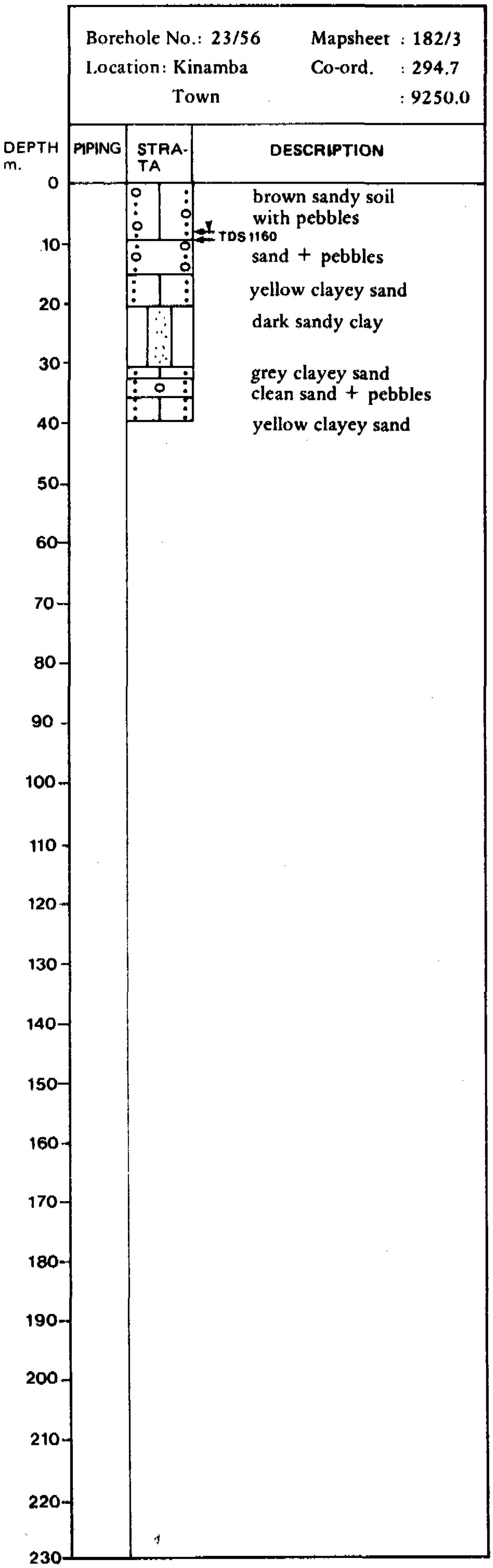

Borehole No.: 37/54
Mapsheet : 181/4
Location: Lloyds Ridge
Co-ord. : 276.4
: 9243.3
PIPING
STRA-TA
DESCRIPTION
DEPTH m.
sandy clay + calcrete
TDS 1220
sand with pebbles + clay
sand
gravel

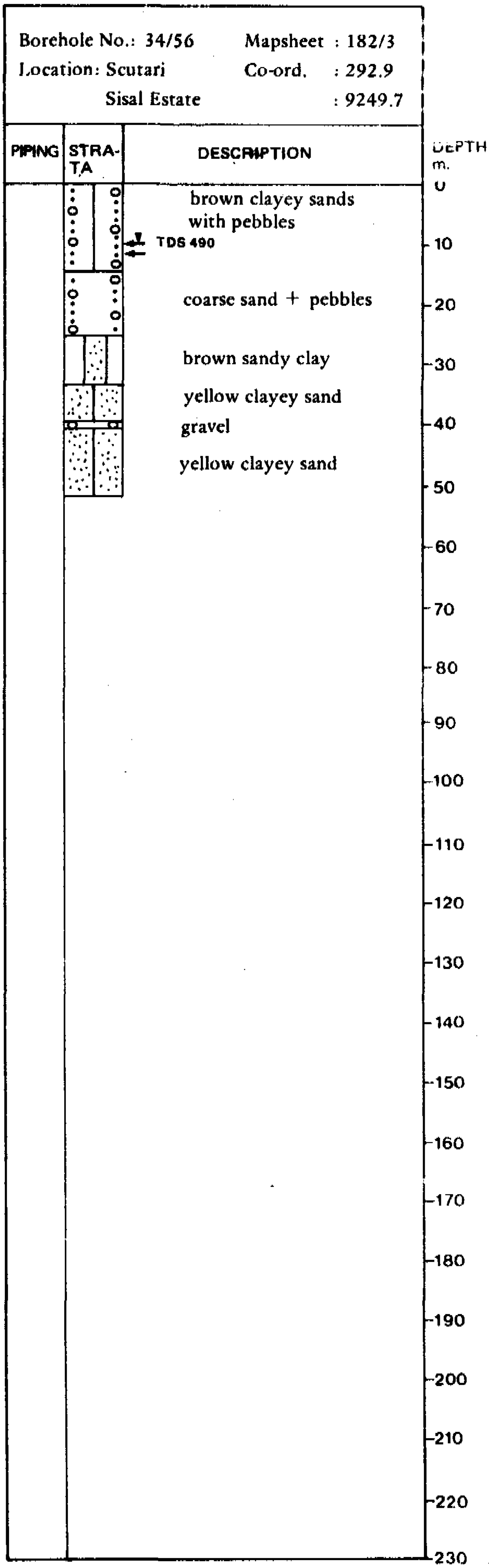

Borehole No.: 43/54
Mapsheet : 165/4
Location: Wami Prison
Co-ord. : 329.8
: 9292.8
DEPTH m.
PIPING
STRA-TA
DESCRIPTION
clayey sand
sand with some clay
medium clayey sand
coarse clayey sand
gneiss
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

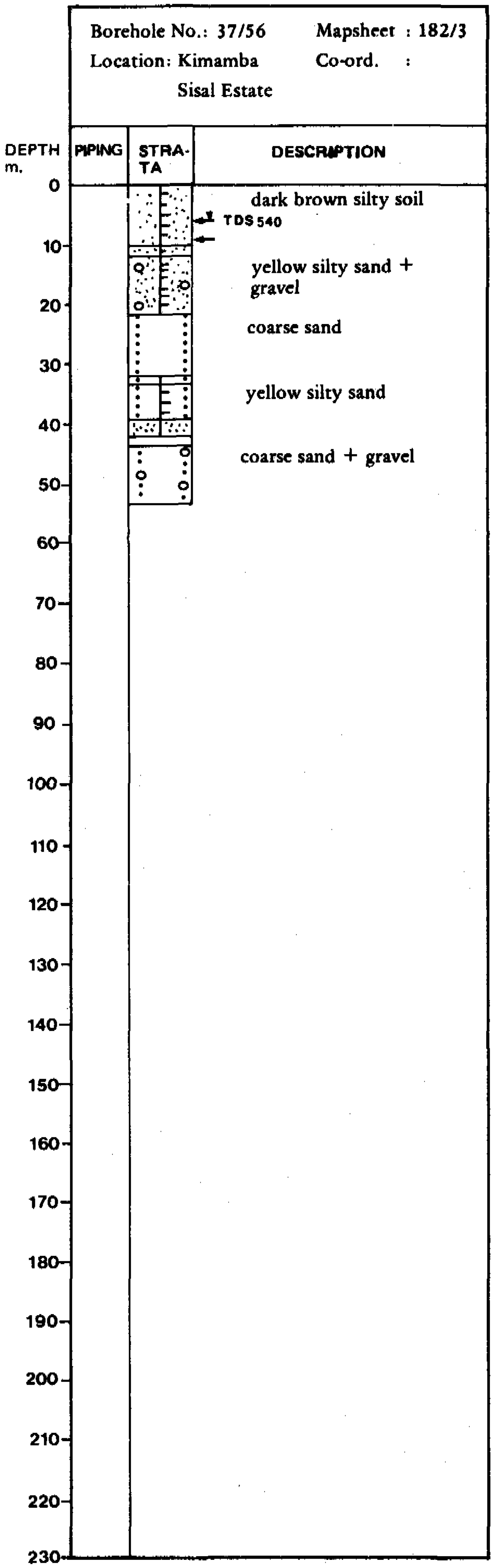

Borehole No.: 2/56
Mapsheet : 184/3
Location: Kidugallo Prison
Co-ord. :
PIPING
STRA-TA
DESCRIPTION
DEPTH m.
sandy clay
white limestone + mads
calcareous sandstone fine grained
TDS 635
coarse grained sandstone
fine grained sandstones
coarse grained sandstone
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230


Borehole No.: 19/56
Mapsheet : 182/3
Location: Antonion
Sisal Estate
Co-ord. : 295.6
: 9249.9
DEPTH m.
PIPING
STRA-TA
DESCRIPTION
brown clayey sand
TDS 720
pebbles + sand
clayey coarse sands + pebbles
coarse sand
medium sand
yellow claye sand
brown clayey sand
white coarse sand + pebbles
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

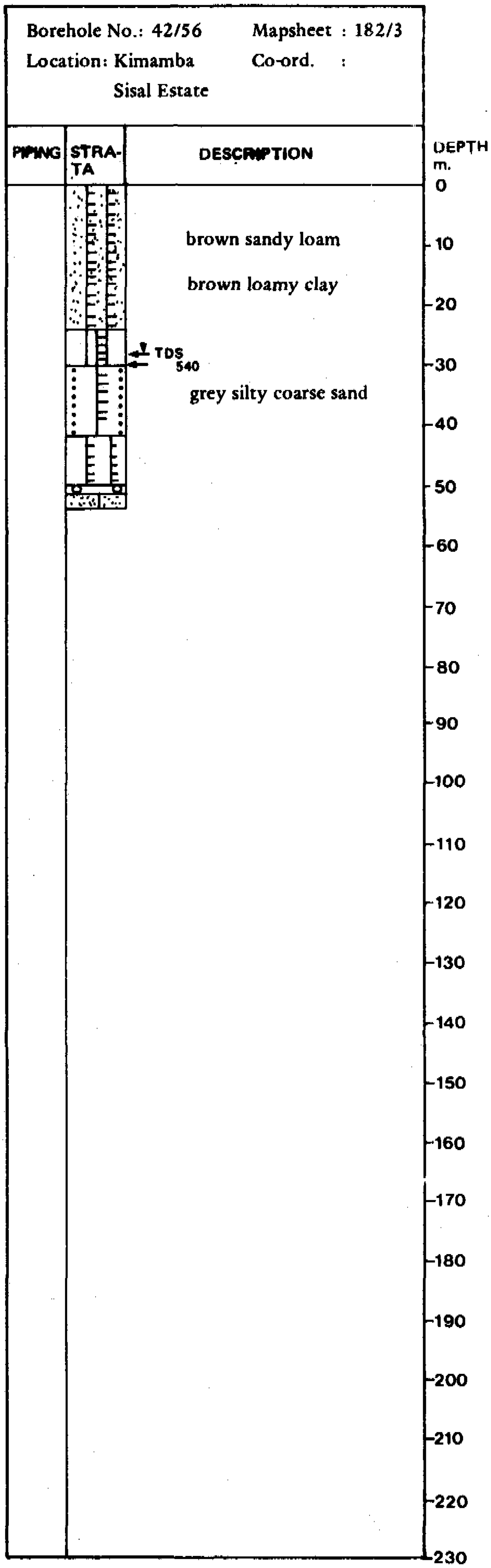

Borehole No.: 21/56
Mapsheet : 183/1
Location: Kihonda
Sisal Estate
Co-ord. : 350.7
: 9255.6
PIPING
STRA-TA
DESCRIPTION
DEPTH m
orange/red clayey loam
strongly wheathered gneiss
gneiss
TDS 128
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230


Borehole No.: 23/56
Mapsheet : 182/3
Location: Kinamba Town
Co-ord. : 294.7
: 9250.0
DEPTH m.
PIPING
STRA-TA
DESCRIPTION
brown sandy soil with pebbles
TDS 1160
sand + pebbles
yellow clayey sand
dark sandy clay
grey clayey sand
clean sand + pebbles
yellow clayey sand
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230


Borehole No.: 34/56
Mapsheet : 182/3
Location: Scutari Sisal Estate
Co-ord. : 292.9
: 9249.7
PIPING
STRA-TA
DESCRIPTION
DEPTH m.
brown clayey sands with pebbles
TDS 490
coarse sand + pebbles
brown sandy clay
yellow clayey sand
gravel
yellow clayey sand
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

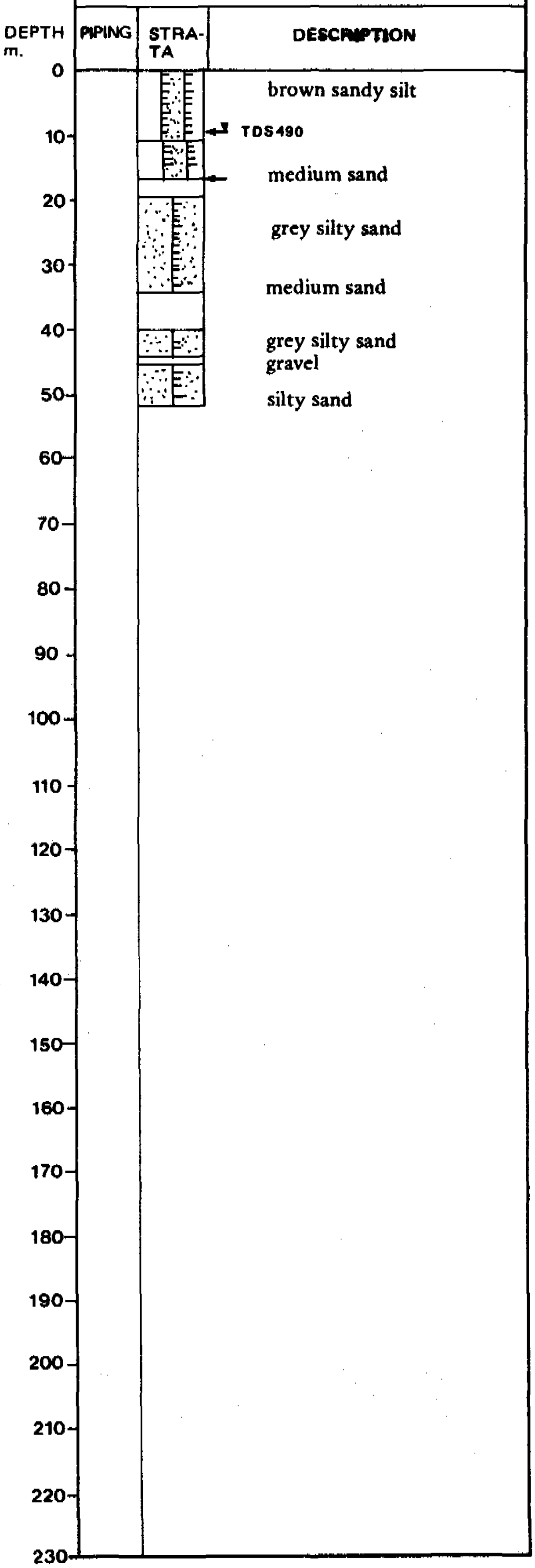


Borehole No.: 37/56
Mapsheet : 182/3
Location: Kimamba Sisal Estate
Co-ord. :
DEPTH m.
PIPING
STRATA
DESCRIPTION
dark brown silty soil
TDS 540
yellow silty sand + gravel
coarse sand
yellow silty sand
coarse sand + gravel
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

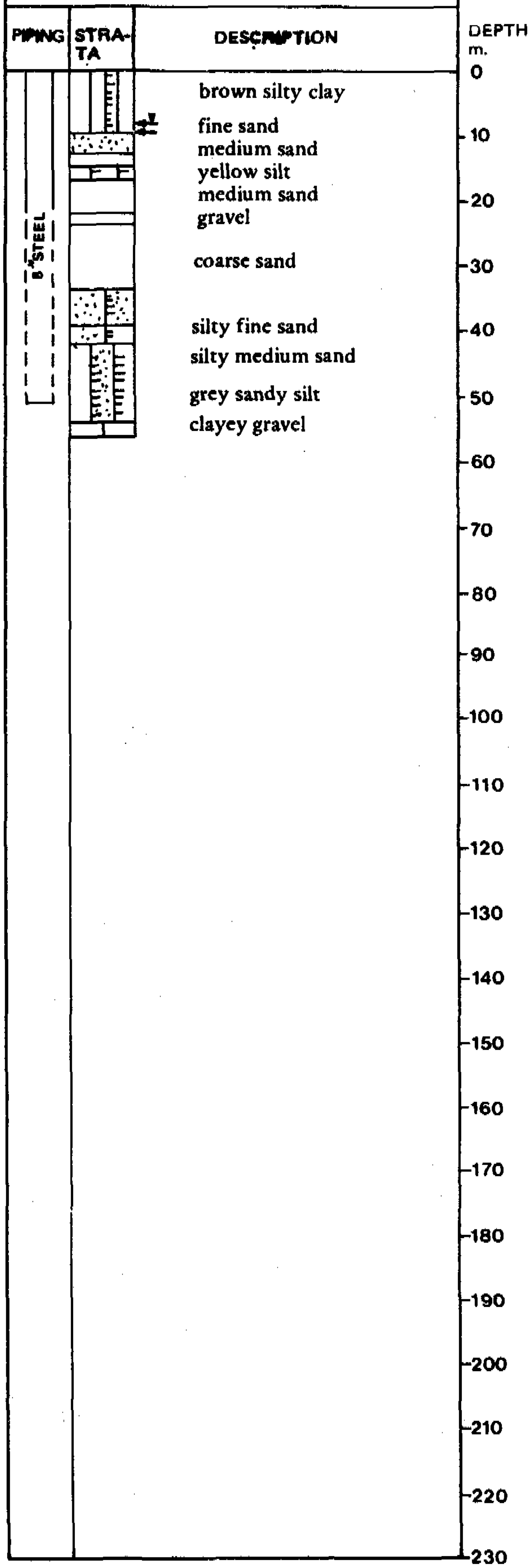


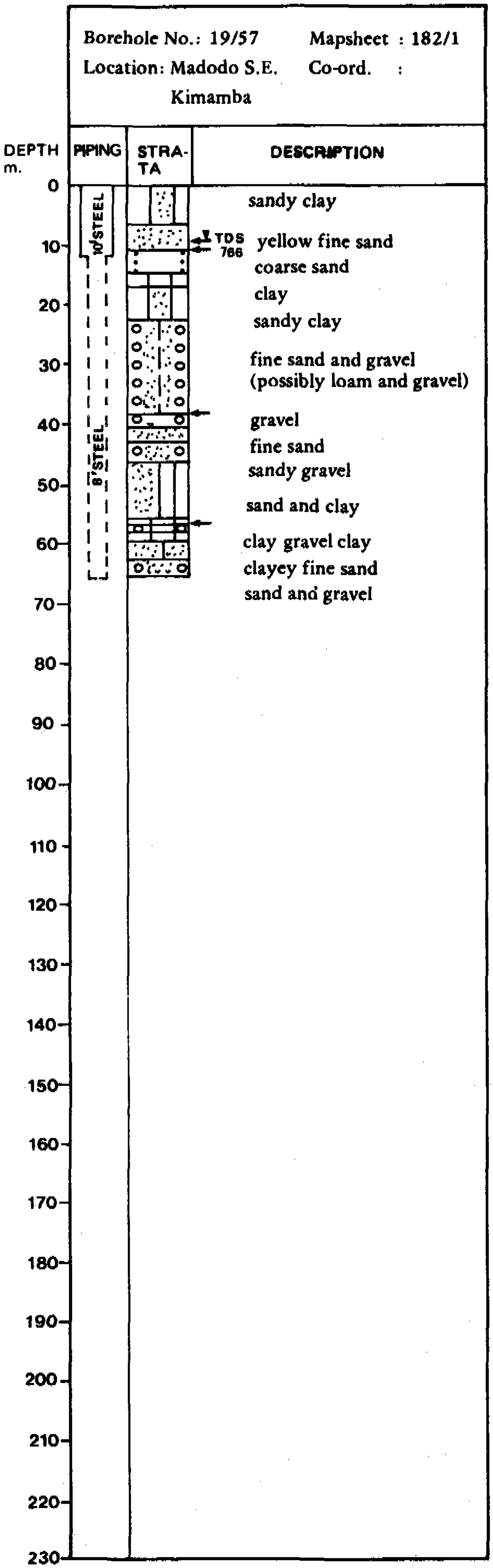
Borehole No.: 42/56
Mapsheet : 182/3
Location: Kimamba Sisal Estate
Co-ord. :
PIPING
STRATA
DESCRIPTION
DEPTH m.
brown sandy loam
brown loamy clay
TDS 540
grey silty coarse sand
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

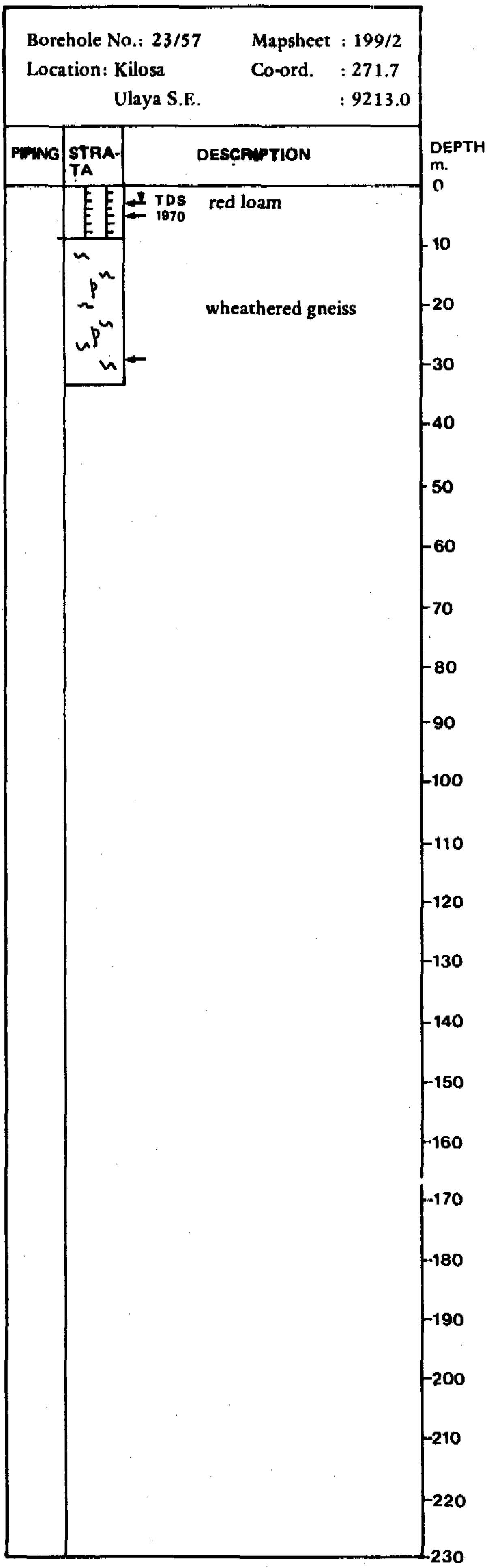
Borehole No.: 2/57 Mapsheet : 182/3
Location: Kimamba Co-ord. : 293.2
Scutari S.E. : 9250.0

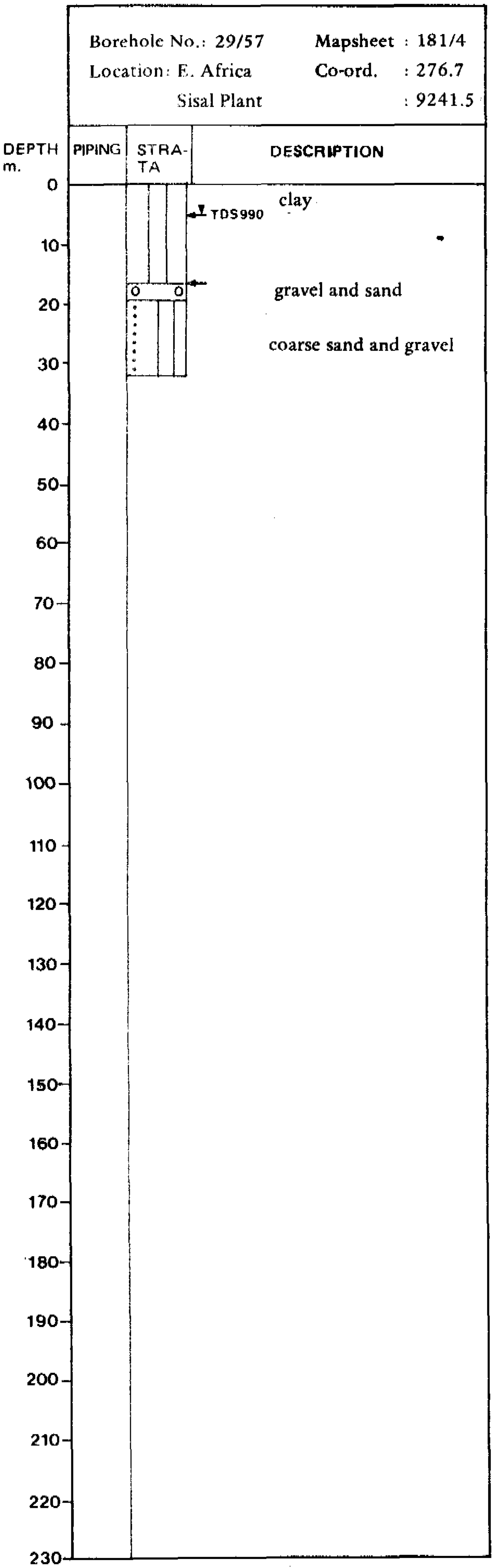


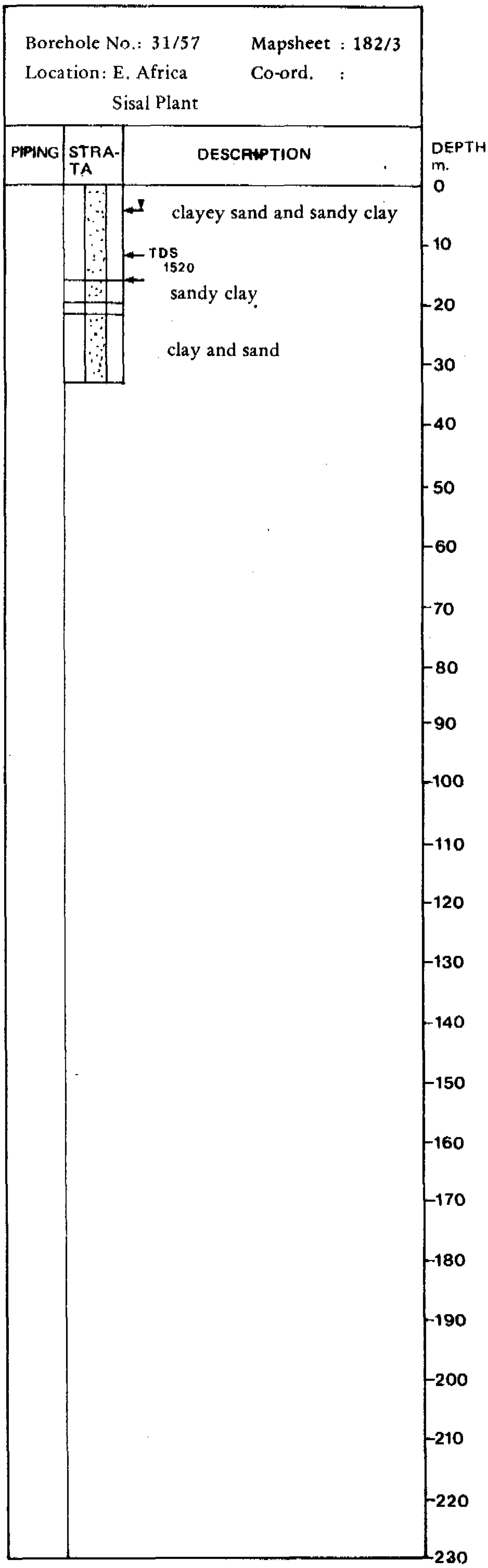
Borehole No.: 10/57 Mapsheet : 182/3
Location: Kinamba Co-ord. :
Antonion S.E.



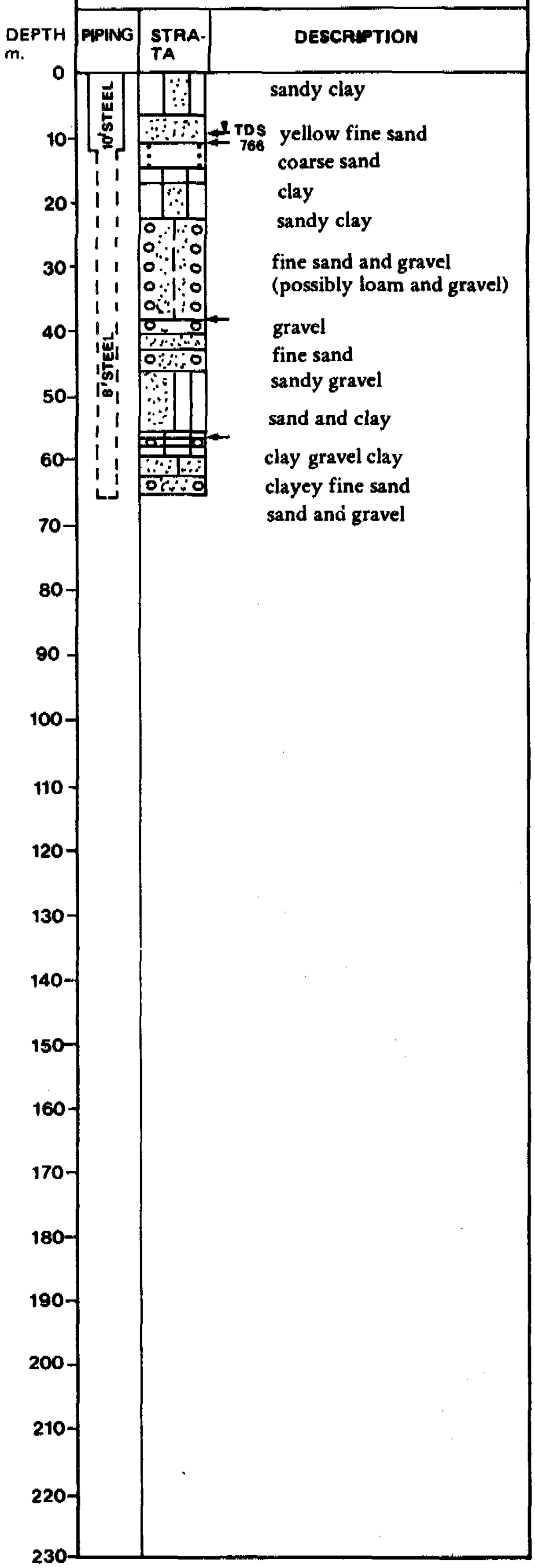

Borehole No.: 19/57
Mapsheet : 182/1
Location: Madodo S.E. Kimamba
Co-ord. :
DEPTH m.
PIPING
STRA-TA
DESCRIPTION
10"STEEL
8"STEEL
TDS 766
sandy clay
yellow fine sand
coarse sand
clay
sandy clay
fine sand and gravel (possibly loam and gravel)
gravel
fine sand
sandy gravel
sand and clay
clay gravel clay
clayey fine sand
sand and gravel


Borehole No.: 23/57
Mapsheet : 199/2
Location: Kilosa Ulaya S.E.
Co-ord. : 271.7 : 9213.0
PIPING
STRA-TA
DESCRIPTION
DEPTH m.
TDS 1970
red loam
wheathered gneiss

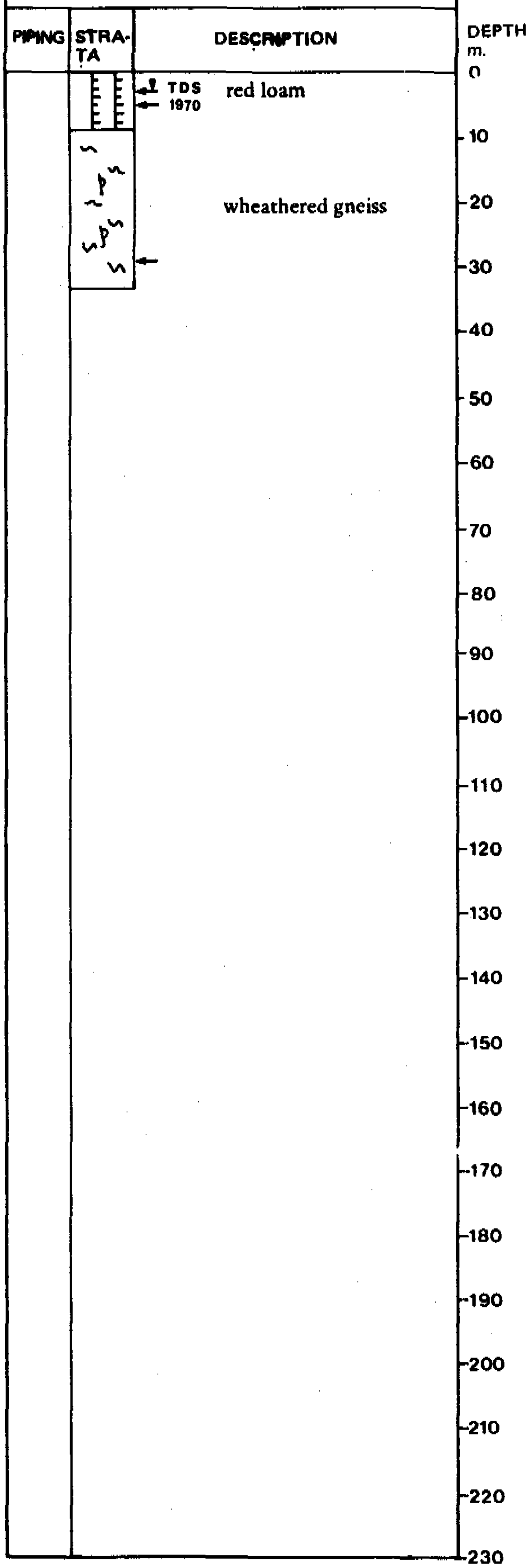

Borehole No.: 29/57
Mapsheet : 181/4
Location: E. Africa
Sisal Plant
Co-ord. : 276.7
: 9241.5
DEPTH m.
PIPING
STRA-TA
DESCRIPTION
TDS990
clay
gravel and sand
coarse sand and gravel
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

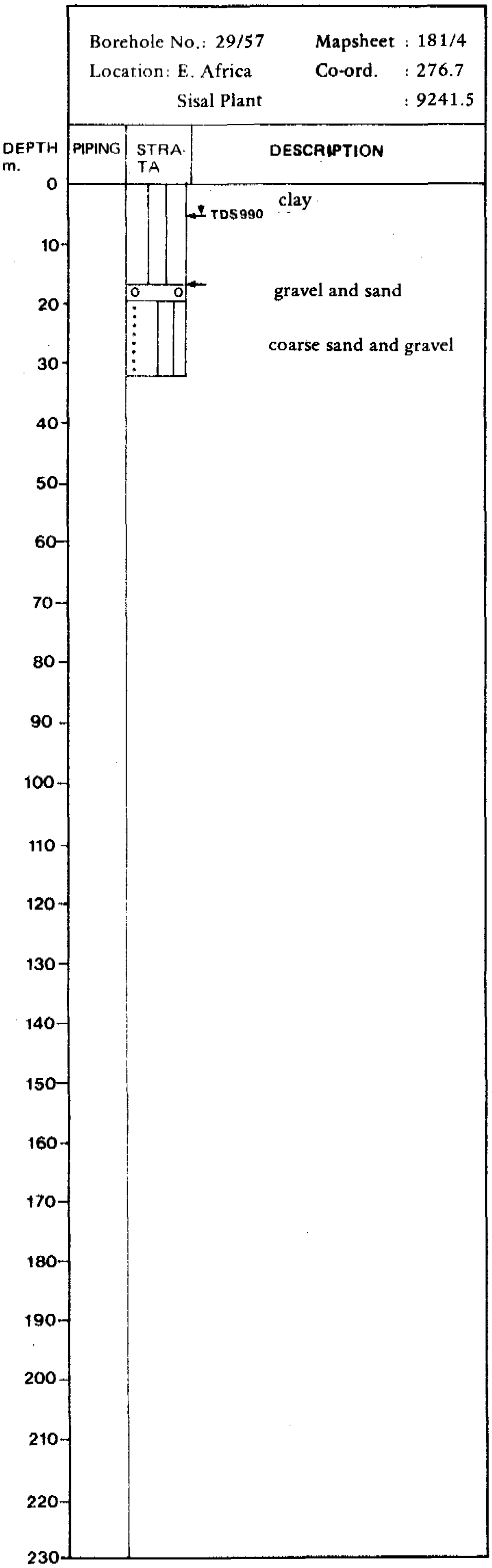

Borehole No.: 31/57
Mapsheet : 182/3
Location: E. Africa
Sisal Plant
Co-ord. :
PIPING
STRA-TA
DESCRIPTION
DEPTH m.
clayey sand and sandy clay
TDS 1520
sandy clay
clay and sand
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

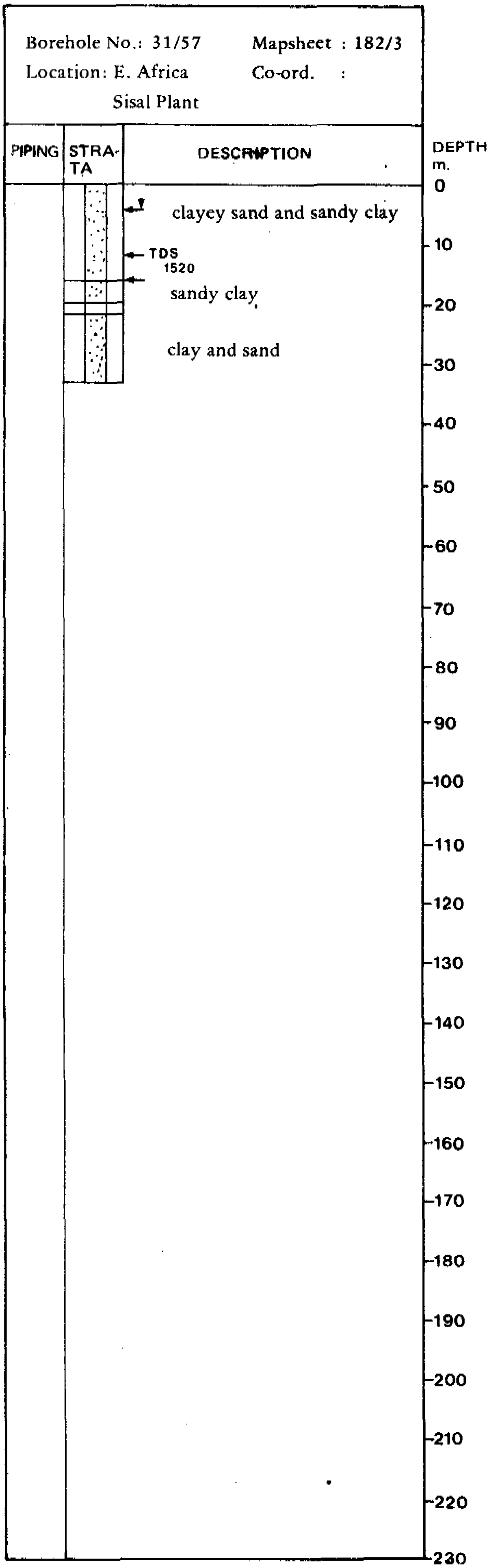
Borehole No.: 19/57 Mapsheet : 182/1
Location: Madodo S.E. Co-ord. :
Kimamba

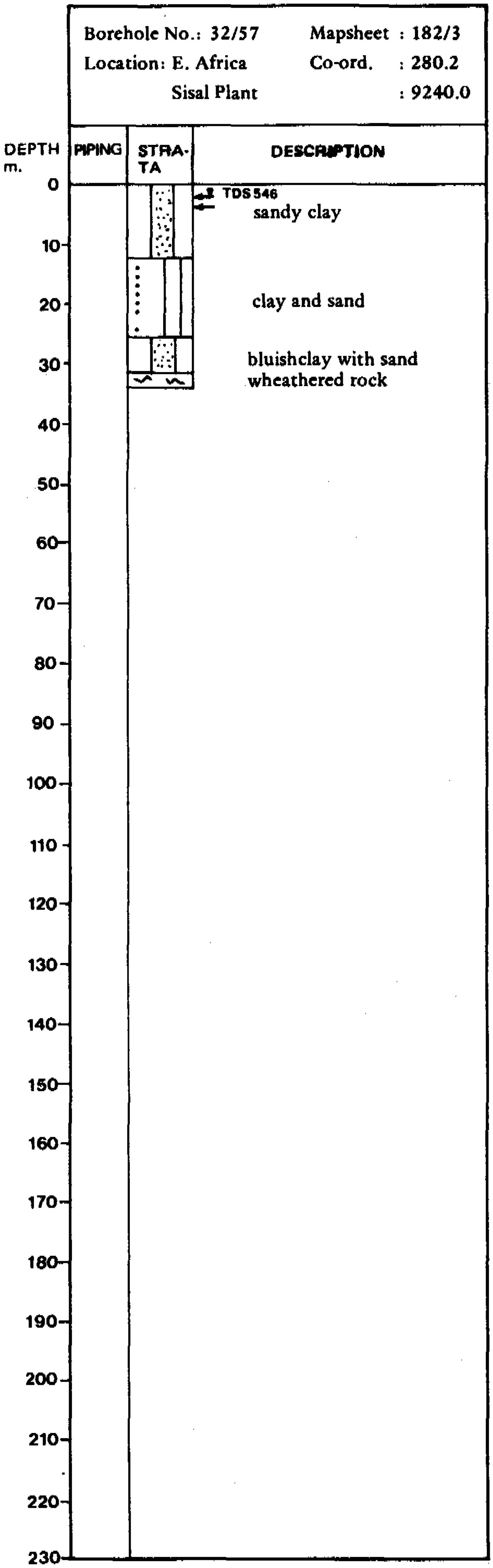


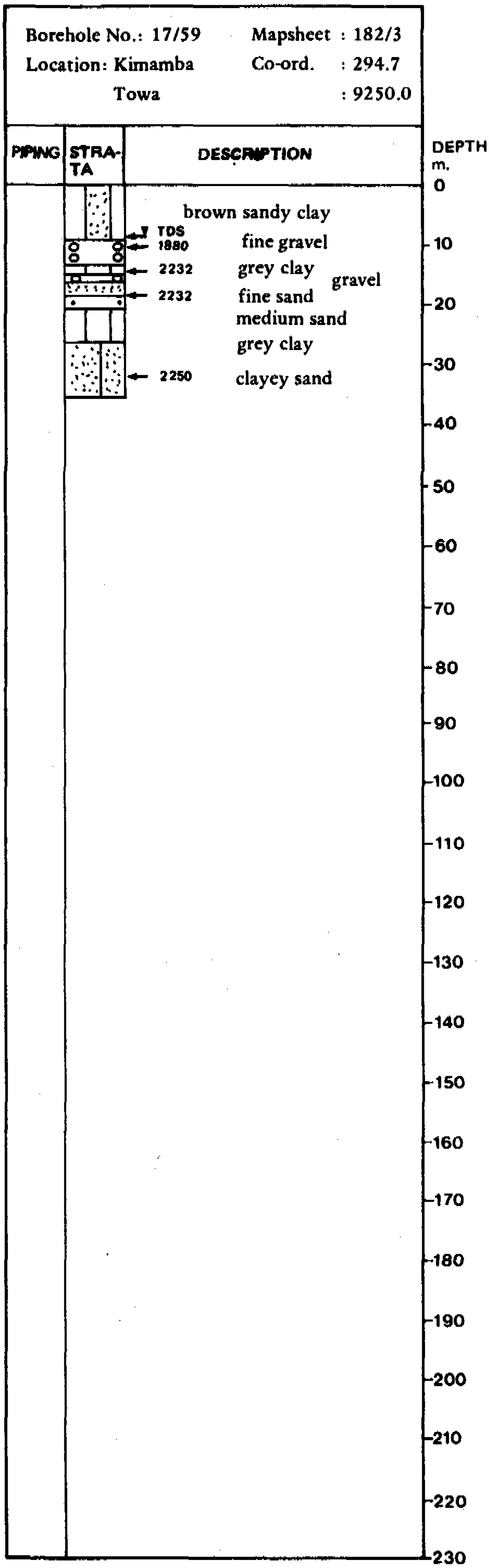
Borehole No.: 23/57 Mapsheet : 199/2
Location: Kilosa Co-ord. : 271.7
Ulaya S.E. : 9213.0

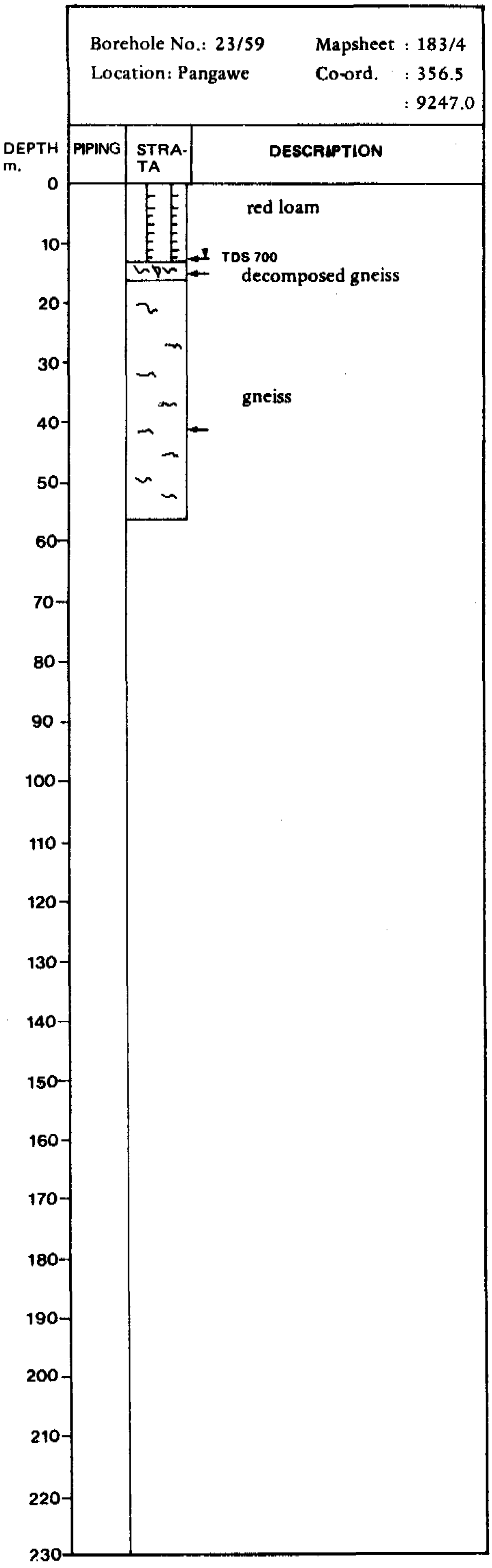


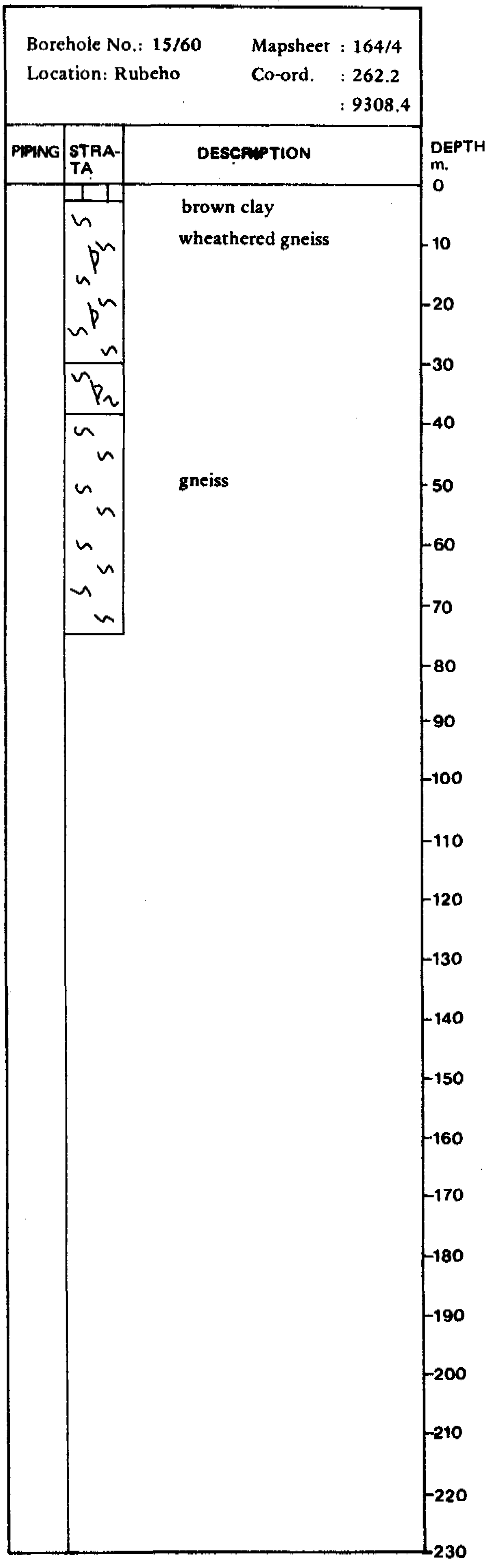

Borehole No.: 29/57
Mapsheet : 181/4
Location: E. Africa
Co-ord. : 276.7
Sisal Plant
: 9241.5
DEPTH m.
PIPING
STRATA
DESCRIPTION
TDS990
clay
gravel and sand
coarse sand and gravel
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230


Borehole No.: 31/57
Mapsheet : 182/3
Location: E. Africa
Co-ord. :
Sisal Plant
PIPING
STRATA
DESCRIPTION
DEPTH m.
clayey sand and sandy clay
TDS 1520
sandy clay
clay and sand
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230


Borehole No.: 32/57
Mapsheet : 182/3
Location: E. Africa
Sisal Plant
Co-ord. : 280.2
: 9240.0
DEPTH m.
PIPING
STRATA
DESCRIPTION
TDS 546
sandy clay
clay and sand
bluishclay with sand
wheathered rock
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

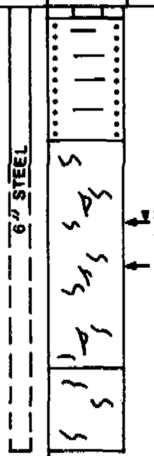

Borehole No.: 17/59
Mapsheet : 182/3
Location: Kimamba
Towa
Co-ord. : 294.7
: 9250.0
PIPING
STRATA
DESCRIPTION
DEPTH m.
brown sandy clay
TDS 1880
fine gravel
2232
grey clay
gravel
2232
fine sand
medium sand
grey clay
2250
clayey sand
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230


Borehole No.: 23/59
Location: Pangawe
Mapsheet : 183/4
Co-ord. : 356.5
: 9247.0
DEPTH m.
PIPING
STRA-TA
DESCRIPTION
red loam
TDS 700
decomposed gneiss
gneiss
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230


Borehole No.: 15/60
Location: Rubeho
Mapsheet : 164/4
Co-ord. : 262.2
: 9308.4
PIPING
STRA-TA
DESCRIPTION
DEPTH m.
brown clay
wheathered gneiss
gneiss
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

Borehole No.: 16/60 Mapsheet : 164/2
Location: Meshugi Co-ord. :

DEPTH m.	PIPING	STRATA	DESCRIPTION
0			black clay
10			unsorted subrounded sand with thin black clay layers
20			
30			saline water; slightly decomposed gneiss
40			
50			gneiss
60			
70			
80			
90			
100			
110			
120			
130			
140			
150			
160			
170			
180			
190			
200			
210			
220			
230			

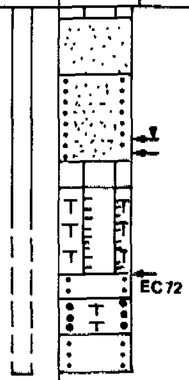


Borehole : Mapsheet :
Location: Co-ord. :

PIPING	STRATA	DESCRIPTION	DEPTH m.
			0
			10
			20
			30
			40
			50
			60
			70
			80
			90
			100
			110
			120
			130
			140
			150
			160
			170
			180
			190
			200
			210
			220
			230

Borehole No.: 17/60 Mapsheet : 165/4
Location: Magole Co-ord. : 319.5
: 9295.5

DEPTH m.	PIPING	STRATA	DESCRIPTION
0			brown clay
			very fine brown sand
10			fine-medium sand
20			yellow clay
30			red loam with calcrete horizons
40		EC 72	medium sand
			coarse sand with calcrete
50			medium sand



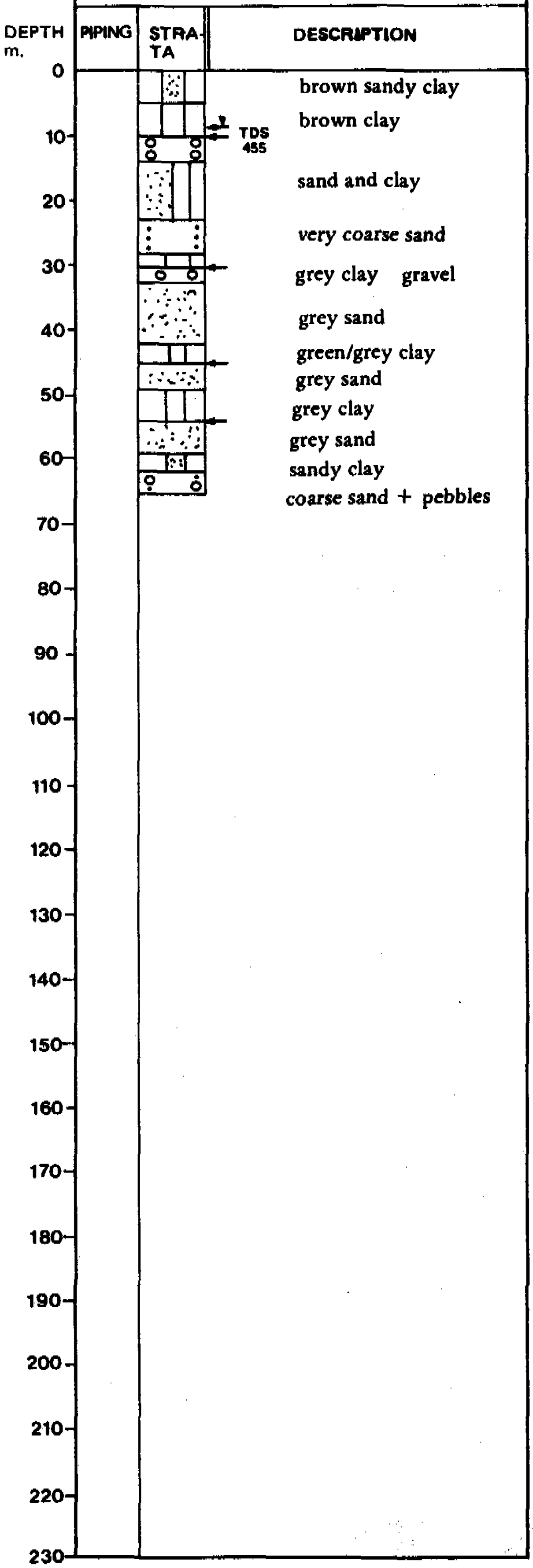
Depth scale (m): 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230

Borehole : Mapsheet :
Location: Co-ord. :

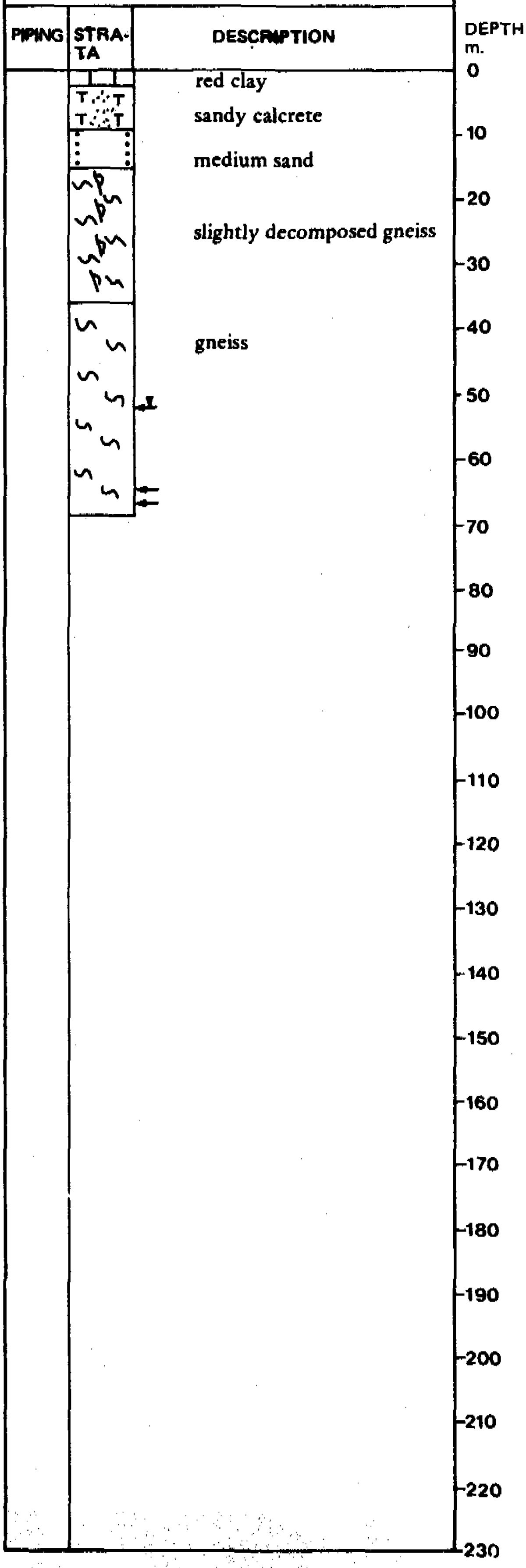
PIPING	STRATA	DESCRIPTION	DEPTH m
			0

Depth scale (m): 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230

Borehole No.: 31/60 Mapsheet : 182/3
Location: Kinamba town Co-ord. : 295.0
: 9249.9

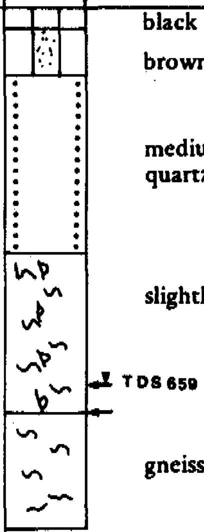


Borehole No.: 3460 Mapsheet : 164/4
Location: Rubeho Co-ord. : 261.2
: 9306.6



Borehole No.: 37/60 Mapsheet : 164/4
Location: Kisitwe Co-ord. : 264.3
: 9302.4

DEPTH m.	PIPING	STRATA	DESCRIPTION
			black clay
			brown sandy clay
			medium-coarse quartz sand
			slightly decomposed gneiss
			gneiss



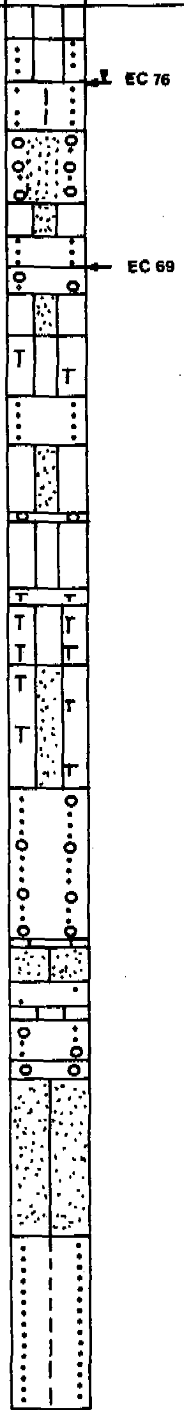
DEPTH m.: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230

Borehole : Mapsheet :
Location: Co-ord. :

PIPING	STRATA	DESCRIPTION	DEPTH m.
			0
			10
			20
			30
			40
			50
			60
			70
			80
			90
			100
			110
			120
			130
			140
			150
			160
			170
			180
			190
			200
			210
			220
			230

Borehole No.: 23/61 Mapsheet : 182/3
Location: Kinamba Co-ord. : 295.1
: 9249.8

DEPTH m.	PIPING	STRATA	DESCRIPTION



DEPTH m.: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230

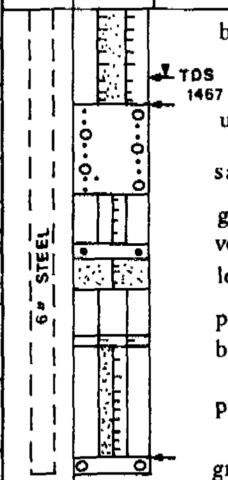
Borehole : Mapsheet :
Location: Co-ord. :

PIPING	STRATA	DESCRIPTION	DEPTH m.

DEPTH m.: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230

Borehole No.: 30/61 Mapsheet : 182/3
Location: Scutari S.E. Co-ord. : 293.2
Kinamba : 9249.9

DEPTH m.	PIPING	STRATA	DESCRIPTION
0			brown sandy loam
10			unsorted fine-coarse sand with gravel
20			
30			grey loamy clay
			very coarse sand
			loamy fine sand
40			pale grey clay
			brown loam
50			pale grey loamy sand clay
60			gravel
70			
80			
90			
100			
110			
120			
130			
140			
150			
160			
170			
180			
190			
200			
210			
220			
230			



Borehole :
Mapsheet :
Location:
Co-ord. :

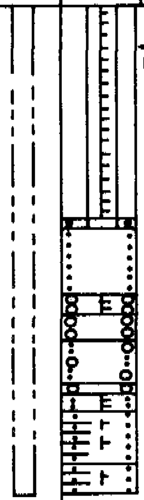
PIPING	STRATA	DESCRIPTION	DEPTH m.
			0
			10
			20
			30
			40
			50
			60
			70
			80
			90
			100
			110
			120
			130
			140
			150
			160
			170
			180
			190
			200
			210
			220
			230

Borehole No.: 6/62 Mapsheet : 165/4

Location: Mwomero Co-ord. : 328.0

: 9302.8

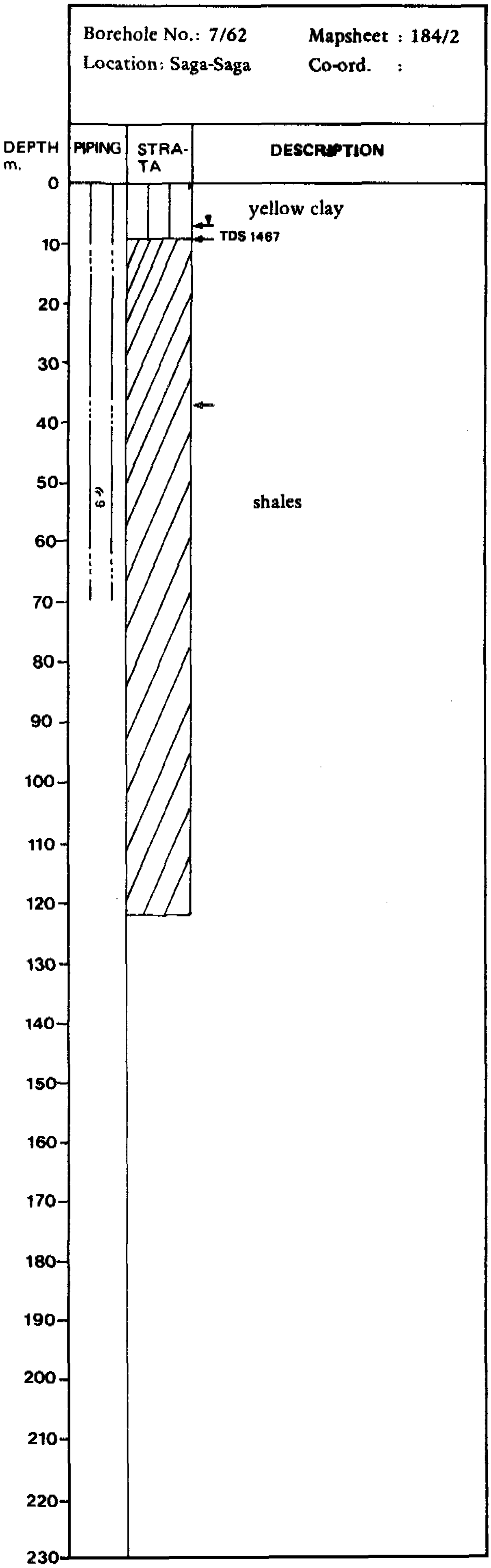
DEPTH m.	PIPING	STRATA	DESCRIPTION
0			EC 259
10			brown silty clay
20			
30			brown sandy clay
			brown sand
40			grey silty coarse sand + gravel
			rounded gravel
50			grey sand + fine gravel
			grey silty sand
60			cemented silty sand
70			
80			
90			
100			
110			
120			
130			
140			
150			
160			
170			
180			
190			
200			
210			
220			
230			

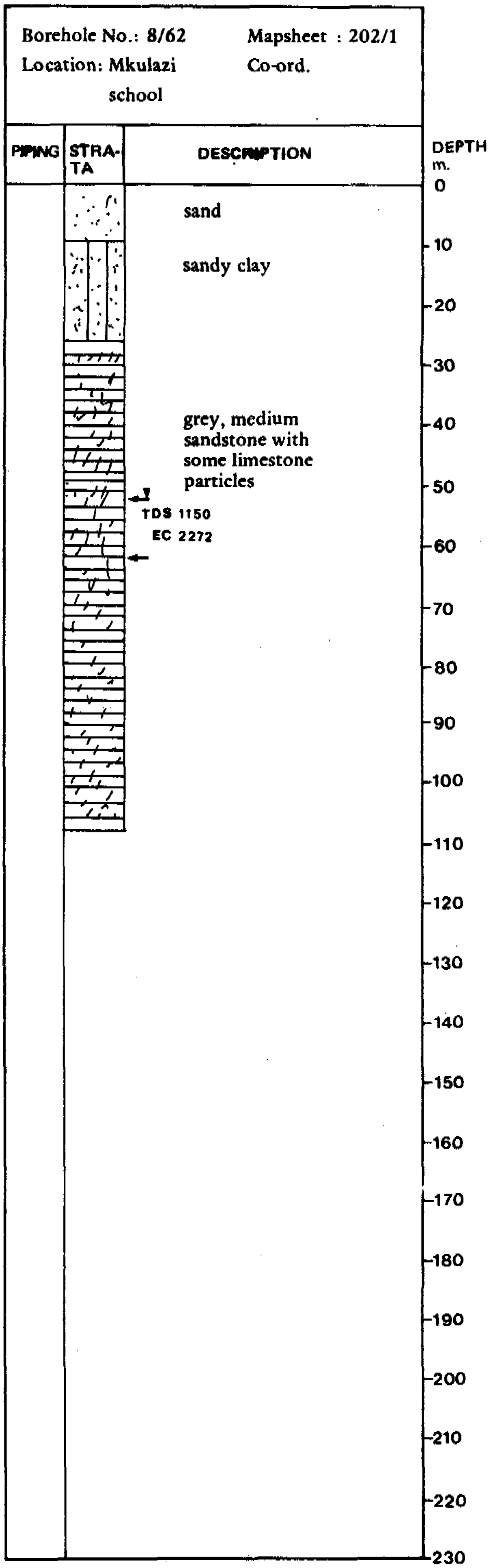


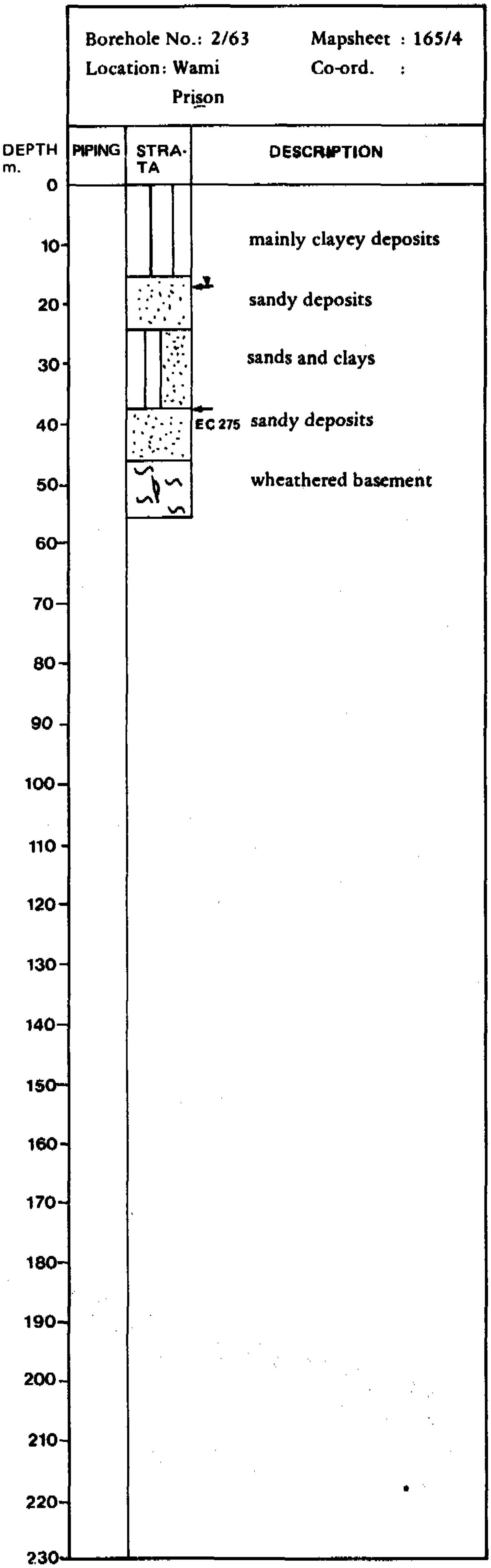
Borehole : Mapsheet :

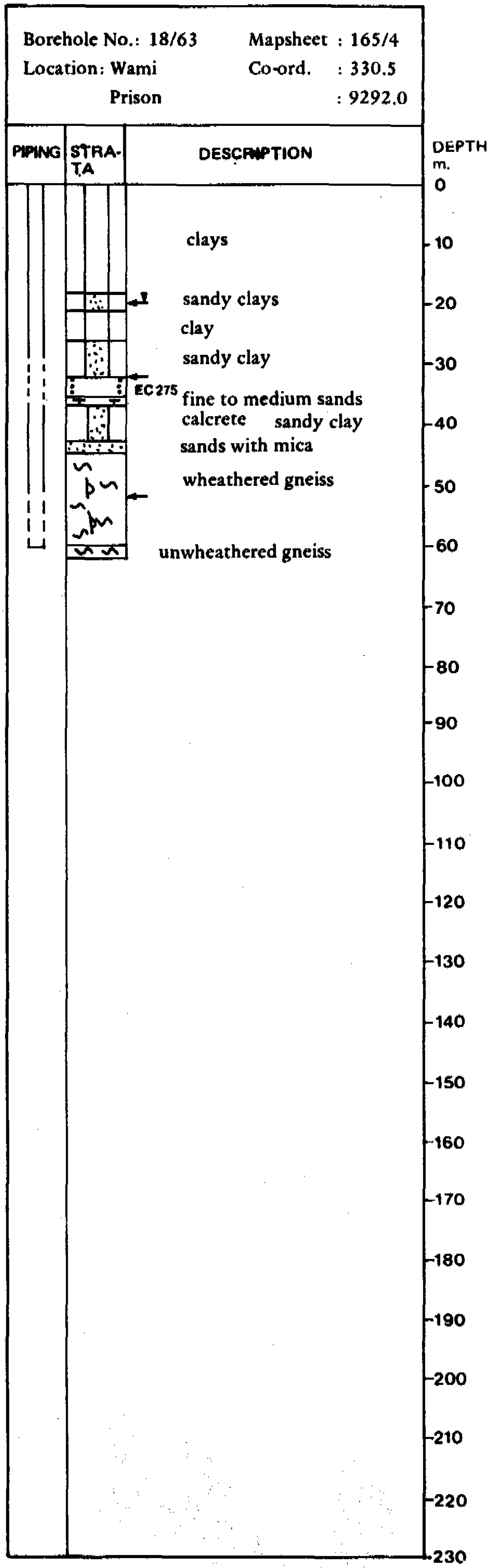
Location: Co-ord. .

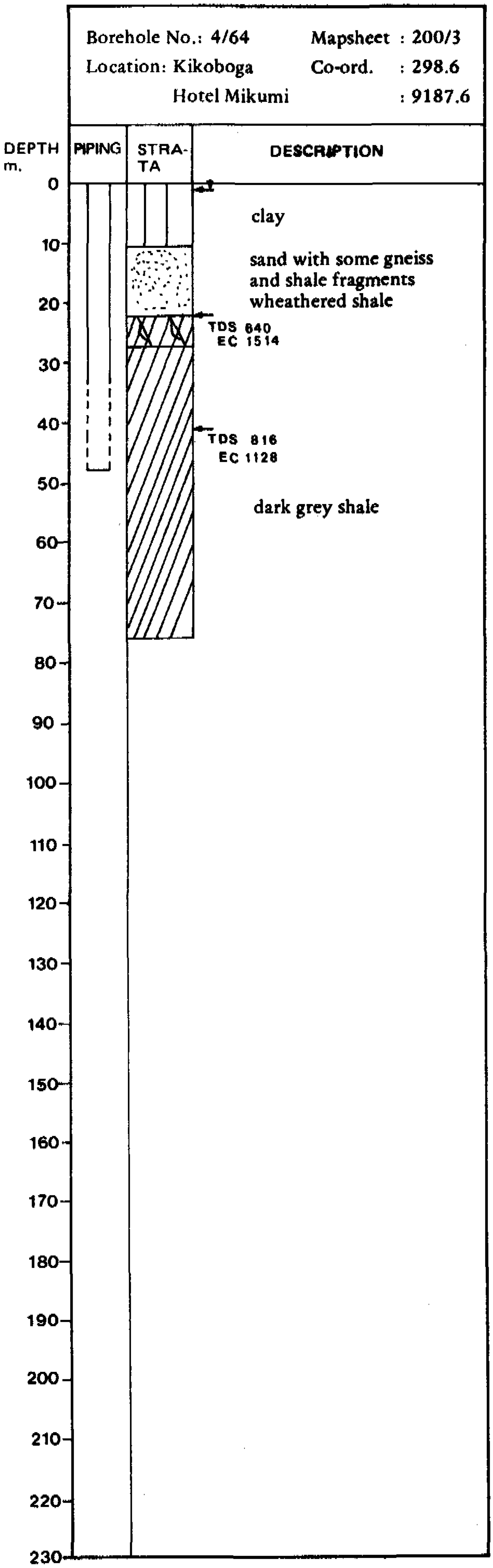
PIPING	STRATA	DESCRIPTION	DEPTH m.
			0
			10
			20
			30
			40
			50
			60
			70
			80
			90
			100
			110
			120
			130
			140
			150
			160
			170
			180
			190
			200
			210
			220
			230

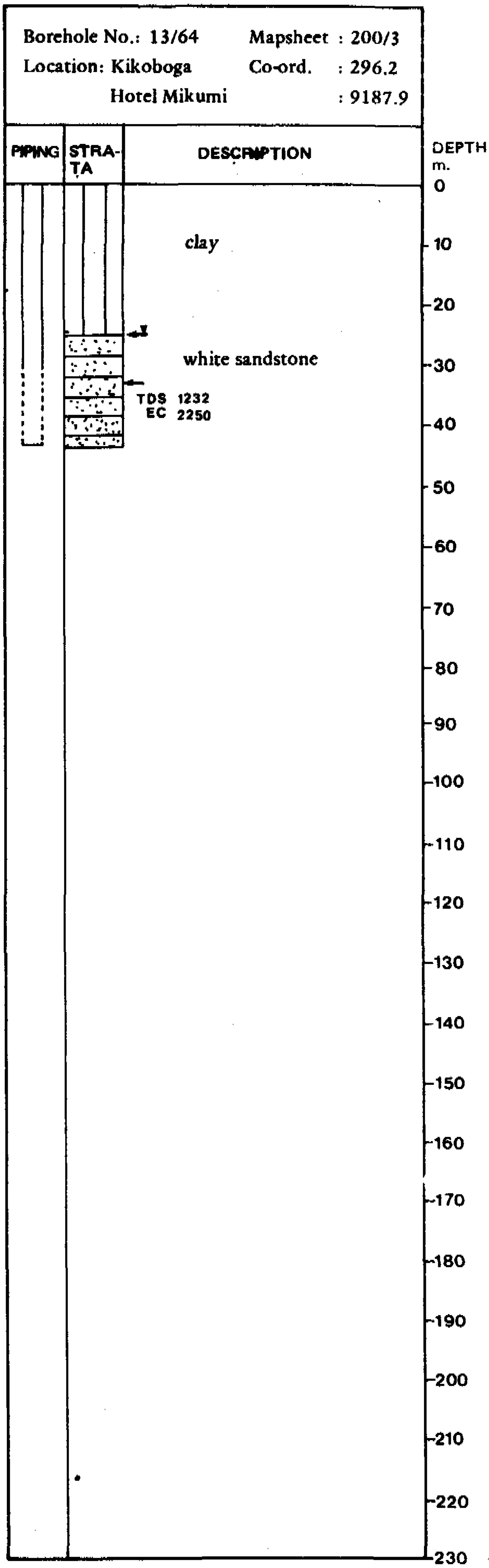

Borehole No.: 7/62
Mapsheet : 184/2
Location: Saga-Saga
Co-ord. :
DEPTH m.
PIPING
STRATA
DESCRIPTION
yellow clay
TDS 1467
shales
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

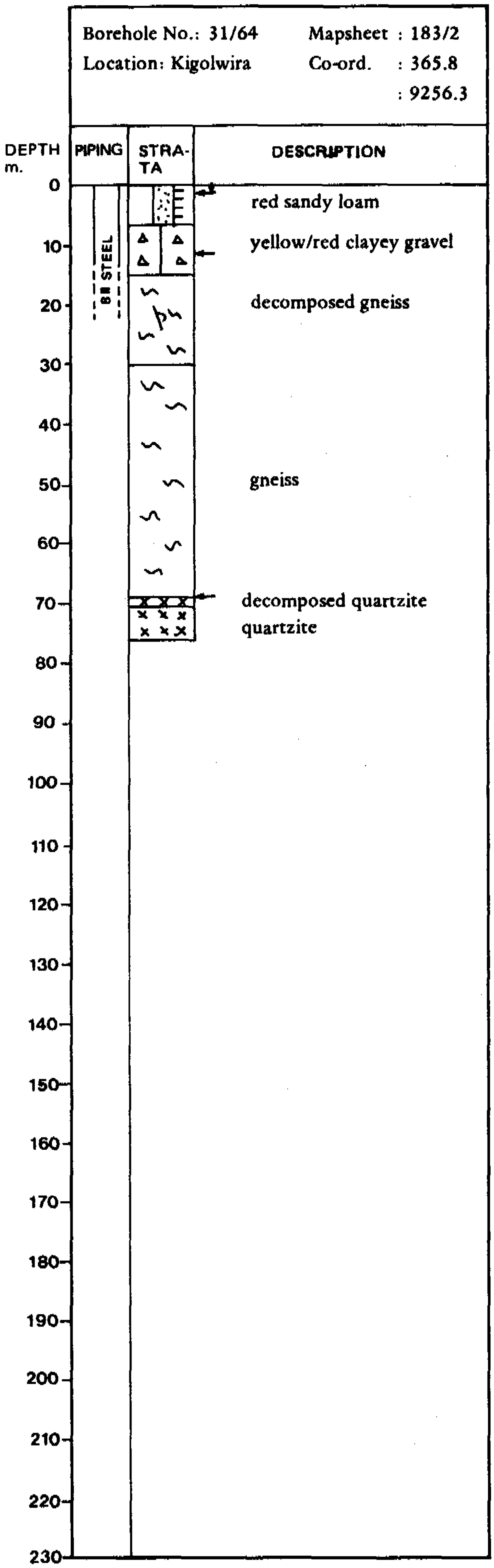

Borehole No.: 8/62
Mapsheet : 202/1
Location: Mkulazi school
Co-ord.
PIPING
STRATA
DESCRIPTION
DEPTH m.
sand
sandy clay
grey, medium sandstone with some limestone particles
TDS 1150
EC 2272
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230


Borehole No.: 2/63
Mapsheet : 165/4
Location: Wami Prison
Co-ord. :
DEPTH m.
PIPING
STRA-TA
DESCRIPTION
mainly clayey deposits
sandy deposits
sands and clays
EC 275
sandy deposits
wheathered basement
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

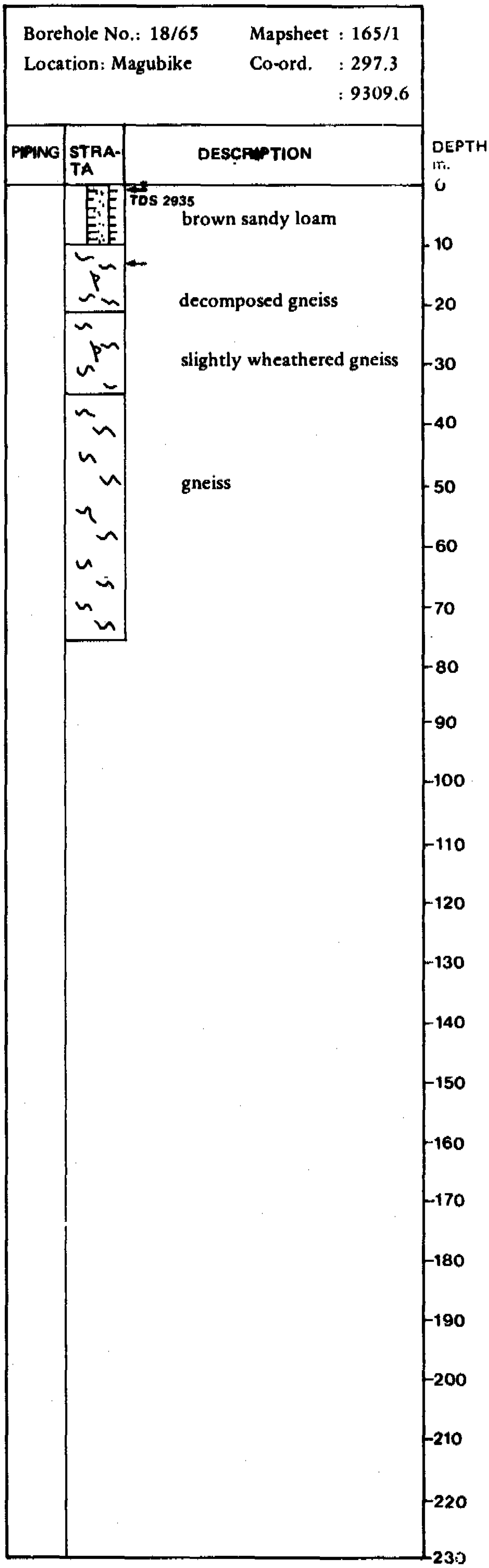

Borehole No.: 18/63
Mapsheet : 165/4
Location: Wami Prison
Co-ord. : 330.5
: 9292.0
PIPING
STRA-TA
DESCRIPTION
DEPTH m.
clays
sandy clays
clay
sandy clay
EC 275
fine to medium sands
calcrete
sandy clay
sands with mica
wheathered gneiss
unwheathered gneiss
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230


Borehole No.: 4/64
Mapsheet : 200/3
Location: Kikoboga Hotel Mikumi
Co-ord. : 298.6 : 9187.6
DEPTH m.
PIPING
STRATA
DESCRIPTION
clay
sand with some gneiss and shale fragments
wheathered shale
TDS 640 EC 1514
TDS 816 EC 1128
dark grey shale
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

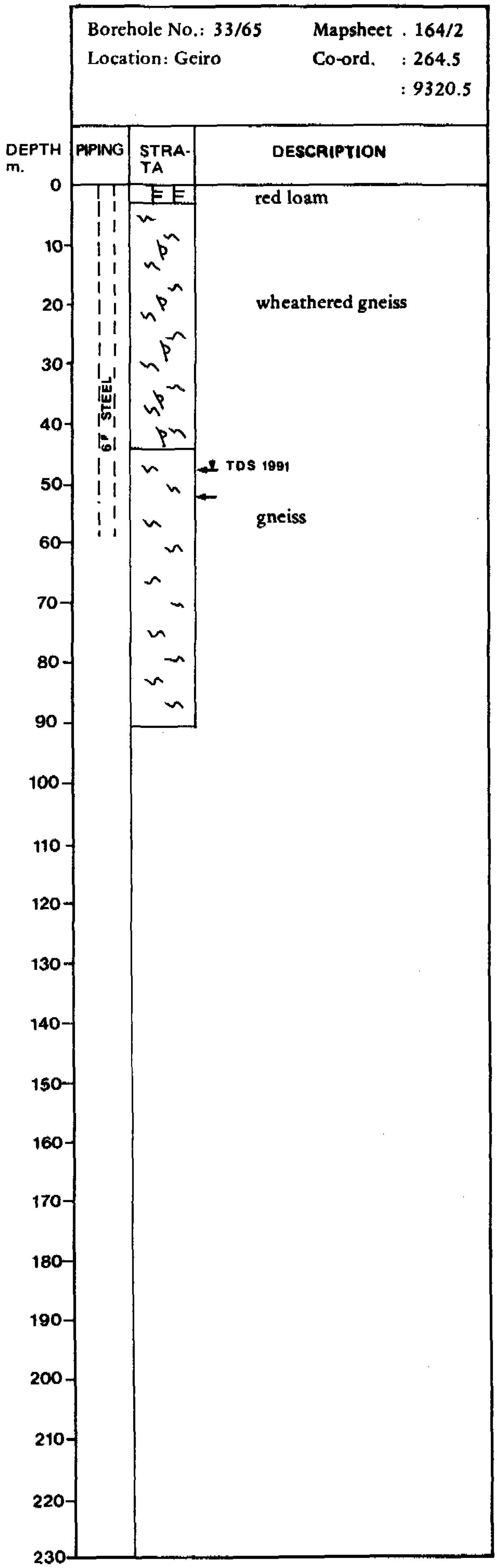

Borehole No.: 13/64
Mapsheet : 200/3
Location: Kikoboga Hotel Mikumi
Co-ord. : 296.2 : 9187.9
PIPING
STRATA
DESCRIPTION
DEPTH m.
clay
white sandstone
TDS 1232 EC 2250
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

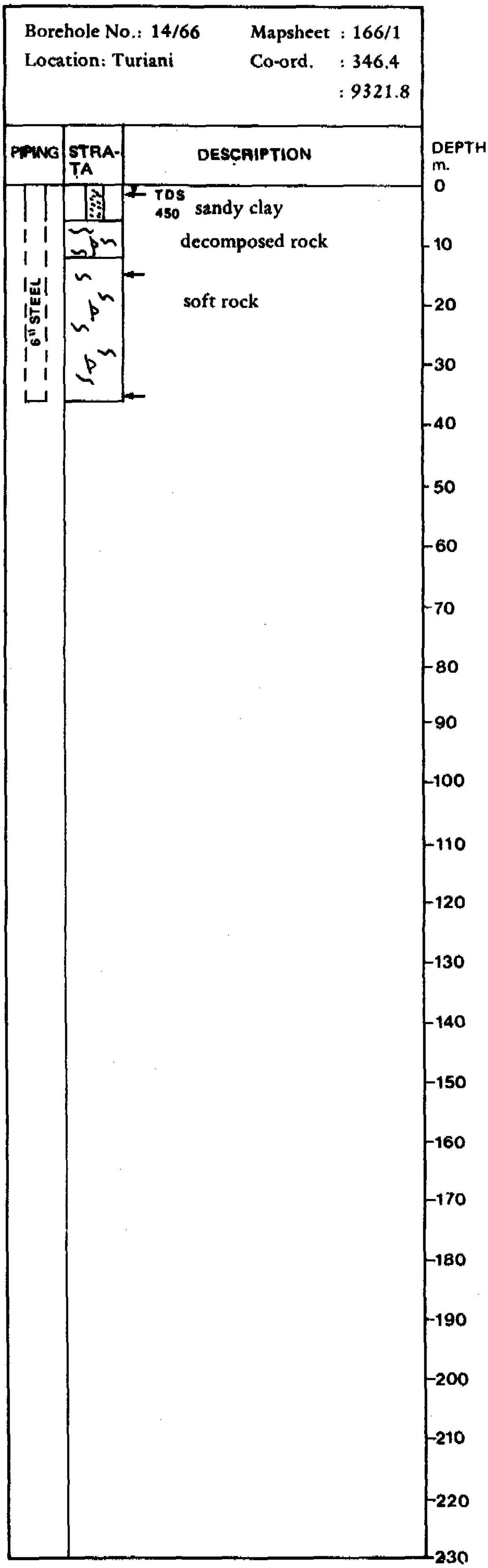


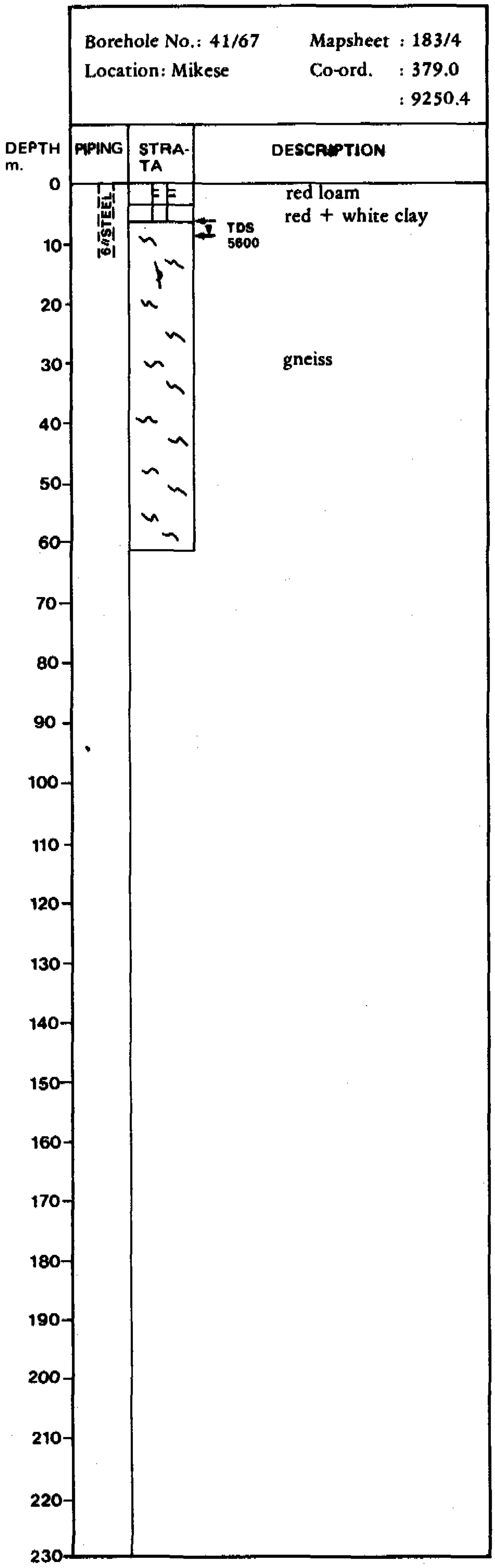
Borehole No.: 31/64
Mapsheet : 183/2
Location: Kigolwira
Co-ord. : 365.8
: 9256.3
DEPTH m.
PIPING
STRA-TA
DESCRIPTION
8" STEEL
red sandy loam
yellow/red clayey gravel
decomposed gneiss
gneiss
decomposed quartzite
quartzite
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

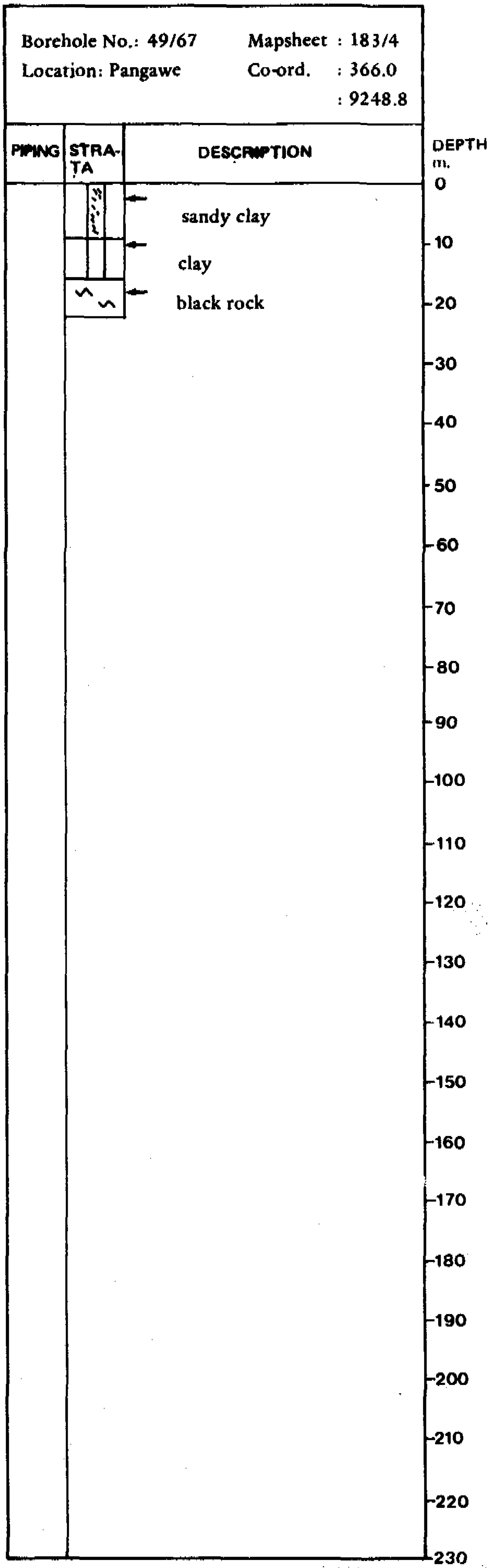


Borehole No.: 18/65
Mapsheet : 165/1
Location: Magubike
Co-ord. : 297.3
: 9309.6
PIPING
STRA-TA
DESCRIPTION
DEPTH m.
TDS 2935
brown sandy loam
decomposed gneiss
slightly wheathered gneiss
gneiss
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230


Borehole No.: 33/65
Mapsheet . 164/2
Location: Geiro
Co-ord. : 264.5
: 9320.5
DEPTH m.
PIPING
STRATA
DESCRIPTION
red loam
wheathered gneiss
6" STEEL
TDS 1991
gneiss
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230


Borehole No.: 14/66
Mapsheet : 166/1
Location: Turiani
Co-ord. : 346.4
: 9321.8
PIPING
STRATA
DESCRIPTION
DEPTH m.
TDS 450
sandy clay
decomposed rock
soft rock
6" STEEL
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230


Borehole No.: 41/67
Mapsheet : 183/4
Location: Mikese
Co-ord. : 379.0
: 9250.4
DEPTH m.
PIPING
STRATA
DESCRIPTION
6" STEEL
TDS 5600
red loam
red + white clay
gneiss
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230


Borehole No.: 49/67
Mapsheet : 183/4
Location: Pangawe
Co-ord. : 366.0
: 9248.8
PIPING
STRATA
DESCRIPTION
DEPTH m.
sandy clay
clay
black rock
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

Borehole No.: 17/68 Mapsheet : 184/3
Location: Ngerengere Co-ord. : 330.2
: 9293.3

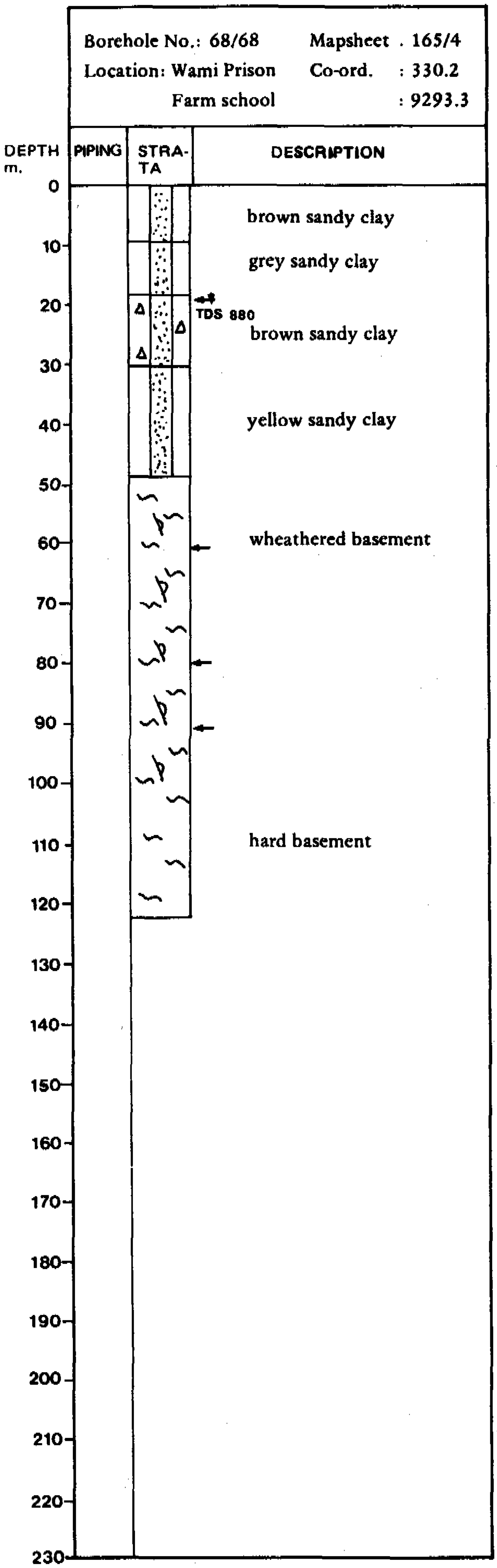
DEPTH m.	PIPING	STRATA	DESCRIPTION
0			black rock
			fine sand
10			gravel
			grey sandy clay
20			green sandy clay
			decomposed gneiss
30			
40			
			gneiss
50			
60			
70			

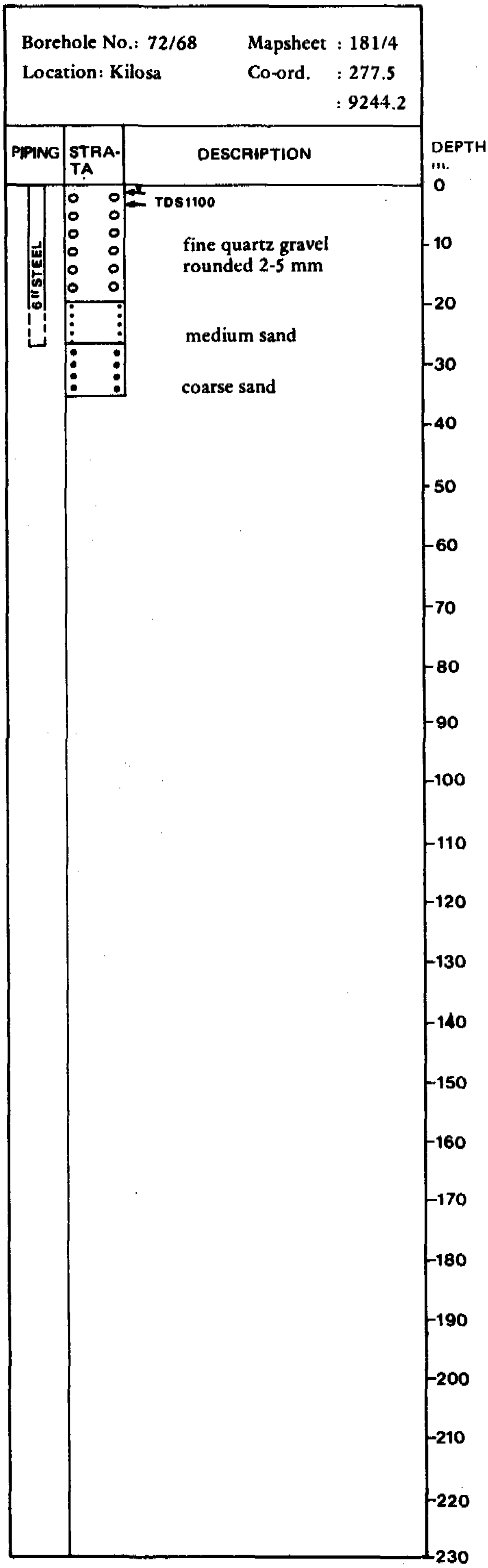
DEPTH m.: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230

Borehole : Mapsheet :
Location: Co-ord. :

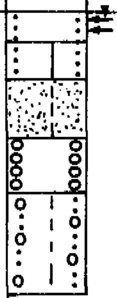
PIPING	STRATA	DESCRIPTION	DEPTH m.
			0

DEPTH m.: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230


Borehole No.: 68/68
Mapsheet . 165/4
Location: Wami Prison Farm school
Co-ord. : 330.2
: 9293.3
DEPTH m.
PIPING
STRATA
DESCRIPTION
brown sandy clay
grey sandy clay
TDS 880
brown sandy clay
yellow sandy clay
wheathered basement
hard basement
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

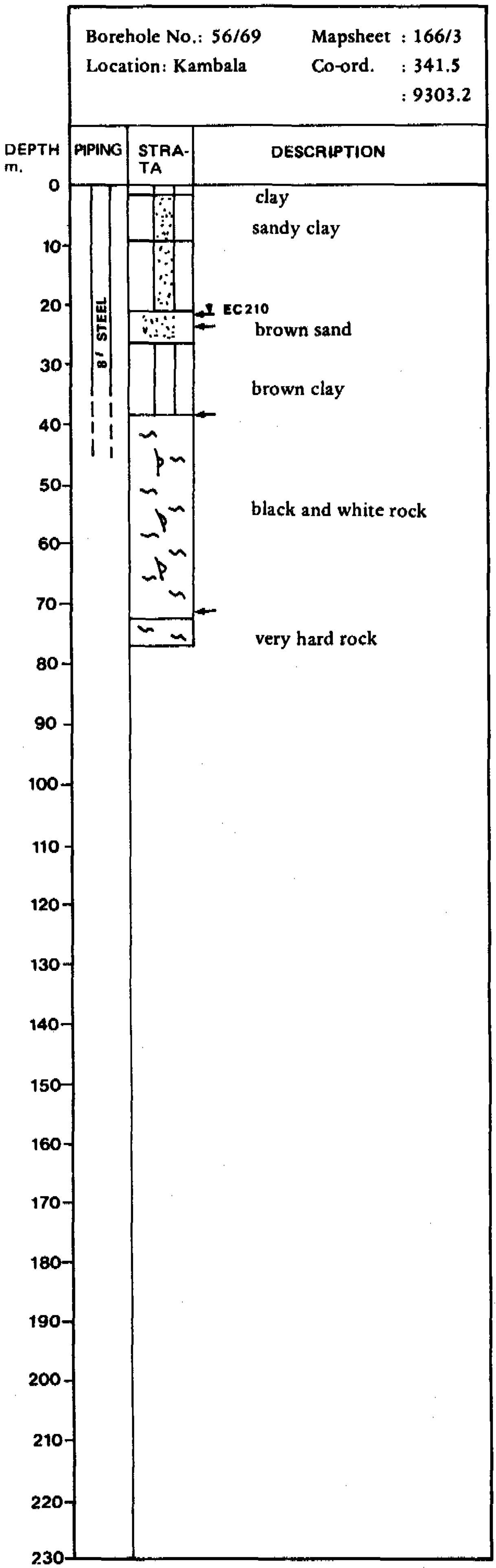

Borehole No.: 72/68
Mapsheet : 181/4
Location: Kilosa
Co-ord. : 277.5
: 9244.2
PIPING
STRATA
DESCRIPTION
DEPTH m.
6" STEEL
TDS1100
fine quartz gravel rounded 2-5 mm
medium sand
coarse sand
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

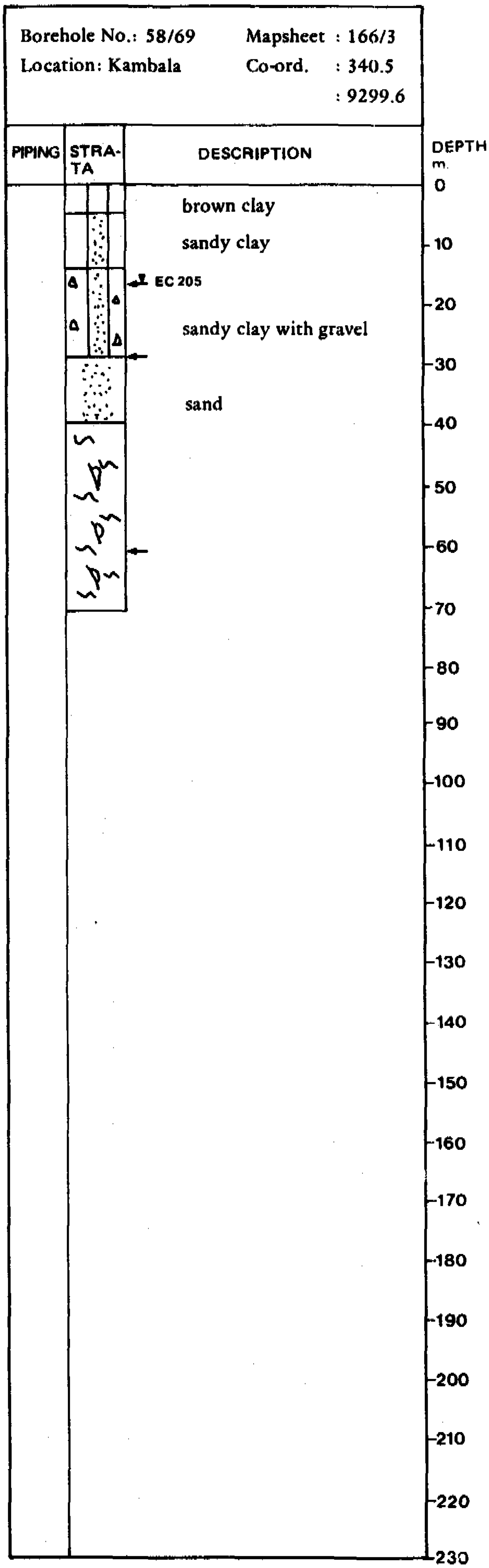
Borehole No.: 75/68	Mapsheet : 181/4
Location: Kilosa	Co-ord. : 277.5
	: 9244.2

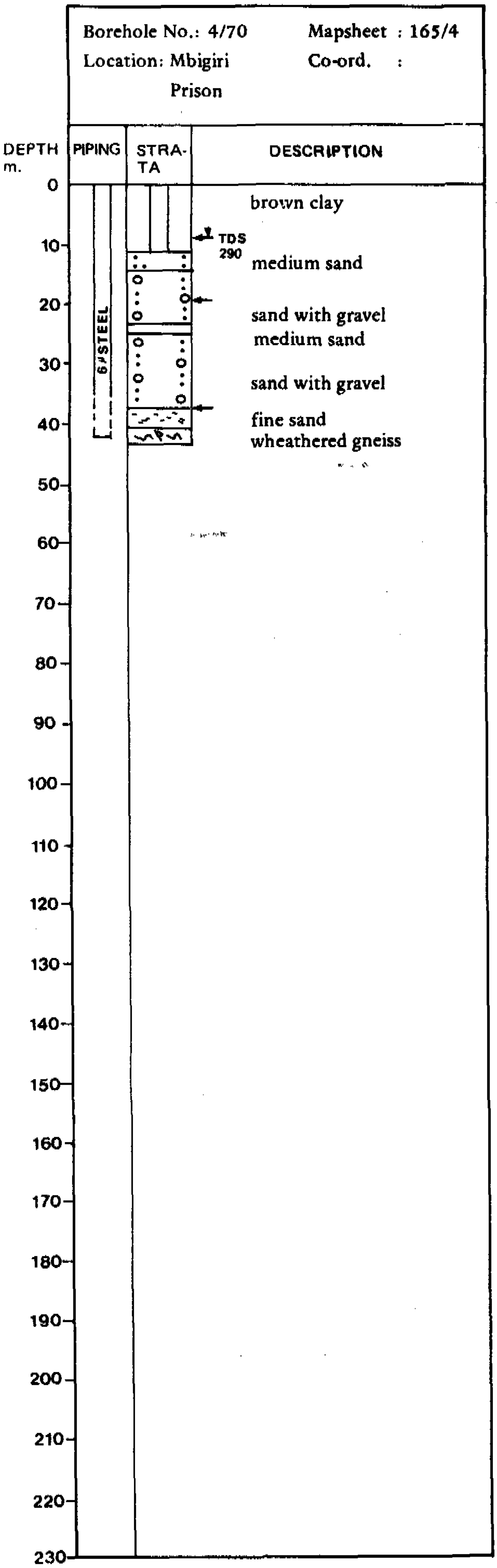
DEPTH m.	PIPING	STRATA	DESCRIPTION
0			TDS 400 — coarse sand
			clayey coarse sand
10			claye fine sand
20			gravel
30			clayey gravel sand
40			
50			
60			
70			
80			
90			
100			
110			
120			
130			
140			
150			
160			
170			
180			
190			
200			
210			
220			
230			

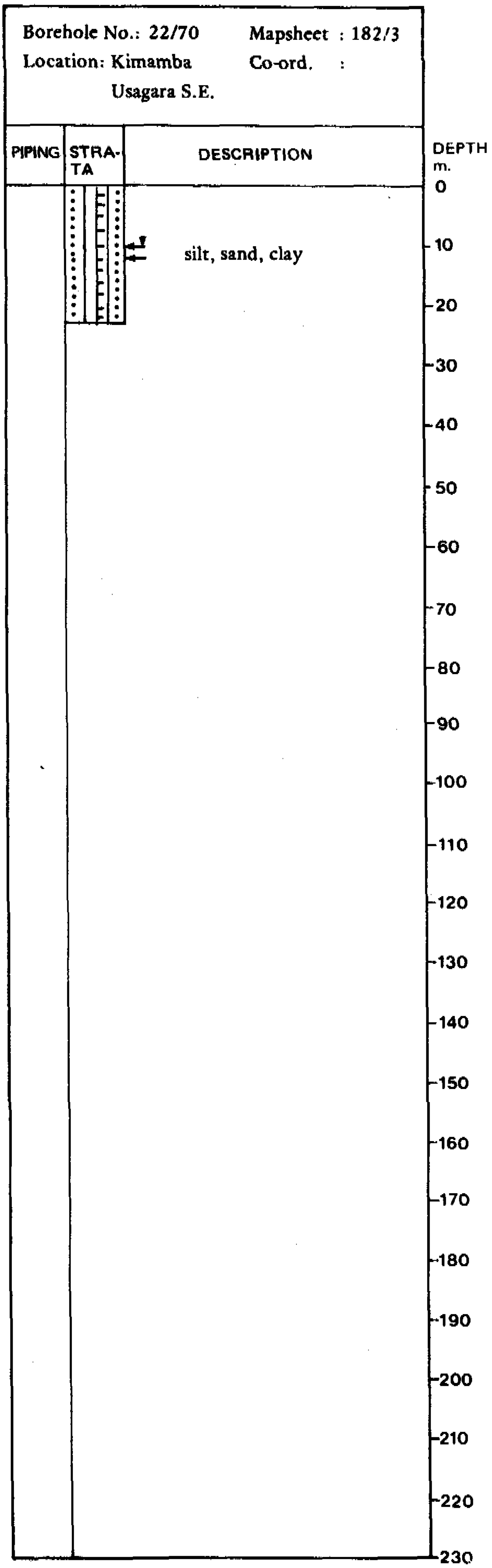
Borehole :	Mapsheet :
Location:	Co-ord. :

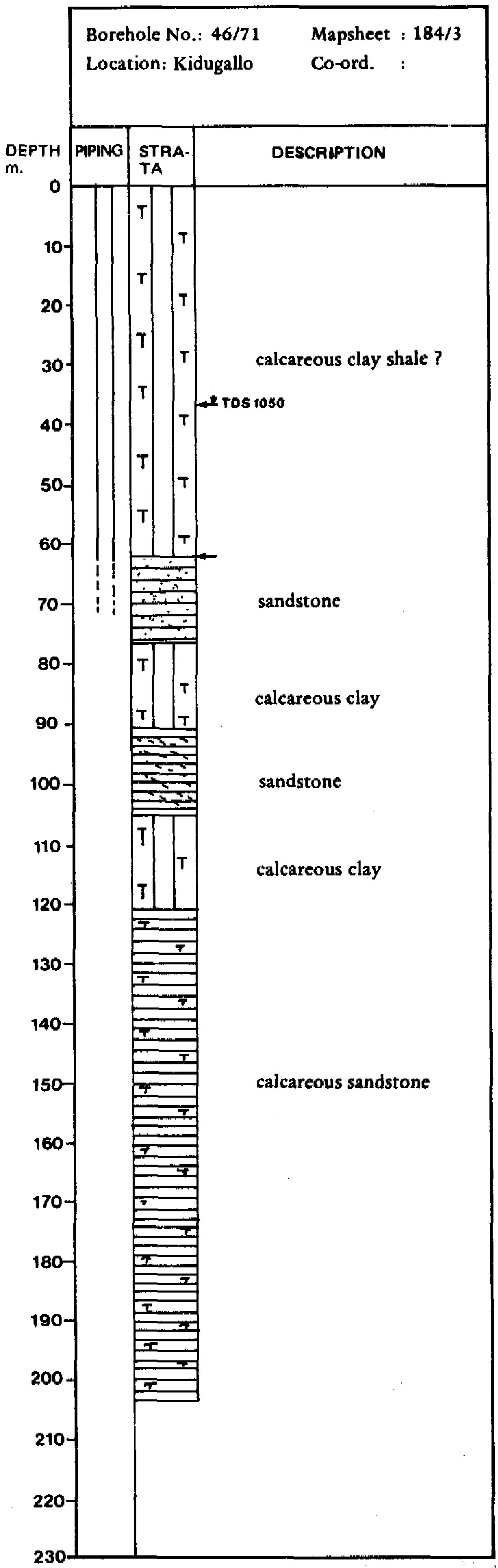
PIPING	STRATA	DESCRIPTION	DEPTH m.
			0
			10
			20
			30
			40
			50
			60
			70
			80
			90
			100
			110
			120
			130
			140
			150
			160
			170
			180
			190
			200
			210
			220
			230

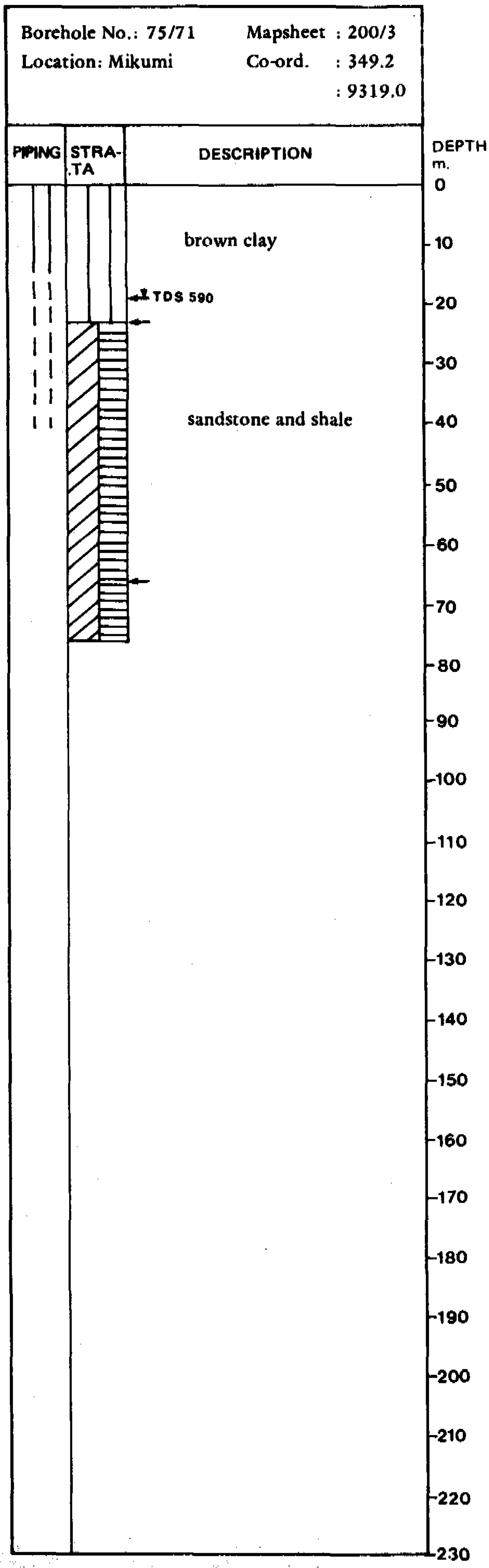

Borehole No.: 56/69
Mapsheet : 166/3
Location: Kambala
Co-ord. : 341.5
: 9303.2
DEPTH m.
PIPING
STRATA
DESCRIPTION
8" STEEL
EC 210
clay
sandy clay
brown sand
brown clay
black and white rock
very hard rock
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

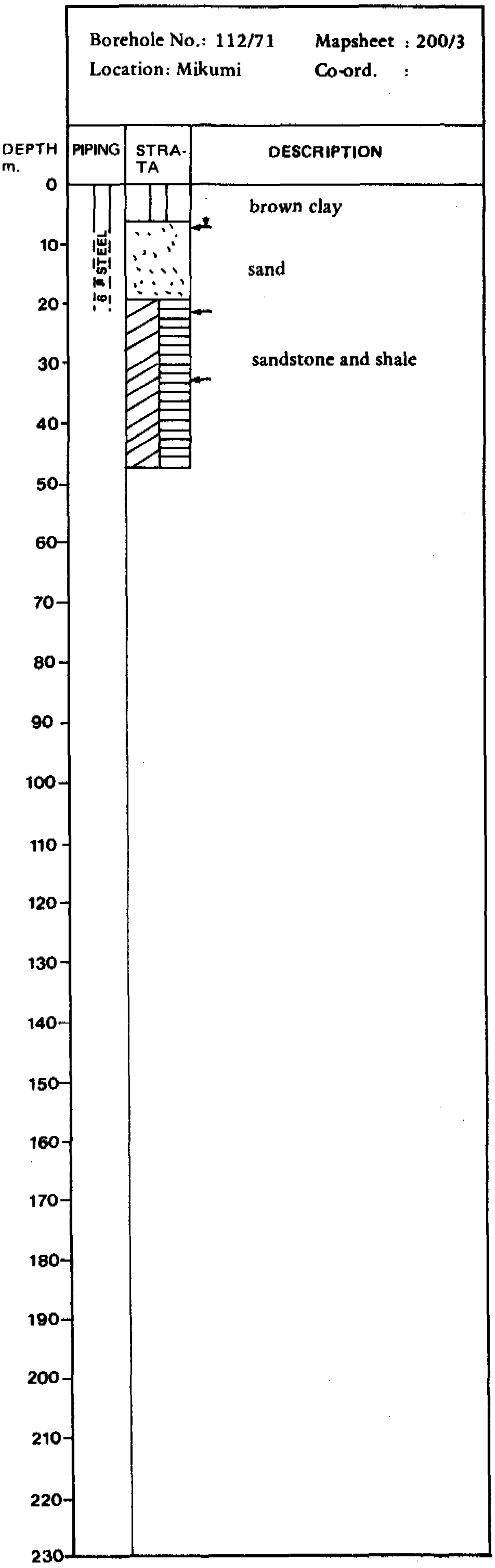

Borehole No.: 58/69
Mapsheet : 166/3
Location: Kambala
Co-ord. : 340.5
: 9299.6
PIPING
STRATA
DESCRIPTION
DEPTH m.
EC 205
brown clay
sandy clay
sandy clay with gravel
sand
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

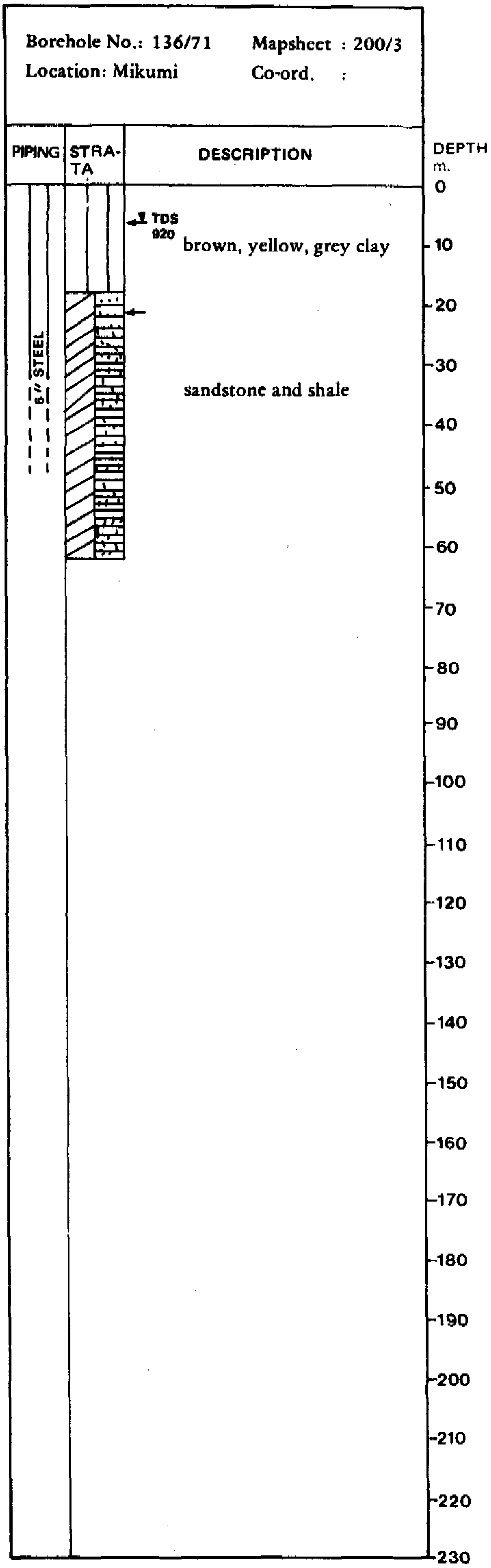

Borehole No.: 4/70
Mapsheet : 165/4
Location: Mbigiri Prison
Co-ord. :
DEPTH m.
PIPING
STRATA
DESCRIPTION
6" STEEL
TDS 290
brown clay
medium sand
sand with gravel
medium sand
sand with gravel
fine sand
wheathered gneiss

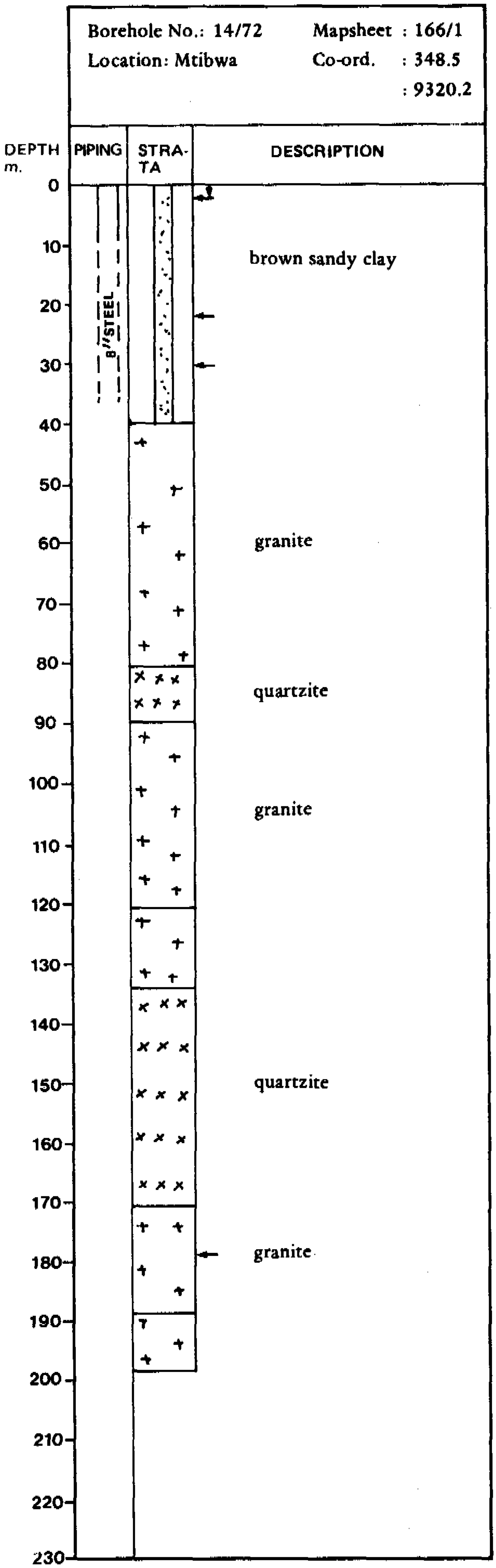

Borehole No.: 22/70
Mapsheet : 182/3
Location: Kimamba Usagara S.E.
Co-ord. :
PIPING
STRATA
DESCRIPTION
DEPTH m.
silt, sand, clay


Borehole No.: 46/71
Mapsheet : 184/3
Location: Kidugallo
Co-ord. :
DEPTH m.
PIPING
STRA-TA
DESCRIPTION
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
calcareous clay shale ?
TDS 1050
sandstone
calcareous clay
sandstone
calcareous clay
calcareous sandstone

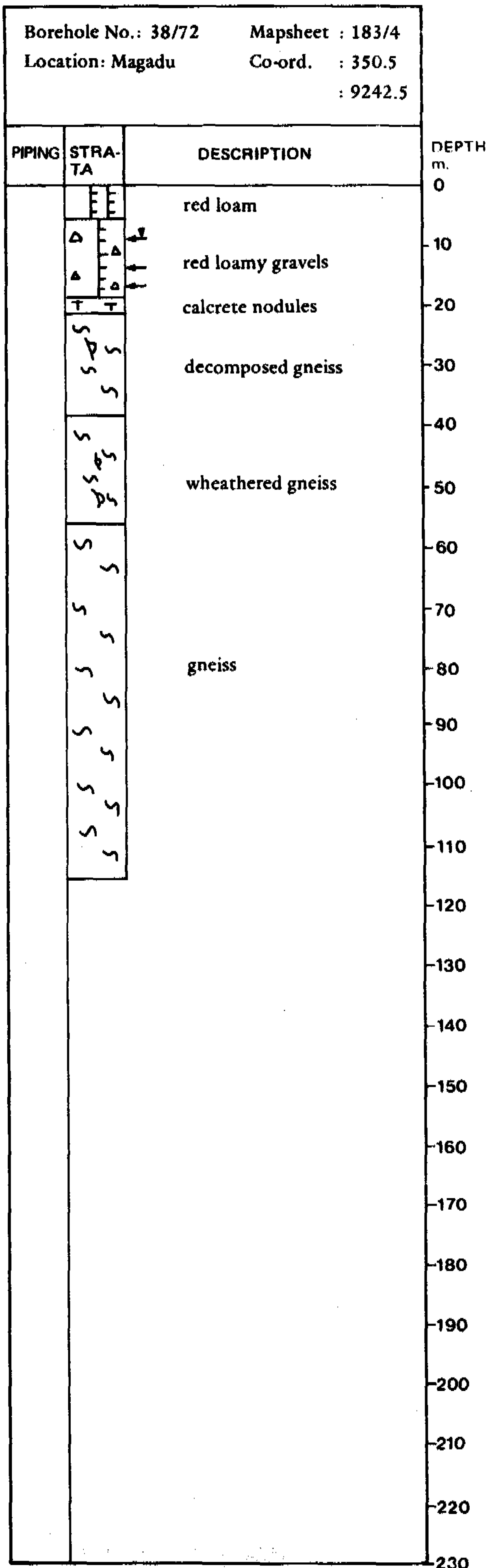

Borehole No.: 75/71
Mapsheet : 200/3
Location: Mikumi
Co-ord. : 349.2
: 9319.0
PIPING
STRA-TA
DESCRIPTION
DEPTH m.
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
brown clay
TDS 590
sandstone and shale


Borehole No.: 112/71
Mapsheet : 200/3
Location: Mikumi
Co-ord. :
DEPTH m.
PIPING
STRA-TA
DESCRIPTION
6" STEEL
brown clay
sand
sandstone and shale
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

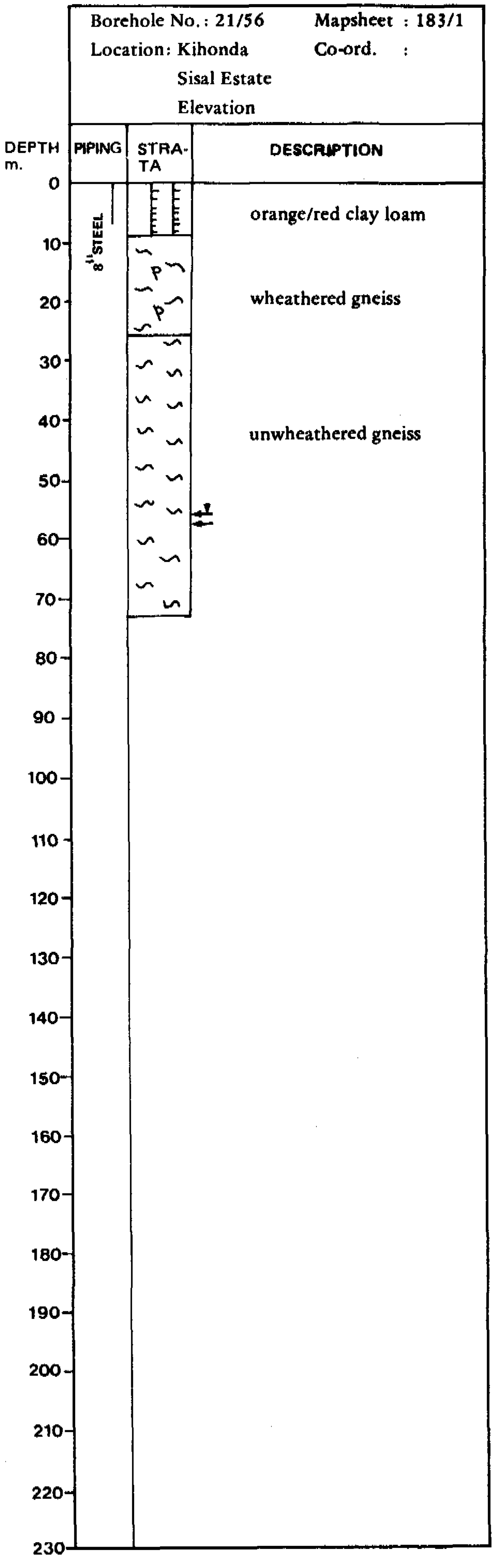

Borehole No.: 136/71
Mapsheet : 200/3
Location: Mikumi
Co-ord. :
PIPING
STRA-TA
DESCRIPTION
DEPTH m.
6" STEEL
TDS 920
brown, yellow, grey clay
sandstone and shale
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

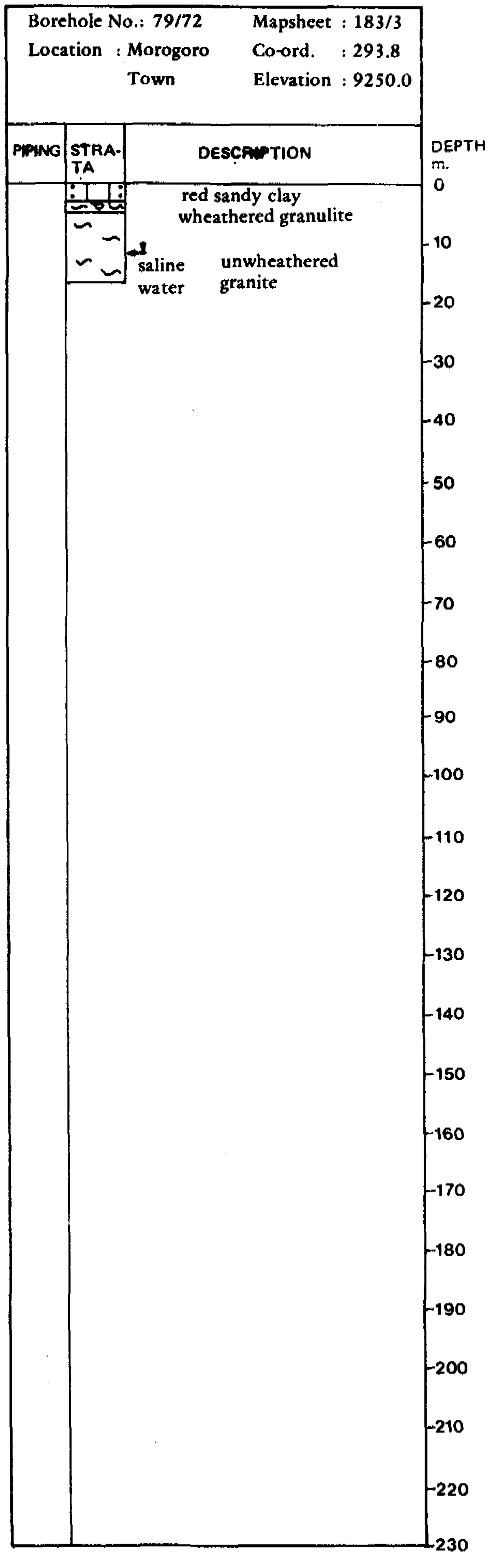


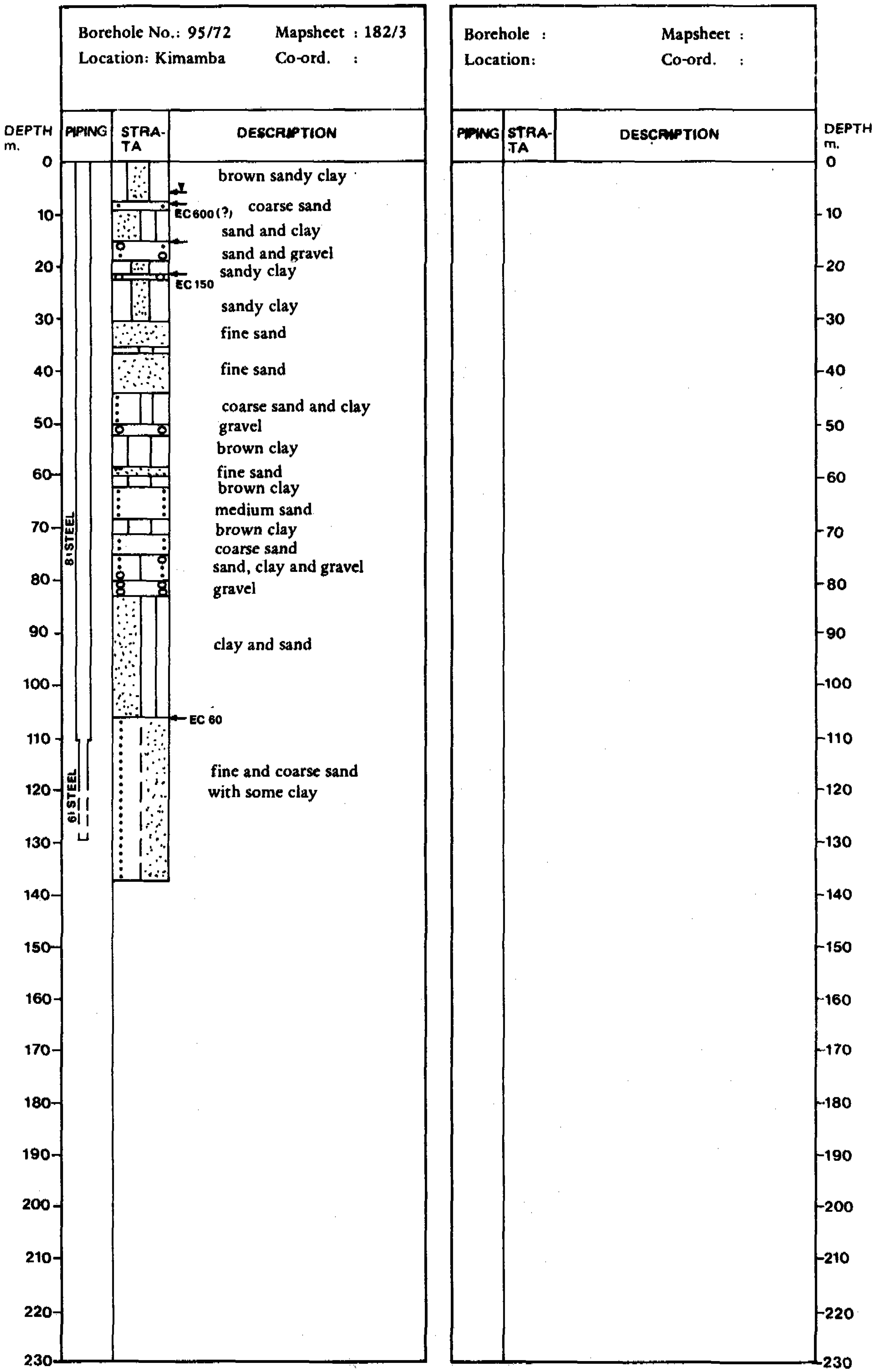
Borehole No.: 14/72
Location: Mtibwa
Mapsheet : 166/1
Co-ord. : 348.5
: 9320.2
DEPTH m.
PIPING
STRATA
DESCRIPTION
8" STEEL
brown sandy clay
granite
quartzite
granite
quartzite
granite
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

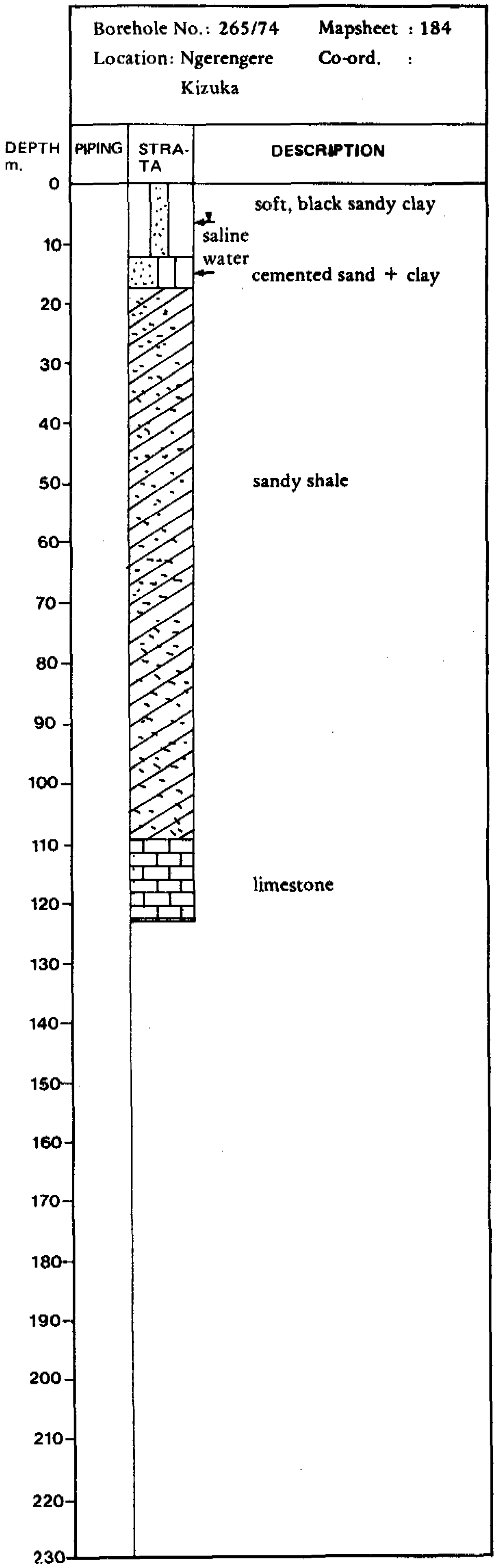


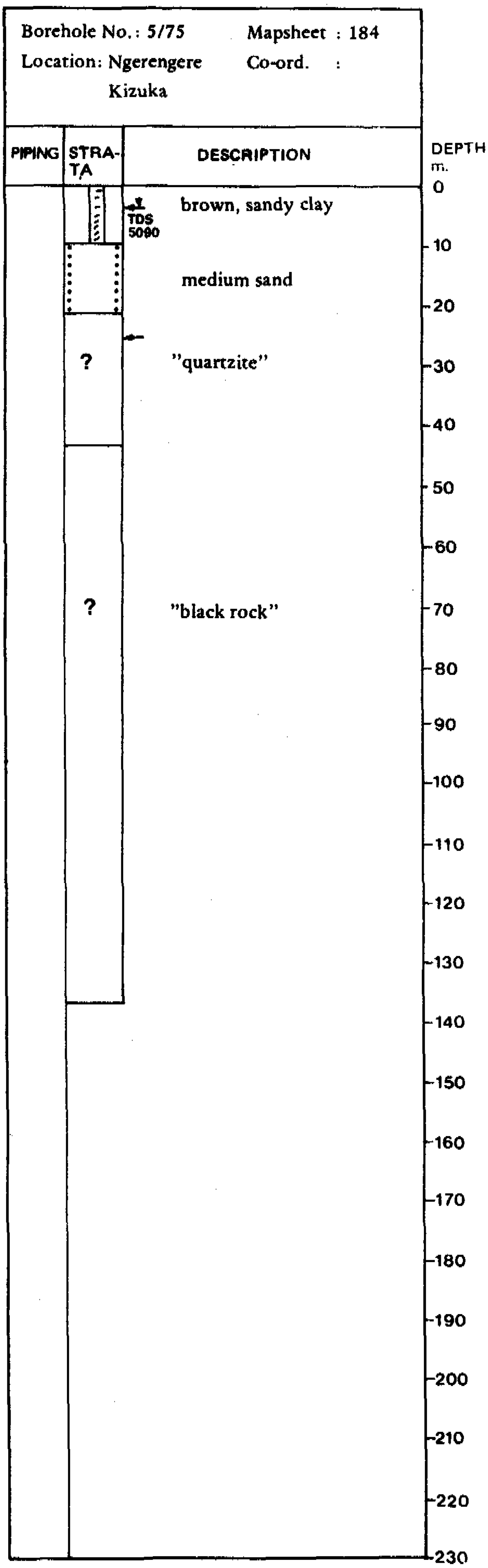
Borehole No.: 38/72
Location: Magadu
Mapsheet : 183/4
Co-ord. : 350.5
: 9242.5
PIPING
STRATA
DESCRIPTION
DEPTH m.
red loam
red loamy gravels
calcrete nodules
decomposed gneiss
wheathered gneiss
gneiss
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

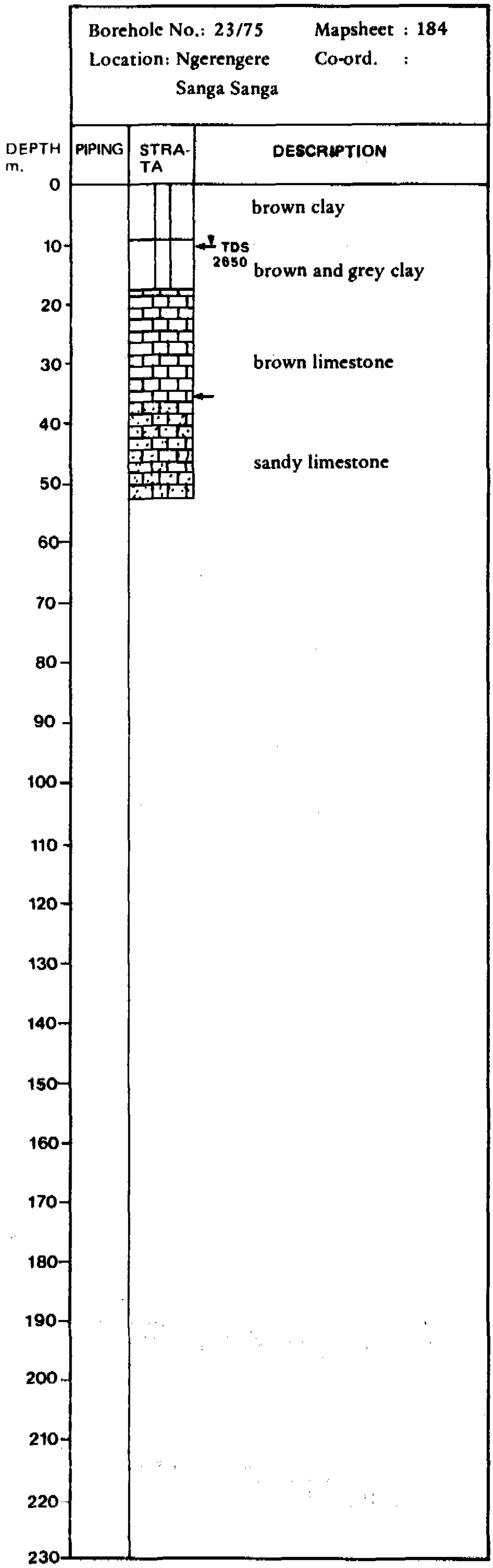

Borehole No.: 21/56
Mapsheet : 183/1
Location: Kihonda Sisal Estate
Co-ord. :
Elevation
DEPTH m.
PIPING
STRATA
DESCRIPTION
8" STEEL
orange/red clay loam
wheathered gneiss
unwheathered gneiss
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

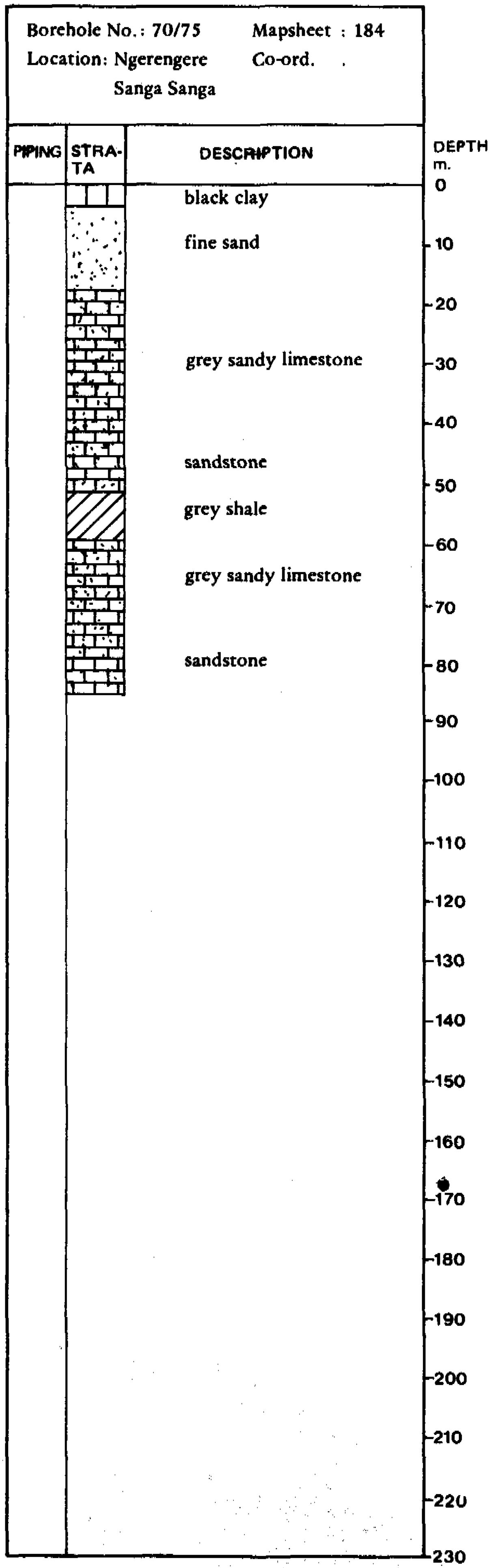

Borehole No.: 79/72
Mapsheet : 183/3
Location : Morogoro Town
Co-ord. : 293.8
Elevation : 9250.0
PIPING
STRATA
DESCRIPTION
DEPTH m.
red sandy clay
wheathered granulite
saline water
unwheathered granite
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

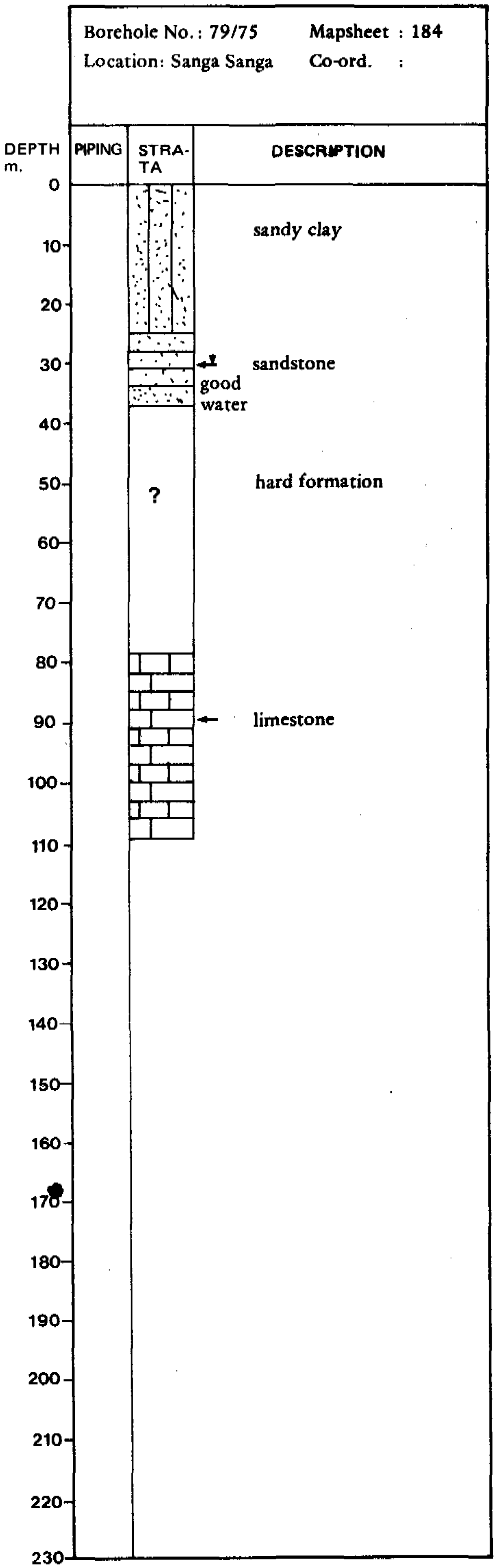

Borehole No.: 95/72
Mapsheet : 182/3
Location: Kimamba
Co-ord. :
DEPTH m.
PIPING
STRATA
DESCRIPTION
brown sandy clay
EC600(?)
coarse sand
sand and clay
sand and gravel
EC 150
sandy clay
sandy clay
fine sand
fine sand
coarse sand and clay
gravel
brown clay
fine sand
brown clay
medium sand
brown clay
coarse sand
sand, clay and gravel
gravel
clay and sand
EC 60
fine and coarse sand
with some clay
8" STEEL
6" STEEL
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
Borehole :
Mapsheet :
Location:
Co-ord. :
PIPING
STRATA
DESCRIPTION
DEPTH m.

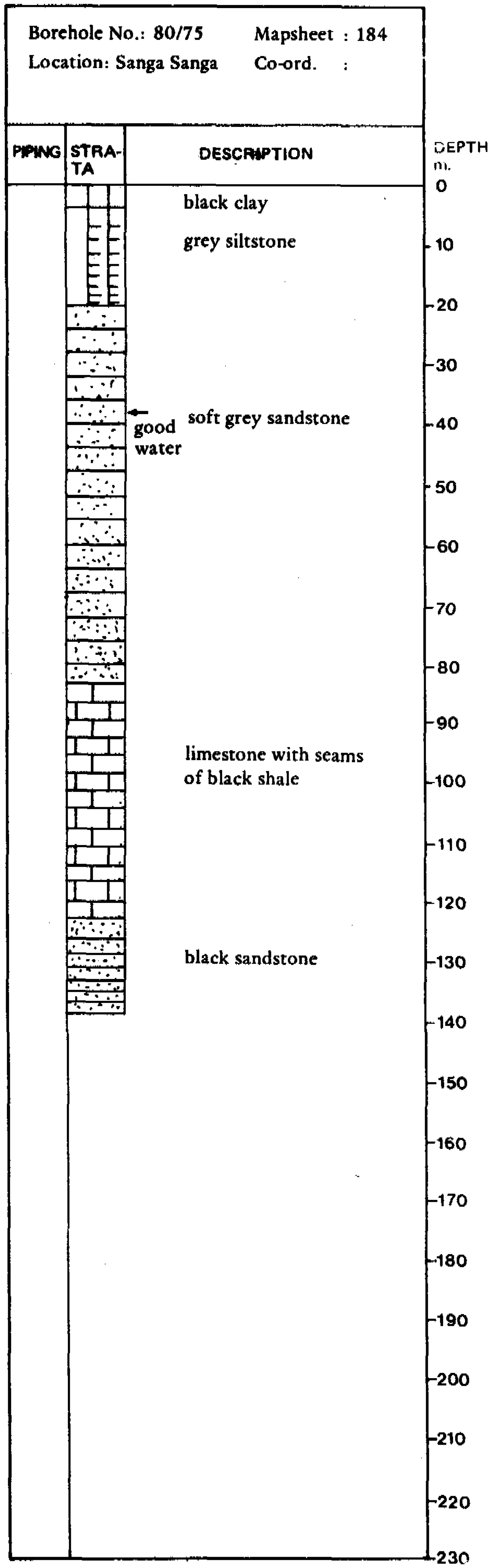

Borehole No.: 265/74
Mapsheet : 184
Location: Ngerengere Kizuka
Co-ord. :
DEPTH m.
PIPING
STRATA
DESCRIPTION
soft, black sandy clay
saline water
cemented sand + clay
sandy shale
limestone
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

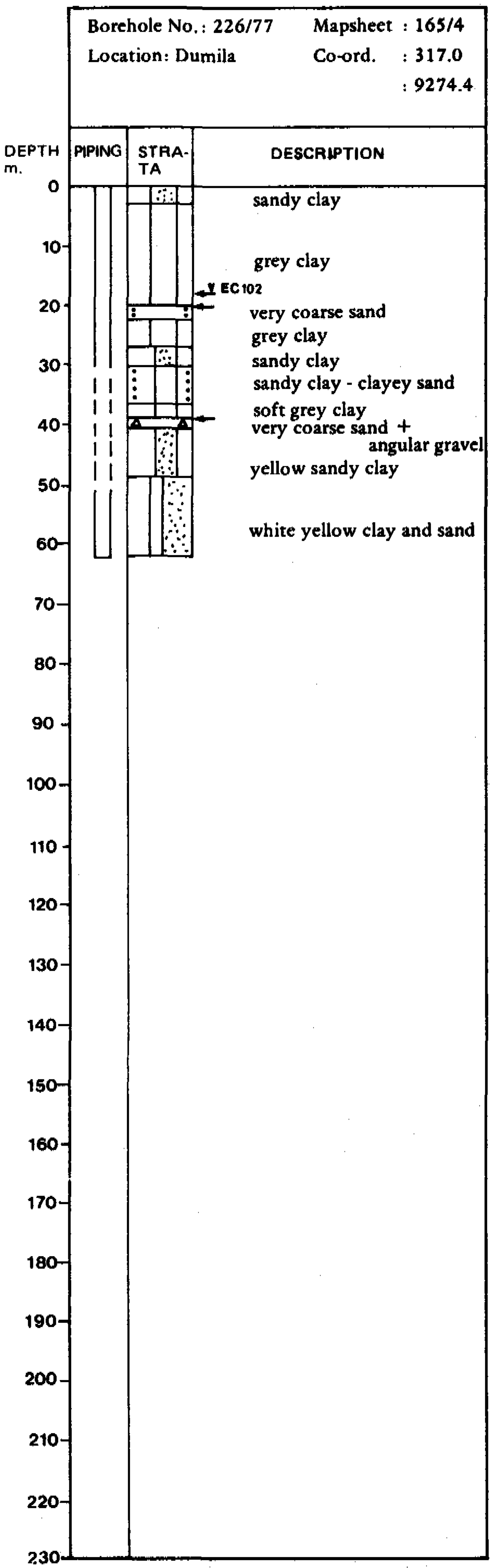

Borehole No.: 5/75
Mapsheet : 184
Location: Ngerengere Kizuka
Co-ord. :
PIPING
STRATA
DESCRIPTION
DEPTH m.
TDS 5090
brown, sandy clay
medium sand
?
"quartzite"
?
"black rock"
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

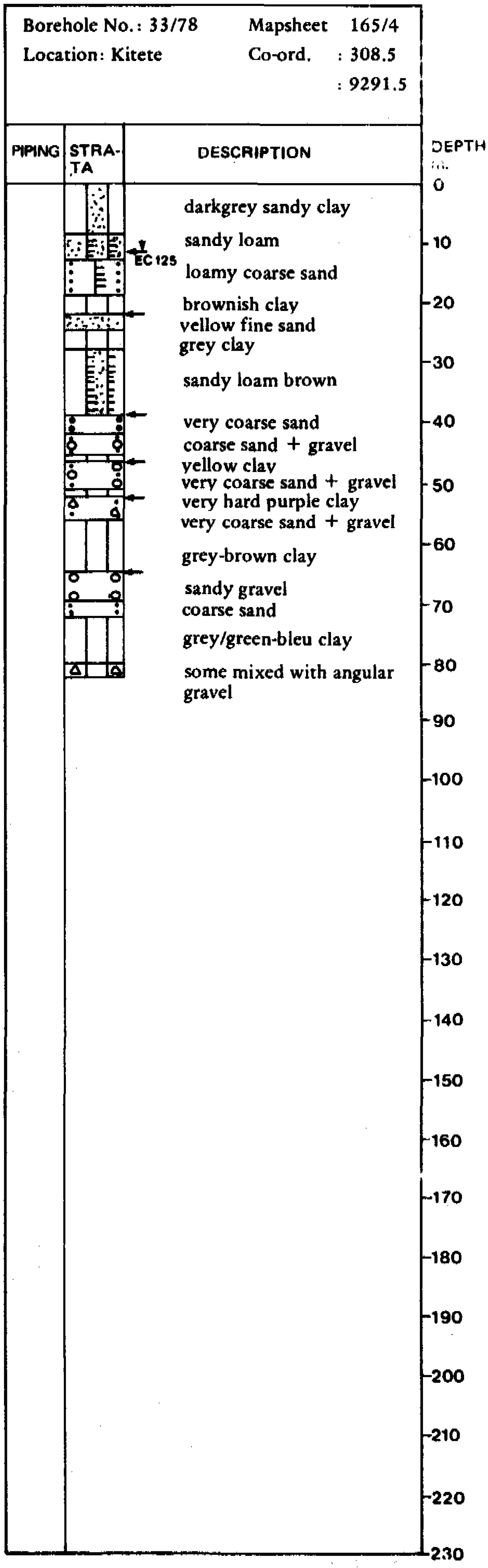

Borehole No.: 23/75
Mapsheet : 184
Location: Ngerengere
Sanga Sanga
Co-ord. :
DEPTH m.
PIPING
STRA-TA
DESCRIPTION
brown clay
TDS 2650
brown and grey clay
brown limestone
sandy limestone
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230


Borehole No.: 70/75
Mapsheet : 184
Location: Ngerengere
Sanga Sanga
Co-ord.
PIPING
STRA-TA
DESCRIPTION
DEPTH m.
black clay
fine sand
grey sandy limestone
sandstone
grey shale
grey sandy limestone
sandstone
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230


Borehole No.: 79/75
Mapsheet : 184
Location: Sanga Sanga
Co-ord. :
DEPTH m.
PIPING
STRA-TA
DESCRIPTION
sandy clay
sandstone
good water
hard formation
?
limestone
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230


Borehole No.: 80/75
Mapsheet : 184
Location: Sanga Sanga
Co-ord. :
PIPING
STRA-TA
DESCRIPTION
DEPTH m.
black clay
grey siltstone
good water
soft grey sandstone
limestone with seams of black shale
black sandstone
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230


Borehole No.: 226/77
Mapsheet : 165/4
Location: Dumila
Co-ord. : 317.0
: 9274.4
DEPTH m.
PIPING
STRA-TA
DESCRIPTION
EC 102
sandy clay
grey clay
very coarse sand
grey clay
sandy clay
sandy clay - clayey sand
soft grey clay
very coarse sand + angular gravel
yellow sandy clay
white yellow clay and sand
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230


Borehole No.: 33/78
Mapsheet 165/4
Location: Kitete
Co-ord. : 308.5
: 9291.5
PIPING
STRA-TA
DESCRIPTION
DEPTH m.
EC 125
darkgrey sandy clay
sandy loam
loamy coarse sand
brownish clay
yellow fine sand
grey clay
sandy loam brown
very coarse sand
coarse sand + gravel
yellow clay
very coarse sand + gravel
very hard purple clay
very coarse sand + gravel
grey-brown clay
sandy gravel
coarse sand
grey/green-bleu clay
some mixed with angular gravel
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

Borehole No.: 175/77 Mapsheet : 182/1
Location: Msowero Co-ord. : 302.8
: 9278.5

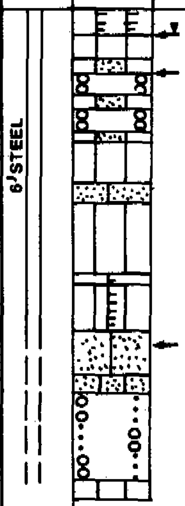
DEPTH m.	PIPING	STRATA	DESCRIPTION
0	6" STEEL	EC155	grey clay
			gravel
			clayey gravel
10			white clay
20			
30			wheathered gneiss
40			
50			
60			
70			
80			
90			partly wheathered gneiss
100			
110			
120			
130			
140			
150			
160			
170			
180			
190			
200			
210			
220			
230			

Borehole : Mapsheet :
Location: Co-ord. :

PIPING	STRATA	DESCRIPTION	DEPTH m.
			0
			10
			20
			30
			40
			50
			60
			70
			80
			90
			100
			110
			120
			130
			140
			150
			160
			170
			180
			190
			200
			210
			220
			230

Borehole No.: 95/78 Mapsheet : 182/3
Location: Chanzuru Co-ord. : 287.4
: 9248.9

DEPTH m.	PIPING	STRATA	DESCRIPTION

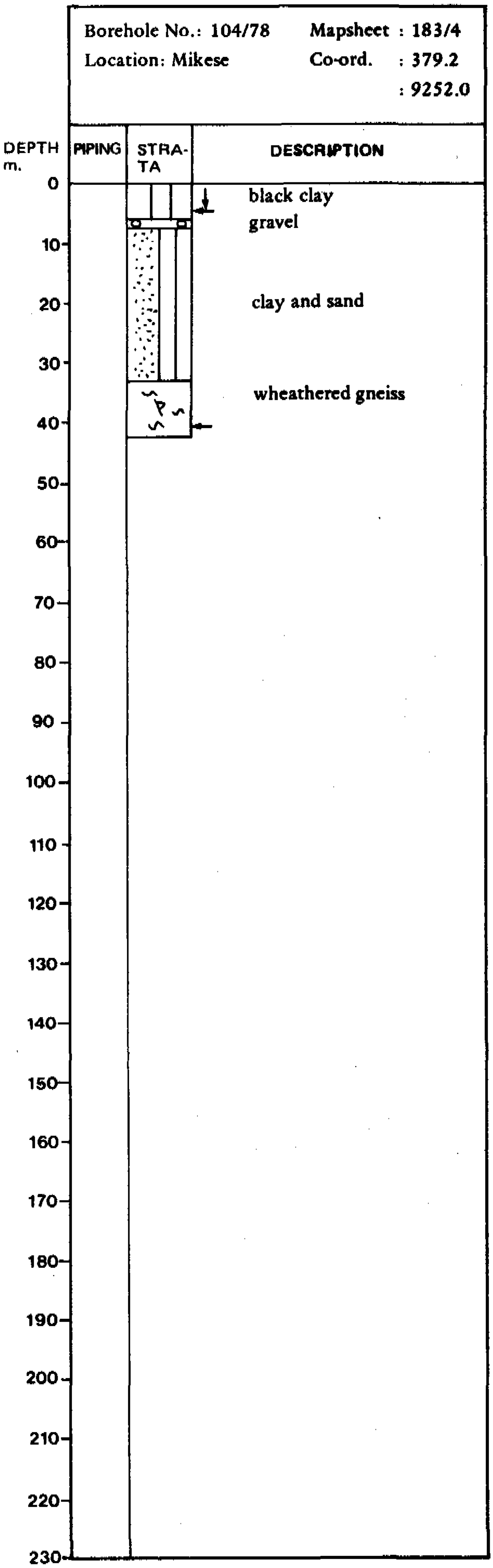


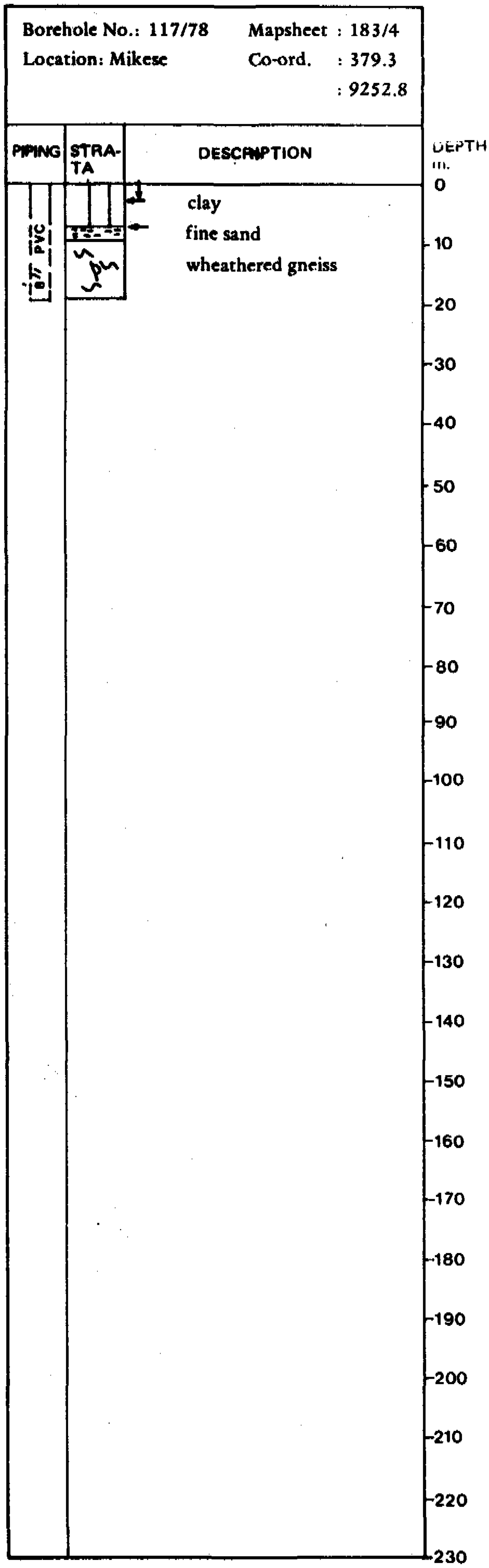
DEPTH m.: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230

Borehole :
Mapsheet :
Location:
Co-ord. :

PIPING	STRATA	DESCRIPTION	DEPTH m.

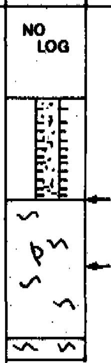
DEPTH m.: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230


Borehole No.: 104/78
Mapsheet : 183/4
Location: Mikese
Co-ord. : 379.2
: 9252.0
DEPTH m.
PIPING
STRA-TA
DESCRIPTION
black clay
gravel
clay and sand
wheathered gneiss
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230


Borehole No.: 117/78
Mapsheet : 183/4
Location: Mikese
Co-ord. : 379.3
: 9252.8
PIPING
STRA-TA
DESCRIPTION
DEPTH m.
PVC
clay
fine sand
wheathered gneiss
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

Borehole No.: 75/78   Mapsheet : 183/1
Location: Pakawa Ranch   Co-ord. :

DEPTH m.	PIPING	STRATA	DESCRIPTION
0		NO LOG	
10			
20			loam and fine sand
30			wheathered gneiss
40			
50			gneiss
60			
70			
80			
90			
100			
110			
120			
130			
140			
150			
160			
170			
180			
190			
200			
210			
220			
230			



Borehole :   Mapsheet :
Location: Co-ord. :

PIPING	STRATA	DESCRIPTION	DEPTH m
			0
			10
			20
			30
			40
			50
			60
			70
			80
			90
			100
			110
			120
			130
			140
			150
			160
			170
			180
			190
			200
			210
			220
			230

DATA DD 3

CHEMICAL ANALYSES OF GROUND WATER FROM BOREHOLES

Table DD 3 - Chemical analyses of ground water from boreholes

bore-hole no.	location	depth	date of sampling	date of analysis	spec. cond. at 25°C	pH	Ca^{2+}	Mg^{2+}	TH	Fe	Mn	NH^{+}	Na^{+}	K^{+}	F^{-}	Cl^{-}	HCO	NO	NO	SO^{2-}	PO_4^{3-}
		m			mS/m		ppm		ppm $CaCO_3$						parts per million						
2/53	Gairo			11-02-53												472	482			110	
			11-02-61	1-03-61	1982	7.9	72.8	123.3	696			0.4			0.1	520	296				
3/53	Ngerengere			7.08.53											6.0	432	388			406	
23/53	Kidugallo			12-08-53											0.6	330	802			136	
37/54	Kimamba			12-10-54		8.0	63	107							1.2	65	960			360	
43A/54	Wami					8.5	21	35							1.1	9	1240			3	
30/55	Madoto		27-09-55	25-10-55		7.5	43	53							0.3	32				86	
40/55	Kimamba		19-10-55	2-11-55		6.5	55	32							0.2	7					
2/56	Kidugallo			21-05-56		7.5	125	23							nil	83				37	
			14-12-67	30-12-67	119	8.1	22	67	334			nil	98	4.2	nil	84	304	nil	nil		
6/56	Kidugallo			19-04-56		7.5	504	47							1	708				458	
19/56	Kimamba			26-10-56		7.5	93	56							1	94	430				
21/56	Kihonda			22-08-56		7.5	15	9							0.2	29	100			nil	
23/56	Kimamba			7-09-56		7.0	98	120							4	93	720			270	
			30-09-63	8-11-63	63	8.3	94	nil	236						0.4	28	252				
34/56	Kimamba			20-11-56		7.5	46	47							1	33	430			72	
42/56	Kimamba			11-02-57		7.5	69	34					65	3	1	28	49			89	
2/57	Kimamba			11-03-57		7.5	58	39					65	3	1	22	427			77	
10/57	Kimamba			6-05-57		7.5	58	27					37	3	0.6	11	290			100	
19/57	Madoto			19-07-57		7.5	79	71					88	1.5	0.4	65	525			176	
23/57	Kilosa			6-09-57		7.5	293	46					285	8	1	306	345			781	
							240	57	840			0.24	440			244	352	nil	nil	823	
							300	36	900			nil	340			292	256	nil	nil	809	
							288	50	930			nil	380			292	272	nil	nil	813	
29/57	Kilosa			10-09-57			97	72					154	1	1	163	439			223	
15/59	Mikumi			21-01-60		7.0	90	80							0.4	140	710	nil		70	
				21-01-60		7.0	120	90							0.3	210	780			100	
			20-05-63	25-05-63	23	6.8	24	9	96			nil			0.4	8	112	nil	nil		
			20-05-63	25-05-63	25	6.7	25	12	110			nil			0.4	4	120	nil	nil		
17/59	Kimamba			21-05-59		7.5	146	137					280	2	3	200					
				4-07-59																	
				10-07-57		7.5	160	140					240		2	170				740	
		10-14	10-10-63	30-10-63	330	7.9	78	202	1036			nil			0,5	224	660	nil	21		
		16-20	10-10-63	31-10-63	317	7.9	73	202	1028			nil			0.5	224	660	nil	21		
		20-23	10-10-63	31-10-63	277	7.9	57	227	1072			nil			0.5	224	704	nil	21		
		23-26	10-10-63	31-10-63	317	7.9	72	217	1084			nil			0.5	224	704	nil	21		
		29-32	10-10-63	31-10-63	276	7.9	58	220	1056			nil			0.5	224	704	nil	21		

bore-hole no.	cations anions	TDS	H_2S	O_2	SS	turb	color	coliform	Cu	Zn	Pb
			ppm		mg/l	FTU	Pt/Co	count 100 ml		ppm	
2/53		1696									
		1506									
3/53		1719									
23/53		1340									
37/54		1220									
43A/54		810									
30/55		520									
40/55		420									
2/56		746									
		635									
6/56		3048									
19/56		720									
21/56		128									
23/56		1160									
		383									
34/56		490									
42/56		540									
2/57		490									
10/57		400									
19/57		766									
23/57		1970									
		2134									
		2130									
		2130									
29/57		990									
15/59		860									
		1070									
		146									
		171									
17/59		1840									
		1640									
		1880									
		2220									
		2232									
		2250									
		2247									
		2250									

Continued 1

bore-hole no.	location	depth	date of sampling	date of analysis	spec. cond. at 25°C	pH	Ca^{2+}	Mg^{2+}	TH	Fe	Mn	NH^+	Na^+	K^+	F^-	Cl^-	HCO	NO	NO	SO^{2-}	PO_4^{3-}
		m			mS/m		ppm		ppm $CaCO_3$						parts per million						
17/59	Kimamba	25-30	10-10-60	31-10-60	276	8.0	64	215	1056			nil			0.5	244	592	nil	21		
		15	30-09-63	8-11-63	294	7.9	104	194	1070			nil			0.3	228	664	nil	17		
		21	30-09-63	8-11-63	280	7.7	132	180	1080			nil			0.4	204	736	nil	18		
		30	30-09-63	8-11-63	266	7.8	109	170	980			nil			0.3	168	808	nil	10		
19/59	Mikumi		8-10-59	14-10-59	151	7.3	87	76	536	0.1		nil	115		0.6	148	612	nil	nil		
17/0	Magole			17-11-60	72	8.2	22	33	192	nil	nil				0.3	44	356				
31/60	Kimamba	10	3-12-60	14-12-60	101	8.4	41	80	438			nil			9.0	108	288	4.0	2.2		
		45	11-01-61	27-01-61	58	8.1	43	36	256			nil			0.5	20	200	nil	nil		
		52	11-01-61	27-01-61	63	8.1	43	36	256			nil			0.4	64	168	nil	2.4		
			23-01-61	3-02-61	59	7.8	40	31	230			nil			0.8	40	212	nil	nil		
34/60	Rubeho		11-02-61	1-03-61	240	8.1	145	128	900			nil			0.4	668	188	nil	nil		
37/60	Kisitwe																				
23/61	Kimamba	10		23-06-61		8.4			210			nil			1.2	60	332	nil	nil		
		17		23.06.61		8.1			720						0.8	208	344	nil	nil		
		34		23-01-61		8.1			374			nil			0.6	76	268	nil	nil		
			26-07-61	1-08-61	110	8.1	59	61	406			nil			0.4	104	204	nil	nil		
			26-07-61	1-08-61	70	8.1	44	36	256			nil			0.4	36	196	nil	nil		
			26-07-61	31-07-61	61	8.1	40	35	244			nil			0.4	44	172	nil	nil		
			9-08-61	21-08-61	122	8.2	61	74	462			nil			0.3	100	300	nil	nil		
			9-08-61	21-08-61	70	8.3	51	32	262			nil			0.3	44	228	nil	nil		
30/61	Kimamba		17-01-62	27-01-62		8.0	99	137	822			nil			0.6	208	644	nil	nil		
6/62	Mvomero		16-03-62	20-03-61	62	7.7	51	20	248	nil	nil	nil			0.5	120	156	nil	nil		
			2-05-62	10-05-62	260	8.2	148	78	696	nil	nil	nil			0.2	392	128	nil	4.8		
7/62	Saga Saga		7.06-62	16-06-62	1058	8.0	522	538	3620			0.5			0.6	872	444	0.1	4.2		
			5-07-62	16-07-62	995	8.0	552	576	3780			nil			0.6	964	348	nil	nil		
			26-07-62	2-08-62	312	8.4	128	109	776												
			17-08-62	24-08-62	581	8.2	230	222	1500			0.5			2.0	716	336	nil	nil		
8/62	Mkulazi	102	13-02-62	20-02-62	227	8.3	47	85	480			nil			nil	392	412	nil	nil		
)762	Gronero		9-07-62	14-07-62	505	8.0	43	30	364			nil			0.6	396	148	nil	0.6		
		105	17-08-62	24-08-62		8.3	13	10	880			nil			nil	172	628	nil	nil		
			18-12-72	2-01-63	120	8.3	14	15	100			nil			4.0	156	588	nil	nil		
2/63	Wami	37	29-08-63	4-09-63	277	8.6	7	15	160	nil	nil	nil			2.0	368	1040	nil	nil		
		44	29-08-63	4-09-63	273	8.6	6	15	156	nil	nil	nil			2.0	408	1080	nil	nil		
		49	29-08-63	4-09-63	275	8.6	6	14	148	nil	nil	nil			2.0	344	976	nil	nil		

bore-hole no.	cations anions	TDS	H_2S	O_2	SS	turb	color	coliform	Cu	Zn	Pb
			ppm		mg/l	FTU	Pt/Co	count 100 ml		ppm	
17/59		2310									
		1995									
		1982									
		1602									
19/59		917									
17/0		445							nil	nil	nil
31/60		760									
		364									
		455									
		378									
34/60		1848									
37/60											
23/61		760									
		1477									
		691									
		844									
		413									
		428									
		831									
		464									
30/61		1467							nil	nil	nil
6/62		542							nil	nil	nil
		1650							nil	nil	nil
7/62		7008									
		6764									
		5442									
8/62		1150									
9/62		3751									
		1290									
		1245									
2/63		1769							nil	nil	nil
		1880							nil	nil	nil
		1639							nil	nil	nil

Continued 2

bore-hole no.	location	depth	date of sampling	date of analysis	spec. cond. at 25°C	pH	Ca^{2+}	Mg^{2+}	TH	Fe	Mn	NH_4^+	Na^+	K^+	F^-	Cl^-	HCO_3	NO	NO	SO_4^{2-}	PO_4^{3-}
		m			mS/m		ppm		ppm $CaCO_3$						parts per million						
5/63	Mgugu		25-05-63	3-04-63	570	7.9	64	595	2640			nil			2.4	880	620	nil	nil	1756	
		27	29-08-63	4-09-63	562	8.0	144	192	2320			nil			2.0	892	488	nil	nil		
		37	29-08-63	9-09-63	559	7.9	150	184	2280			nil			2.0	860	576	nil	nil		
18/63	Wami		22-11-63	29-11-63		8.4	9	23	158	nil	nil	nil			1.2	304	1364	nil	nil	nil	
			25-11-63	5-12-63		8.5	4	13	312	nil	nil	nil			2.0	172	1180	nil	nil	nil	
4/64	Kigoboga			4-04-64		7.5	58	75							2.0	50	nil	nil	nil	15	
			2-04-64	9-04-64	151	7.7	51	48	328			nil			0.9	4.0	404	nil	nil		
			5-05-64	15-05-64	113	7.9	30	53	296						0.6	148	548	nil	nil		
13/64	Kigoboga		7-08-64	19-08-64	225	8.1	53	78	456			nil			1.0	60	468	nil	nil		
18/65	Magubike		4-08-65	27-08-65	489	8.2	32	140	676			nil			2.0	944	736	nil	nil		
			15-11-65	27-01-66	443	8.3	22	170	764			nil			1.4	2024	376	nil	nil		
			10-08-67	28-08-67		8.5	8	234	999			nil			nil	1124	452	nil	nil		
33/65	Gairo		19-01-66	2-02-68	220	8.0	130	118	818			nil			nil	528	236	nil	2.3		
			31-05-71	24-06-71	285	7.5	182	145	1052	0.09		0.4	254	6.5	0.5	100	322	nil	1.6		
14/66	Turiani			30-01-67		8.0	34	29	206						0.4	68					
				30-05-69		8.3	48	23					74		2.0	57	299			51	
				14-10-69	86	8.1	43	72				0.1	28	3	0.2	60					
41/67	Mikese		31-10-67	17-11-67	265	7.1	184	427	220			nil	387	8	2.0	304	220	nil	1.0		
			14-11-67	6-12-67	176	7.4	18	104	510			nil	232	7	1.6	332	400	nil	nil		
68/68	Wami		6-10-68	10-10-68		8.0	35	21					300		0.1	57	903				
72/68	Kilosa		4-08-71	11-08-71	150	8.1	94	67	507	0.9		nil	161	2	1.3	211	560	nil	0.4		
75/68	Kilosa		13-04-72	17-05-72	63	7.6	64	22	200	4.2		nil	114	6	0.2	21	166	nil	nil	123	
			27-07-72	29-08-72	47	6.7	38	20	178	4.2		0.3	14	5	0.2	19	133	nil	nil	73	
78/68	Kilosa		27-07-72	29-08-72	65	6.7	67	22	258	4.4		0.9	14	6	0.4	142	187	nil	nil	142	
29/69	Mtibwa					8.3	43	26	580				34		0.4	36					
56/69	Kambala		3-09-69	14-10-69	324	8.7	28	58	310	nil	nil	nil	150	5	0.8	164	600	nil	nil		
58/69	Kambala	70		29-11-69	153	8.4	54	28	250	1.2	0.1	0.3	380	2	1.0	259	598	nil	0.1	268	
4/70	Mbigili					7.9	23	18	130				6	4	0.5	42	175			25	
46/71	Kidugallo	60	12-08-71	18-08-71	114	7.8	116	30	295				126	3	1.0	142	496	4.5	nil		
		60	7-07-71	15-07-71	150	7.1	103	30	381			nil	201	6	1.1	177	560	nil	2.8		
		60	21-07-71	29-07-71	150	7.4	140	9	386	0.4		0.4	115	13	1.4	199	524	nil	15.2		
73/71	Mtibwa					6.9	56	19	810	0.9			98	2	0.4	142				37	
14/72	Mtihwa					8.5	29	19	443	1.9			57	3		61				21	
38/72	Magadu	24	24-04-72	19-05-72	650	7.4	169	152	1049	3.2		nil	936	6	0.2	2201	362	nil	0.2	95	
		36	17-06-72	10-08-72	270	7.4	149	142	952	0.1		nil	346	5	0.2	1164	121	nil	nil	55	

bore-hole no.	cations anions	TDS	H_2S	O_2	SS	turb	color	coliform	Cu	Zn	Pb
			ppm		mg/l	FTU	Pt/Co	count 100 ml		ppm	
5/63		5055									
		4810									
		4549									
18/63		2007							nil	nil	nil
		1630							nil	nil	nil
4/64		500									
		604									
		816									
13/64		1232									
18/65		2935									
		2680									
		3331								1.6	
33/65		1991									
		1800									
14/66		484									
		468									
		692									
41/67		848									
		1051									
68/68		886									
72/68		1100									
75/68		400									
		510									
78/68		425									
29/69		330									
56/69		1564							nil	nil	nil
58/69		1618									
4/70		290									
46/71		750									
		1000									
		1370									
73/71		630									
14/72		310									
38/72		4250									
		1650									

Continued 3

bore-hole no.	location	depth	date of sampling	date of analysis	spec. cond. at 25°C	pH	Ca^{2+}	Mg^{2+}	TH	Fe	Mn	NH_4^+	Na^+	K^+	F^-	Cl^-	HCO_3	NO_2	NO_3	SO_4^{2-}	PO_4^{3-}
		m			mS/m		ppm		ppm $CaCO_3$						parts per million						
95/72	Kimamba	18	18-08-72	24-08-72																	
		30	29-08-72	6-09-72																	
			14-09-72	27-10-72	150	8.1	51	62	380	75	nil	nil	115	1	0.1	102	278	nil	nil	277	
		129	39-11-72	9-12-72																	
		123	28-11-72	19-12-72	58	7.8	35	17	157	0.4		nil	66	4	0.2	29	255	nil	1.7	27	
		100-120	15-12-72	19-12-72	60	7.7	35	18	159	0.4	0.6	nil	65	6	0.2	30	234	nil	1.6		
		125	27-12-72	16-01-73	58	7.9	56	19	160	nil	0.5	nil	103	3	0.3	26	236	nil	nil	50	
175/77	Msowero				155	8.6	90	48	425	2.5		nil	215	11	1.0	173	559	nil	0.5		
226/77	Dumila				102	8.7	14	8	68	4	0.7		82	43	3.5	125	396	nil	nil		

bore-hole no.	cations anions	TDS	H_2S	O_2	SS	turb	color	coliform	Cu	Zn	Pb
			ppm		mg/l	FTU	Pt/Co	count 100 ml		ppm	
95/72		4680									
		1125									
		800									
		525									
		350									
		360									
		390									
175/77		1040									
225/77											

Data DD 4

Hydrogeological field data of existing ground water supplies

DD 4 - **Hydrogeological field data of existing ground water supplies**

village	nos. and types of ground water supplies (Nov. 1978)*						type of supply	total depth (m-GL)	aquif. depth (m-GL)	aquif. thickn. (m-GL)	aquif. type	water level (m-GL)	EC mS/m	date	regular measurement programme				remarks
	hh	hhrb	sw	psw	pbh	s									min. WL (m-GL)	max. WL (m-GL)	min. EC mS/m	max. EC mS/m	
Berega		many					psw	3.0	0-7.0	7.0	coarse sand	0.6	106	5-07-78	0.6	0.0	94	110	
							hhrb	0.7	0-7.0	7.0	coarse sand	0.6	110	5-07-78	0.6	0.0	94	110	
Bonye	no ground water supplies													8-08-78					
Bwakira Chini		5		1			pws	3.0	0-3.0	3.0	sand	0.0	18	8-08-78					
Bwakira Juu			1				sw	2.4			fine sand	1.5	39	8-08-78					
Chakwale	no ground water supplies																		
Changarawe	6		1				sw	7.0			basement	1.7	202	12-10-78					dry in dry season
							hh	0.5	0-2.7	2.7	coarse sand	0.4	8						
Changumbu	many		2				sw	2.4				1.3	13	16-10-78					
							hh	1.0	0-2.0	2.0	middle sand	0.8	10						
							hh	0.7	0-1.5	1.5	middle sand	0.5	27						aquifer is weathered sandstone
Chanzuru	8						hh	2.1			sand	1.5	100	12-10-78					
							hh	2.1			sand	1.4	160						
							hh	2.8			sand	2.5	42						
							hh	3.4			sand	2.3	60						
Chogowale	6						hh	1.0	1-3.5	2.5	sand	1.0	60	11-08-78					
Dakawa			4				sw	7.3				7.0	91	8-08-78					all wells dry in dry season
							sw	6.3				dry							
							sw	7.9				dry							
Dakawa wami			1				sw	7.1				6.8	32	15-08-78					
Dibamba			1				sw	6.8				5.5	175	15-08-78					
Difinga	5						hh	4.5			clay		9	11-08-78					
Dihinda	10						hh	2.4			sandy clay	2.4	5	11-08-78					
							hh	1.4			sandy clay	1.4	6						
Dihombo	3						hh	3.0				1.5	15	11-08-78					
Doma	many		3				sw	6.5			sandy loam	4.8	183	19-10-78					
							sw	6.0			sandy loam	3.5	137						
Dumila		many					hh	0.5	0-7.0	7.0	sand	0.5		16-06-78					
Fulwe			4				sw	6.3				2.4	26	16-06-78					dry in dry season
							sw	3.5				1.3	400						
							sw	3.4				2.1	32						
Gairo	no ground water supplies																		
Gomero		5					hhrb	1.5	0-3.0	3.0	coarse sand	1.5	70	9-08-78	2.5	1.0	65	80	
Gozo	many																		
Hembeti	3												20	16-08-78					
Idindo		many					hhrb	0.5	0-7.0	7.0	coarse sand	0.5	130	28-06-78	1.2	0.4	67	90	
Ibuti	1						hh	2.5	2.0-2.5		coarse sand	2.5	29	28-06-78					yield only 100 l/day

village	nos. and types of ground water supplies (Nov. 1978)*						type of supply	total depth (m-GL)	aquif. depth (m-GL)	aquif. thickn. (m-GL)	aquif. type	water level (m-GL)	EC mS/m	date	regular measurement programme				remarks
	hh	hhrb	sw	psw	pbh	s									min. WL (m-GL)	max. WL (m-GL)	min. EC mS/m	max. EC mS/m	
Idibo		many					hhrb	0.2	0-5.0	5.0	coarse sand	0.2	68	29-06-78	0.7	0.0	62	78	
Ihenje		2					hhrb	0.6	0-2.0	2.0	coarse sand	0.6	150	28-06-78					dry in dry season
Ilahala	4												5	25-06-78					
Italagwe			1				sw	4.2				1.5	75	6-07-78	2.0	1.0	70	100	
Iyogwe	5		1				sw	3.6			sand	0.5	3	6-07-78	1.2				
							hh	1.4			sand	0.8	82						
Kibedya	no ground water supplies																		
Kidogo Basi	2						hh					2.0	150	29-09-78					
Kidudwe	20						hh	4.5	4.0-?			4.3	33	24-08-78					
							hh	5.3	5.0-?			4.8	41						
Kidudwe	5		2				sw	3.0				2.2		24-08-78	3.4	2.0	54	58	
Ujamaa							sw	3.0				2.0							
							hh	1.8			sand + gravel	1.5							
Kiduhi				1															
Kidunda	no ground water supplies																		
Kiegea	many						hh	0.2					85	6-07-78					dry in dry season
Kigugu	no ground water supplies																		
Kihonda	no ground water supplies																		
Kilama	no ground water supplies																		
Kinonko		5					hhrb	1.5			coarse sand	1.0	120	9-10-78	2.0				
Kinyolisi		many					hhrb	0.2			coarse sand	0.1	61	6-07-78	0.6	0.0	61	70	
Kisaki				1															
Kituoni																			
Kisala	10						hh	2.2				2.1	22	24-08-78	2.8	2.0	19	24	
Kitaita	20						hh	3.7			coarse sand	3.7	9						dry in dry season
Kitete			2				sw						19	31-08-78					
Msindazi							sw	4.0			sand	3.25	18						
Kiwege	6						hh	2.0			loamy sand	2.0	9						very small yields
Kondoa	10						hh	2.5	2.2-?		sand	2.2	52		4.4	2.0	5.0	52	
Kongwa	no ground water supplies													20-07-78					
Kunke	4						hh	6.1			cemented sand	5.9	225	24-08-78			220	250	
							hh	6.7				6.6	130		6.7	6.0	130	130	
							hh	6.8				6.7	110						
							hh	6.4				6.0	80						

village	nos. and types of ground water supplies (Nov. 1978)*						type of supply	total depth (m-GL)	aquif. depth (m-GL)	aquif. thickn. (m-GL)	aquif. type	water level (m-GL)	EC mS/m	date	regular measurement programme				remarks
	hh	hhrb	sw	psw	pbh	s									min. WL (m-GL)	max. WL (m-GL)	min. EC mS/m	max. EC mS/m	
Kwaba		4					hhrb	0.4			coarse sand	0.4	125	18-10-78	1.0				
Leshata		6					hhrb	0.4				0.2	40	29-06-78	1.4	0.0	40	50	
Lubungu	2		2				sw	4.1			sandy loam	3.7	53	29-09-78					dry out
							sw	3.4				3.1	82						
Luhindo	no ground water supplies																		
Lukenge	2						swrb	1.5				1.3	20	11-08-78					pumped supply
							hh	1.4			basement	1.4	8						out of order
							hh	2.5			cemented sand	2.4	7						
Lukobe	3		1				sw	3.5				3.1	142	28-09-78		0.0			bedrock at SM
							hh	2.5			sand	2.5	12						
Luhulunge	no ground water supplies																		
Luloengwe	2	2					hh	3.0	1.5-?		middle sand	3.0	142	18-10-78	4.0				
							hh	2.5			sand	2.5	130		4.0				
							hhrb	2.0			coarse sand	2.0	100						
Mabula		8					hhrb	0.3			coarse sand	0.3	160	7-07-78	0.4	0.0	85	150	Kibedya river
							hhrb	0.1			coarse sand	0.1	85						Berega river
Machatu	no ground water supplies																		
Madege		5					hhrb	0.9			coarse sand	0.9	200	29-06-78	1.2	0.0	140	200	
Madizini	20						hh	4.1				3.0	30	24-08-78	4.1	2.8	24	30	
Madoto					1		pbh						75	25-07-78					borehole from sisal estate
Madudu	5		2				sw	7.2				3.9	60	15-08-78	6.0	3.0	55	60	never dry
							sw	3.2				3.2	64						) dry in dry
							hh	3.0			coarse sand	2.4	49		3.0	2.0	39	60	) season
Magera		10					hhrb	0.3			sand + gravel	0.3	80	7-07-78	1.8	0.0	60	110	
Magole					1		pbh						72	16-07-78					often out of order
Magomeni	4		3																
Magubike		8			1		pbh						490	10-10-78					abandoned
							hhrb	2.0				2.0	84						
Maguha						1							49	4-07-78					
Maharaka		4					hhrb	1.0			sandy loam	1.0	140	19-10-78					
							hhrb	1.0			sand		130						
Makyuy		6					hhrb	2.2				2.1	28	6-07-78					
Makuyu (Tur)	3		2				sw	10.0				4.5	26	15-08-78	7.0	4.0	26	28	
							sw	4.5			middle sand	2.6	61		3.7	2.0	49	65	
							hh	11.5			sand	11.0	64		11.5	10.5	60	80	
							hh	13.0			loam + stores	12.9	102		12.9	12.2	100	115	
Malangalo	10						hh	3.0			coarse sand	1.6	68	12-10-78					
							hh	2.8				2.4	84		5.0	2.0	70	90	

village	nos. and types of ground water supplies (Nov. 1978)*						type of supply	total depth (m-GL)	aquif. depth (m-GL)	aquif. thickn. (m-GL)	aquif. type	water level (m-GL)	EC mS/m	date	regular measurement programme				remarks
	hh	hhrb	sw	psw	pbh	s									min. WL (m-GL)	max. WL (m-GL)	min. EC mS/m	max. EC mS/m	
Malui	10		1				sw	4.8				3.6	48	12-10-78					
							hh	3.0				2.8	42						
Mamboya	4		1			1	sw	5.4				1.3	29	4-07-78					
Mamoya			6				sw	4.0				3.7	50	25-08-78	4.8	2.5	30	50	
Mandela			4				sw	9.2				6.0	115	15-08-78	9.2	6.0	115	140	)dry in dry
							sw	18.5				18.4	138		18.2	18.2	42	45	)season
							sw	19.5				19.4	115		19.5				)
							sw	25.1				22.6	68		25.1	20.4	54	69	
Mangae		6	1				sw	7.8				6.2	192	19-10-78					
							hhrb	1.0				1.0	180						
Manyinga	15						hh	1.7	0.8-?		coarse sand	1.3	34	24-08-78	1.7	1.2	33	38	
Maseyu	4		1				sw					dry		29-09-78					
							hh	1.0				1.0	60						
Matele	no ground water supplies																		
Matuli		6					hhrb	0.4			coarse sand	3.0	75	18-10-78	1.5				
Mbili		6					hhrb	0.4				0.3	50-300	5-07-78	1.3	0.0	50	330	salt and dry in dry season
Mbwade (Ma)			1				sw	12.2				9.6	128	25-07-78	10.2	9.5	105	140	
Mbwade (Bw)	no ground water supplies																		
Melela			1	1			psw	5.0			gneiss	4.1	84	19-10-78					under construction
							sw	3.0			gneiss	2.8	81						
Meshugi	no ground water supplies																		
Mfulu			5				sw	3.4				2.0	96	15-08-78	3.0	1.8			
							sw	2.2	2.1-2.3	0.2	coarse sand	2.1	21		2.6	2.0	20	40	
Mikese			4		1		pbh						820	16-06-78					abandoned
							sw	6.6				1.1	73						
							sw	7.0				1.8	80		7.0	1.0	80	100	
Milengwele-	3		1				sw	4.0				3.3	56	9-08-78					
ngwe							hh	2.7		0.1	loamy sand	2.7	140						dry in dry season
Mindu	no ground water supplies																		
Mirama			3				sw						20	15-08-78					
							sw	14.0				3.6	85	19-06-78					
							sw	14.6				7.3	98	19-06-78	9.3	6.9	84	98	
Mkalama	no ground water supplies																		
Mkambarani	8						hh	1.5			loam	1.0	80-180	25-08-78					dry in dry season
Mkulazi	4		3				sw	3.9				2.8	5	16-10-78					dry in dry season
							hh	1.0			sand	1.0	5						

village	nos. and types of ground water supplies (Nov. 1978)*						type of supply	total depth (m-GL)	aquif. depth (m-GL)	aquif. thickn. (m-GL)	aquif. type	water level (m-GL)	EC mS/m	date	regular measurement programme				remarks
	hh	hhrb	sw	psw	pbh	s									min. WL (m-GL)	max. WL (m-GL)	min. EC mS/m	max. EC mS/m	
Mkundi (mag)	no ground water supplies																		
Mkundi (Ng)	3						hh	3.5			sand	3.4	22	28-09-78	5.0				
Mlilingwa	10						hh	0.7			laterite	0.5	5	9-10-78					
							hh	0.7				0.5	8		3.0				very low yields
Mngazi	no ground water supplies																		
Msonge	no ground water supplies																		
Msongozi	4	4					hh	2.7			loamy sand	2.5	160	20-10-78					
							hh	4.1				4.0	6						
							hhrb	1.2			loamy sand	1.0	7						
Mtamba	3					3	s						400						
							hh	0.1				0.5	16						
Mtumbatu	6						hh	1.0				0.9	9	28-06-78	3.6				dry in dry season
Mugudeni	4						hh	3.9				1.8	120-180	27-06-78					
Muhenda													73	24-06-78					
Muhungamkola	3						hh	0.9				0.5	80	29-09-78					low yields
							hh	2.6				2.5	18						
							hh	1.2				1.0	125						
Mvomero			3				sw	7.0				4.7	90	11-10-78					
Mvuha	no ground water supplies																		
Mvumi	no ground water supplies																		
Mwandi		6					hhrb	0.7				0.5	80	3-08-78	0.6	0.4	80	80	
Ndole	no ground water supplies																		
Ndogomi		6					hhrb	1.4				1.3	49	29.06-78	2.1	0.0	50	170	
Ngerengere				1			psw						58	9-10-78					
Ngerengere Darajani	no ground water supplies													9-10-78					
Ngiloli	no ground water supplies													28-06-78					
Ngongoro	4		1				sw	2.1				0.4	48	9-10-78					
							hh	1.0				0.7	16		1.8				
Nguyami		6					hhrb	0.4				0.3	90-180	29-06-78	1.6	0.0	90	280	
Nyangala	2						hh						40		1.5				
Nyarutanga		5					hhrb	1.5	0-3.0	3.0	coarse sand	1.5	70	9-08-78					
Peapea	4						hh	2.5				2.1	74		3.5	2.4	58	74	
Rudewa	17						hh	9.5				6.0	50	25-07-78	6.1	6.0			
Batini							hh	7.0				5.5	28		5.9	5.4	22	28	
Rudewa Gongoni	no ground water supplies																		

village	nos. and types of ground water supplies (Nov. 1978)*						type of supply	total depth (m-GL)	aquif. depth (m-GL)	aquif. thickn. (m-GL)	aquif. type	water level (m-GL)	EC mS/m	date	regular measurement programme				remarks
	hh	hhrb	sw	psw	pbh	s									min. WL (m-GL)	max. WL m-GL)	min. EC mS/m	max. EC mS/m	
Rudewa Mbuyuni	8						hh	5.0				4.4	38	25-07-78	5.3	4.2	20	38	
Sangasanga	2						hh	2.5				2.5	40	20-10-78					very low yields
Seregete A	no ground water supplies																		
Seregete B	no ground water supplies																		
Sesenga	no ground water supplies																		
Tabu Hotel		5					hhrb	0.5				0.4	8	28-06-78					
Tambuu						4							50	21-07-78					
Tindiga	10		1				hh	4.5				3.0	40	12-10-78					
Tuho																			
Tungi	no ground water supplies																		
Ulaya	no ground water supplies																		
Vigolegole	no ground water supplies																		

hh = hand dug hole
hhrb = hand dug hole in river bed
sw = shallow well
psw = pumped supply from shallow well
pbh = pumped supply from borehole
s = spring

DATA DD 5

SUMMARY OF MWCP-HAND DRILLED HOLES APPROVED FOR CONSTRUCTION OF SHALLOW WELLS

DD 5 - **Summary of MWCP hand drilled holes, approved for construction of shallow wells**

village	hand drilling no.	total depth (m-GL)	aquifer depth from - to (m-GL)	aquifer thickness (m)	aquifer type	water level during drilling (m-GL)	tested yield (1/HR)	maximum drawdown	KD (m^2/day)	K (m/day)	EC during drilling (mS/m)	remarks
Chanzuru	182/3-1	9.5	1.5- 5.0	3.5	fine sand	1.5	1564				96	
	182/3-2	10.0	2.0- 6.8	4.8	fine sand	1.91	1632				100	
	182/3-3	10.0	2.4- 4.0	1.6	fine sand	1.93	1462				150	
			5.0- 6.4	1.4	fine sand							
			8.0-10.0	2.0	fine sand						170	
	882/3-5	8.1	1.2- 8.0	6.8	fine sand	1.28	1598					
	182/3-6	10.4	2.1- 5.8	3.7	fine sand	0.95	1245				100	
			6.0- 6.9	0.9	fine sand							
			9.8-10.4	0.6	fine sand							
	182/3-7	8.0	1.0- 2.3	1.3	fine sand	0.77	1377				61	
			4.9- 7.6	2.7	middle sand							
	182/3-8	10.0	2.0- 5.0	3.0	fine sand	2.05	1513				100	
			6.8- 7.0	0.2	fine sand							
			8.2-10.0	1.8	fine sand							
	182/3-9	12.0	2.3- 3.8	1.5	fine sand	2.50	1200				95	
			10.2-12.0	1.8	fine sand							
	182/3-10	10.0	2.5- 3.0	0.5	fine sand	0.97	1309				90	
			4.5- 5.0	0.5	fine sand							
			6.0- 7.0	1.0	fine sand							
Ilonga	182/3-23	10.0	3.0- 8.0	5.0	fine sand	3.06	1071				58	
	182/3-24	10.0	3.5-10.0	6.5	fine sand	4.31	1309				70	
	182/3-25-3	11.8	5.0- 5.6	0.6	fine sand	4.49	1139				42	
			7.0- 8.5	1.5	fine sand							
			11.2-11.8	0.6	fine sand							
	182/3-26	11.5	10,4-11.5	1.1	coarse sand	1.20	1734				27	
	182/3-27	8.5	1.7- 2.3	0.6	fine sand	1.52	1272				31	
			2.9- 8.5	5.6	fine sand							
	182/3-29	10.0	3.8- 6.1	2.3	fine sand	3.4	1200				150	
			7.0-10.0	3.0	fine sand							
Italagwe	176/1-29-2	7.0	2.3- 2.5	0.2	fine sand	2.3	1380	0.6	69	345	80	
			6.0- 7.0	1.0	middle sand							
	165/1-30	5.5	4.0- 5.5	1.5	middle sand	1.8	1200	0.4	90	60	66	
	165/1-31-2	6.5	3.0- 6.0	3.0	middle sand	2.9	1530	0.3	153	51	86	
Iyogwe	165/1-20	9.5	7.0- 9.0	2.0	fine sand	1.8	1200	0.3	120	60	110	
	165/1-21-4	7.0	1.2- 5.0	3.8	middle sand	1.4	1200	0.4	90	24	140	
	165/1-22-3	5.7	1.5- 3.0	1.5	middle sand	1.5					120	
Dakwawa	166/3-11-1	10.0	7.5- 9.1	1.6	fine sand	7.5	900				90	
Wami	166/3-12-1	11.3	9.2-11.3	1.9	middle sand	9.2	900				84	
	166/3-13-1	10.3	8.0-10.3	2.3	middle sand	7.5	900				33	
	166/3-14-1	10.0	7.5-10.0	2.5	middle sand	7.5	900				34	
Dibamba	165/4-32-2	10.0	5.9- 6.5	0.6	middle sand	5.2	1100	0.6	55	92	30	

village	hand drilling no.	total depth (m-GL)	aquifer depth from - to (m-GL)	aquifer thickness (m)	aquifer type	water level during drilling (m-GL)	tested yield (l/HR)	maximum drawdown	KD (m^2/day)	K (m/day)	EC during drilling (mS/m)	remarks
Dihombo	166/3-7-1	8.5	5.0- 8.0	3.0	fine sand	1.3	1200	0.4	90	30	30	
	166/3-6-1	8.0	4.2- 8.0	3.8	middle sand	1.7	1200	2.8	13	3	20	
	166/3-5-1	9.0	5.0- 9.0	4.0	fine sand	2.1	1400	0.4	105	26	20	
Dumila	165/4-8-2	7.0	4.0- 6.0	2.0	middle sand	3.8	1400	0.3	140	70	95	
Hembeti	165/4-17-1	9.2	8.0- 9.2	1.2	coarse sand	5.8	1200	0.4	90	75	15	
	166/3-4-1	9.0	2.0- 2.5	0.5	coarse sand	1.4	1380	0.3	138	276	60	
			6.0- 9.0	3.0	coarse sand							
	166/3-3-1	7.0	2.5- 6.8	4.3	fine sand	2.0	1400	0.7	60	14	70	
	166/3-1-1	7.5	3.5- 7.5	4.0	middle sand	1.9	1200	0.6	60	15	20	
Kibungo	183/4-12-3	3.5	0.8- 3.5	2.7	middle sand	0.8	600	0.7	26	10	45	
	183/4-11-1	5.2	1.0- 4.8	3.8	coarse sand	0.8	1000	0.7	43	11	38	
Kikundi	183/4-10-7	4.7	1.0- 3.5	2.5	middle sand	0.3	600	3.3	5	2	170	
	183/4-9-5	5.5	2.0- 5.5	3.4	sand	0.3	1300	0.3	130	37	76	
Kinouko	184/1-4-1	6.8	5.2- 6.8	1.6	fine sand	1.7	1260				150	
Kiroka	183/4-3-2	6.5	2.0- 4.5	2.5	clay sand	1.0	1000	0.1	300	120	68	
	183/4-2-3	3.0	1.4- 3.0	1.6	sand	0.5	500	2.5	6	4	70	
	183/4-1-1	3.2	2.5- 3.2	0.7	clay/stones	0.7	1000	0.3	100	143	68	
Kiziwa	183/8-3	3.3	2.0- 3.3	1.3	middle sand	1.9	1000	0.9	33	25	58	
	183/4-6-1	4.2	2.0- 4.2	2.2	middle sand	1.0	1200	0.2	180	82	88	
	183/4-5-3	5.0	0.5- 1.5	1.0	fine sand	0.6	700	3.4	6	6	74	
			3.0- 4.5	1.5	fine sand							
Kondoa	182/3-13	10.0	2.3- 7.2	4.9	fine sand	2.43	1505				50	
	182/3-14	10.0	1.8- 5.7	3.9	middle sand	1.93	1224				58	
			6.4- 7.0	0.6	fine sand							
			7.9- 8.8	0.9	fine sand							
			9.8-10.0	0.2	fine sand							
	182/3-15	10.0	1.2- 1.5	0.3	fine sand	1.37	1479				55	
			3.0- 4.9	1.9	fine sand							
			7.7- 9.0	1.3	fine sand							
	182/3-16	10.0	2.0- 2.3	0.3	fine sand	2.16	1666				37	
			2.5-10.0	7.5	fine sand							
	182/3-17	10.0	3.0- 3.8	0.8	fine sand	2.20	1241				38	
			4.3- 9.0	4.7	fine sand							
	182/3-19	11.5	2.0- 7.0	5.0	fine sand	1.31	1139				57	
	182/3-20	11.0	0.5- 5.8	5.3	fine sand	0.50	1632				100	
Konga	183/3-11-1	6.7	3.5- 6.5	3.0	loam/stones	3.5	500	2.5	6	2	50	
	183/3-9-1	9.0	5.5- 6.5	1.0	fine sand	4.8	1000				15	
Kwamtonga	166/1-17-1	9.0	5.7- 5.8	0.1	fine sand	1.9	1000	3.6	8	80	28	
	166/1-15-1	8.5	3.5- 5.5	2.0	loamy sand	0.8						
Madoto	182/1-2-1	11.0	9.3- 9.7	0.4	clay sand	3.05	629				185	
			9.8- 9.9	0.1	fine sand							
	182/1-5-1a	9.6	3.6- 4.2	0.6	fine sand	1.80	1020				70	
			9.4- 9.6	0.2	fine sand							

village	hand drilling no.	total depth (m-GL)	aquifer depth from - to (m-GL)	aquifer thickness (m)	aquifer type	water level during drilling (m-GL)	tested yield (1/HR)	maximum drawdown	KD (m^2/day)	K (m/day)	EC during drilling (mS/m)	remarks
	182/1-5-1b	8.8	4.5- 5.8	1.3	middle sand	2.90	1020				52	
			8.2- 8.8	0.6	middle sand							
Magubike	165/1-16-4	4.6	1.0- 1.3	0.3	sand	0.5	1440	0.4	108	600	88	
	165/1-17-3	7.0	5.0- 7.0	2.0	coarse sand	2.0	1275	0.2	191	96	175	
Maharaka	200/2-8-2	6.5	3.5- 6.2	2.7	middle sand	1.6	1200	0.4	90	33	100	
	200/2-7-2	4.8	0.5- 2.2	1.7	fine sand	0.5	1200	1.0	36	21	155	
			3.5- 4.8	1.3	weathered basement							
	200/2-6-1	9.0	4.5- 5.2	0.7	fine sand	2.9	1000	0.1	300	429	150	
			6.5- 8.2	1.7	middle sand							
Makuyu	165/1-24-3	7.0	4.0- 6.3	2.3	fine sand	2.7	1530	0.2	230	100	35	
	165/1-25-2	8.8	5.0- 7.0	2.0	fine sand	4.3	1530	0.35	131	66	54	
	165/1-26-2	7.5	6.0- 7.0	1.0	middle sand	1.3	1200				120	
	165/1-21-4	6.5	2.5- 6.0	3.5	fine sand	1.7	990	3.8	8	2	77	
	165/4-34-1	9.0	0.8- 2.0	1.2	sand	0.4	1150	0.4	86	72	110	
Mandela	165/4-47-2	9.0	8.2- 9.0	0.8	coarse sand	5.70	950	1.7	17	21	130	
	165/4-45-1	8.2	6.5- 8.2	1.7	middle sand	6.5	990				55	
Manza	201/1-3-2	9.0	2.0- 6.5	4.0	middle sand	1.8	1280	0.3	128	32	70	
	201/1-2-1	5.8	4.5- 5.8	1.3	stones	1.8	820	0.8	31	24	130	
	201/1-1-2	5.2	3.0- 4.5	1.5	weathered basement	0.2	1170	1.0	35	23	130	
Mbogo	166/1-14-1	9.0	5.2- 8.5	3.2	middle sand	1.6					10	
	166/1-13-1	9.0	2.0- 3.0	1.0	coarse sand	2.0	1200	0.4	90	90	19	
			5.7- 6.0	0.3	fine sand							
Mikese	183/4-15-1	7.0	1.8- 6.0	3.2	fine sand	1.1	900	4.2	6	2	120	
	183/4-16-1	6.4	2.2- 6.4	4.2	fine sand	0.4	1000				61	
	183/4-20-1	6.0	4.2- 4.5	0.3	middle sand	0.8	1100				140	
			5.8- 6.0	0.2	middle sand							
	183/4-21-1	7.0	2.0- 3.2	1.2	fine sand	0.3	1140	0.5	68	57	89	
Mirama	165/4-43-1	7.3	1.0- 7.0	6.0	middle sand	0.9	1430	1.2	36	6	50	
	165/4-44-3	10.0	2.7-5.8	3.1	middle sand	2.4	1300	0.1	390	126	20	
	165/4-40-3	11.0	0.8- 1.2	0.3	coarse sand	0.7	900				150	
			8.2- 9.1	0.9	middle sand							
			10.2-11.0	0.8	middle sand							
Mkindo	166/1-4-1	9.0	5.0- 5.8	0.8	fine sand	3.7	1240	0.7	53	66	35	
			6.5- 8.0	1.5	middle sand							
	166/1-3-1	9.0	4.0- 5.5	1.5	fine sand	4.1	1200	0.8	45	30	15	
			6.5- 9.0	2.5	loamy sand							
	166/1-2-1	9.0	6.0- 9.0	3.0	coarse sand	5.4	1200	0.7	51	17	75	
	166/1-1-1	8.0	5.0- 6.5	1.5	voarse sand	3.6	600	2.0	6	4	120	
	166/3-91-1	8.5	3.5- 5.5	2.0	loamy sand	2.0	1100	2.0	11	6	20	
			6.5- 8.5	2.0	coarse sand							

village	hand drilling no.	total depth (m-GL)	aquifer depth from - to (m-GL)	aquifer thickness (m)	aquifer type	water level during drilling (m-GL)	tested yield (1/HR)	maximum drawdown	KD (m^2/day)	K (m/day)	EC during drilling (mS/m)	remarks
Msongozi	200/2-4-1	9.5	6.0- 9.0	3.0	middle sand	3.6	1000	0.6	50	17	175	
	200/2-3-1	7.0	2.0- 7.0	5.0	loam/stones	1.9	1300	0.1	390	78	150	
	200/2-1-3	7.0	5.0- 7.0	2.0	coarse sand	1.2	1300	0.1	390	195	180	
Msufini	165/4-16-1	7.0	0.8- 1.3	0.5	fine sand	0.8	1480	4.5	10	20	70	
			4.0- 5.2	1.2	fine sand							
	165/4-15-1	7.5	3.0- 3.5	0.5	middle sand	1.8	1400	0.4	105	210	22	
			4.2- 4.8	0.6	loam							
	165/4-15-1	5.0	2.3- 4.0	1.7	fine sand	2.0	1100	2.5	13	8	62	
Mugudeni	165/4-7-1	8.2	5.8- 8.0	2.2	coarse sand	5.3	1300	0.2	195	89	80	
	165/4-6-1	7.5	3.5- 6.5	3.0	fine sand	1.1	1240	3.0	12	4	175	
	165/4-3-1	8.0	5.5- 6.5	1.0	fine sand	2.5	1200	0.2	180	180	115	
	165/4-2-1	9.0	3.5- 4.5	1.0	fine sand	1.4	1100	0.5	66	66	150	
			5.0- 8.0	3.0	fine sand							
	165/4-2-2	6.5	3.5- 5.5	2.0	fine sand	2.4	1100	0.2	165	83	150	
Mvomero	165/4-31-1	9.0	5.5- 8.6	2.6	middle sand	4.7	950	1.5	19	7	120	
	165/4-25-1	9.5	6.8- 9.5	2.7	middle sand	7.1	1200				35	
	165/4-26-1	9.0	6.5- 9.0	2.5	fine sand	1.9	1200				95	
	165/4-24-1	9.5	8.0- 9.5	1.5	loam	6.9	650					
Ngerengere	184/1-2-2	6.1	4.0- 6.1	2.1	fine sand	3.1	1330				170	
Darajani												
Rudewa	182/1-7	15.0	9.8-11.2	1.4	clay sand	4.3	1071				42	
Batini	182/1-8-1	10.0	3.7- 4.1	0.4	fine sand	5.0	646				45	
	182/1-9	10.0	4.9- 6.2	1.3	fine sand	5.0	459				70	
	182/1-10	10.0	4.8- 5.0	0.2	coarse sand	5.3	1224				35	
	182/1-11-	10.0	5.0- 6.0	1.0	loam sand	4.48	1462				24	
	182/1-13-2	11.0	6.8- 9.5	2.7	fine sand	7.25	1309				14	
	182/1-14	10.0	5.7- 9.8	4.1	coarse sand	5.6	1224				32	
	182/1-15-2	10.0	6.2- 7.5	1.3	fine sand	4.8	1207				36	
	182/1-16-1	10.0	4.1- 5.0	0.9	fine sand	4.0	1275				22	
			6.0- 6.6	0.6	fine sand							
	182/1-17	9.2	5.8- 6.9	1.1	fine sand	5.0	1241				30	
			7.2- 9.0	1.8	fine sand							
	182/1-18	12.0	5.0- 5.7	0.7	coarse sand	5.0	1530				64	
	182/1-20	11.0	6.5- 7.2	0.7	middle sand	5.68	1000				44	
	182/1-37	12.0	9.8-10.8	1.0	fine sand	5.86	540				32	
Rudewa	182/1-31-2	8.0	0.6- 3.2	2.6	middle sand	0.4	1173				20	
Gongoni	182/1-32-1	10.0	3.5- 5.3	1.8	middle sand	1.55	561				87	
Rudewa	182/1-12	10.0	5.1- 5.8	0.7	middle sand	5.3	826				24	
Mbuyuni			9.4- 9.7	0.3	fine sand							
	182/1-19	10.0	6.0- 6.5	0.5	fine sand	4.7	1676				28	
	182/1-21-1	11.5	4.0- 4.3	0.3	coarse sand	4.0	1207				25	
			6.0- 7.4	1.3	fine sand							
			7.6- 8.4	0.8	fine sand							
	182/1-22-1	9.1	4.5- 5.5	1.0	middle sand	4.57	1530				26	

village	hand drilling no.	total depth (m-GL)	aquifer depth from - to (m-GL)	aquifer thickness (m)	aquifer type	water level during drilling (m-GL)	tested yield (1/HR)	maximum drawdown	KD (m^2/day)	K (m/day)	EC during drilling (mS/m)	remarks
			5.9- 9.10	3.2	fine sand							
	182/1-23	10.0	3.9- 4.5	0.6	middle sand	4.1	1003				30	
	182/1-25-1	13.0	11.8-13.0	1.2	fine sand	5.0	1105				130	
	182/1-26-1	11.2	10.5-11.0	0.5	middle sand	3.5	969				74	
	182/1-27-1	11.0	4.0- 6.2	2.2	fine sand	3.75	1088				110	
			10.1-11.0	0.9	fine sand							
	182/1-28-1	13.5	13.2-13.5	0.3	fine sand	3.7	935				62	
	182/1-29-2	10.0	9.0- 9.7	0.7	fine sand	3.15	986				57	
	182/1-30-1	8.2	3.0- 3.2	0.2	coarse sand	2.9	1173				31	
			5.1- 8.0	2.9	middle sand							

DATA DD 6

DATA ON GEO-ELECTRICAL SOUNDINGS

Explanation of letters used in following tables:

a) The soundings have been successively numbered in chronological order per 1:50,000 topographical mapsheets.

b) Some location names are only represented on the 1:50,000 mapsheet. SE = sisal estate

c) The midpoint of the soundings are represented in kilometer co-ordinates in accordance to the 1:50,000 mapsheets.

For the investigated area these co-ordinates can be converted into length and latitude degrees with the following equations:

length: $X_{degree} = 9,05 \times 10^{-3}\ x_{km} + 34,5$

latitude: $Y_{degree} = -\ 9,03 \times 10^{-3}\ Y_{km} + 90,3$

d) Elevation in metres above sea level.

e) The azimuth of the soundings is given in the 360° system.

map-sheet	number a)	date 1978	location b)	co-ordinates c)	eleva-tion d)	L/2 max	azimuth e)
165/3	1	14-7	Mbugani	306,0-9281,8	230	200	45
165/4	1	31-5	-	334,3-9390,7	375	175	130
	2	31-5	-	329,9-9393,8	385	125	135
	3	1-6	-	308,4-9391,3	455	200	70
	4	1-6	Madudu	311,8-9392,3	455	200	85
	5	1-6	Dumila	316,4-9394,2	430	200	60
	6	1-6	Magole	319,3-9395,0	425	200	80
	7	2-6	Mandela	321,9-9397,1	430	200	40
	8	2-6	-	323,6-9398,8	430	200	60
	9	2-6	Mugudeni	326,1-9300,6	420	200	45
	10	5-6	Mvomero	327,6-9302,3	410	300	170
	11	5-6	-	327,2-9303,4	415	200	90
	12	5-6	Mirama	328,2-9395,7	395	200	135
	13	6-6	Mugudeni	325,9-9299,7	420	150	65
	14	6-6	-	326,4-9299,1	410	150	160
	15	6-6	-	327,0-9297,2	400	175	155
	16	6-6	-	331,5-9292,2	380	150	130
	17	6-6	-	327,0-9301,5	410	175	50
	18	12-6	-	326,0-9303,4	420	175	90
	19	12-6	-	324,0-9302,9	440	175	70
	20	13-6	-	329,2-9303,9	410	200	60
	21	13-6	Kigugu	330,8-9304,8	390	100	60
	22	13-6	Msufini	332,1-9305,7	390	300	40
	23	13-6	-	333,5-9306,5	390	100	100
	24	23-6	-	328,6-9302,8	400	200	80
	25	26-6	-	329,4-9302,9	400	500	100
	26	26-6	Dibamba	330,9-9303,0	390	600	60
	27	27-6	-	308,6-9291,6	455	150	80
	28	27-6	-	309,7-9291,8	450	250	55
	29	27-6	-	310,6-9292,1	450	250	75
	30	27-6	Madudu	313,1-9292,6	440	175	75
	31	28-6	-	315,5-9293,8	435	250	75
	32	28-6	-	314,3-9293,3	440	175	75
	33	28-6	-	317,2-9294,6	425	200	70
	34	28-6	Magole	319,5-9254,6	420	175	135
	35	28-6	-	320,9-9296,1	430	200	45
	36	29-6	-	326,7-9298,2	405	175	160
	37	29-6	-	332,6-9291,3	375	150	130
	38	29-6	-	333,9-9290,3	375	125	115
	39	29-6	-	329,3-9294,4	390	125	135
	40	29-6	-	328,7-9295,1	390	150	135

map-sheet	number a)	date 1978	location b)	co-ordinates c)	eleva-tion d)	L/2 max	azimuth e)
165/4	41	29-6	Mandela	322,9-9298,3	430	150	50
	42	30-6	-	332,1-9303.6	380	500	65
	43	5-7	Mbugani SE	306,7-9283,4	425	300	20
	44	5-7	Kitete SE	307,4-9284,9	425	250	20
	45	6-7	Kitete SE	307,8-9286,4	430	300	10
	46	6-7	Kitete SE	308,1-9288,2	435	250	0
	47	6-7	Kitete	307,9-9290,4	435	250	150
	48	14-7	Kitete SE	308,0-9289,6	430	350	175
	49	7-8	-	324,2-9282,4	370	100	90
	50	7-8	-	324,4-9286,4	385	200	45
	51	7-8	Magole farms	324,2-9288,3	390	200	50
	52	14-8	Magole farms	323,6-9295,0	415	200	40
	53	14-8	Magole farms	323,6-9296,2	420	200	60
	54	14-8	Mandela	321,3-9297,7	430	400	65
	55	15-8	Mandela	321,2-9298,3	440	500	0
	56	15-8	Mandela	320,8-9297,9	440	500	170
	57	15-8	Mandela	322,1-9296,7	430	175	150
	58	18-8	Dibamba	329 -9302	400	300	90
	59	18-8	Dibamba	330,1-9302,8	400	600	90
	60	18-8	Dibamba	331 -9302	395	300	80
	61	21-8	Mkundi	315 -9299	470	200	0
	62	21-8	Mkundi	315 -9298	460	200	170
	63	21-8	Mkundi	315 -9298	470	250	90
	64	21-8	Mkundi	316 -9297	460	175	170
	65	21-8	Mkundi	316 -9298	460	150	90
	66	22-8	Madudu	311,6-9292,1	440	250	85
	67	22-8	-	311,8-9290,7	430	250	85
	68	22-8	Peyapeya SE	311,9-9289,3	430	200	85
	69	22-8	Peyapeya SE	311,9-9287,8	425	175	85
	70	23-8	-	310,9-9293,2	460	300	90
	71	23-8	-	310,6-9293,9	480	300	90
	72	23-8	-	312,8-9293,5	455	250	90
	73	23-8	-	311,6-9293,4	455	300	165
	74	23-8	-	313,1-9286,3	420	250	100
	75	19-9	Mbigili SE	322,7-9289,1	395	150	50
	76	19-9	Mbigili SE	322,0-9290,3	400	200	50
	77	19-9	Mbigili SE	321,1-9291,6	405	150	55
	78	19-9	Mbigili SE	320,3-9292,3	410	175	55
	79	19-9	Mbigili SE	319,8-9289,7	405	200	140
	80	20-9	Mbigili SE	320,7-9287,2	390	200	145
	81	20-9	-	326,6-9287,0	380	100	20
	82	20-9	-	329,3-9286,2	370	75	145

map-sheet	number a)	date 1978	location b)	co-ordinates c)	elevation d)	L/2 max	azimuth e)
165/4	83	20-9	Wami Prison	330,2-9289,7	380	125	45
	84	3-10	Wami Prison	330,7-9292,8	385	125	140
	85	9-10	-	320,7-9299,7	440	250	0
	86	9-10	Magole farms	323,8-9293,6	405	200	55
	87	9-10	Magole farms	323,9-9292,0	400	200	50
	88	9-10	Magole farms	324,1-9290,3	390	100	50
	89	10-10	-	327,7-9295,8	395	125	55
	90	10-10	-	326,1-9296,3	405	175	55
	91	10-10	Mirama	327,9-9296,2	395	200	135
	92	10-10	-	328,8-9295,5	390	150	40
	93	18-10	Makuyu	320,7-9301,5	450	75	70
	94	18-10	Makuyu	320,7-9300,9	440	350	90
	95	18-10	-	320,7-9299,9	440	300	0
	96	7-11	-	324,9-9302,7	420	300	60
	97	7-11	-	324,7-9201,5	420	250	60
	98	7-11	-	327,7-9297,5	400	150	160
	99	8-11	-	329,3-9296,6	390	175	140
	100	8-11	-	328,7-9297,0	395	290	140
	101	8-11	-	325 -9300	420	400	55
	102	14-11	-	324,9-9302,3	420	500	55
	103	14-11	Mirama	329,4-9295,9	390	250	135
166/1	1	28-8	Mtibwa	351,8-9319,8	370	150	55
	2	28-8	Mtibwa	351,8-9320,7	370	150	60
	3	29-8	Mtibwa	351,2-9321,5	380	200	35
	4	29-8	Mtibwa	352,7-9319,4	370	125	55
	5	29-8	-	356 -9316	360	100	175
	6	29-8	Lukenge	348,8-9309,8	360	100	45
	7	29-8	Lukenge	348,0-9310,8	360	100	5
	8	29-8	Lukenge	349,1-9313,0	360	150	90
	9	30-8	-	351,2-9312,8	360	300	90
	10	30-8	-	354,9-9313,3	350	150	90
	11	30-8	-	349,1-9313,6	360	100	95
	12	30-8	-	349,3-9315,2	360	125	95
	13	30-8	Kidudwe	354,2-9316,3	360	100	90
	14	30-8	Mtibwa	439,6-9319,4	370	200	145
	15	31-8	Kigugu	343,0-9310,6	355	200	40
	16	31-8	Kigugu	343,6-9311,5	355	150	0
	17	31-8	Kigugu	342,2-9311,5	360	175	20
	18	31-8	Kigugu	341,8-9310,9	360	300	40
	19	31-8	-	349,7-9321,9	380	175	30
	20	1-9	Kidudwe	354,7-9317,3	360	200	20

map-sheet	number a)	date 1978	location b)	co-ordinates c)	eleva-tion d)	L/2 max	azimuth e)
166/1	21	1-9	-	349,7-9316,7	360	250	90
	22	19-10	Kigugu	342,2-9312,3	360	150	20
	23	19-10	Kigugu	342,3-9310,7	360	250	40
	24	19-10	Kigugu	343,0-9311,0	360	175	40
	25	19-10	Kigugu	343,6-9310,8	360	150	50
166/3	1	7-6	-	334,9-9289,8	370	150	110
	2	7-6	-	336,4-9289,2	365	125	110
	3	7-6	Dakawa	337,7-9288,2	360	150	155
	4	7-6	Wami SE	339,7-9286,8	360	100	60
	5	8-6	-	337,8-9289,6	360	125	0
	6	8-6	-	338,1-9291,4	360	125	5
	7	8-6	-	338,5-9293,3	360	250	15
	8	8-6	-	338,9-9295,1	360	350	5
	9	8-6	Wami SE	339,0-9286,4	360	60	155
	10	9-6	-	338,9-9296,7	360	250	0
	11	9-6	-	338,9-9298,3	360	125	5
	12	9-6	-	338,8-9299,9	360	125	170
	13	9-6	-	338,8-9301,2	360	150	5
	14	14-6	Dihombo	338,5-9307,9	360	125	55
	15	14-6	-	339,4-9308,9	360	125	35
	16	14-6	Hembeti SE	337,0-9307,1	365	200	55
	17	14-6	Hembeti	335,5-9306,9	375	200	90
	18	15-6	-	339,7-9285,3	360	100	155
	19	15-6	Luhindo	340,2-9283,8	360	125	0
	20	15-6	-	340,5-9282,4	370	100	160
	21	20-6	Wami SE	339,4-9285,2	360	100	60
	22	20-6	Wami SE	340,2-9282,5	410	150	55
	23	22-6	Dihombo	338,5-9307,9	360	30	55
	24	22-6	-	338,9-9302,4	360	200	10
	25	22-6	-	339,0-9303,5	360	175	5
	26	22-6	-	339,2-9304,6	360	125	5
	27	23-6	-	339,2-9305,9	360	125	145
	28	23-6	-	338,9-9306,8	360	200	160
	29	23-6	Dihombo	338,6-9307,6	360	175	155
	30	23-6	Hembeti	337,1-9307,3	365	200	55
	31	16-8	Wami SE	338,9-9285,0	360	200	60
	32	16-8	Wami SE	338,4-9284,8	360	300	150
	33	16-8	-	340,0-9286,0	360	200	55
	34	16-8	-	339,3-9285,9	360	200	150
	35	16-8	-	339,9-9284,8	360	100	150
	36	17-8	-	338,5-9286,9	350	100	135
	37	17-8	Dakawa	337,7-9288,8	360	100	20

map-sheet	number a)	date 1978	location b)	co-ordinates c)	elevation d)	L/2 max	azimuth e)
166/3	38	17-8	-	337,5-9288,6	360	200	150
	39	17-8	-	336,5-9288,8	360	150	75
	40	17-8	-	336,7-9288,0	360	175	45
	41	17-8	-	337,4-9297,4	360	100	0
181/4	1	19-7	Kilosa	276,3-9245,3	490	400	75
	2	2-8	-	276,8-924²,4	490	350	15
182/1	1	4-7	Msowero	302,9-9278,4	435	600	45
	2	5-7	-	303,9-9279,5	420	500	35
	3	5-7	Mbugani	304,9-9280,7	425	500	45
	4	10-7	Msowero	302,1-9277,6	435	250	10
	5	10.7	Msowero SE	301,5-9276,0	420	250	35
	6	10-7	Msowero SE	300,6-9274,7	420	250	35
	7	11-7	Msowero SE	299,8-9273,3	420	600	30
	8	11-7	-	297,2-9269,7	235	125	20
	9	11-7	Tanganyika SE	206,6-9268,1	235	150	15
	10	11-7	Tanganyika SE	295,9-9266,9	440	150	30
	11	11-7	Tanganyika SE	294,8-9265,1	440	100	30
	12	11-7	Rudewa-Gongoni	293,8-9263,6	440	125	30
	13	12-7	Rudewa-Batini	292,6-9260,9	235	600	5
	14	13-7	Rudewa-Batini	292,4-9261,2	235	500	30
	15	13-7	-	291,3-9260,1	435	600	60
	16	20-7	-	289,8-9259,1	440	300	40
	17	21-7	Ilonga SE	288,5-9257,8	445	150	40
	18	24-7	Msimba	287,4-9256,5	460	175	40
	19	24-7	Msimba	286,3-9255,3	470	400	40
	20	24-7	Ilonga SE	285,2-9254,0	490	450	40
	21	26-7	Rudewa SE	292,4-9259,2	440	500	40
	22	27-7	Madoto	292,9-9254,3	440	700	150
	23	28-7	-	292,4-9256,3	440	600	150
	24	3-8	Tanganyika SE	296,8-9267,7	440	200	30
	25	3-8	Tanganyika SE	297,0-9266,7	425	800	25
	26	3-8	-	297,4-9264,6	420	600	25
	27	24-8	Msowero SE	304,5-9276,2	420	600	15
	28	24-8	Msowero SE	302,3-9277,4	430	400	10
	29	24-8	-	305,7-9276,1	420	400	100
	30	25-8	Msowero SE	302,9-9276,8	425	500	15
	31	25-8	Dundumwa	304,9-9277,1	420	250	115
	32	25-8	-	304,1-9278,5	425	175	80
	33	26-10	-	294,2-9263,4	440	60	30
	34	26-10	-	294,9-9263,4	440	175	20
	35	26-10	-	297,3-9263,3	420	300	30

map-sheet	number a)	date 1978	location b)	co-ordinates c)	elevation d)	L/2 max	azimuth e)
182/1	36	27-10	Kimamba SE	294,1-9255,9	430	500	175
	37	27-10	Madoto SE	295,4-9253,6	430	700	170
	38	27-10	-	290,7-9258,4	435	300	70
	39	9-11	-	294,6-9263,3	435	250	45
	40	9-11	-	297,9-9264,4	420	500	15
	41	9-11	-	295,6-9264,1	435	200	145
182/3	1	19-7	-	280,7-9246,1	490	300	70
	2	19-7	-	282,3-9246,5	475	300	70
	3	19-7	-	283,8-9247,1	470	300	70
	4	24-7	Ilonga SE	284,2-9252,7	500	300	45
	5	25-7	-	281,3-9247,4	490	600	30
	6	25-7	-	282,3-9249,2	490	500	25
	7	25-7	Ilonga	283,0-9250,6	490	175	25
	8	25-7	-	285,4-9247,5	465	250	75
	9	25-7	-	287,1-9248,4	455	700	35
	10	26-7	Mpirani	288,5-9249,3	450	800	65
	11	26-7	-	289,8-9250,7	450	800	40
	12	27-7	Kimamba	293,8-9251,0	440	600	160
	13	27-7	Madoto SE	293,4-9252,8	440	600	160
	14	28-7	-	289,8-9252,5	440	700	80
	15	28-7	Kimamba	293,8-9251,0	440	250	160
	16	31-7	-	295,5-9249,2	435	300	160
	17	31-7	Kimamba	294,8-9248,9	435	400	160
	18	1-8	Kimamba	293,4-9249,9	440	400	100
	19	1-8	Kimamba	293,5-9249,6	440	500	75
	20	1-8	Kimamba	296,0-9250,1	435	700	75
	21	2-8	Tanzania SE	280,1-9239,9	480	200	100
	22	2-8	Tanzania SE	280,0-9240,0	480	350	100
	23	4-8	Kimamba	294,7-9250,9	435	700	80
	24	4-8	Madoto SE	296,3-9252,0	435	800	80
	25	4-9	Mbwade	297,7-9252,9	430	600	170
	26	4-9	Mbwade	298,5-9252,4	430	400	80
	27	7-9	-	299,8-9252,6	430	200	80
	28	7-9	-	300,9-9252,8	425	600	80
	29	7-9	-	302,1-9252,9	420	500	80
	30	8-9	Mbwade	298,8-9251,8	430	500	170
	31	8-9	-	299,3-9253,1	430	600	180
	32	8-9	-	303,7-9252,6	420	700	100
	33	11-9	-	305,8-9251,7	420	700	80
	34	11-10	Mkata Ujamaa	302,1-9231,3	430	175	140
	35	11-10	Mkata Ujamaa	303,3-9230,5	430	150	145

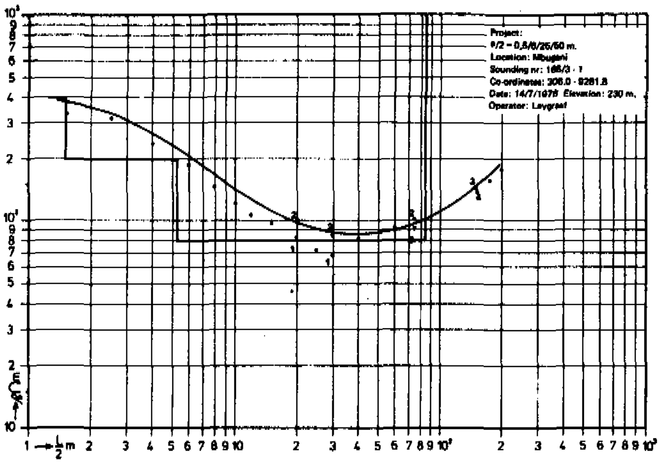
map-sheet	number a)	date 1978	location b)	co-ordinates c)	eleva-tion d)	L/2 max	azimuth e)
182/3	36	11-10	Mkata Ujamaa	302,6-9230,8	430	350	45
	37	12-10	Mkata Ujamaa	301,9-9231,0	430	75	45
	38	12-10	Mkata Ujamaa	302,7-9231,0	430	400	45
	39	12-10	-	304,5-9229,5	440	100	135
	40	12-10	-	305,7-9228,4	450	200	165
	41	24-10	Kilangali	287,2-9231,9	450	150	135
	42	24-10	Kwungu SE	286,2-9232,3	450	250	130
	43	24-10	-	285,0-9233,2	460	200	130
	44	24-10	Kondoa	284,4-9246,2	465	350	70
	45	25-10	Malangali	290,3-9244,1	450	200	90
	46	25-10	-	288,8-9244,2	450	100	65
	47	25-10	Mabwere-bwere	287,3-9243,8	455	200	55
	48	25-10	Manyema	285,8-9243,6	460	400	95
	49	26-10	-	282,7-9245,5	470	400	70
	50	10-11	.	289,5-9244,4	450	500	90
	51	10-11	Mabwere-bwere	287,1-9243,3	455	200	90
	52	10-11	-	284,1-9244,9	465	100	90
	53	13-10	-	293,0-9247,2	445	600	75
	54	13-11	-	282,5-9244,9	470	800	85
182/4	1	11-9	-	307,6-9252,0	415	700	85
	2	11-9	-	309,3-9252,2	415	700	85
	3	12-9	-	310,7-9252,4	410	700	85
	4	12-9	-	312,3-9252,6	410	700	86
	5	12-9	-	313,9-9252,8	405	700	85
	6	13-9	-	315,5-9252,9	400	700	85
	7	13-9	-	317,4-9252,9	400	400	90
	8	13-9	-	320,4-9252,9	400	250	105
	9	13-9	-	319,4-9252,8	400	500	95
	10	14-9	-	321,6-9252,1	400	200	145
	11	14-9	-	322,3-9250,7	410	150	160
	12	14-9	-	322,8-9249,1	420	300	160
	13	14-9	-	323,1-9257,7	420	175	180
	14	14-9	-	324,1-9246,6	430	150	125
	15	14-9	-	325,5-9245,9	440	350	115
	16	14-9	-	326,9-9245,2	450	200	115
	17	15-9	-	327,8-9244,0	460	200	150
	18	15-9	-	328,5-9242,6	465	175	0
	19	15-9	-	328,6-9240,9	480	150	160
	20	15-9	-	328,6-9240,8	480	150	160
	21	15-9	-	329,1-9239,2	500	150	0
	22	26-9	-	329,8-9236,6	520	175	75

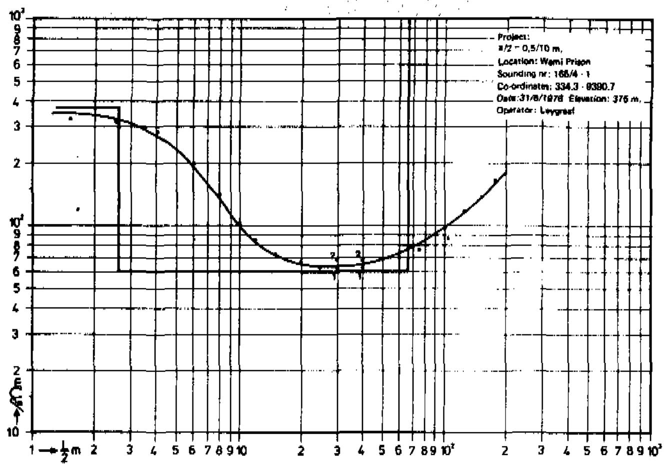
map-sheet	number a)	date 1978	location b)	co-ordinates c)	elevation d)	L/2 max	azimuth e)
182/4	23	26-9	-	331,8-9236,9	520	150	120
	24	26-9	-	333,8-9235,8	570	150	135
	25	13-10	-	308,3-9226,4	470	150	120
	26	13-10	-	309,1-9226,1	470	175	110
183/1	1	15-6	-	341,2-9281,1	375	150	150
	2	15-6	-	341,6-9279,5	385	125	0
	3	15-6	-	341,9-9278,0	390	300	180
	4	16-6	-	342,1-9276,5	395	125	155
	5	16-6	-	342,6-9275,1	400	100	145
	6	16-6	-	343,4-9273,9	415	300	150
	7	16-6	-	344,1-9272,3	425	200	165
	8	16-6	-	344,2-9270,9	430	100	155
	9	16-6	-	344,9-9269,7	440	200	140
	10	19-6	-	345,5-9268,1	460	75	150
	11	19-6	-	346,2-9266,7	480	100	135
	12	19-6	-	347,0-9263,5	490	150	155
	13	19-6	-	347,5-9263,9	510	200	160
	14	20-6	-	344,2-9270,6	430	75	155
	15	20-6	-	341,7-9279,9	380	100	60
	16	20-6	-	342,0-9277,5	390	150	80
	17	21-9	-	351,0-0254,5	510	100	150
	18	21-9	-	350,7-9256,2	520	150	165
	19	21-9	Mkundi	350,4-9257,7	570	200	165
	20	21-9	Mkundi	349,7-9259,2	580	200	145
	21	21-9	Mkundi	348,7-9260,5	580	125	155
	22	25-9	-	348,3-9262,0	560	250	160
	23	28-9	Tungi SE	357,6-9254,8	480	100	85
	24	28-9	Tungi SE	357,4-9256,0	490	100	85
	25	28-9	Tungi SE	357,3-9256,2	500	200	85
183/2	1	4-10	Mikese	379,8-9255,9	380	30	10
183/3	1	30-5	Kihonda	351,9-9250,6	480	150	175
	2	30-5	Kihonda	351,8-9251,6	480	100	160
	3	21-9	Kihonda	351,2-9252,8	490	300	160
	4	25-9	-	352,0-9249,7	500	300	175
	5	25-9	-	352,3-9248,2	510	100	175
	6	25-9	Morogoro	352,4-9246,0	500	100	175
	7	25-9	Morogoro	352,9-9245,1	500	100	175
	8	26-9	-	334,8-9234,6	600	100	120
	9	26-9	Kinyenze	336,3-9233,4	570	175	90

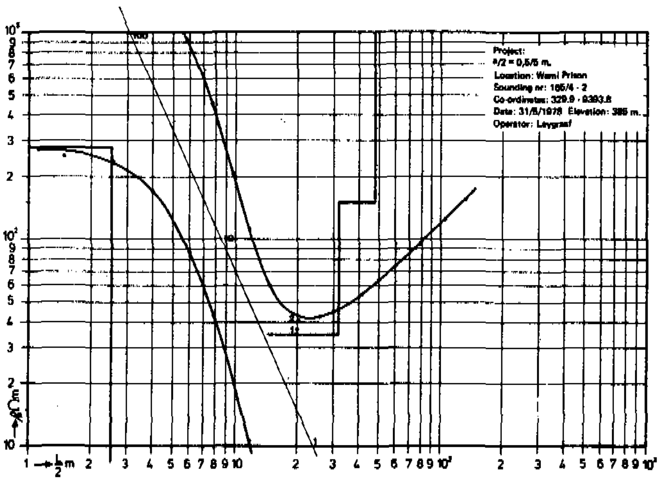
map-sheet	number a)	date 1978	location b)	co-ordinates c)	elevation d)	L/2 max	azimuth e)
183/3	10	28-9	Tungi SE	358,3-9252,4	480	100	90
	11	28-9	Tungi SE	357,6-9250,9	480	100	90
	12	28-9	Tungi SE	357,5-9249,4	500	175	90
	13	29-9	Morogoro	353,3-9243,7	540	75	30
	14	29.9	Morogoro	353,7-9244,2	540	100	145
	15	29-9	Tanke SE	350,3-9242,9	520	75	40
	16	2-10	-	338,3-9232,7	560	350	145
	17	2-10	Mlali	338,3-9231,4	580	175	110
	18	2-10	Mlali	338,2-9230,5	580	100	20
	19	13-10	Tanke SE	349,5-9244,4	505	125	135
183/4	1	4-10	-	379,2-9250,7	420	100	10
	2	4-10	-	379,3-9250,1	400	50	130
	3	4-10	-	379,1-9251,3	400	75	170
	4	4-10	-	379,2-9253,8	400	100	0
	5	5-10	-	366,1-9248,4	490	100	50
	6	5-10	Mgugu	72,6-9247,9	440	100	120
	7	5-10	-	366,9-9248,8	485	300	60
	8	5-10	Pangawe	365,2-9247,7	540	100	90
	9	5-10	Pangawe	365,7-9247,6	520	150	130
184/1	1	6-10	-	393,4-9264,9	280	75	60
	2	6-10	-	393,5-9264,8	280	125	140
	3	6-10	-	392,6-9265,0	280	75	140
	4	6-10	-	393,5-9265,5	280	30	35
	5	6-10	-	394,1-9264,2	280	75	0
200/2	1	13-10	-	309,8-9225,6	480	175	40

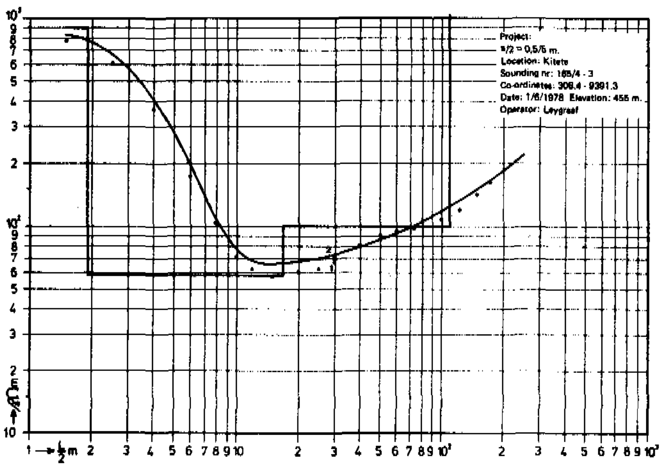
DATA DD 7

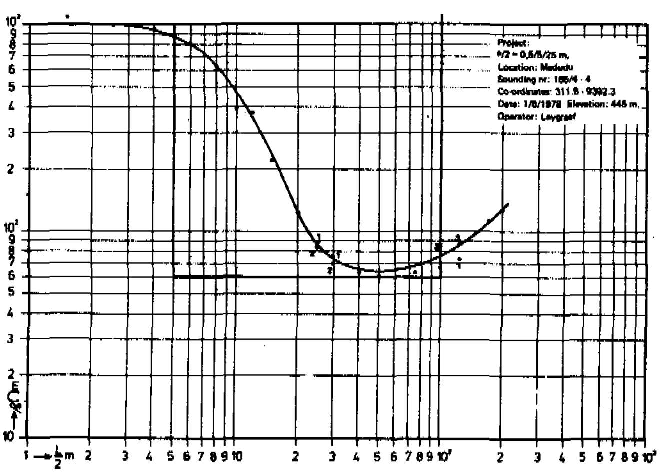
THE GEO-ELECTRICAL SOUNDINGS AND THEIR INTERPRETATIONS

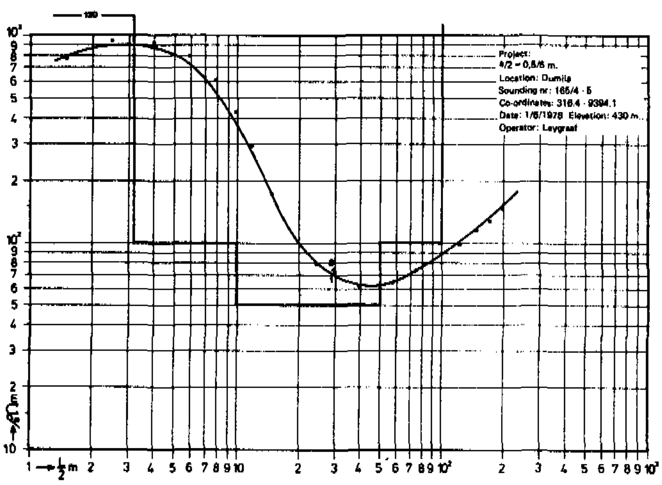

Project:
a/2 = 0,5/5/25/50 m.
Location: Mbugani
Sounding nr: 165/3 - 1
Co-ordinates: 306.0 - 9281.8
Date: 14/7/1978 Elevation: 230 m.
Operator: Leygraaf

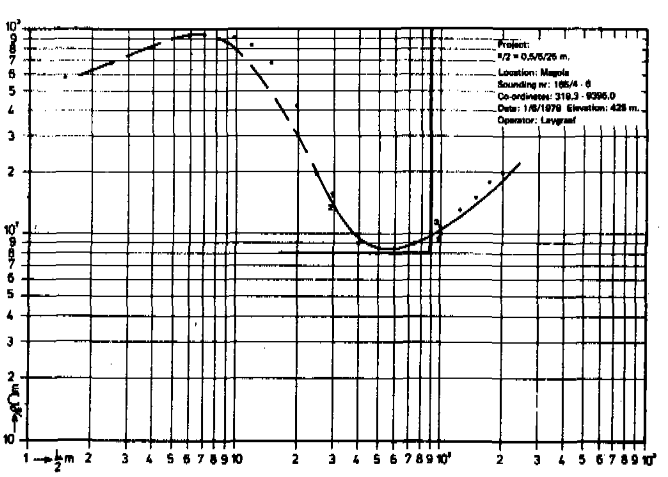

Project:
a/2 = 0,5/10 m.
Location: Wami Prison
Sounding nr: 165/4 - 1
Co-ordinates: 334.3 - 9390.7
Date: 31/5/1978 Elevation: 375 m.
Operator: Leygraaf

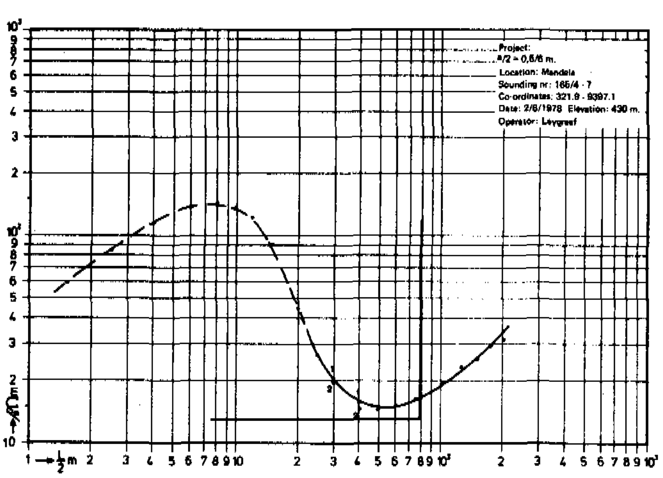

Project:
a/2 = 0,5/5 m.
Location: Wami Prison
Sounding nr: 165/4 - 2
Co-ordinates: 329.9 - 9393.8
Date: 31/5/1978 Elevation: 385 m.
Operator: Leygraaf

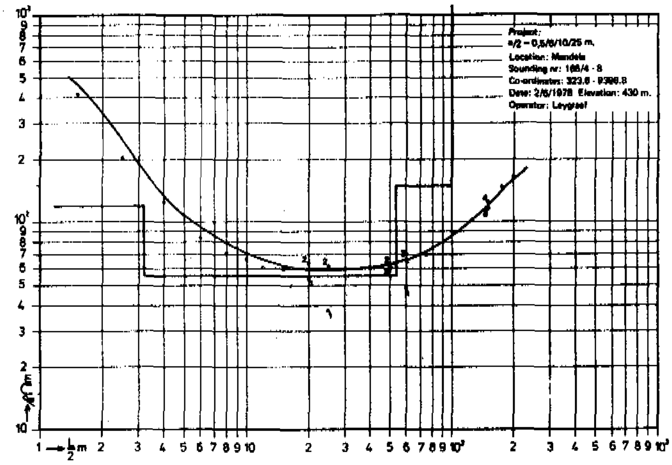

Project:
a/2 = 0,5/5 m.
Location: Kitete
Sounding nr: 165/4 - 3
Co-ordinates: 306.4 - 9391.3
Date: 1/6/1978 Elevation: 455 m.
Operator: Leygraaf

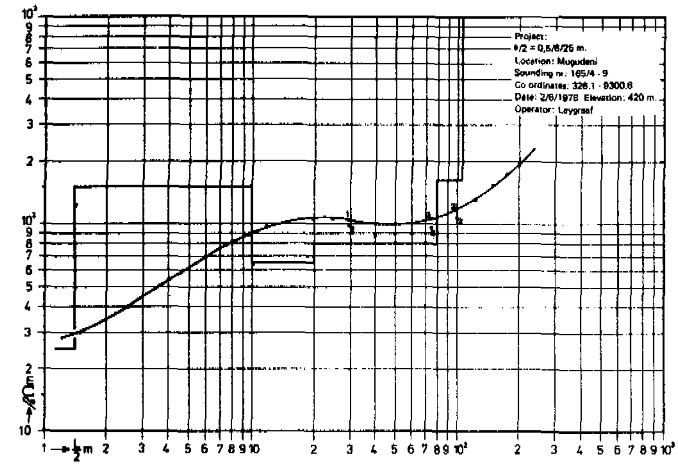

Project:
a/2 = 0,5/5/25 m.
Location: Madudu
Sounding nr: 165/4 - 4
Co-ordinates: 311.8 - 9392.3
Date: 1/6/1978 Elevation: 445 m.
Operator: Leygraaf

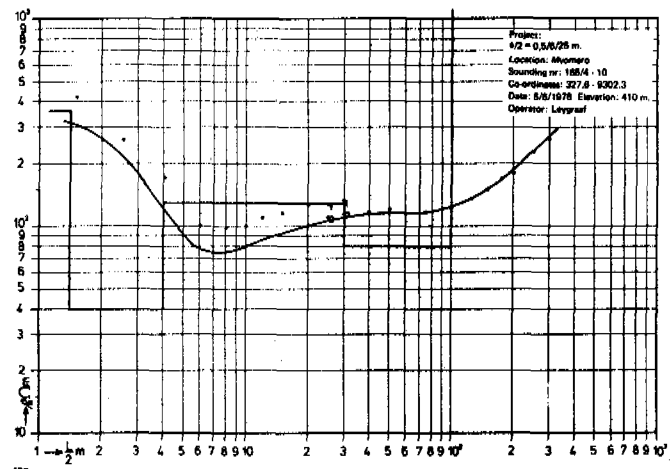

Project:
a/2 = 0,5/5 m.
Location: Dumila
Sounding nr: 165/4 - 5
Co-ordinates: 316.4 - 9394.1
Date: 1/6/1978 Elevation: 430 m.
Operator: Leygraaf

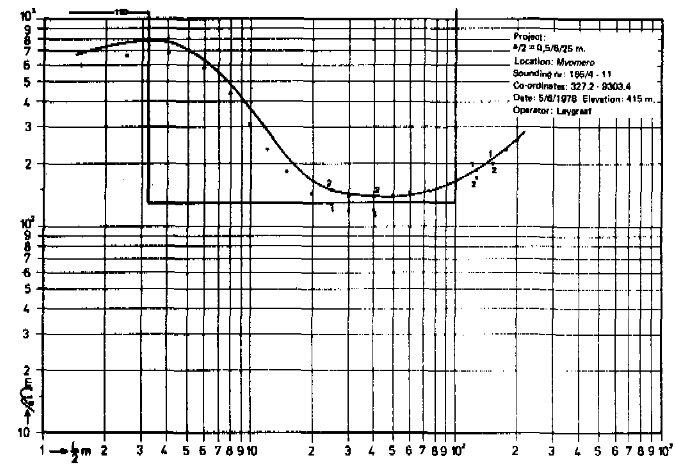

Project:
a/2 = 0,5/5/25 m.
Location: Magole
Sounding nr: 165/4 - 6
Co-ordinates: 319.3 - 9395.0
Date: 1/6/1978 Elevation: 425 m.
Operator: Leygraaf

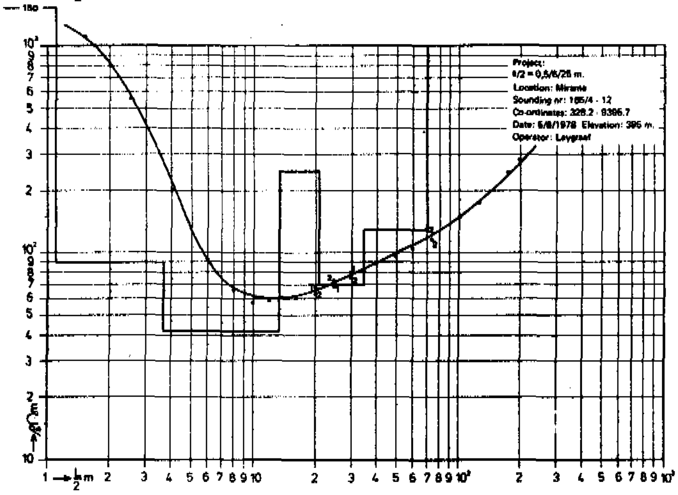

Project:
a/2 = 0,5/5 m.
Location: Mandela
Sounding nr: 165/4 - 7
Co-ordinates: 321.9 - 9397.1
Date: 2/6/1978 Elevation: 430 m.
Operator: Leygraaf

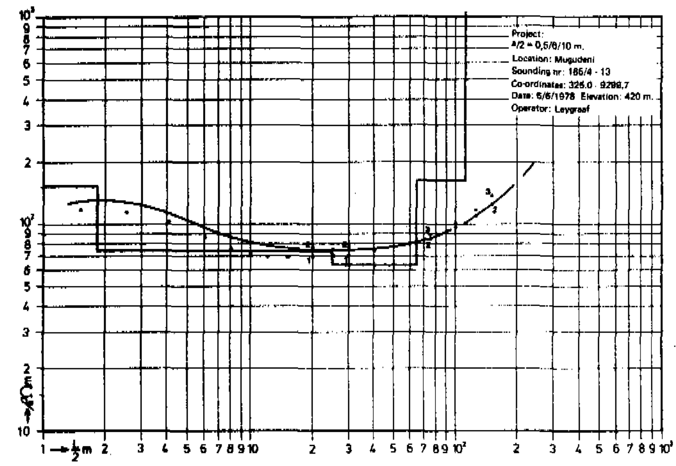

Project:
a/2 = 0,5/6/10/25 m.
Location: Mandela
Sounding nr: 165/4 - 8
Co-ordinates: 323.6 - 9298.8
Date: 2/6/1978 Elevation: 430 m.
Operator: Leygraaf

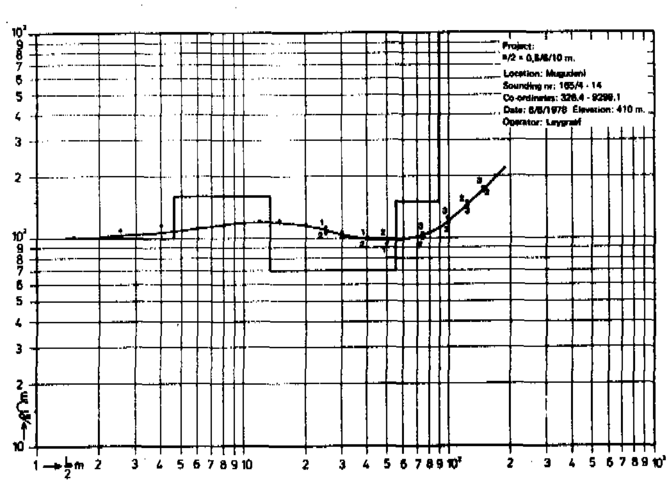

Project:
a/2 = 0,5/6/25 m.
Location: Mugudeni
Sounding nr: 165/4 - 9
Co ordinates: 326.1 - 9300.6
Date: 2/6/1978 Elevation: 420 m.
Operator: Leygraaf

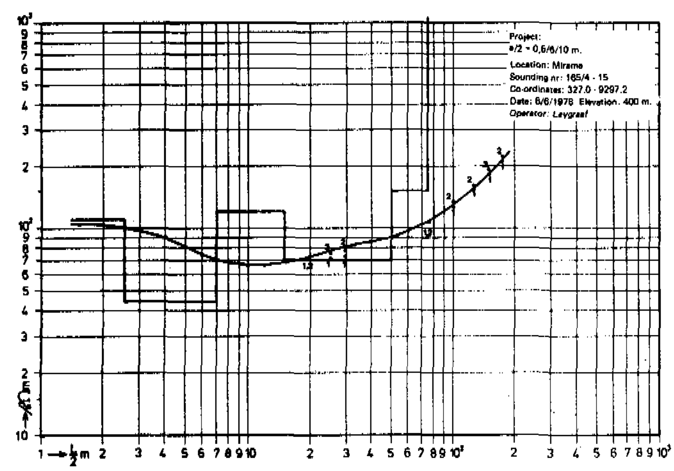

Project:
a/2 = 0,5/6/25 m.
Location: Mvomero
Sounding nr: 165/4 - 10
Co-ordinates: 327.8 - 9302.3
Date: 5/6/1978 Elevation: 410 m.
Operator: Leygraaf

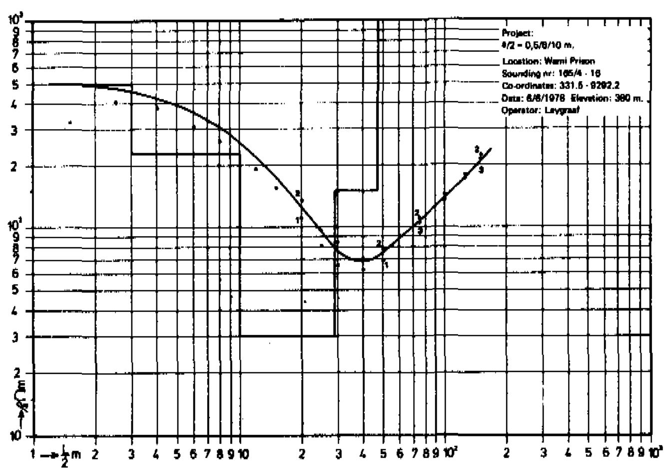

Project:
a/2 = 0,5/6/25 m.
Location: Mvomero
Sounding nr: 165/4 - 11
Co-ordinates: 327.2 - 9303.4
Date: 5/6/1978 Elevation: 415 m.
Operator: Leygraaf

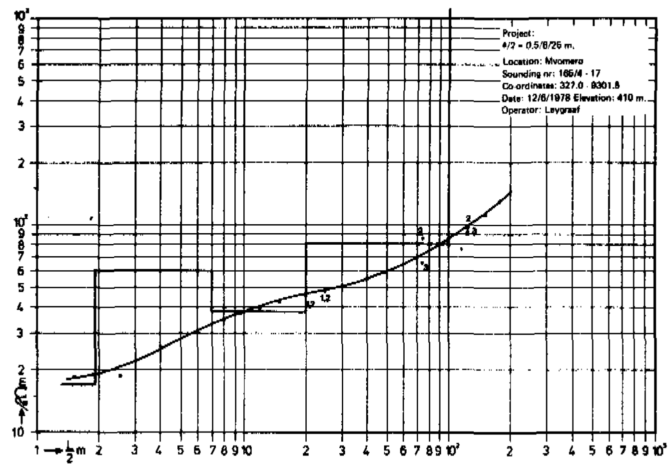

Project:
a/2 = 0,5/6/25 m.
Location: Mirama
Sounding nr: 165/4 - 12
Co-ordinates: 328.2 - 9296.7
Date: 6/6/1978 Elevation: 395 m.
Operator: Leygraaf

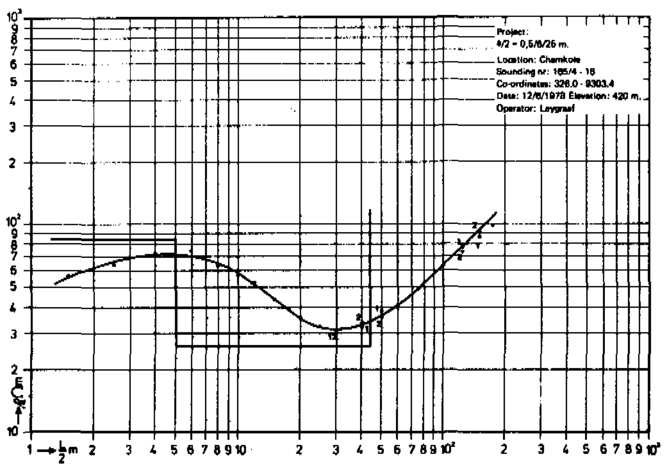

Project:
a/2 = 0,5/6/10 m.
Location: Mugudeni
Sounding nr: 165/4 - 13
Co-ordinates: 326.0 - 9298.7
Date: 6/6/1978 Elevation: 420 m.
Operator: Leygraaf

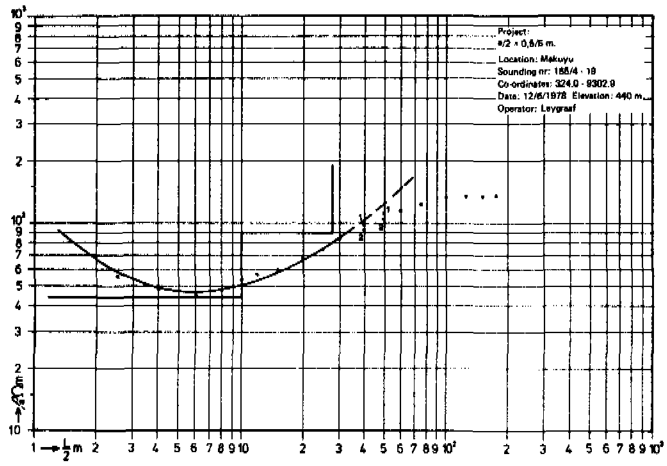

Project:
a/2 = 0,5/6/10 m.
Location: Mugudeni
Sounding nr: 165/4 - 14
Co-ordinates: 326.4 - 9299.1
Date: 6/6/1978 Elevation: 410 m.
Operator: Leygraaf

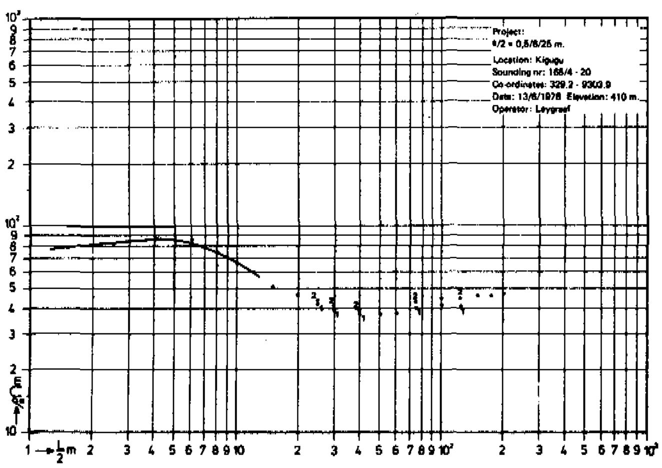

Project:
a/2 = 0,5/6/10 m.
Location: Mirama
Sounding nr: 165/4 - 15
Co-ordinates: 327.0 - 9297.2
Date: 6/6/1978 Elevation: 400 m.
Operator: Leygraaf

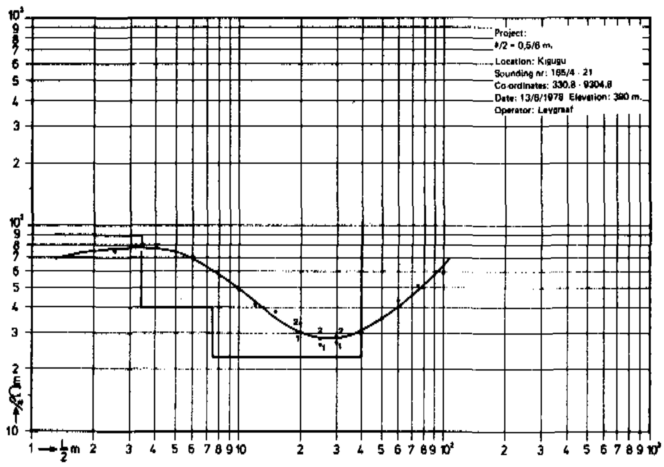

Project:
a/2 = 0,5/8/10 m.
Location: Wami Prison
Sounding nr: 165/4 - 16
Co-ordinates: 331.5 - 9292.2
Date: 6/6/1978 Elevation: 380 m.
Operator: Leygraaf
1 → L/2 m 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 10² 2 3 4 5 6 7 8 9 10³
ρa Ωm

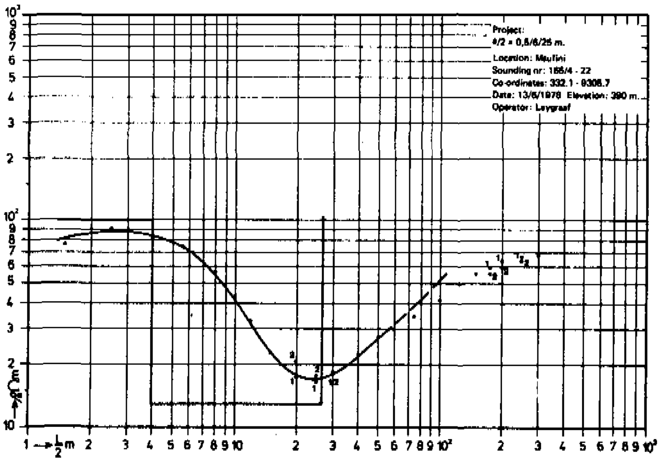

Project:
a/2 = 0.5/8/25 m.
Location: Mvomero
Sounding nr: 165/4 - 17
Co-ordinates: 327.0 - 9301.8
Date: 12/6/1978 Elevation: 410 m.
Operator: Leygraaf
1 → L/2 m 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 10² 2 3 4 5 6 7 8 9 10³
ρa Ωm

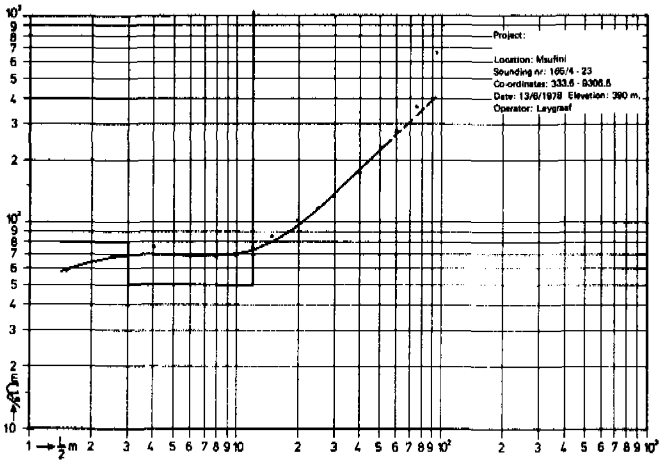

Project:
a/2 = 0,5/8/25 m.
Location: Chamkole
Sounding nr: 165/4 - 18
Co-ordinates: 326.0 - 9303.4
Date: 12/6/1978 Elevation: 420 m.
Operator: Leygraaf
1 → L/2 m 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 10² 2 3 4 5 6 7 8 9 10³
ρa Ωm

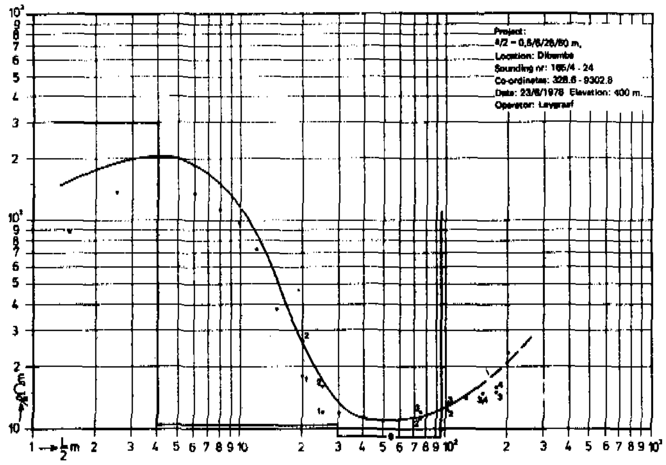

Project:
a/2 = 0,5/5 m.
Location: Makuyu
Sounding nr: 165/4 - 19
Co-ordinates: 324.0 - 9302.9
Date: 12/6/1978 Elevation: 440 m.
Operator: Leygraaf
1 → L/2 m 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 10² 2 3 4 5 6 7 8 9 10³
ρa Ωm

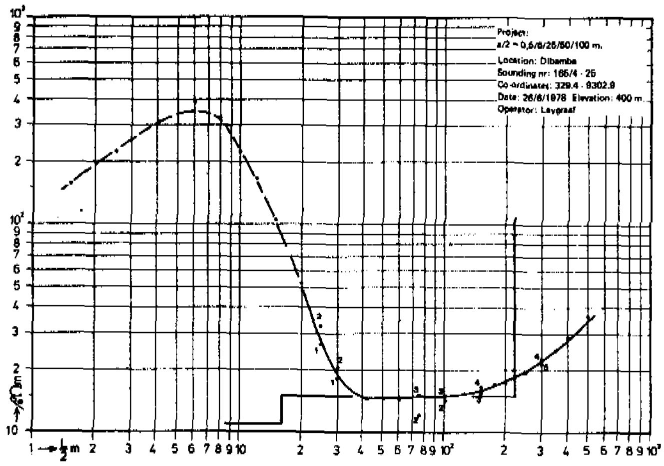

Project:
a/2 = 0,5/8/25 m.
Location: Kigugu
Sounding nr: 165/4 - 20
Co-ordinates: 329.2 - 9300.9
Date: 13/6/1978 Elevation: 410 m.
Operator: Leygraaf
1 → L/2 m 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 10² 2 3 4 5 6 7 8 9 10³
ρa Ωm

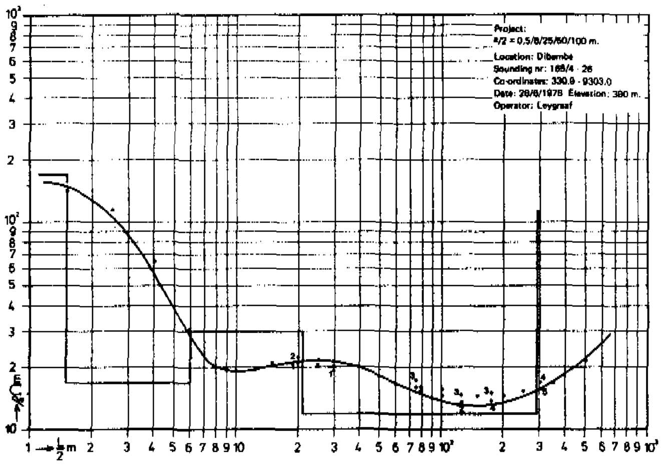

Project:
a/2 = 0,5/8 m.
Location: Kigugu
Sounding nr: 165/4 - 21
Co-ordinates: 330.8 - 9304.8
Date: 13/6/1978 Elevation: 390 m.
Operator: Leygraaf
1 → L/2 m 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 10² 2 3 4 5 6 7 8 9 10³
ρa Ωm

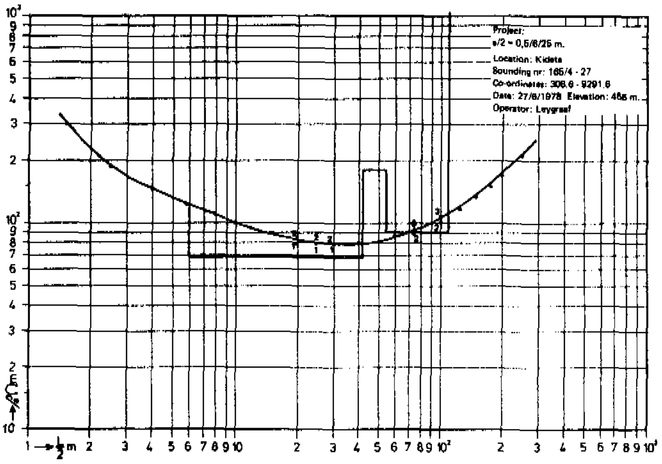

Project:
a/2 = 0,5/6/25 m.
Location: Msufini
Sounding nr: 165/4 - 22
Co-ordinates: 332.1 - 9306.7
Date: 13/6/1978 Elevation: 390 m.
Operator: Leygraaf
1 → L/2 m 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 10² 2 3 4 5 6 7 8 9 10³
ρa Ωm

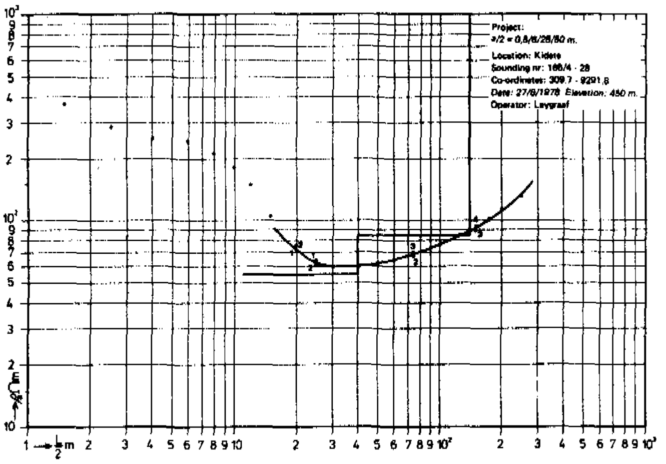

Project:
Location: Msufini
Sounding nr: 165/4 - 23
Co-ordinates: 333.6 - 9306.6
Date: 13/6/1978 Elevation: 390 m.
Operator: Leygraaf
1 → L/2 m 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 10² 2 3 4 5 6 7 8 9 10³
ρa Ωm

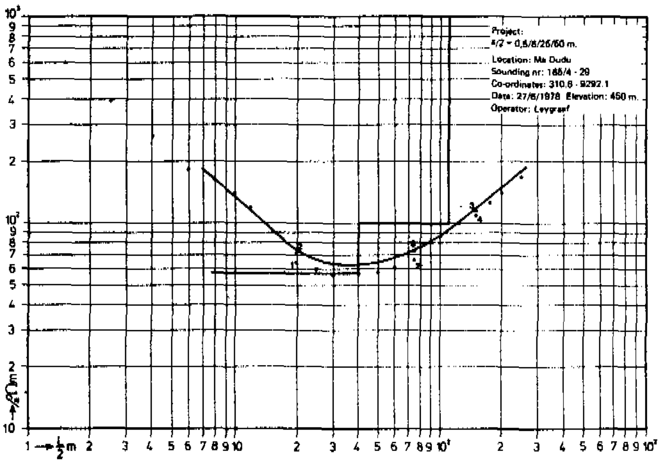

Project:
a/2 = 0,5/6/25/50 m.
Location: Dibamba
Sounding nr: 165/4 - 24
Co-ordinates: 328.6 - 9302.8
Date: 23/6/1978 Elevation: 400 m.
Operator: Leygraaf

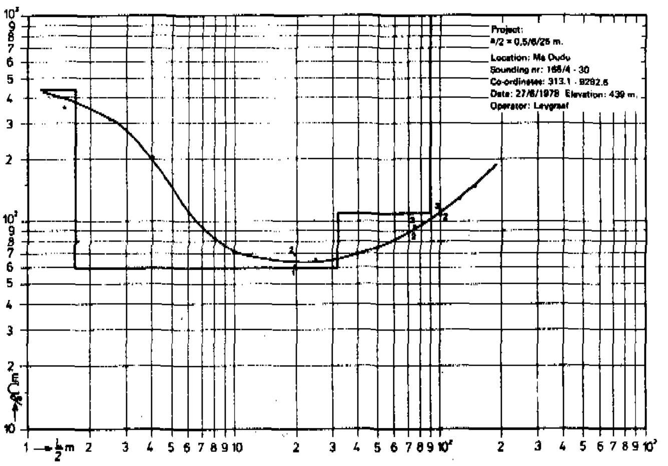

Project:
a/2 = 0,5/6/25/50/100 m.
Location: Dibamba
Sounding nr: 165/4 - 25
Co-ordinates: 329.4 - 9302.9
Date: 26/6/1978 Elevation: 400 m.
Operator: Leygraaf

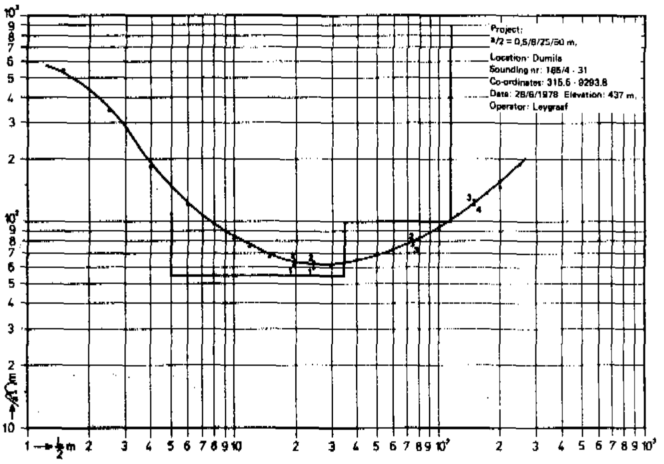

Project:
a/2 = 0,5/6/25/50/100 m.
Location: Dibamba
Sounding nr: 165/4 - 26
Co-ordinates: 330.9 - 9303.0
Date: 26/6/1978 Elevation: 380 m.
Operator: Leygraaf

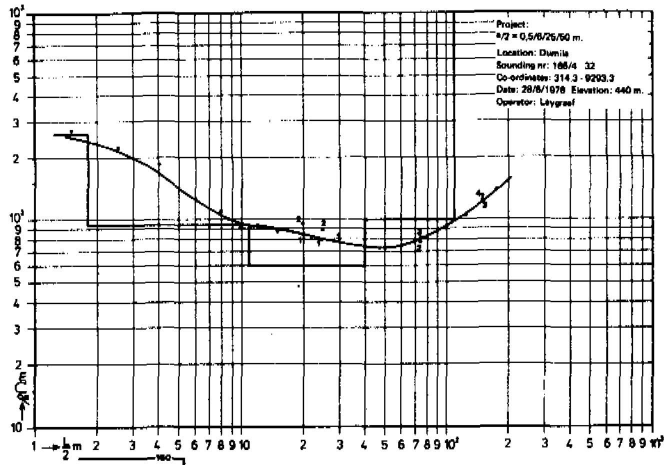

Project:
a/2 = 0,5/6/25 m.
Location: Kidete
Sounding nr: 165/4 - 27
Co-ordinates: 308.6 - 9291.6
Date: 27/6/1978 Elevation: 466 m.
Operator: Leygraaf

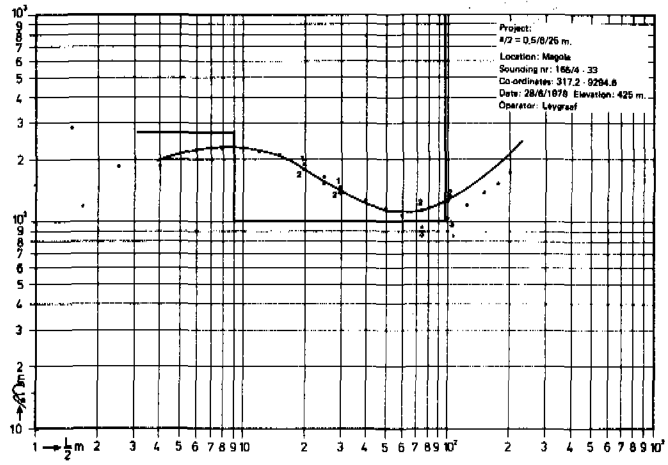

Project:
a/2 = 0,5/6/25/50 m.
Location: Kidete
Sounding nr: 165/4 - 28
Co-ordinates: 309.7 - 9291.6
Date: 27/6/1978 Elevation: 450 m.
Operator: Leygraaf

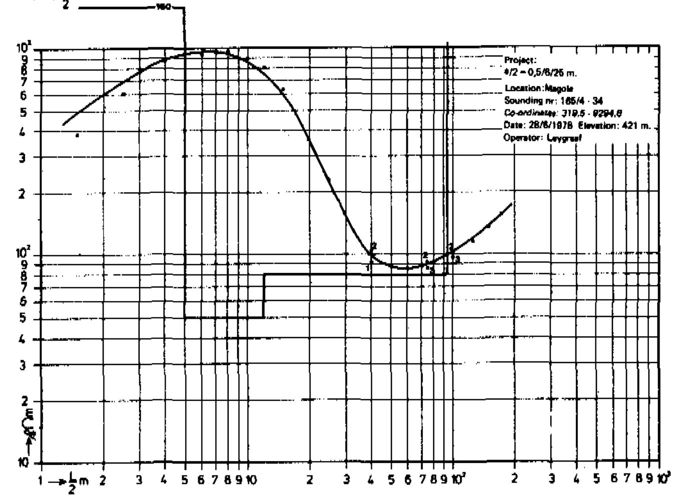

Project:
a/2 = 0,5/6/25/50 m.
Location: Ma Dudu
Sounding nr: 165/4 - 29
Co-ordinates: 310.6 - 9292.1
Date: 27/6/1978 Elevation: 450 m.
Operator: Leygraaf

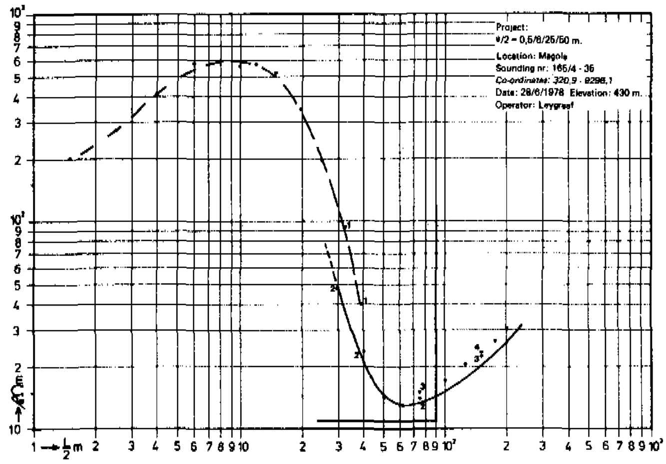

Project:
a/2 = 0,5/6/25 m.
Location: Ma Dudu
Sounding nr: 165/4 - 30
Co-ordinates: 313.1 - 9292.6
Date: 27/6/1978 Elevation: 439 m.
Operator: Leygraaf

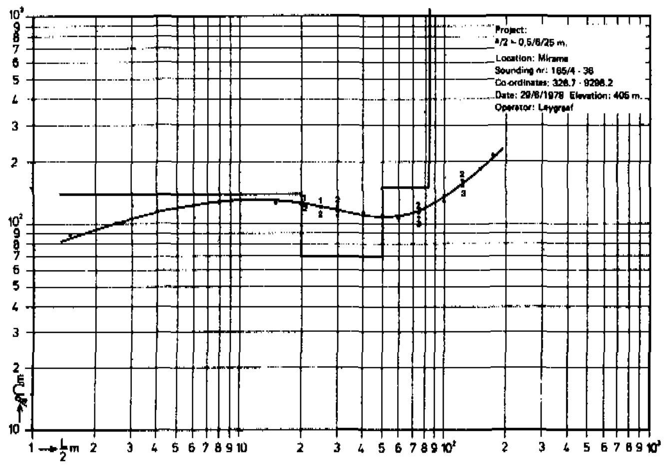

Project:
a/2 = 0,5/6/25/50 m.
Location: Dumila
Sounding nr: 165/4 - 31
Co-ordinates: 315.6 - 9293.8
Date: 28/6/1978 Elevation: 437 m.
Operator: Leygraaf

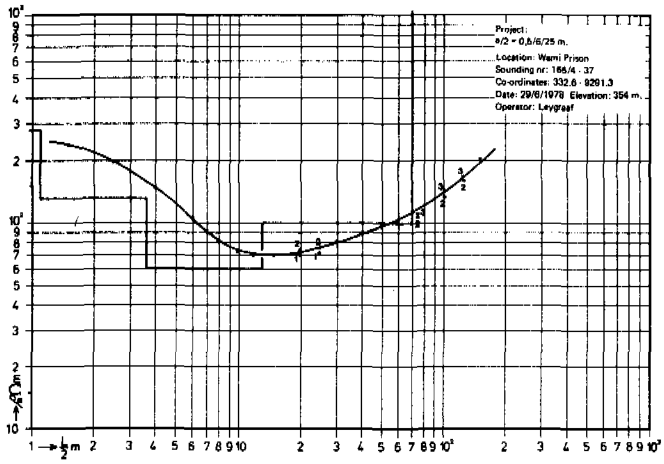

Project:
a/2 = 0,5/6/25/50 m.
Location: Dumila
Sounding nr: 166/4 32
Co-ordinates: 314.3 - 9293.3
Date: 28/6/1978 Elevation: 440 m.
Operator: Leygraaf

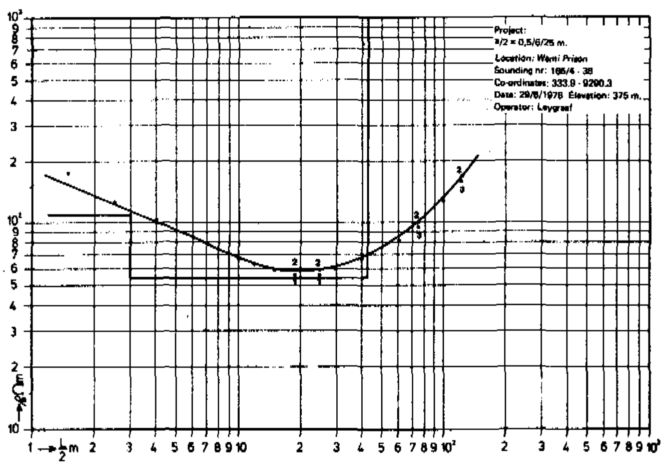

Project:
a/2 = 0,5/6/25 m.
Location: Magole
Sounding nr: 166/4 - 33
Co-ordinates: 317.2 - 9294.6
Date: 28/6/1978 Elevation: 425 m.
Operator: Leygraaf

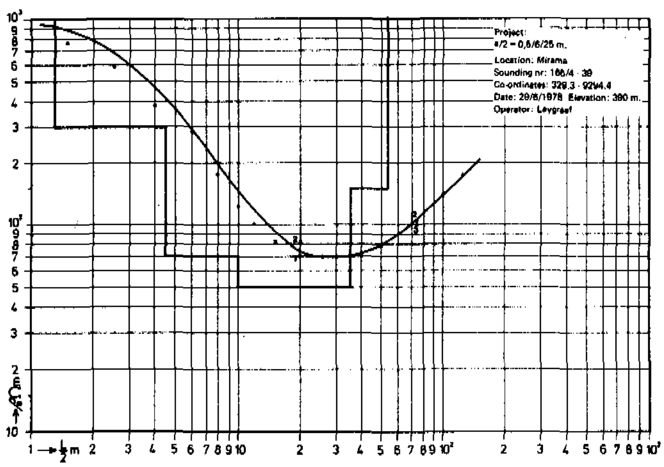

Project:
a/2 = 0,5/6/25 m.
Location: Magole
Sounding nr: 165/4 - 34
Co-ordinates: 319,5 - 9294,6
Date: 28/6/1978 Elevation: 421 m.
Operator: Leygraaf

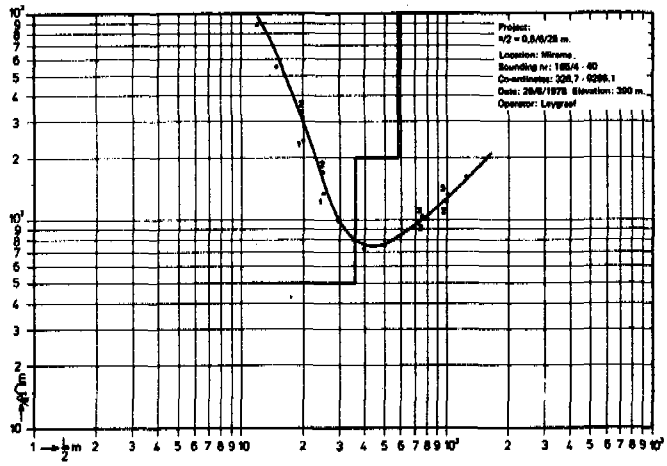

Project:
a/2 = 0,5/6/25/50 m.
Location: Magole
Sounding nr: 165/4 - 36
Co-ordinates: 320,9 - 9298,1
Date: 28/6/1978 Elevation: 430 m.
Operator: Leygraaf

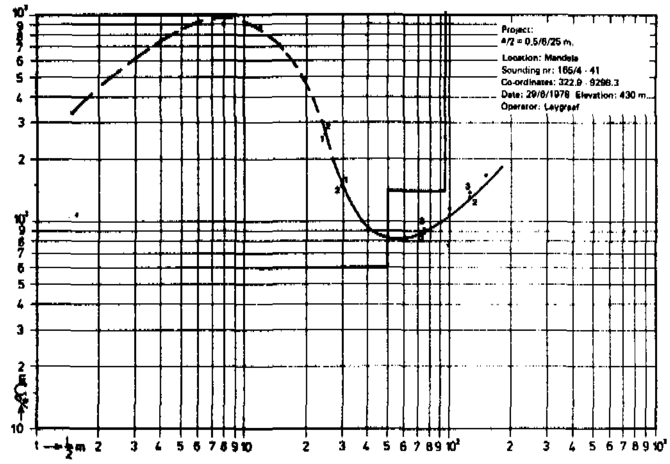

Project:
a/2 = 0,5/6/25 m.
Location: Mirama
Sounding nr: 165/4 - 36
Co-ordinates: 326.7 - 9298.2
Date: 29/6/1978 Elevation: 405 m.
Operator: Leygraaf

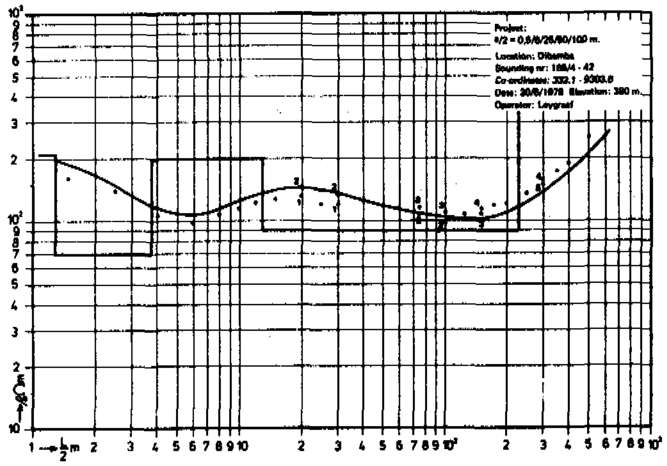

Project:
a/2 = 0,5/6/25 m.
Location: Wami Prison
Sounding nr: 166/4 - 37
Co-ordinates: 332.6 - 9291.3
Date: 29/6/1978 Elevation: 354 m.
Operator: Leygraaf

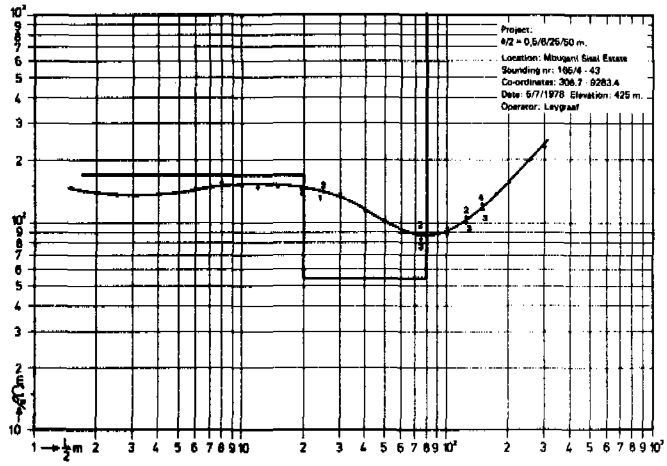

Project:
a/2 = 0,5/6/25 m.
Location: Wami Prison
Sounding nr: 166/4 - 38
Co-ordinates: 333.9 - 9290.3
Date: 29/6/1978 Elevation: 375 m.
Operator: Leygraaf

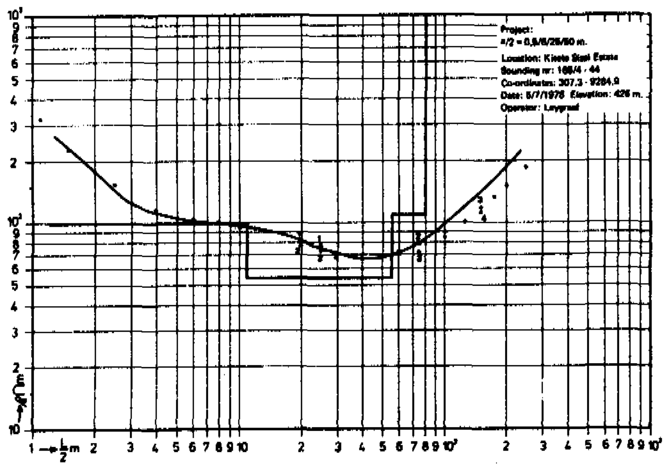

Project:
a/2 = 0,5/6/25 m.
Location: Mirama
Sounding nr: 166/4 - 39
Co-ordinates: 329.3 - 9294.4
Date: 29/6/1978 Elevation: 380 m.
Operator: Leygraaf

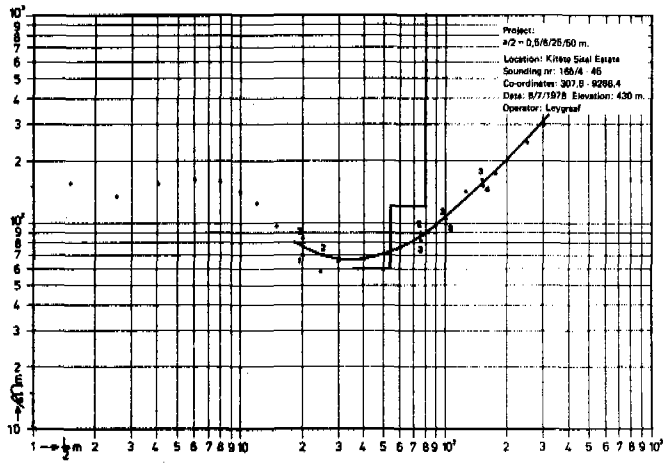

Project:
a/2 = 0,5/6/25 m.
Sounding nr: 165/4 - 40
Date: 29/6/1978 Elevation: 390 m.
Operator: Leygraaf

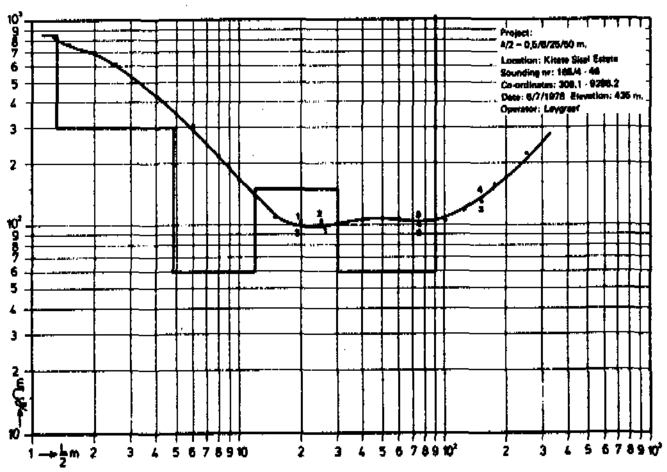

Project:
a/2 = 0.5/6/25 m.
Location: Mandela
Sounding nr: 165/4 - 41
Co-ordinates: 322.9 - 9298.3
Date: 29/6/1978 Elevation: 430 m.
Operator: Leygraaf

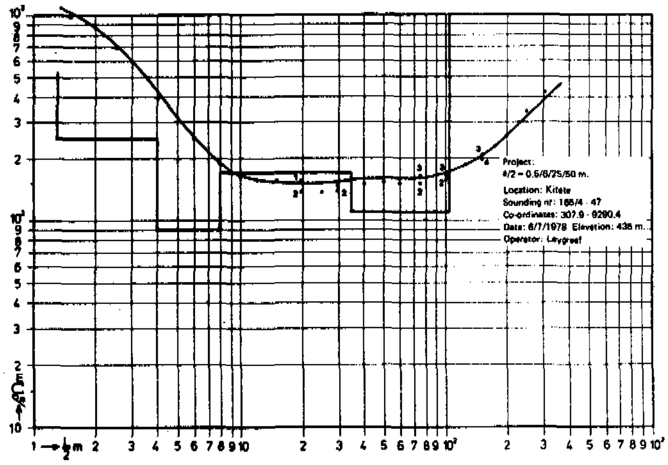

Project:
a/2 = 0,5/6/25/50/100 m.
Location: Dibamba
Sounding nr: 165/4 - 42
Date: 30/6/1978 Elevation: 390 m.
Operator: Leygraaf

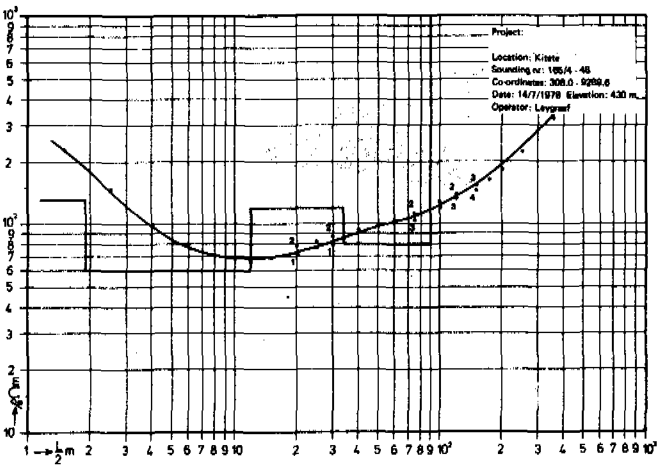

Project:
a/2 = 0,5/6/25/50 m.
Location: Mbugani Sisal Estate
Sounding nr: 165/4 - 43
Co-ordinates: 306.7 - 9283.4
Date: 6/7/1978 Elevation: 425 m.
Operator: Leygraaf

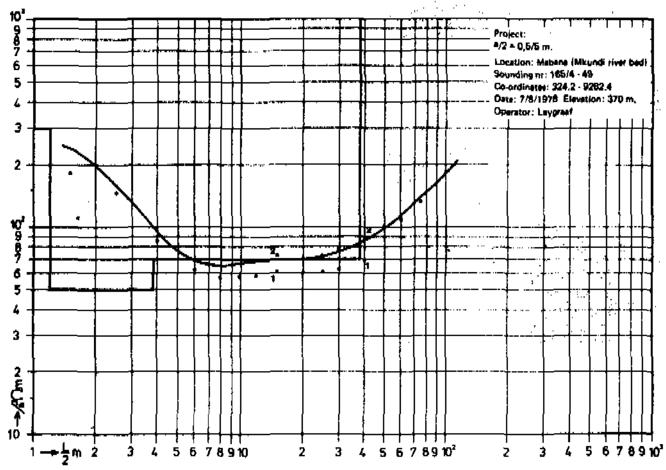

Project:
a/2 = 0,5/6/25/50 m.
Location: Kitete Sisal Estate
Sounding nr: 165/4 - 44
Co-ordinates: 307.3 - 9284.9
Date: 6/7/1978 Elevation: 426 m.
Operator: Leygraaf

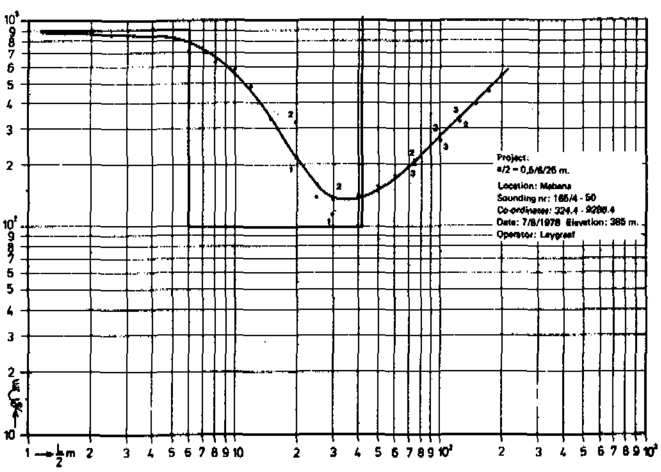

Project:
a/2 = 0,5/6/25/50 m.
Location: Kitete Sisal Estate
Sounding nr: 165/4 - 46
Co-ordinates: 307,8 - 9286,4
Date: 6/7/1978 Elevation: 430 m.
Operator: Leygraaf

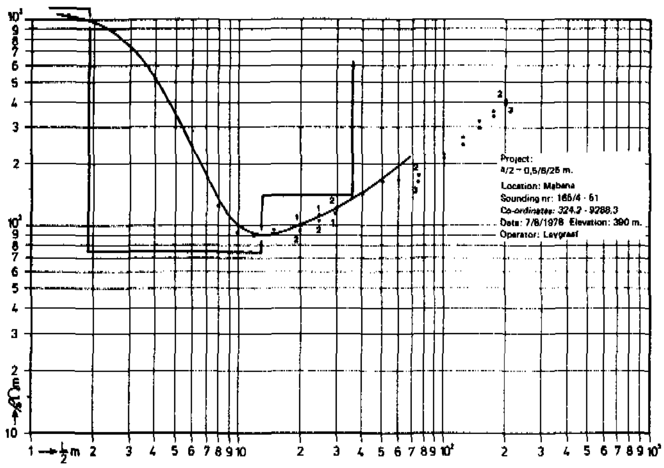

Project:
a/2 = 0,5/6/25/50 m.
Location: Kitete Sisal Estate
Date: 6/7/1978 Elevation: 435 m.
Operator: Leygraaf

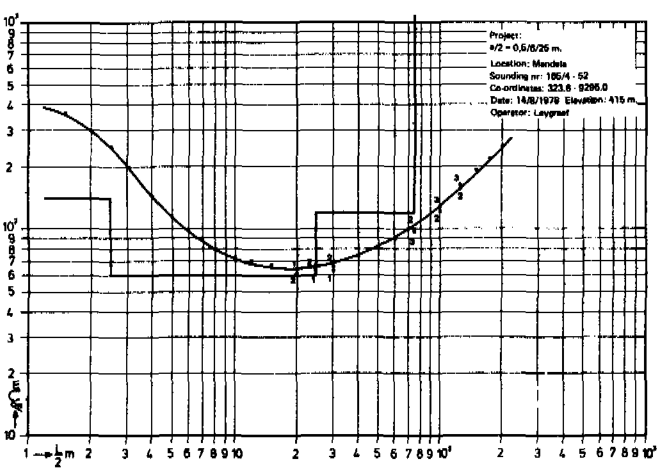

Project:
a/2 = 0.5/6/25/50 m.
Location: Kitete
Sounding nr: 165/4 - 47
Co-ordinates: 307.9 - 9290.4
Date: 6/7/1978 Elevation: 436 m.
Operator: Leygraaf

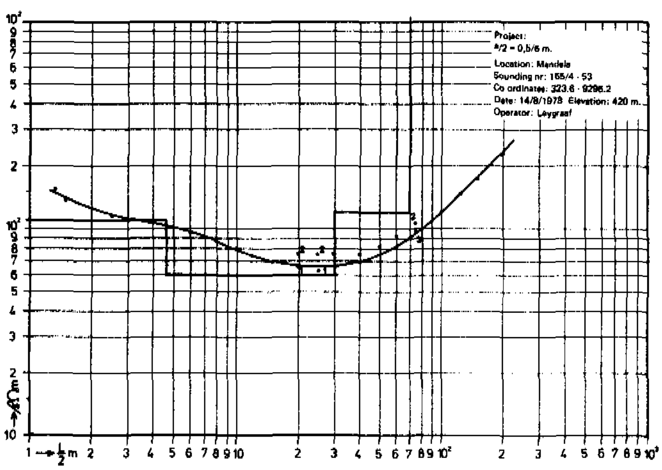

Project:
Location: Kitete
Sounding nr: 165/4 - 48
Co-ordinates: 308.0 - 9289.6
Date: 14/7/1978 Elevation: 430 m.
Operator: Leygraaf

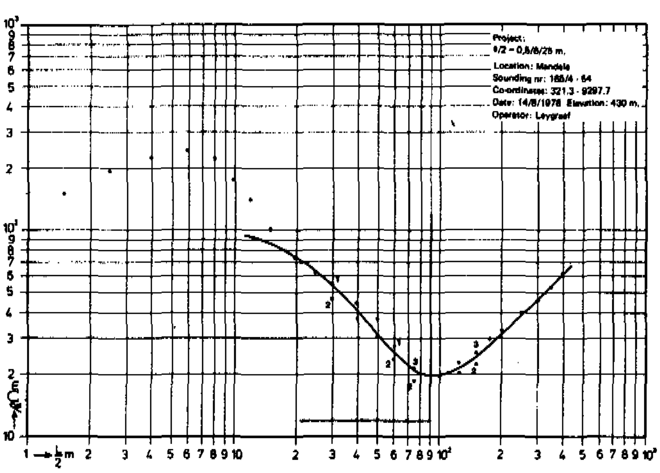

Project:
a/2 = 0,5/5 m.
Location: Mabana (Mkundi river bed)
Sounding nr: 165/4 - 49
Co-ordinates: 324.2 - 9282.4
Date: 7/8/1978 Elevation: 370 m.
Operator: Leygraaf

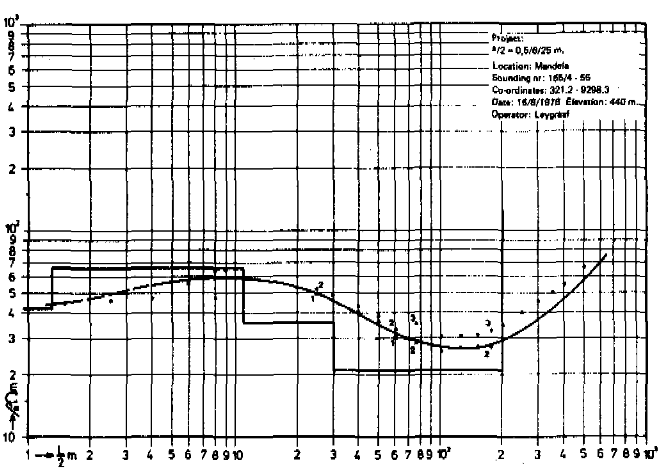

Project:
a/2 = 0,5/6/25 m.
Location: Mabana
Sounding nr: 165/4 - 50
Co-ordinates: 324.4 - 9288.4
Date: 7/8/1978 Elevation: 385 m.
Operator: Leygraaf

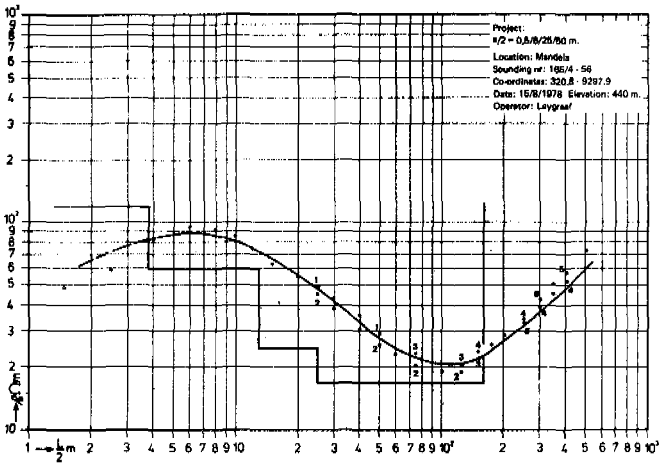

Project:
a/2 = 0,5/6/25 m.
Location: Mabana
Sounding nr: 165/4 - 51
Co-ordinates: 324.2 - 9288.3
Date: 7/8/1978 Elevation: 390 m.
Operator: Leygraaf

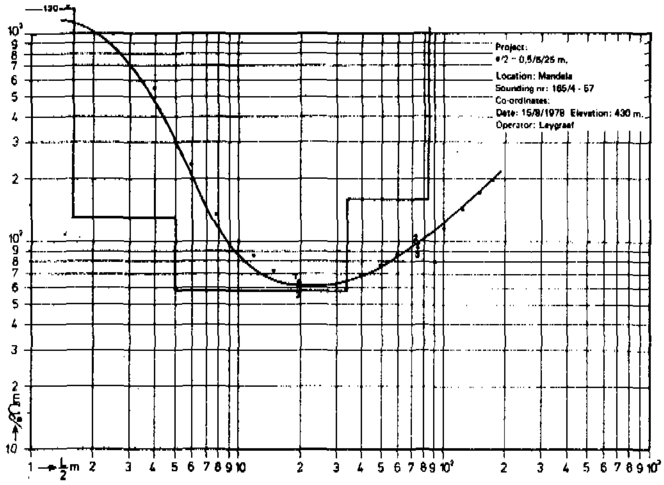

Project:
a/2 = 0,5/6/25 m.
Location: Mandela
Sounding nr: 165/4 - 52
Co-ordinates: 323.6 - 9296.0
Date: 14/8/1978 Elevation: 415 m.
Operator: Leygraaf

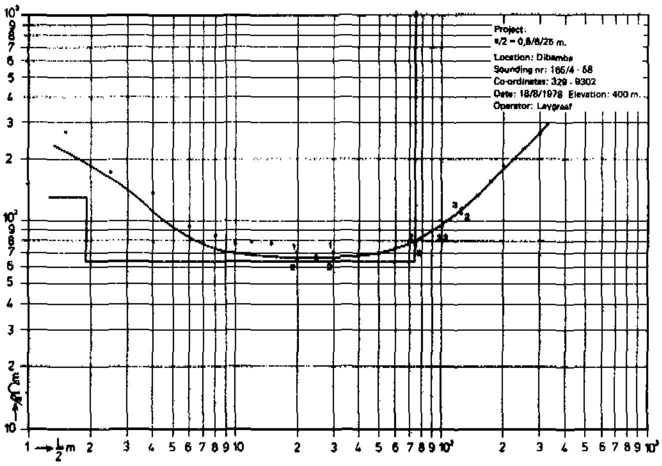

Project:
a/2 = 0,5/6 m.
Location: Mandela
Sounding nr: 165/4 - 53
Co ordinates: 323.6 - 9296.2
Date: 14/8/1978 Elevation: 420 m.
Operator: Leygraaf

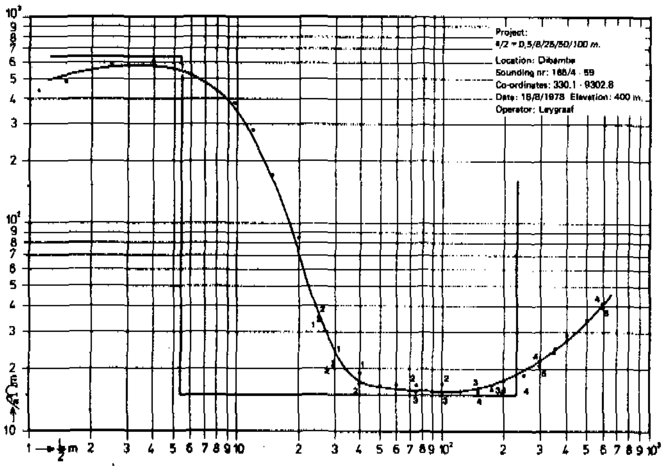

Project:
a/2 = 0,5/6/25 m.
Location: Mandela
Sounding nr: 165/4 - 54
Co-ordinates: 321.3 - 9297.7
Date: 14/8/1978 Elevation: 430 m.
Operator: Leygraaf

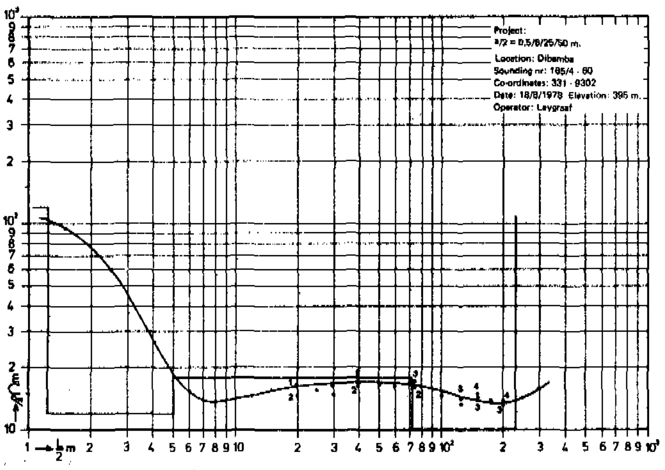

Project:
a/2 = 0,5/6/25 m.
Location: Mandela
Sounding nr: 165/4 - 55
Co-ordinates: 321.2 - 9298.3
Date: 16/8/1978 Elevation: 440 m.
Operator: Leygraaf

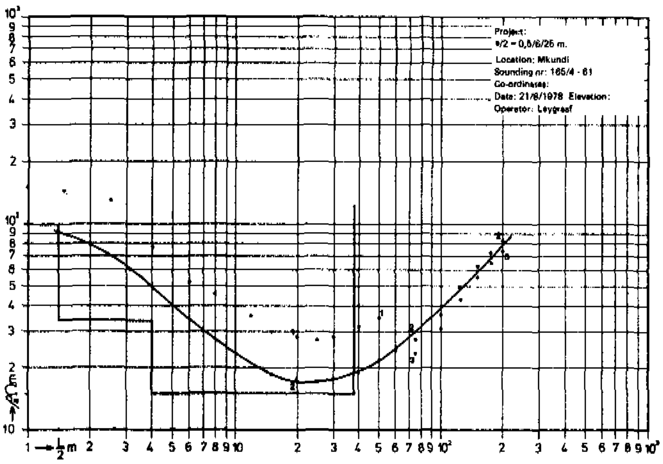

Project:
a/2 = 0,5/6/25/50 m.
Location: Mandela
Sounding nr: 165/4 - 56
Co-ordinates: 320,8 - 9297.9
Date: 15/8/1978 Elevation: 440 m.
Operator: Leygraaf

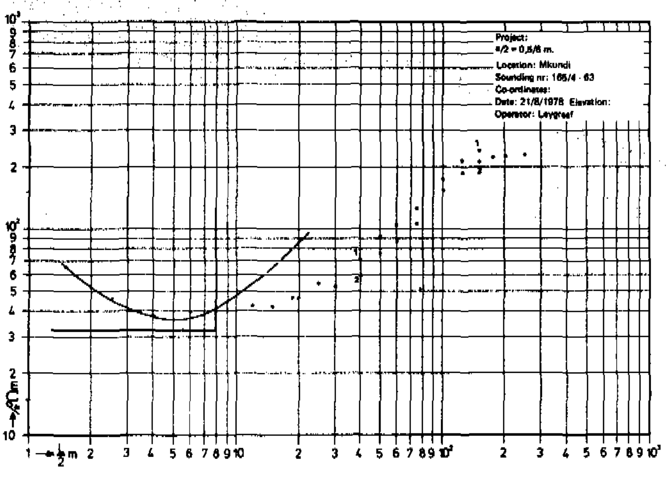

Project:
a/2 = 0,5/6/25 m.
Location: Mandela
Sounding nr: 165/4 - 57
Co-ordinates:
Date: 15/8/1978 Elevation: 430 m.
Operator: Leygraaf

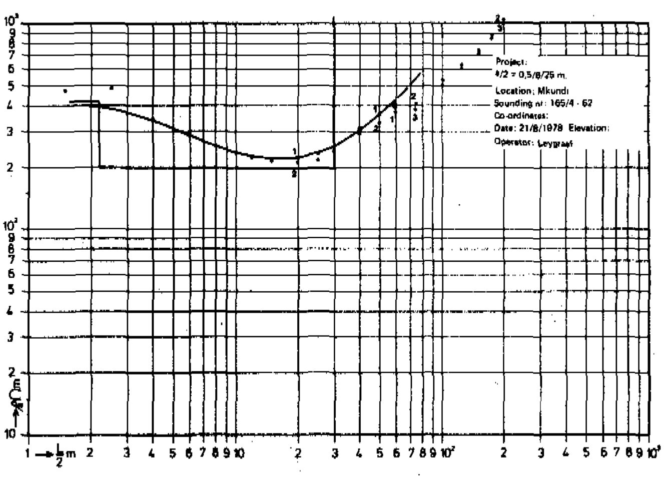

Project:
a/2 = 0,5/6/25 m.
Location: Dibamba
Sounding nr: 165/4 - 58
Co-ordinates: 329 - 9302
Date: 18/8/1978 Elevation: 400 m.
Operator: Leygraaf

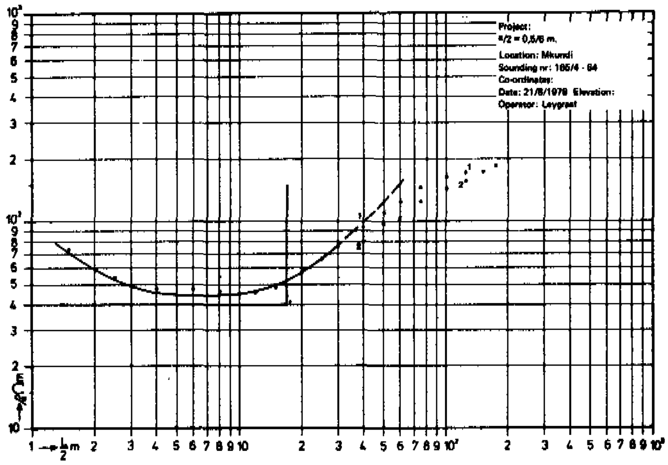

Project:
a/2 = 0,5/6/25/50/100 m.
Location: Dibamba
Sounding nr: 165/4 - 59
Co-ordinates: 330.1 - 9302.8
Date: 18/8/1978 Elevation: 400 m.
Operator: Leygraaf

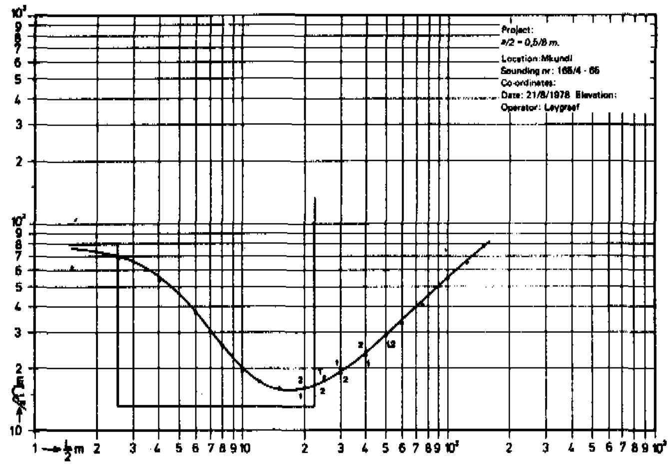

Project:
a/2 = 0,5/6/25/50 m.
Location: Dibamba
Sounding nr: 165/4 - 60
Co-ordinates: 331 - 9302
Date: 18/8/1978 Elevation: 395 m.
Operator: Leygraaf

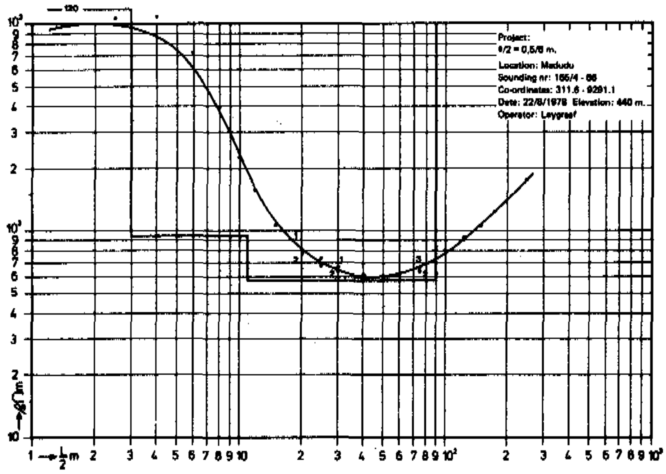

Project:
a/2 = 0,5/6/25 m.
Location: Mkundi
Sounding nr: 165/4 - 61
Co-ordinates:
Date: 21/8/1978 Elevation:
Operator: Leygraaf

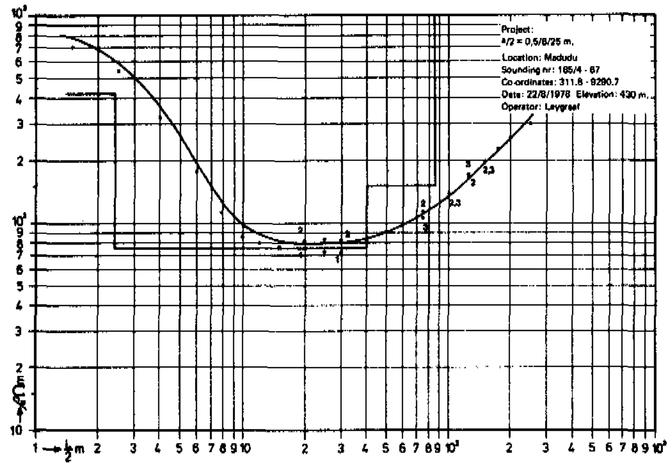

Project:
a/2 = 0,5/6 m.
Location: Mkundi
Sounding nr: 165/4 - 63
Co-ordinates:
Date: 21/8/1978 Elevation:
Operator: Leygraaf

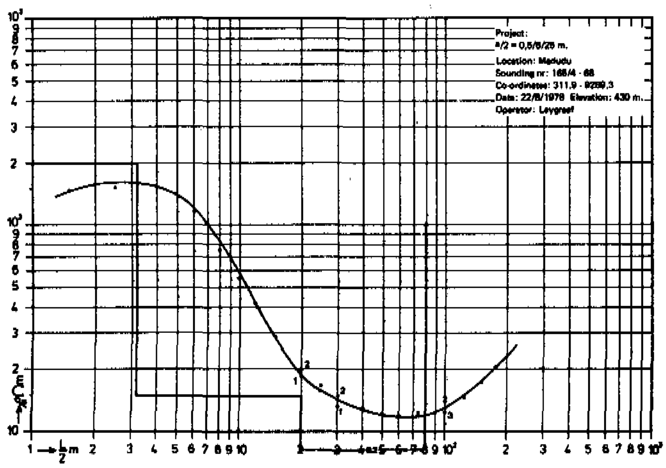

Project:
a/2 = 0,5/6/25 m.
Location: Mkundi
Sounding nr: 165/4 - 62
Co-ordinates:
Date: 21/8/1978 Elevation:
Operator: Leygraaf

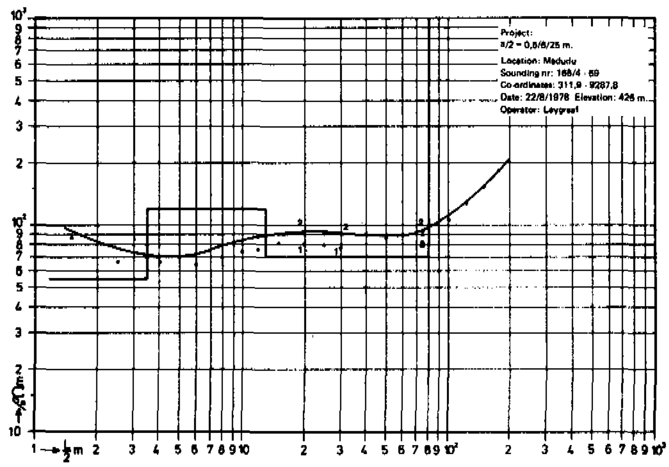

Project:
a/2 = 0,5/6 m.
Location: Mkundi
Sounding nr: 165/4 - 64
Co-ordinates:
Date: 21/8/1978 Elevation:
Operator: Leygraaf

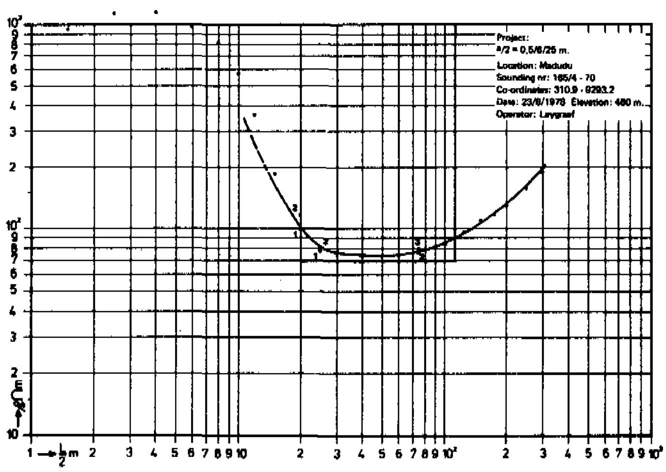

Project:
a/2 = 0,5/8 m.
Location: Mkundi
Sounding nr: 165/4 - 65
Co-ordinates:
Date: 21/8/1978 Elevation:
Operator: Leygraaf

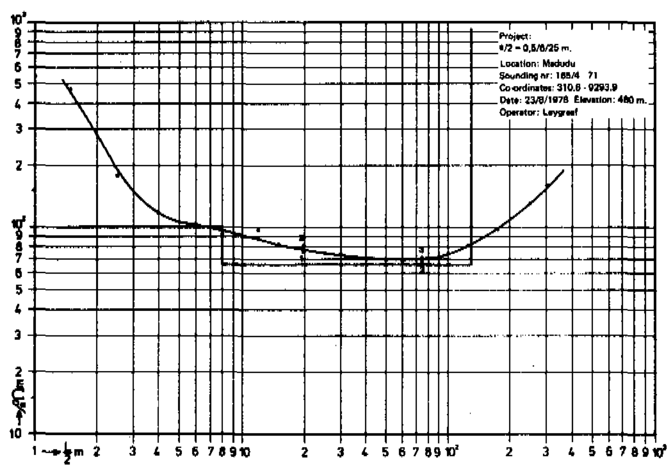

Project:
a/2 = 0,5/6 m.
Location: Madudu
Sounding nr: 165/4 - 66
Co-ordinates: 311.6 - 9291.1
Date: 22/8/1978 Elevation: 440 m.
Operator: Leygraaf

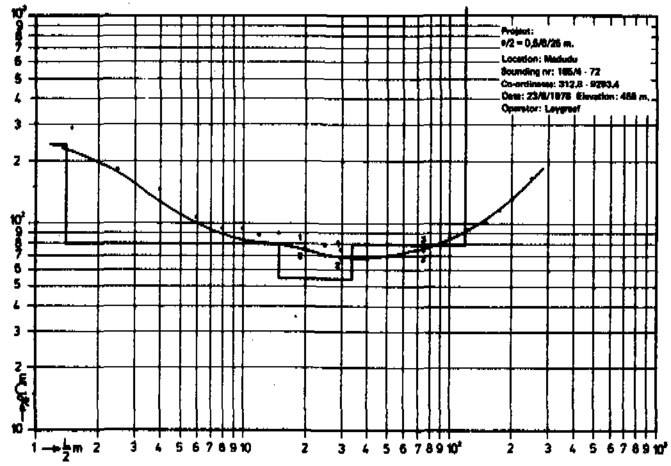

Project:
a/2 = 0,5/6/25 m.
Location: Madudu
Sounding nr: 165/4 - 67
Co-ordinates: 311.8 - 9290.7
Date: 22/8/1978 Elevation: 430 m.
Operator: Leygraaf

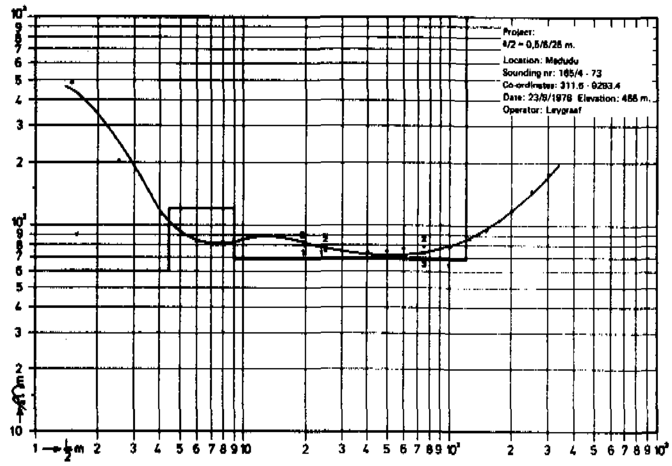

Project:
a/2 = 0,5/6/25 m.
Location: Madudu
Sounding nr: 165/4 - 68
Co-ordinates: 311,9 - 9289,3
Date: 22/8/1978 Elevation: 430 m.
Operator: Leygraaf

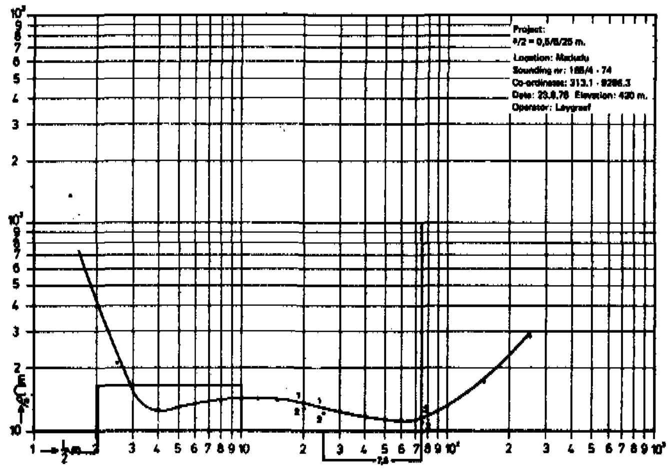

Project:
a/2 = 0,5/6/25 m.
Location: Madudu
Sounding nr: 165/4 - 69
Co-ordinates: 311,9 - 9287,8
Date: 22/8/1978 Elevation: 426 m.
Operator: Leygraaf

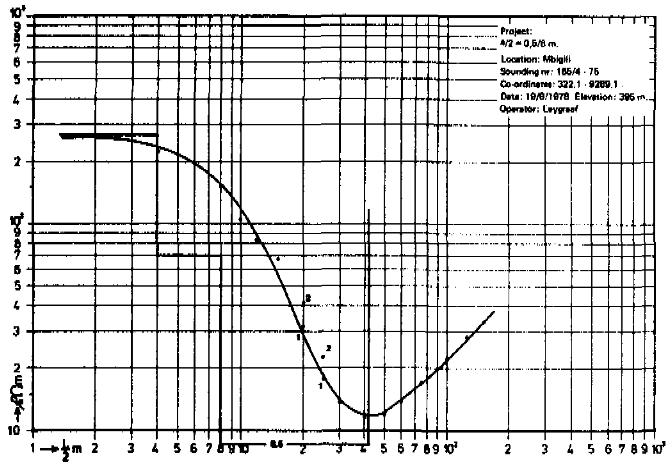

Project:
a/2 = 0,5/6/25 m.
Location: Madudu
Sounding nr: 165/4 - 70
Co-ordinates: 310.9 - 9293.2
Date: 23/8/1978 Elevation: 480 m.
Operator: Leygraaf

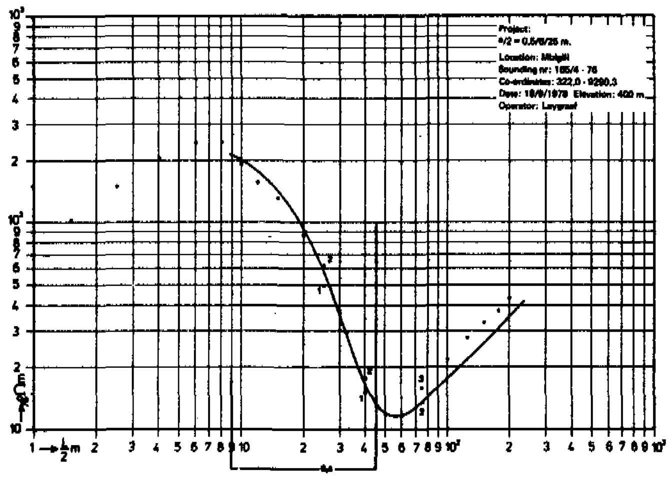

Project:
a/2 = 0,5/6/25 m.
Location: Madudu
Sounding nr: 165/4 71
Co-ordinates: 310.8 - 9293.9
Date: 23/8/1978 Elevation: 480 m.
Operator: Leygraaf

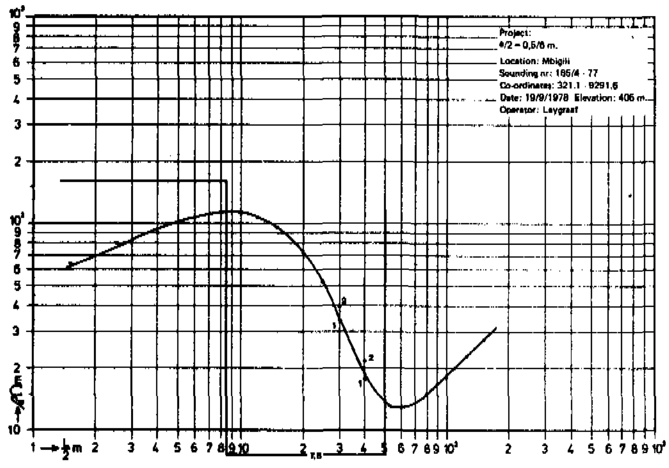

Project:
a/2 = 0,5/6/25 m.
Location: Madudu
Sounding nr: 165/4 - 72
Co-ordinates: 312,8 - 9293.4
Date: 23/9/1978 Elevation: 488 m.
Operator: Leygraaf

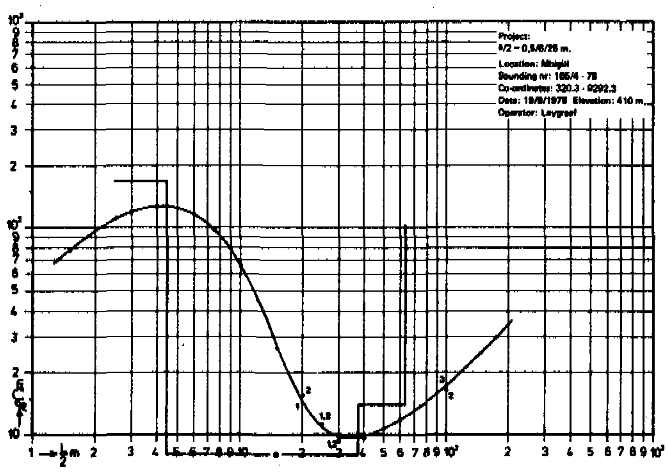

Project:
a/2 = 0,5/6/25 m.
Location: Madudu
Sounding nr: 165/4 - 73
Co-ordinates: 311.6 - 9293.4
Date: 23/9/1978 Elevation: 488 m.
Operator: Leygraaf

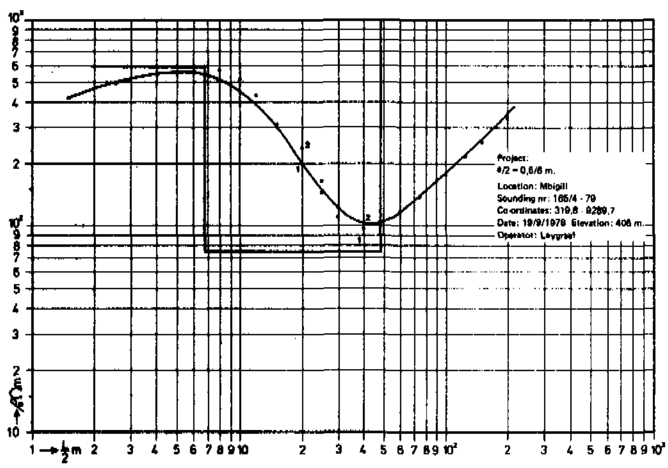

Project:
a/2 = 0,5/6/25 m.
Location: Madudu
Sounding nr: 165/4 - 74
Co-ordinates: 313.1 - 9286.3
Date: 23.9.78 Elevation: 420 m.
Operator: Leygraaf

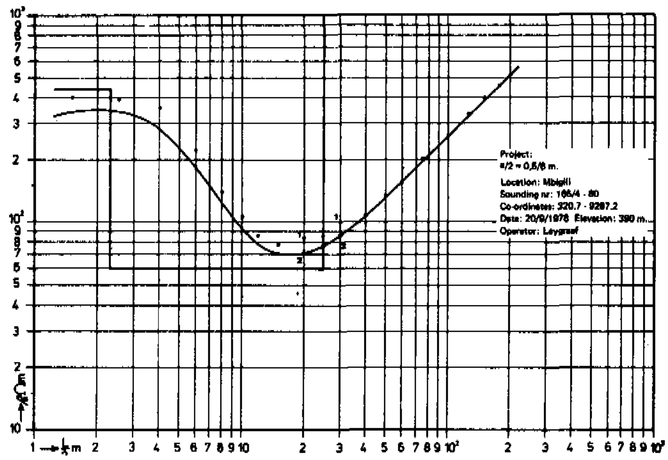

Project:
a/2 = 0,5/6 m.
Location: Mbigili
Sounding nr: 165/4 - 75
Co-ordinates: 322.1 - 9289.1
Date: 19/9/1978 Elevation: 395 m.
Operator: Leygraaf

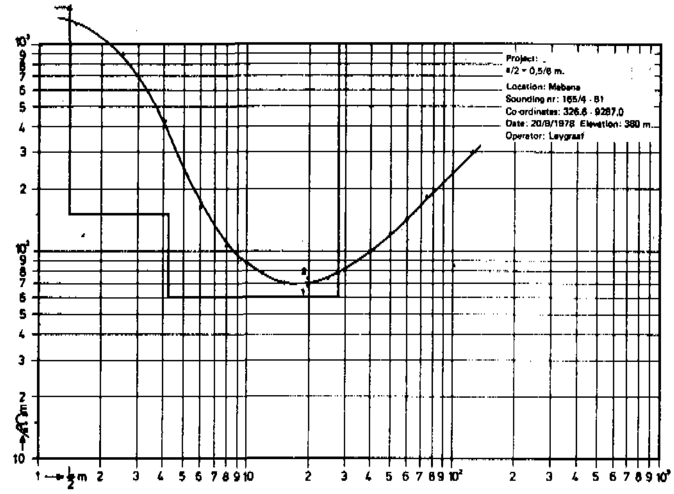

Project:
a/2 = 0,5/6/25 m.
Location: Mbigili
Sounding nr: 165/4 - 76
Co-ordinates: 322,0 - 9290.3
Date: 19/9/1978 Elevation: 400 m.
Operator: Leygraaf

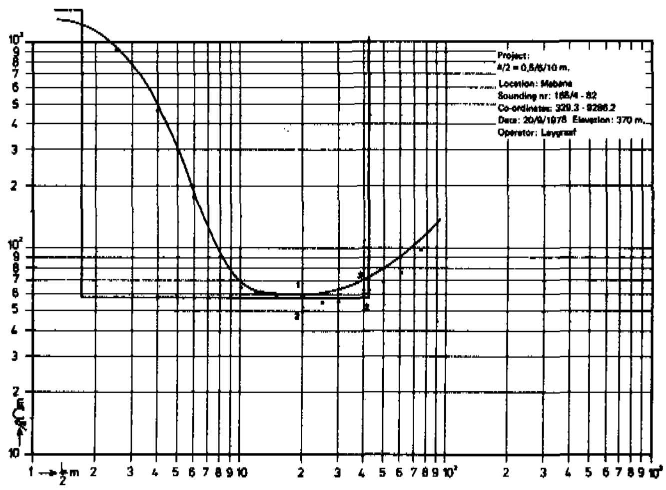

Project:
a/2 = 0,5/6 m.
Location: Mbigili
Sounding nr: 165/4 - 77
Co-ordinates: 321.1 - 9291,6
Date: 19/9/1978 Elevation: 406 m.
Operator: Leygraaf

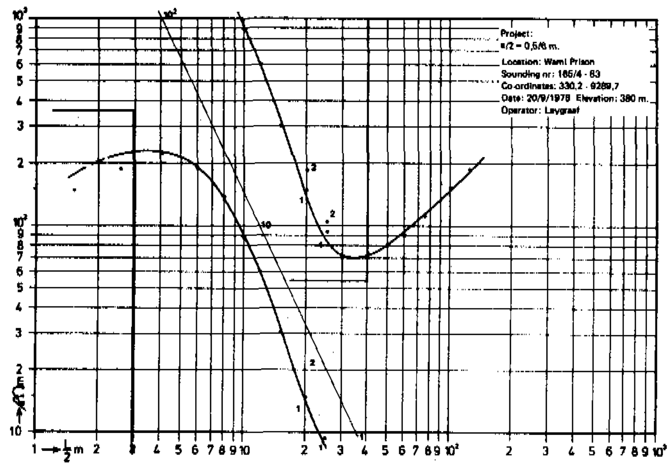

Project:
a/2 = 0,5/6/25 m.
Location: Mbigili
Sounding nr: 165/4 - 78
Co-ordinates: 320.3 - 9292.3
Date: 19/9/1978 Elevation: 410 m.
Operator: Leygraaf

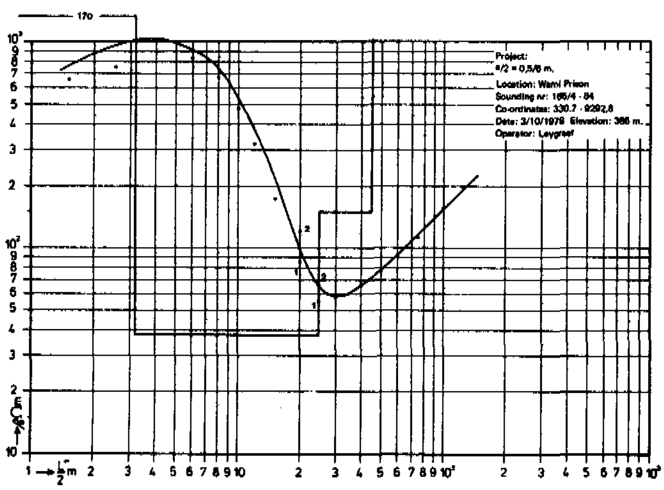

Project:
a/2 = 0,6/6 m.
Location: Mbigili
Sounding nr: 165/4 - 79
Co-ordinates: 319,8 - 9289,7
Date: 19/9/1978 Elevation: 408 m.
Operator: Leygraaf

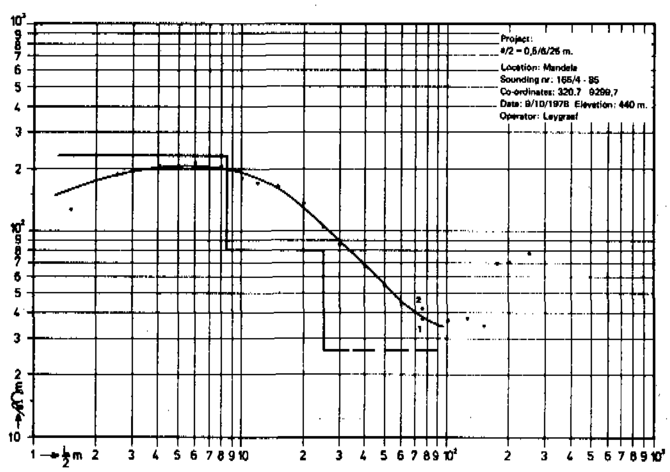

Project:
#/2 = 0,5/6 m.
Location: Mbigili
Sounding nr: 166/4 - 80
Co-ordinates: 320.7 - 9287.2
Date: 20/9/1978 Elevation: 380 m.
Operator: Leygraaf

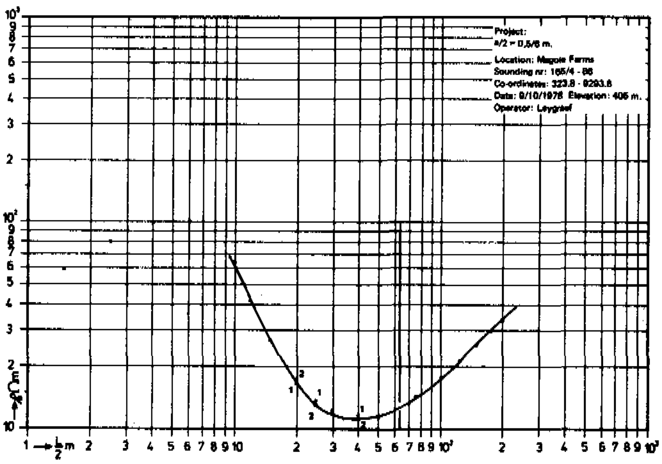

Project:
#/2 = 0,5/6 m.
Location: Mabana
Sounding nr: 165/4 - 81
Co-ordinates: 326.6 - 9287,0
Date: 20/9/1978 Elevation: 380 m.
Operator: Leygraaf

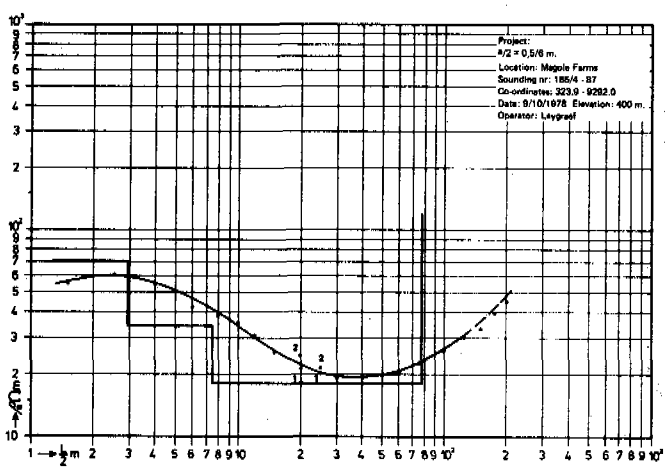

Project:
#/2 = 0,5/6/10 m.
Location: Mabana
Sounding nr: 165/4 - 82
Co-ordinates: 329.3 - 9286.2
Date: 20/9/1978 Elevation: 370 m.
Operator: Leygraaf

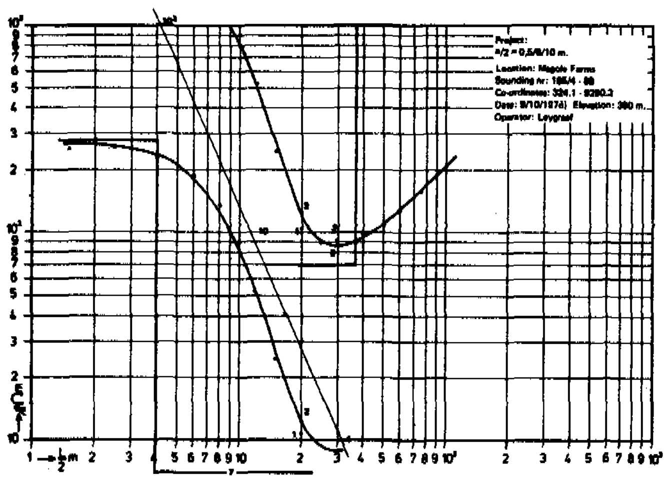

Project:
#/2 = 0,5/6 m.
Location: Wami Prison
Sounding nr: 165/4 - 83
Co-ordinates: 330,2 - 9289,7
Date: 20/9/1978 Elevation: 380 m.
Operator: Leygraaf

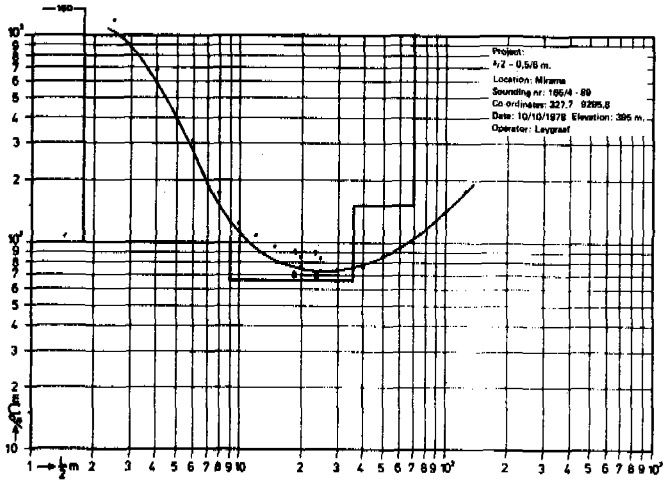

170
Project:
#/2 = 0,5/6 m.
Location: Wami Prison
Sounding nr: 165/4 - 84
Co-ordinates: 330.7 - 9292,8
Date: 3/10/1978 Elevation: 386 m.
Operator: Leygraaf

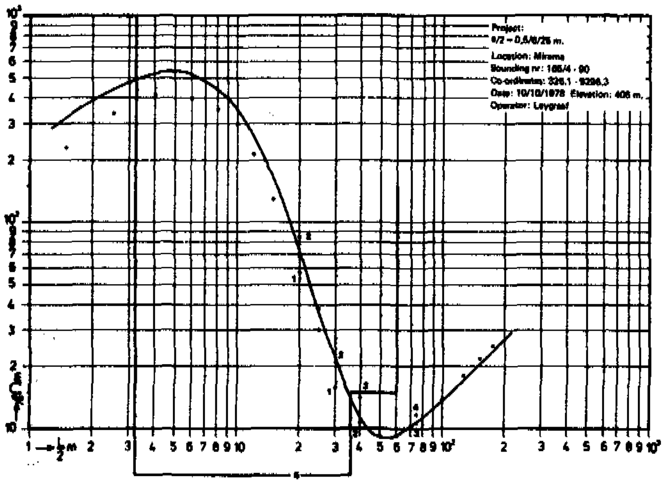

Project:
#/2 = 0,5/6/26 m.
Location: Mandela
Sounding nr: 165/4 - 85
Co-ordinates: 320.7 9299,7
Date: 9/10/1978 Elevation: 440 m.
Operator: Leygraaf

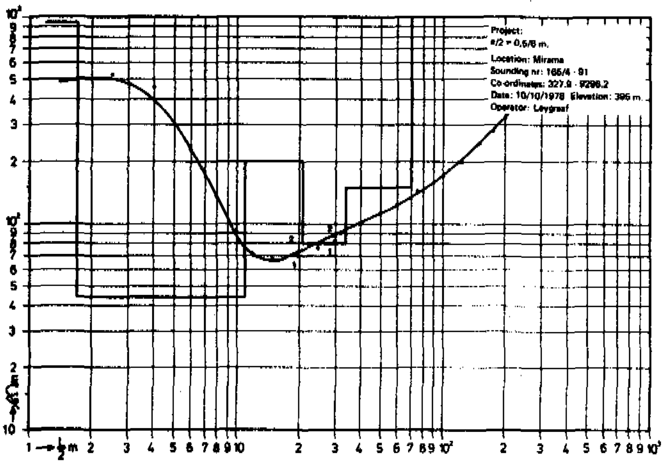

Project:
#/2 = 0,5/6 m.
Location: Magole Farms
Sounding nr: 165/4 - 86
Co-ordinates: 323.8 - 9293.8
Date: 9/10/1978 Elevation: 406 m.
Operator: Leygraaf

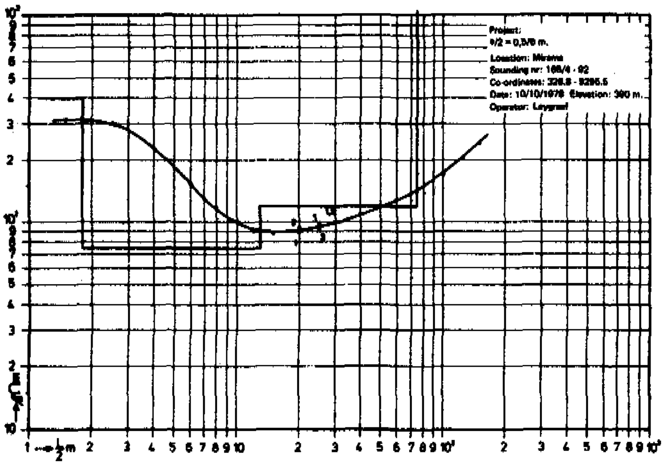

Project:
#/2 = 0,5/6 m.
Location: Magole Farms
Sounding nr: 165/4 - 87
Co-ordinates: 323.9 - 9292.0
Date: 9/10/1978 Elevation: 400 m.
Operator: Leygraaf

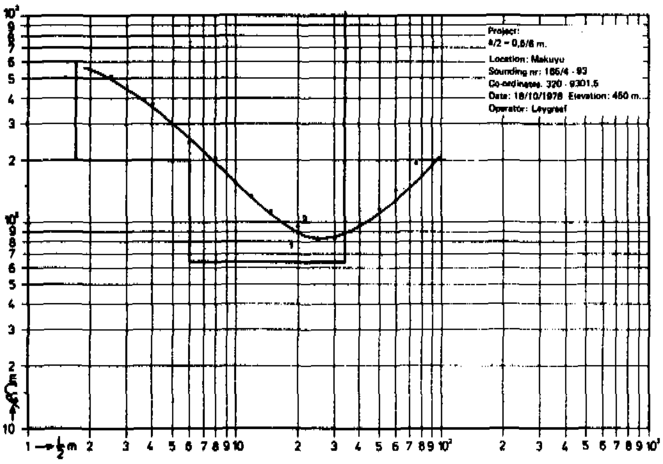

Project:
a/2 = 0,5/8/10 m.
Operator: Leygraaf

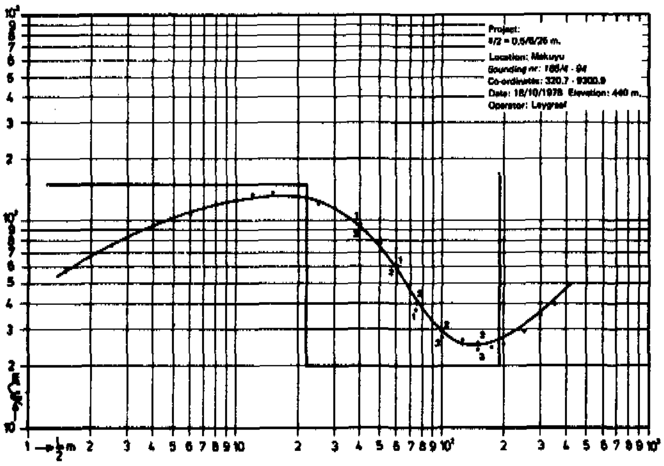

Project:
a/2 – 0,5/8 m.
Location: Mirama
Sounding nr: 165/4 - 89
Co-ordinates: 327.7 9295,8
Date: 10/10/1978 Elevation: 395 m.
Operator: Leygraaf

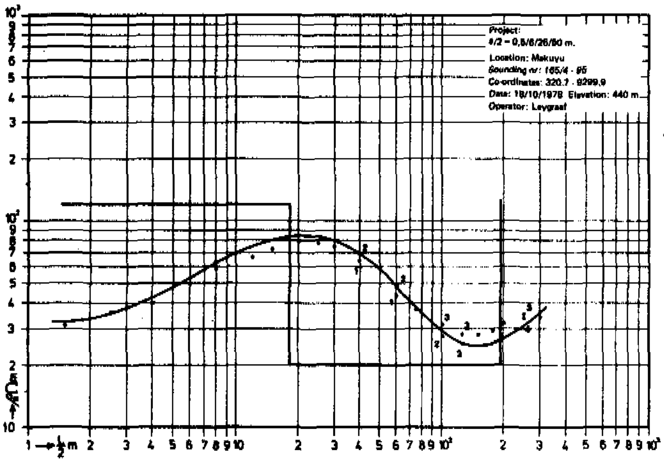

Project:
a/2 = 0,5/8/25 m.
Location: Mirama
Sounding nr: 165/4 - 90
Date: 10/10/1978 Elevation: 406 m.
Operator: Leygraaf

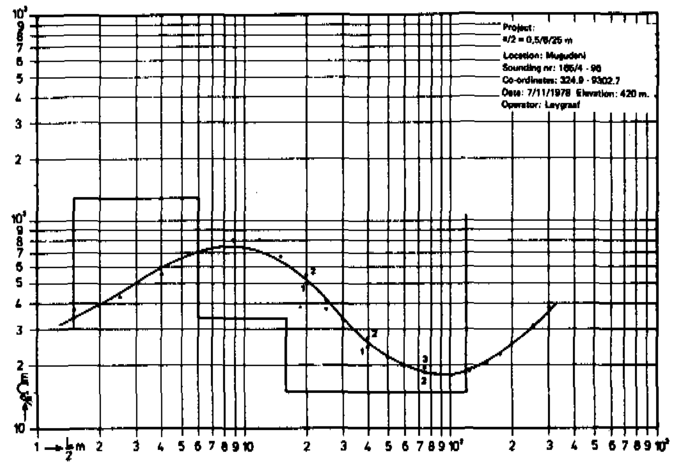

Project:
a/2 = 0,5/8 m.
Location: Mirama
Sounding nr: 165/4 - 91
Co-ordinates: 327.9 - 9298.2
Date: 10/10/1978 Elevation: 395 m.
Operator: Leygraaf

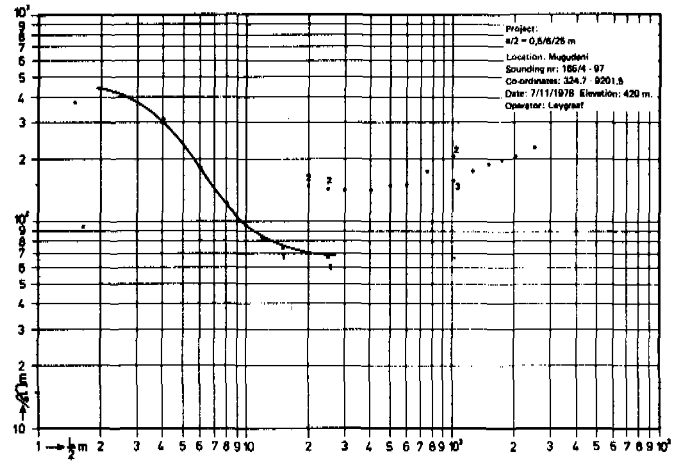

Project:
Location: Mirama
Sounding nr: 165/4 - 92
Date: 10/10/1978 Elevation: 390 m.
Operator: Leygraaf

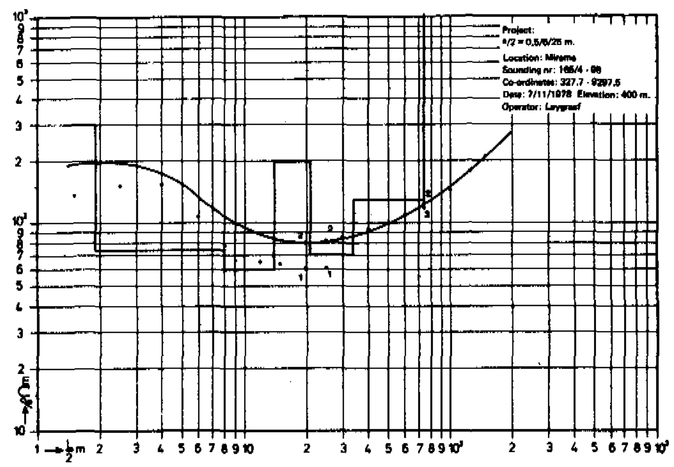

Project:
a/2 = 0,5/8 m.
Location: Makuyu
Sounding nr: 165/4 - 93
Co-ordinates. 320 - 9301,5
Date: 18/10/1978 Elevation: 460 m.
Operator: Leygraaf

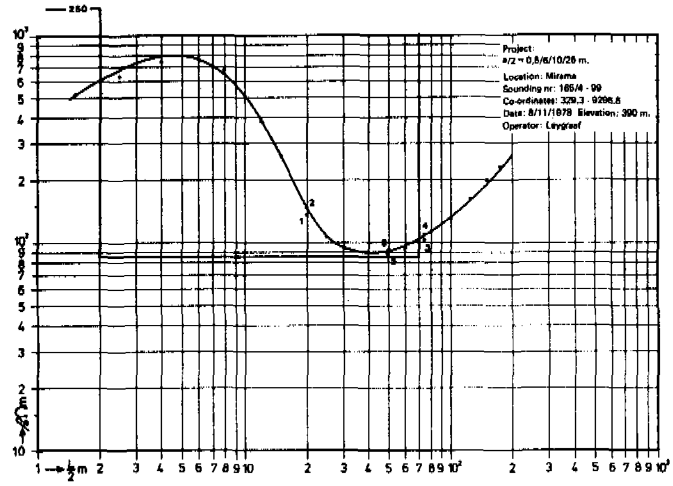

Project:
a/2 = 0.5/8/25 m.
Location: Makuyu
Co-ordinates: 320.7 - 9300.9
Date: 18/10/1978 Elevation: 440 m.
Operator: Leygraaf

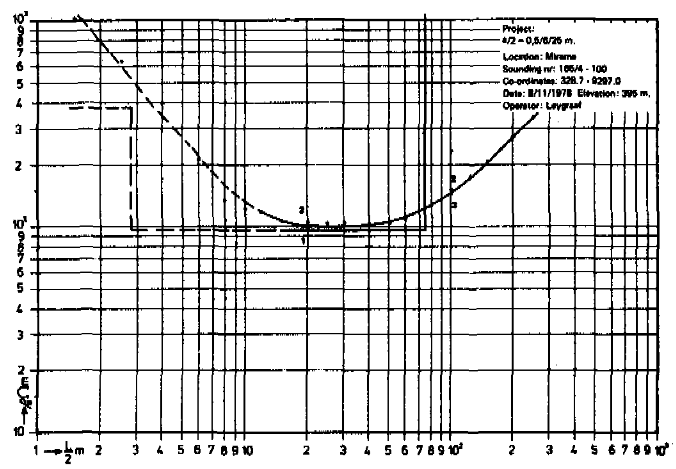

Project:
a/2 = 0,5/8/25/50 m.
Location: Makuyu
Sounding nr: 165/4 - 95
Co-ordinates: 320.7 - 9299,9
Date: 18/10/1978 Elevation: 440 m.
Operator: Leygraaf

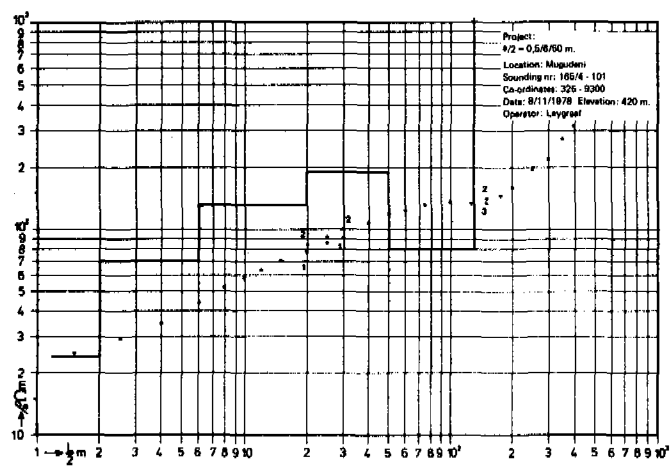

Project:
a/2 = 0,5/6/25 m
Location: Mugudeni
Sounding nr: 165/4 - 96
Co-ordinates: 324.9 - 9302.7
Date: 7/11/1978 Elevation: 420 m.
Operator: Leygraaf

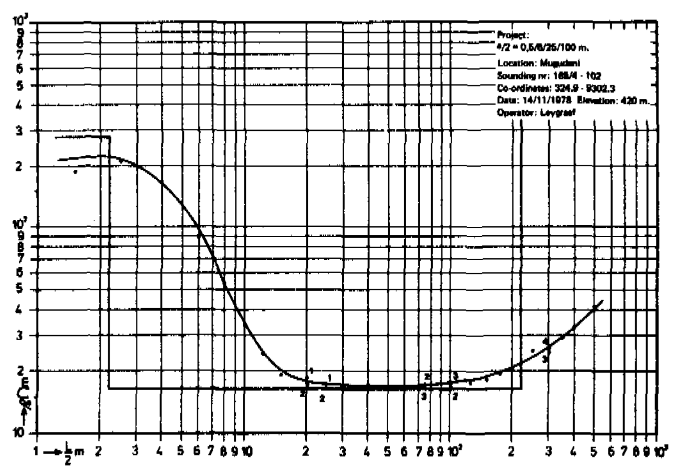

Project:
a/2 = 0,5/6/25 m
Location. Mugudeni
Sounding nr: 165/4 - 97
Co-ordinates: 324.7 - 9201.5
Date: 7/11/1978 Elevation: 420 m.
Operator: Leygraaf

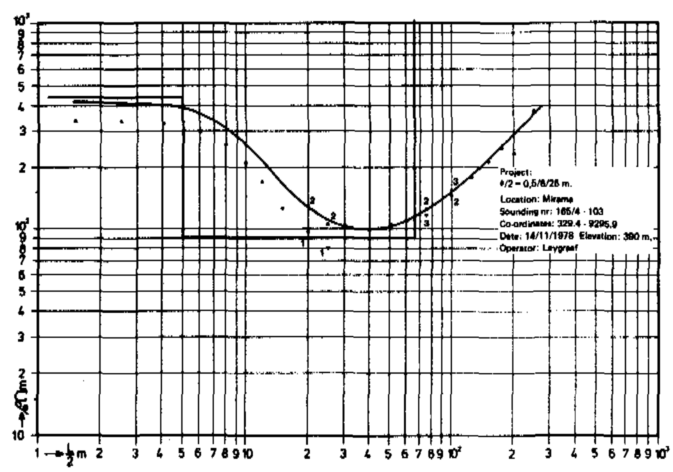

Project:
a/2 = 0,5/6/25 m.
Location: Mirama
Sounding nr: 165/4 - 98
Co-ordinates: 327.7 - 9297.5
Date: 7/11/1978 Elevation: 400 m.
Operator: Leygraaf

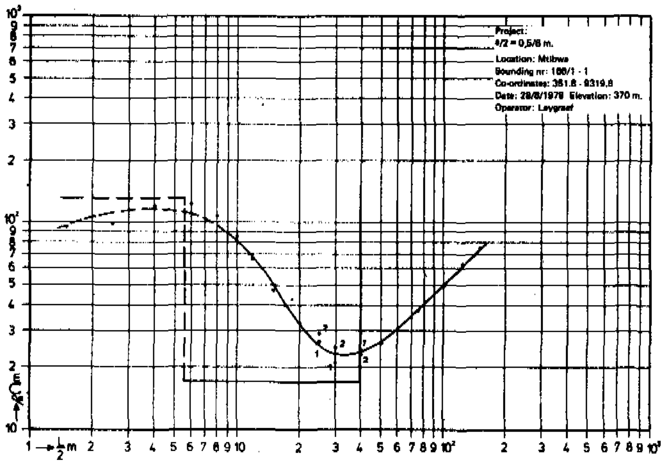

Project:
a/2 = 0,5/6/10/25 m.
Location: Mirama
Sounding nr: 165/4 - 99
Co-ordinates: 329.3 - 9296.5
Date: 8/11/1978 Elevation: 390 m.
Operator: Leygraaf

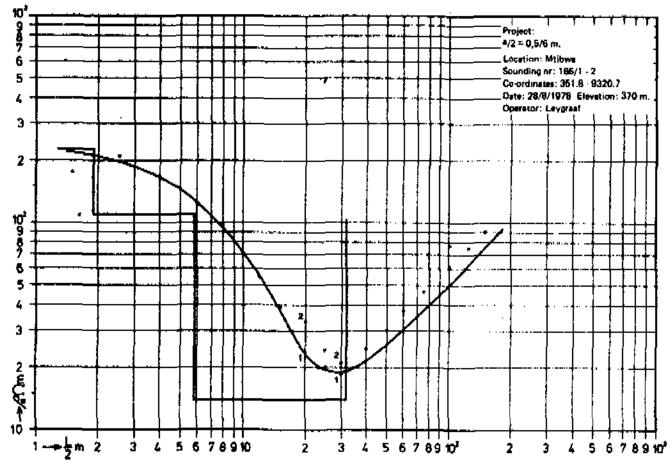

Project:
a/2 = 0,5/6/25 m.
Location: Mirama
Sounding nr: 165/4 - 100
Co-ordinates: 328.7 - 9297.0
Date: 8/11/1978 Elevation: 395 m.
Operator: Leygraaf

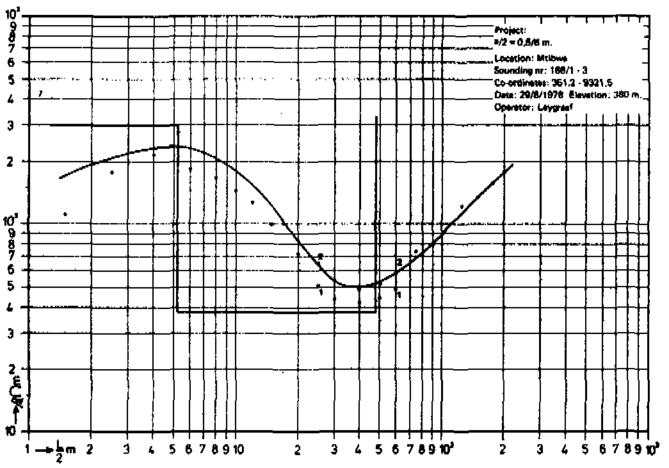

Project:
a/2 = 0,5/6/50 m.
Location: Mugudeni
Sounding nr: 165/4 - 101
Co-ordinates: 326 - 9300
Date: 8/11/1978 Elevation: 420 m.
Operator: Leygraaf

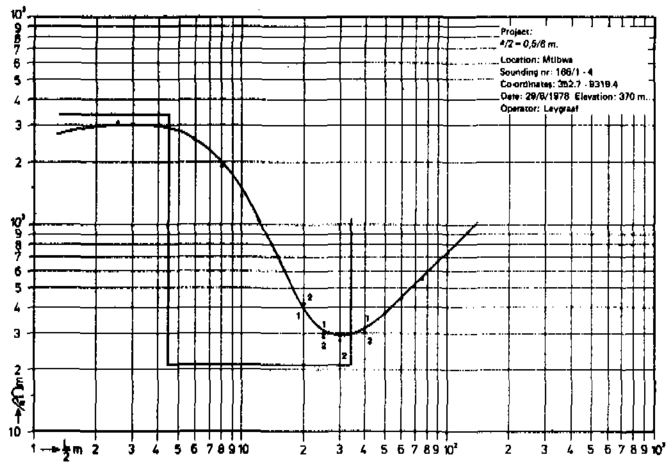

Project:
a/2 = 0,5/6/25/100 m.
Location: Mugudeni
Sounding nr: 165/4 - 102
Co-ordinates: 324.9 - 9302.3
Date: 14/11/1978 Elevation: 420 m.
Operator: Leygraaf

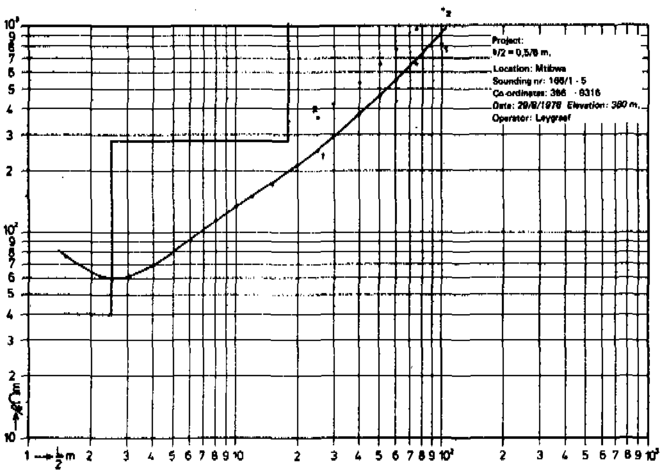

Project:
a/2 = 0,5/6/25 m.
Location: Mirama
Sounding nr: 165/4 - 103
Co-ordinates: 329.4 - 9295.9
Date: 14/11/1978 Elevation: 390 m.
Operator: Leygraaf

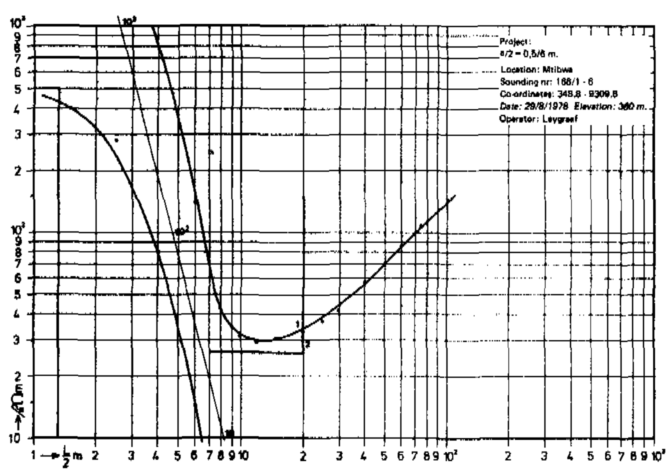

Project:
a/2 = 0,5/6 m.
Location: Mtibwa
Sounding nr: 166/1 - 1
Co-ordinates: 351.8 - 9319,8
Date: 28/8/1978 Elevation: 370 m.
Operator: Leygraaf

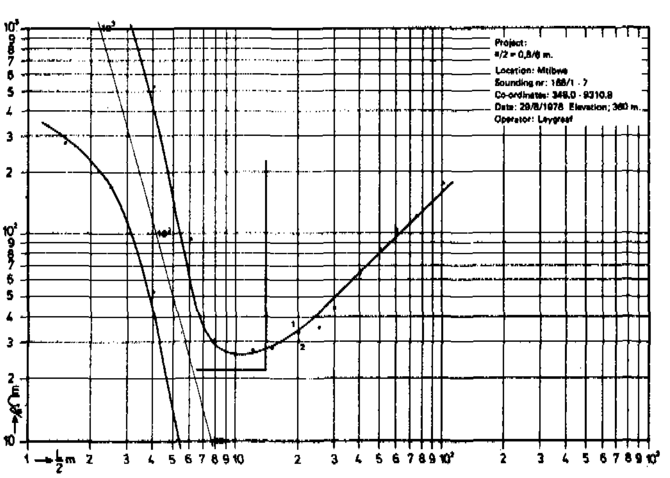

Project:
a/2 = 0,5/6 m.
Location: Mtibwa
Sounding nr: 166/1 - 2
Co-ordinates: 351.8 · 9320.7
Date: 28/8/1978 Elevation: 370 m.
Operator: Leygraaf

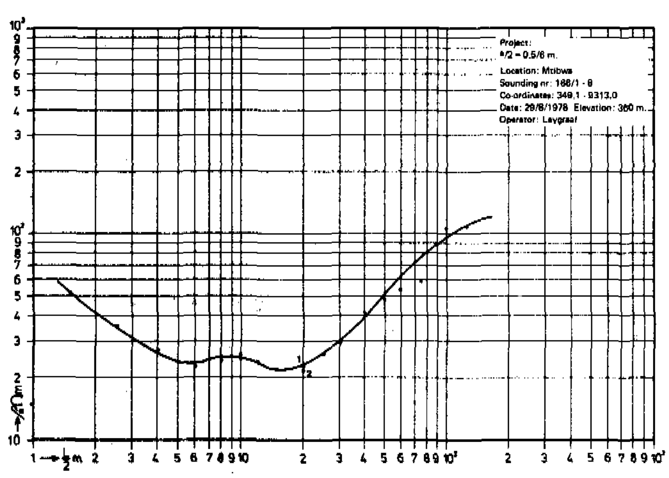

Project:
a/2 = 0,5/6 m.
Location: Mtibwa
Sounding nr: 166/1 - 3
Co-ordinates: 351.3 - 9321.5
Date: 29/8/1978 Elevation: 380 m.
Operator: Leygraaf

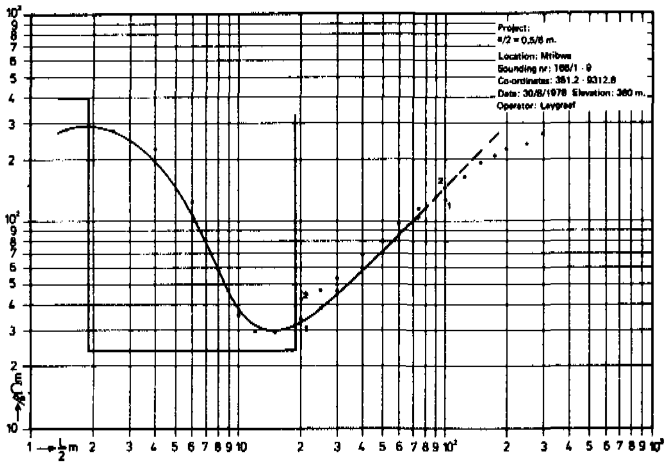

Project:
a/2 = 0,5/6 m.
Location: Mtibwa
Sounding nr: 166/1 - 4
Co-ordinates: 352.7 · 9319.4
Date: 29/8/1978 Elevation: 370 m.
Operator: Leygraaf

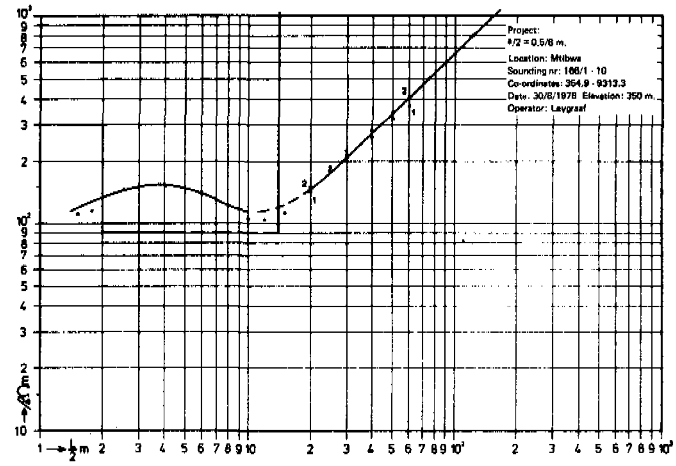

Project:
a/2 = 0,5/6 m.
Location: Mtibwa
Sounding nr: 166/1 - 5
Co-ordinates: 366 · 9316
Date: 29/8/1978 Elevation: 380 m.
Operator: Leygraaf

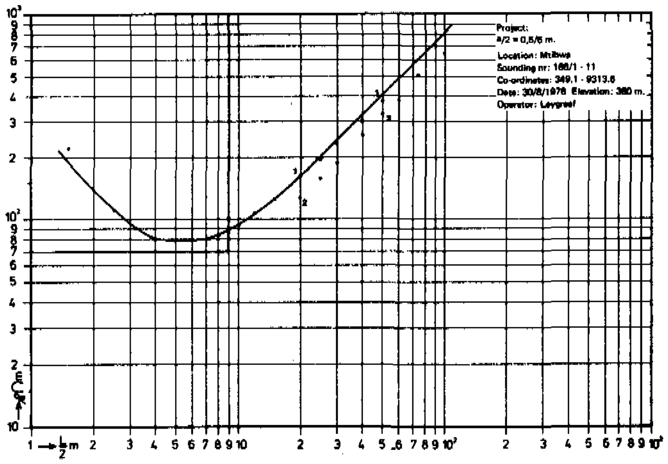

Project:
a/2 = 0,5/6 m.
Location: Mtibwa
Sounding nr: 166/1 - 6
Co-ordinates: 348,8 · 9309,8
Date: 29/8/1978 Elevation: 360 m.
Operator: Leygraaf

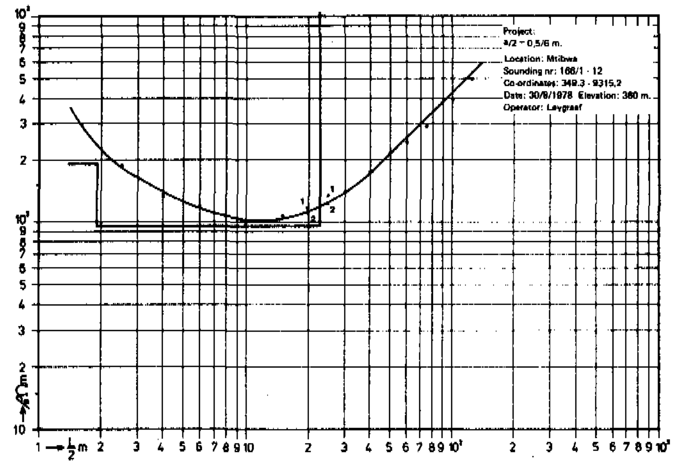

Project:
a/2 = 0,5/6 m.
Location: Mtibwa
Sounding nr: 166/1 - 7
Co-ordinates: 349.0 - 9310.8
Date: 29/8/1978 Elevation: 360 m.
Operator: Leygraaf

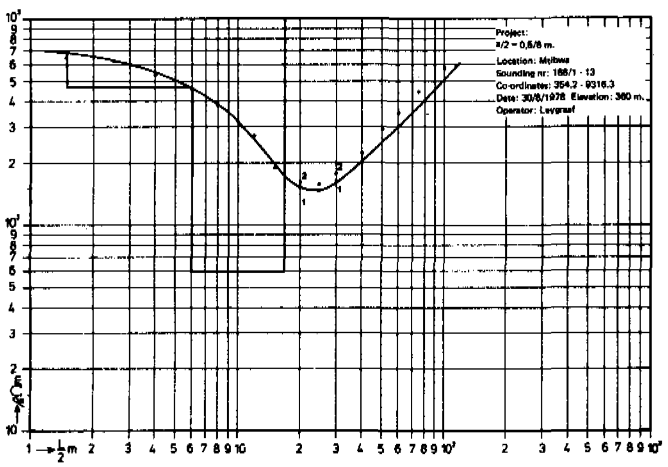

Project:
a/2 = 0.5/6 m.
Location: Mtibwa
Sounding nr: 166/1 - 8
Co-ordinates: 349,1 · 9313,0
Date: 29/8/1978 Elevation: 360 m.
Operator: Leygraaf

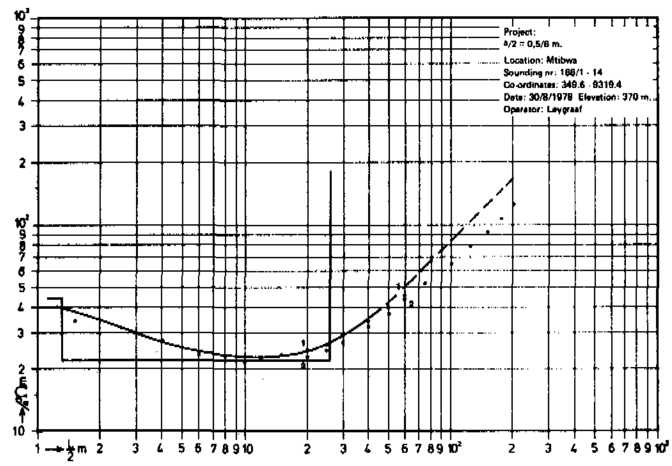

Project:
a/2 = 0.5/6 m.
Location: Mtibwa
Sounding nr: 166/1 - 9
Co-ordinates: 351.2 - 9312.8
Date: 30/8/1978 Elevation: 360 m.
Operator: Leygraaf

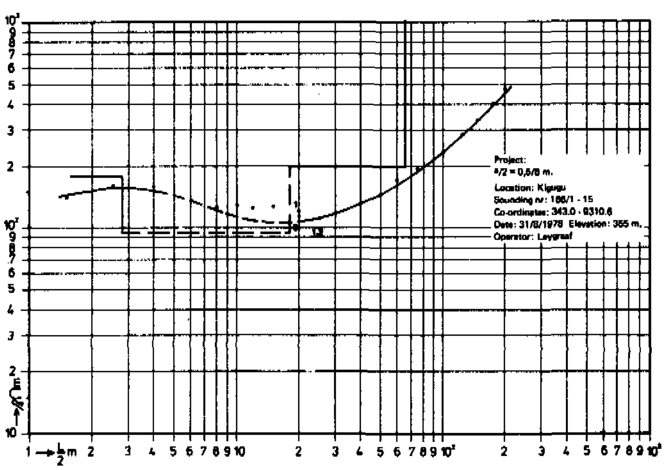

Project:
a/2 = 0.5/6 m.
Location: Mtibwa
Sounding nr: 166/1 - 10
Co-ordinates: 354.9 - 9313.3
Date. 30/8/1978 Elevation: 350 m.
Operator: Leygraaf

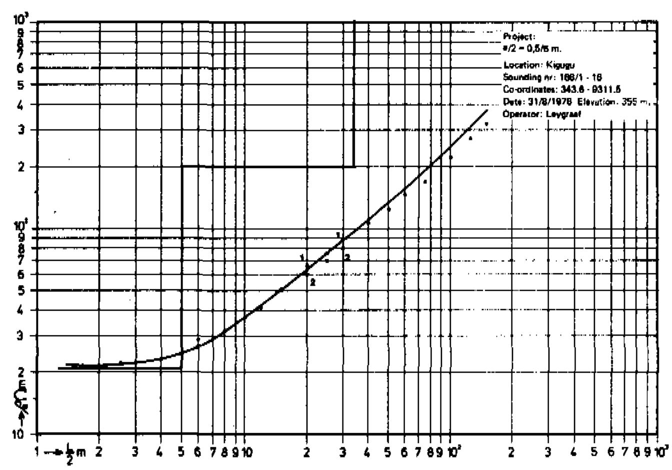

Project:
a/2 = 0,5/6 m.
Location: Mtibwa
Sounding nr: 166/1 - 11
Co-ordinates: 349.1 - 9313.6
Date: 30/8/1978 Elevation: 360 m.
Operator: Leygraaf

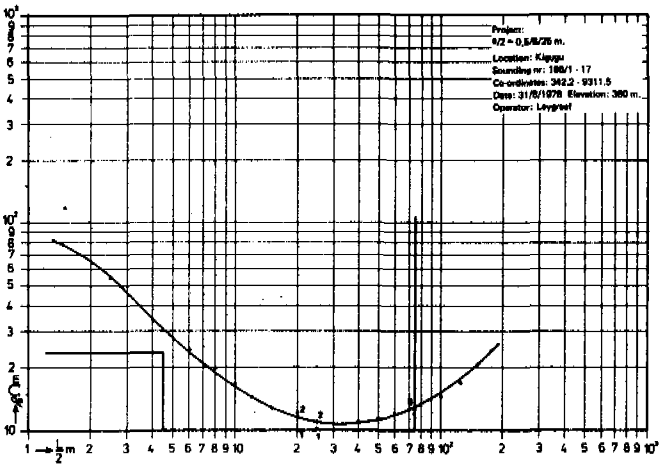

Project:
a/2 = 0,5/6 m.
Location: Mtibwa
Sounding nr: 166/1 - 12
Co-ordinates: 349.3 - 9315,2
Date: 30/8/1978 Elevation: 360 m.
Operator: Leygraaf

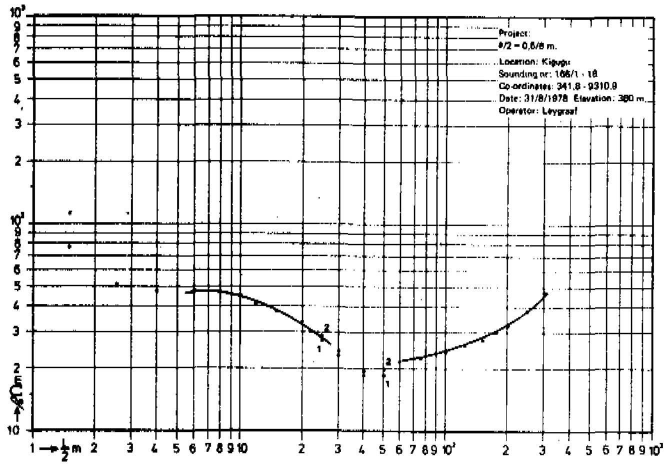

Project:
a/2 = 0,5/6 m.
Location: Mtibwa
Sounding nr: 166/1 - 13
Co-ordinates: 354.2 - 9316.3
Date: 30/8/1978 Elevation: 360 m.
Operator: Leygraaf

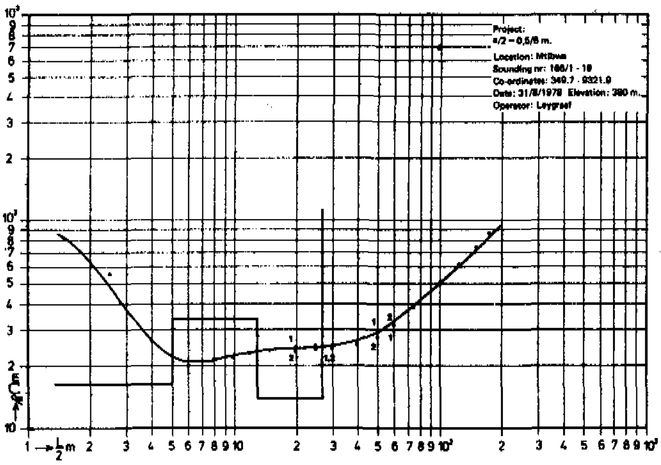

Project:
a/2 = 0,5/6 m.
Location: Mtibwa
Sounding nr: 166/1 - 14
Co-ordinates: 349.6 - 9319.4
Date: 30/8/1978 Elevation: 370 m.
Operator: Leygraaf

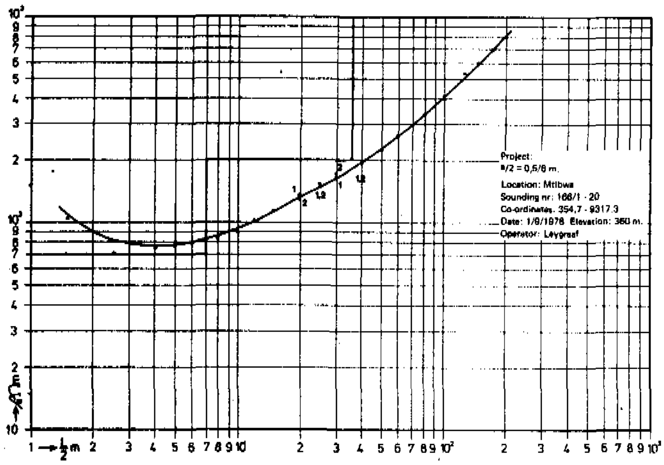

Project:
a/2 = 0,5/6 m.
Location: Kigugu
Sounding nr: 166/1 - 15
Co-ordinates: 343.0 - 9310.6
Date: 31/8/1978 Elevation: 355 m.
Operator: Leygraaf

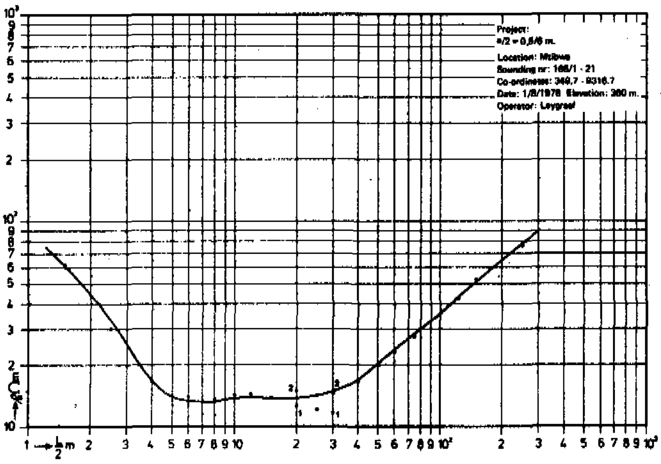

Project:
a/2 = 0,5/6 m.
Location: Kigugu
Sounding nr: 166/1 - 16
Co-ordinates: 343.6 - 9311.5
Date: 31/8/1978 Elevation. 355 m.
Operator: Leygraaf

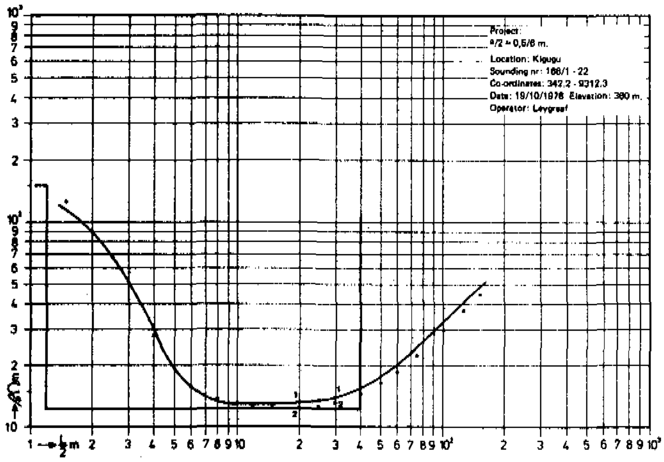

Project:
a/2 = 0,5/8/25 m.
Location: Kigugu
Sounding nr: 166/1 - 17
Co-ordinates: 342.2 - 9311.5
Date: 31/8/1978 Elevation: 380 m.
Operator: Leygraaf

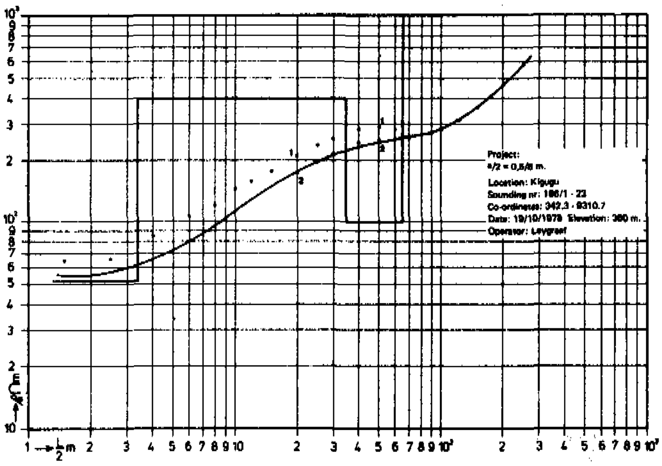

Project:
a/2 = 0,5/8 m.
Location: Kigugu
Sounding nr: 166/1 - 18
Co-ordinates: 341.8 - 9310.9
Date: 31/8/1978 Elevation: 380 m.
Operator: Leygraaf

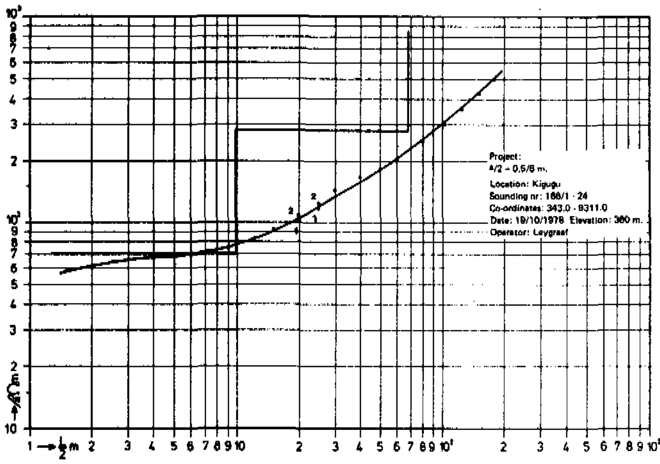

Project:
a/2 = 0,5/8 m.
Location: Mtibwa
Sounding nr: 166/1 - 19
Co-ordinates: 349.7 - 9321.9
Date: 31/8/1978 Elevation: 380 m.
Operator: Leygraaf

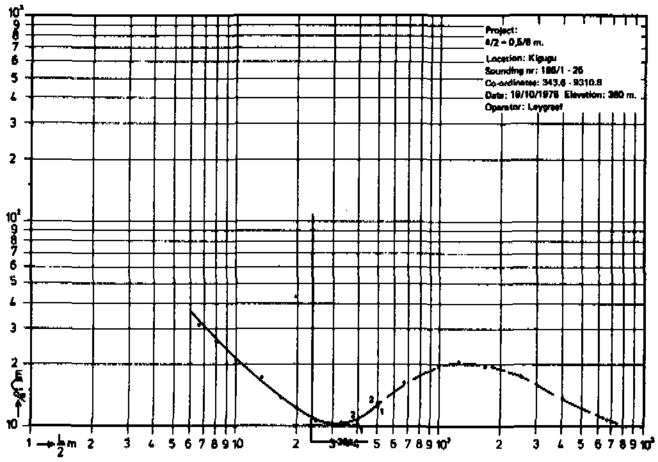

Project:
a/2 = 0,5/8 m.
Location: Mtibwa
Sounding nr: 166/1 - 20
Co-ordinates: 354,7 - 9317.3
Date: 1/8/1978 Elevation: 380 m.
Operator: Leygraaf

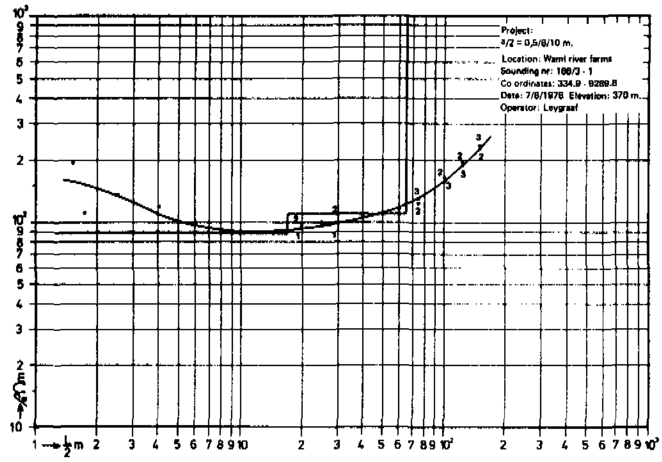

Project:
a/2 = 0,5/8 m.
Location: Mtibwa
Sounding nr: 166/1 - 21
Co-ordinates: 349.7 - 9316.7
Date: 1/8/1978 Elevation: 380 m.
Operator: Leygraaf

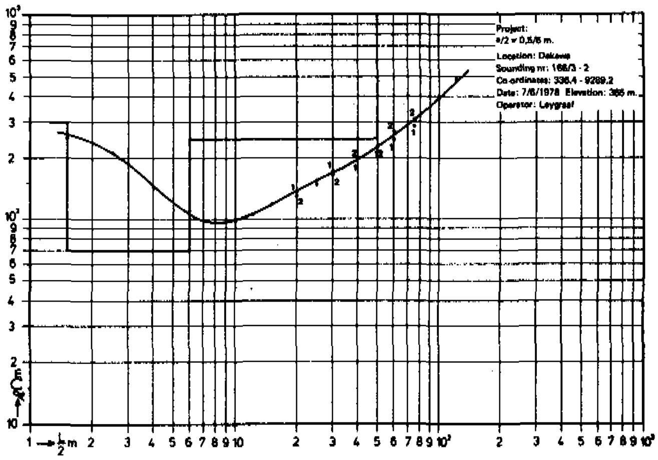

Project:
a/2 = 0,5/8 m.
Location: Kigugu
Sounding nr: 166/1 - 22
Co-ordinates: 342.2 - 9312.3
Date: 19/10/1978 Elevation: 380 m.
Operator: Leygraaf

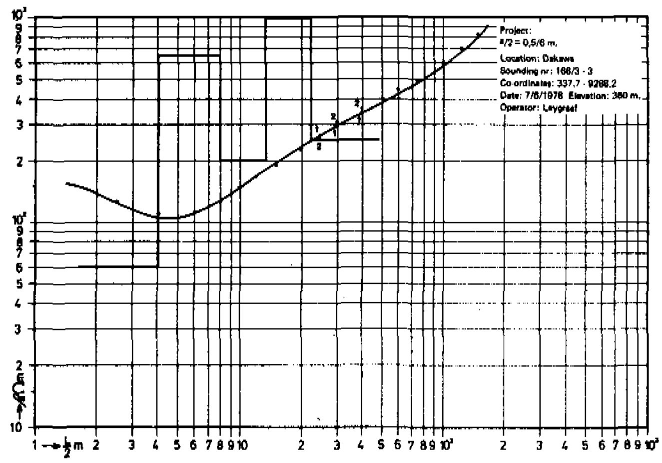

Project:
a/2 = 0,5/8 m.
Location: Kigugu
Sounding nr: 166/1 - 23
Co-ordinates: 342.3 - 9310.7
Date: 19/10/1978 Elevation: 380 m.
Operator: Leygraaf

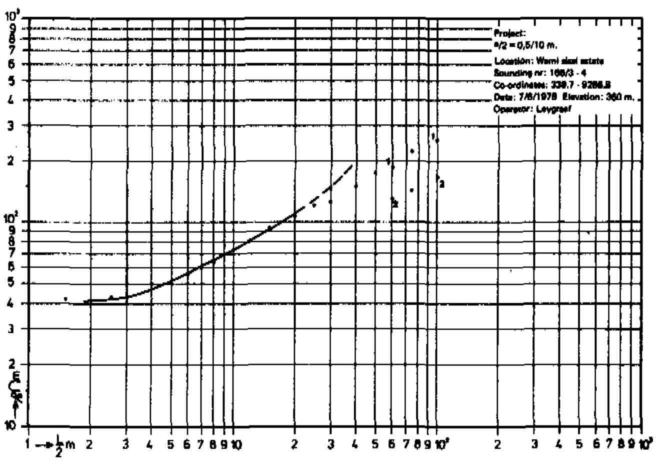

Project:
a/2 = 0,5/8 m.
Location: Kigugu
Sounding nr: 166/1 - 24
Co-ordinates: 343.0 - 9311.0
Date: 19/10/1978 Elevation: 380 m.
Operator: Leygraaf

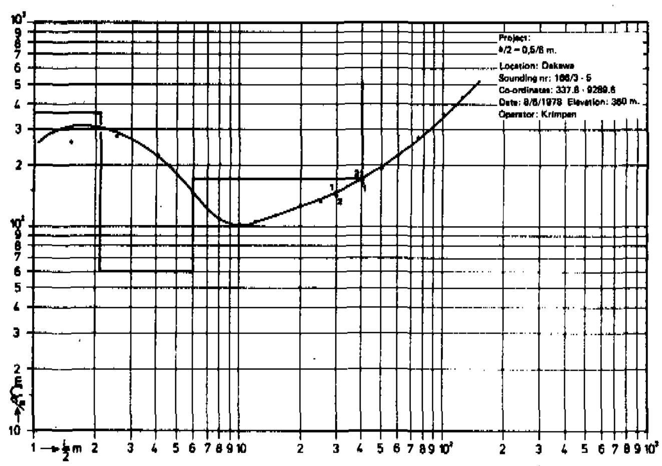

Project:
a/2 = 0,5/6 m.
Location: Kigugu
Sounding nr: 166/1 - 26
Co-ordinates: 343.6 - 9310.8
Date: 19/10/1978 Elevation: 360 m.
Operator: Leygraaf

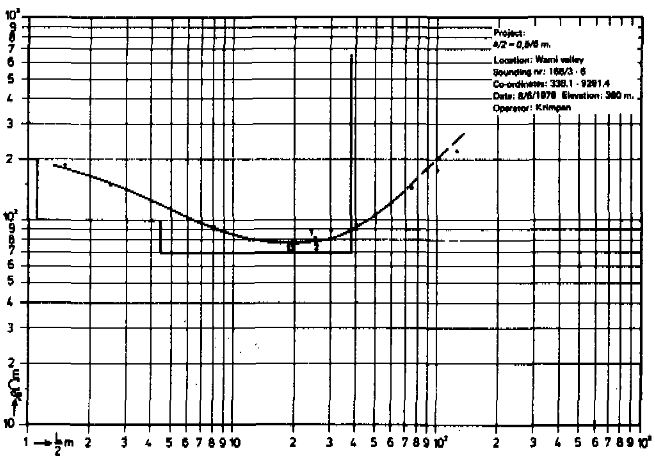

Project:
a/2 = 0,5/6/10 m.
Location: Wami river farms
Sounding nr: 166/3 - 1
Co ordinates: 334.9 - 9289.8
Date: 7/6/1978 Elevation: 370 m.
Operator: Leygraaf

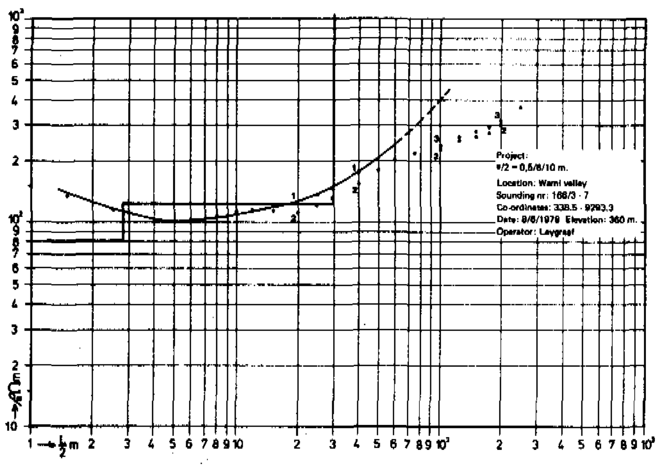

Project:
a/2 = 0,5/6 m.
Location: Dakawa
Sounding nr: 166/3 - 2
Co-ordinates: 336.4 - 9289.2
Date: 7/6/1978 Elevation: 365 m.
Operator: Leygraaf

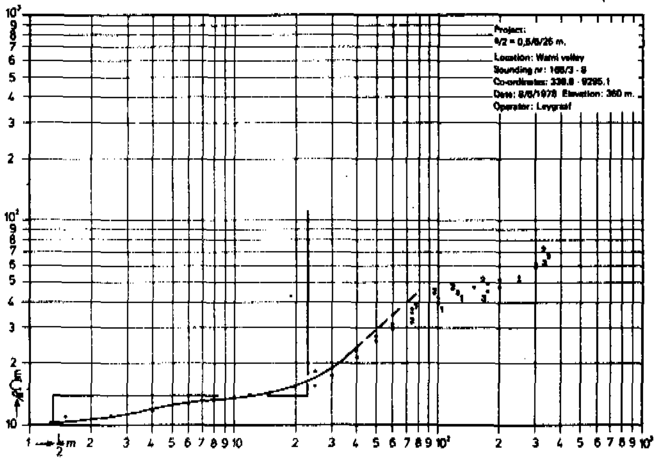

Project:
a/2 = 0,5/6 m.
Location: Dakawa
Sounding nr: 166/3 - 3
Co-ordinates: 337,7 - 9288.2
Date: 7/6/1978 Elevation: 360 m.
Operator: Leygraaf

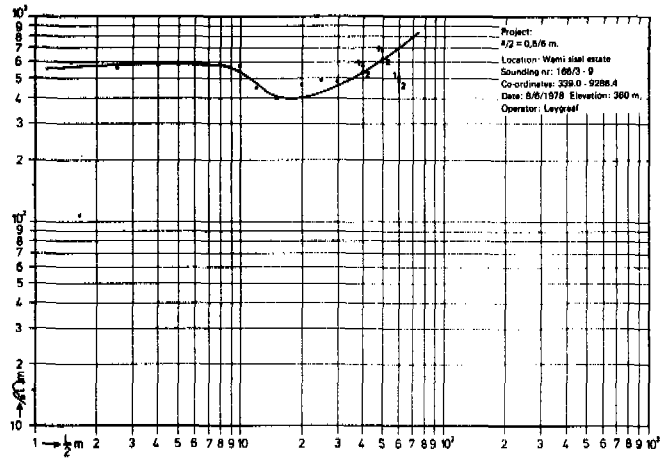

Project:
a/2 = 0,5/10 m.
Location: Wami sisal estate
Sounding nr: 166/3 - 4
Date: 7/6/1978 Elevation: 360 m.
Operator: Leygraaf

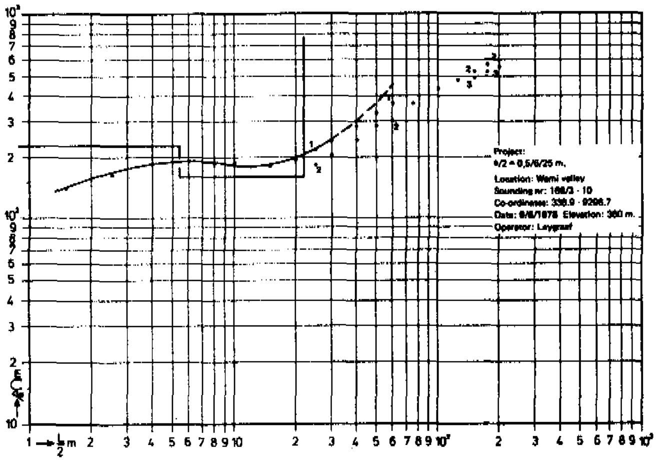

Project:
a/2 = 0,5/6 m.
Location: Dakawa
Sounding nr: 166/3 - 5
Co-ordinates: 337.8 - 9289.6
Date: 8/6/1978 Elevation: 360 m.
Operator: Krimpen

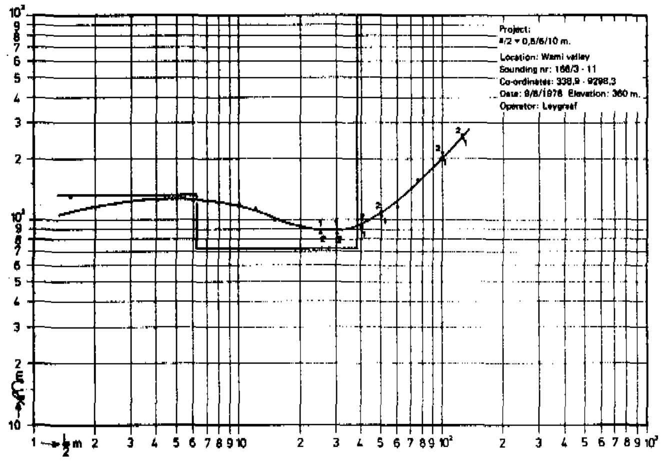

Project:
a/2 = 0,5/6 m.
Location: Wami valley
Sounding nr: 166/3 - 6
Co-ordinates: 338.1 - 9291.4
Date: 8/6/1978 Elevation: 360 m.
Operator: Krimpen

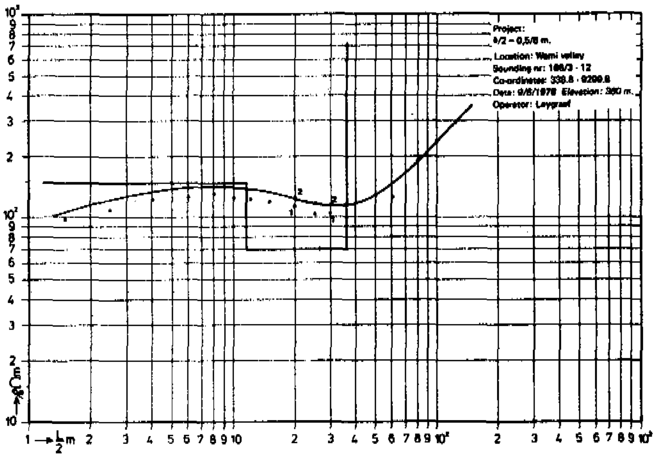

Project:
a/2 = 0,5/6/10 m.
Location: Wami valley
Sounding nr: 166/3 - 7
Co-ordinates: 338.5 - 9293,3
Date: 8/6/1978 Elevation: 360 m.
Operator: Leygraaf

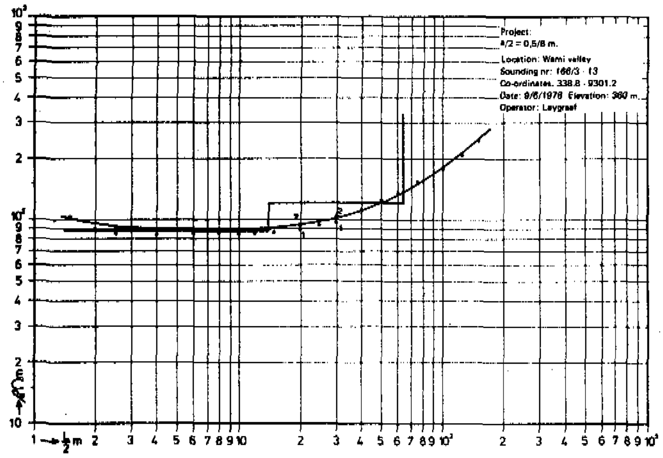

Project:
a/2 = 0,5/6/25 m.
Location: Wami valley
Sounding nr: 166/3 - 8
Co-ordinates: 338.8 - 9295.1
Date: 8/6/1978 Elevation: 360 m.
Operator: Leygraaf

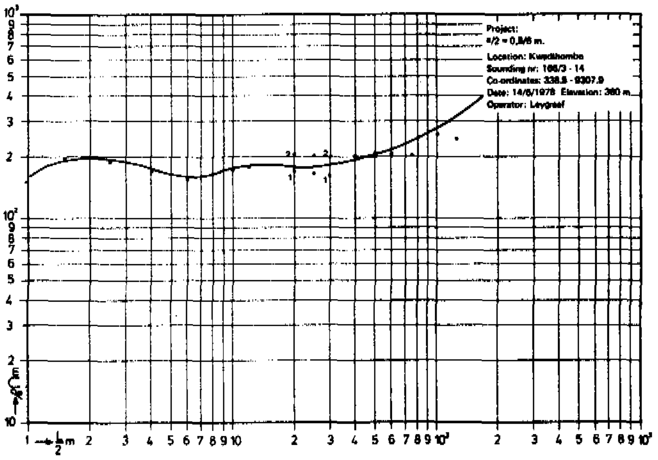

Project:
a/2 = 0,5/6 m.
Location: Wami sisal estate
Sounding nr: 166/3 - 9
Co-ordinates: 339.0 - 9288.4
Date: 8/6/1978 Elevation: 360 m.
Operator: Leygraaf

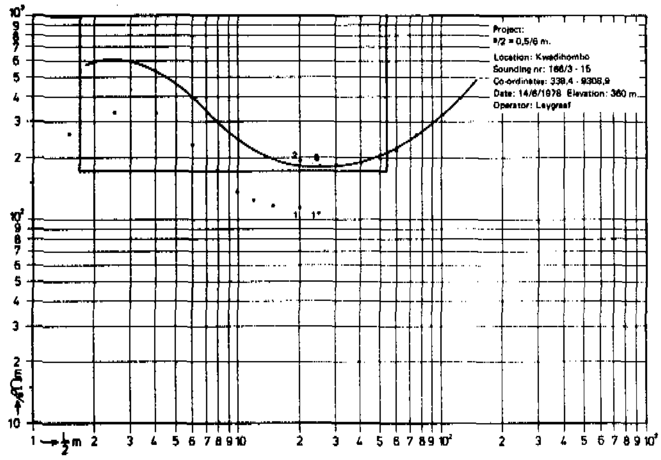

Project:
a/2 = 0,5/6/25 m.
Location: Wami valley
Sounding nr: 166/3 - 10
Co-ordinates: 338.9 - 9296.7
Date: 9/6/1978 Elevation: 360 m.
Operator: Leygraaf

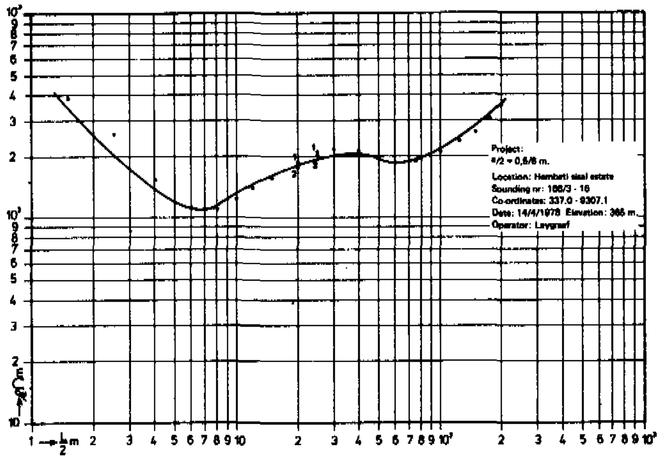

Project:
a/2 = 0,5/6/10 m.
Location: Wami valley
Sounding nr: 166/3 - 11
Co-ordinates: 338,9 - 9298,3
Date: 9/6/1978 Elevation: 360 m.
Operator: Leygraaf

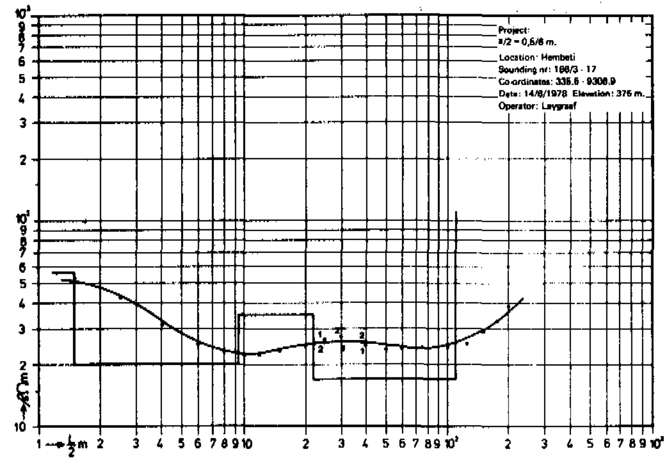

Project:
a/2 = 0,5/6 m.
Location: Wami valley
Sounding nr: 166/3 - 12
Co-ordinates: 338.8 - 9299.8
Date: 9/6/1978 Elevation: 360 m.
Operator: Leygraaf

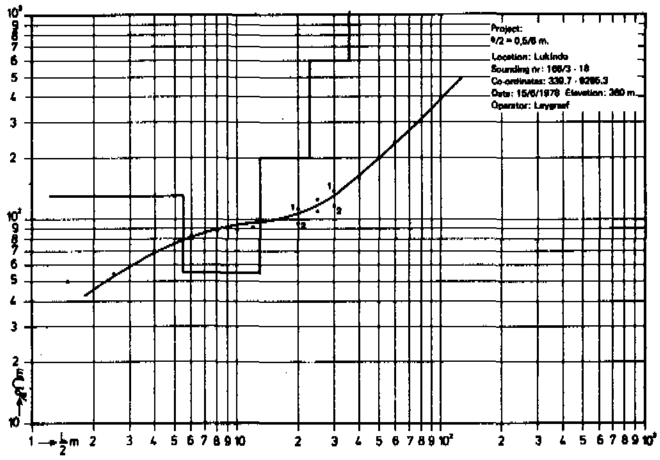

Project:
a/2 = 0,5/8 m.
Location: Wami valley
Sounding nr: 166/3 - 13
Co-ordinates. 338.8 - 9301.2
Date: 9/6/1978 Elevation: 360 m.
Operator: Leygraaf

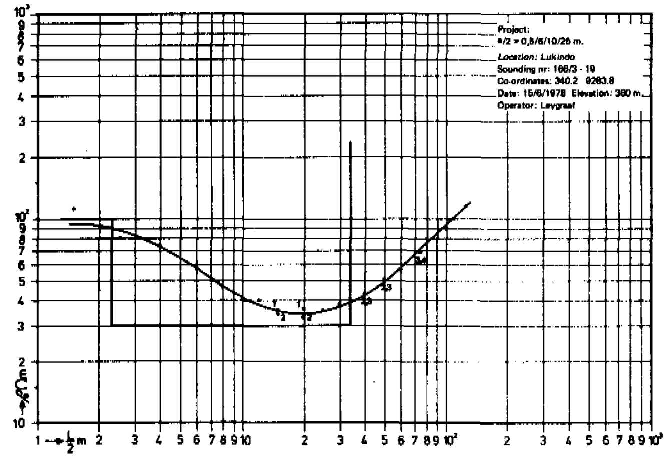

Project:
a/2 = 0,5/6 m.
Location: Kwadihombo
Sounding nr: 166/3 - 14
Co-ordinates: 338.8 - 9307.9
Date: 14/6/1978 Elevation: 360 m.
Operator: Leygraaf

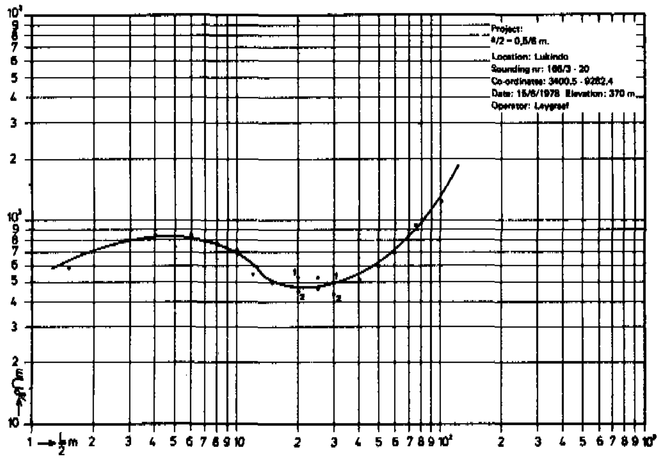

Project:
a/2 = 0,5/6 m.
Location: Kwadihombo
Sounding nr: 166/3 - 15
Co-ordinates: 338,4 - 9308,9
Date: 14/6/1978 Elevation: 360 m.
Operator: Leygraaf

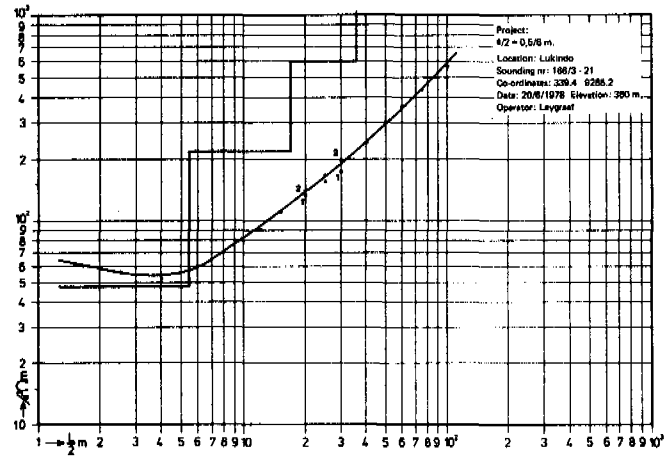

Project:
a/2 = 0,5/6 m.
Location: Hembeti sisal estate
Sounding nr: 166/3 - 16
Co-ordinates: 337.0 - 9307.1
Date: 14/4/1978 Elevation: 365 m.
Operator: Leygraaf

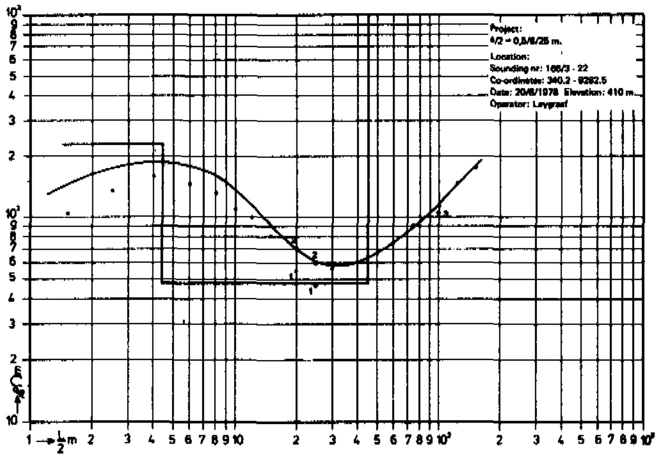

Project:
a/2 = 0,5/6 m.
Location: Hembeti
Sounding nr: 166/3 - 17
Co-ordinates: 335.6 - 9306.9
Date: 14/6/1978 Elevation: 375 m.
Operator: Leygraaf

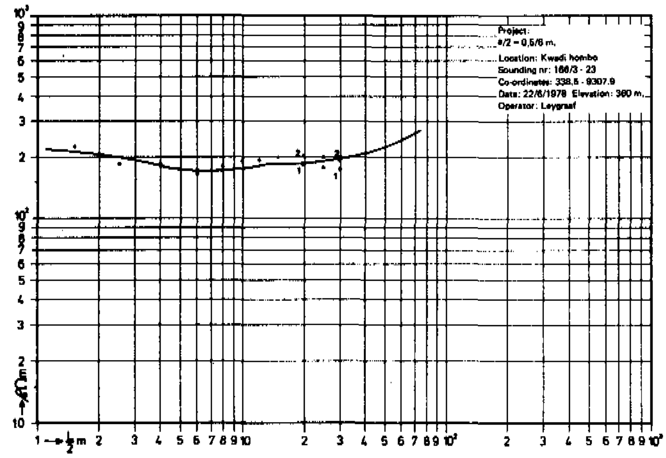

Project:
a/2 = 0,5/6 m.
Location: Lukindo
Sounding nr: 166/3 - 18
Co-ordinates: 339.7 - 9285.3
Date: 15/6/1978 Elevation: 360 m.
Operator: Leygraaf

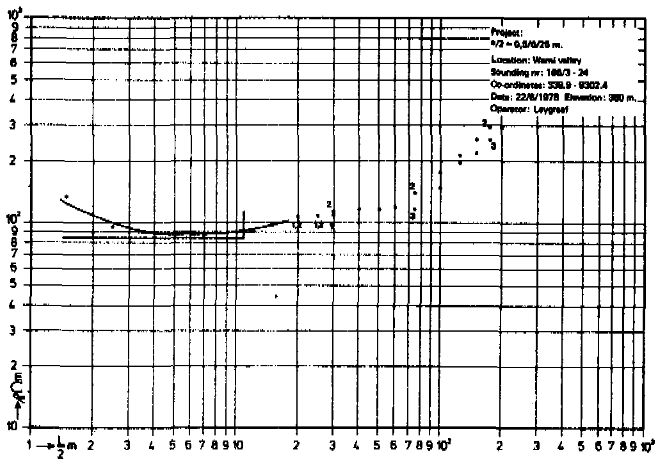

Project:
a/2 = 0,5/6/10/25 m.
Location: Lukindo
Sounding nr: 166/3 - 19
Co-ordinates: 340.2 9283.8
Date: 15/6/1978 Elevation: 360 m.
Operator: Leygraaf

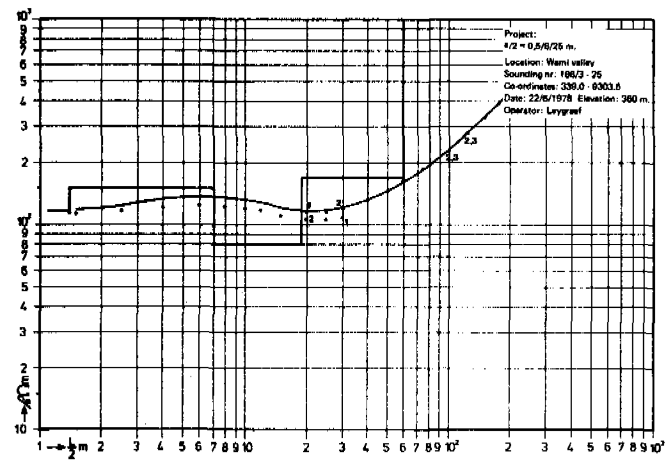

Project:
a/2 = 0,5/6 m.
Location: Lukindo
Sounding nr: 166/3 - 20
Co-ordinates: 3400.5 - 9282.4
Date: 15/6/1978 Elevation: 370 m.
Operator: Leygraaf

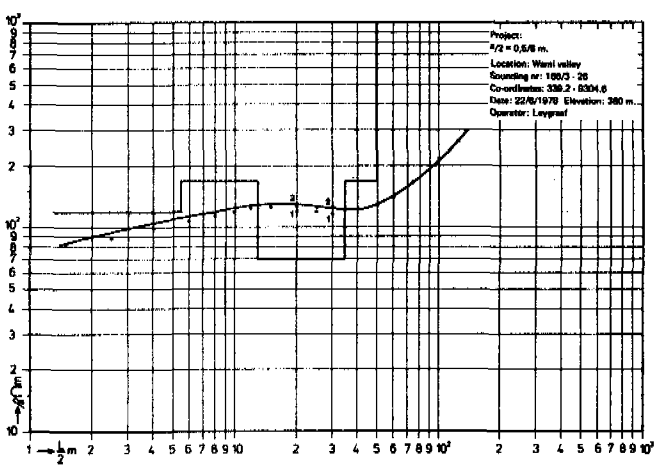

Project:
a/2 = 0,5/6 m.
Location: Lukindo
Sounding nr: 166/3 - 21
Co-ordinates: 339.4 9286.2
Date: 20/6/1978 Elevation: 380 m.
Operator: Leygraaf

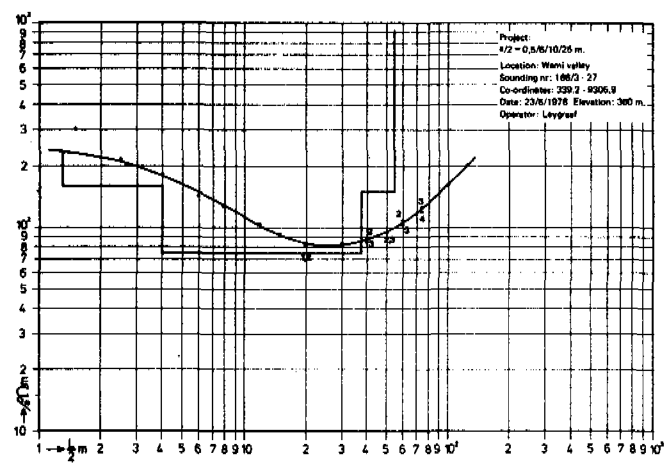

Project:
a/2 = 0,5/6/25 m.
Location:
Sounding nr: 166/3 - 22
Co-ordinates: 340.2 - 9282.5
Date: 20/6/1978 Elevation: 410 m.
Operator: Leygraaf

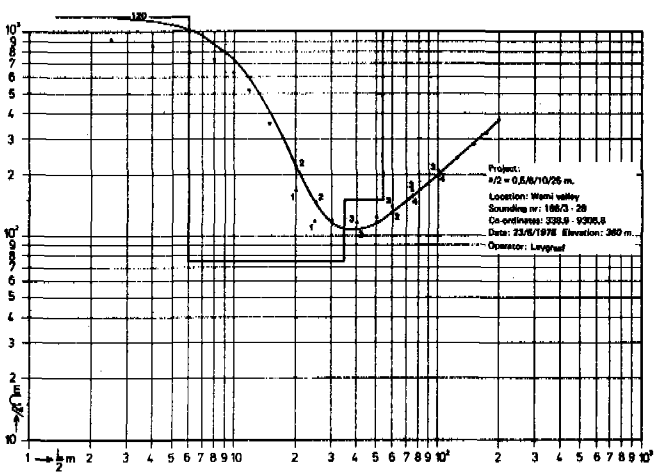

Project:
a/2 = 0,5/6 m.
Location: Kwadi hombo
Sounding nr: 166/3 - 23
Co-ordinates: 338.6 - 9307.9
Date: 22/6/1978 Elevation: 360 m.
Operator: Leygraaf

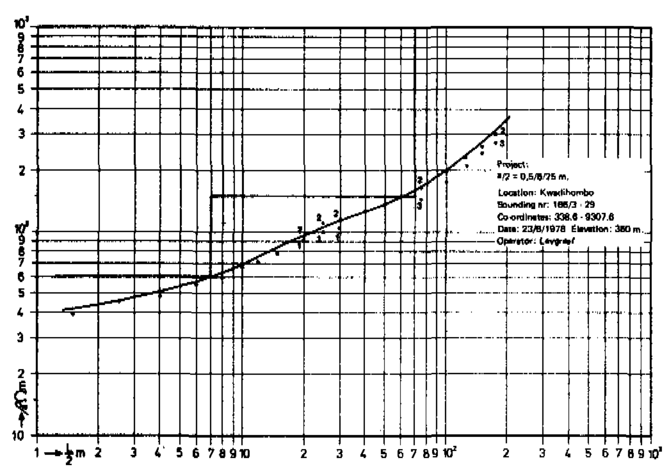

Project:
a/2 = 0,5/6/25 m.
Location: Wami valley
Sounding nr: 166/3 - 24
Co-ordinates: 339.9 - 9302.4
Date: 22/6/1978 Elevation: 380 m.
Operator: Leygraaf

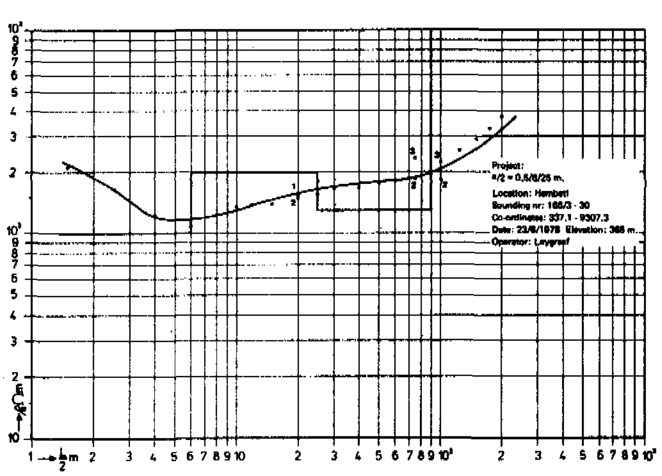

Project:
a/2 = 0,5/6/25 m.
Location: Wami valley
Sounding nr: 166/3 - 25
Co-ordinates: 339.0 - 9303.6
Date: 22/6/1978 Elevation: 380 m.
Operator: Leygraaf

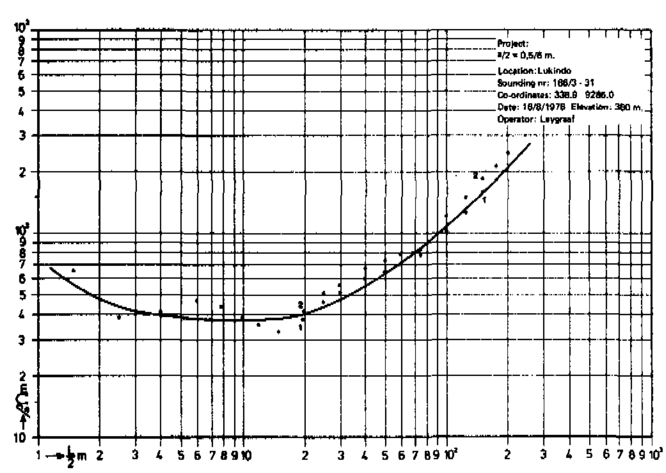

Project:
a/2 = 0,5/6 m.
Location: Wami valley
Sounding nr: 166/3 - 26
Co-ordinates: 339.2 - 9304.6
Date: 22/6/1978 Elevation: 380 m.
Operator: Leygraaf

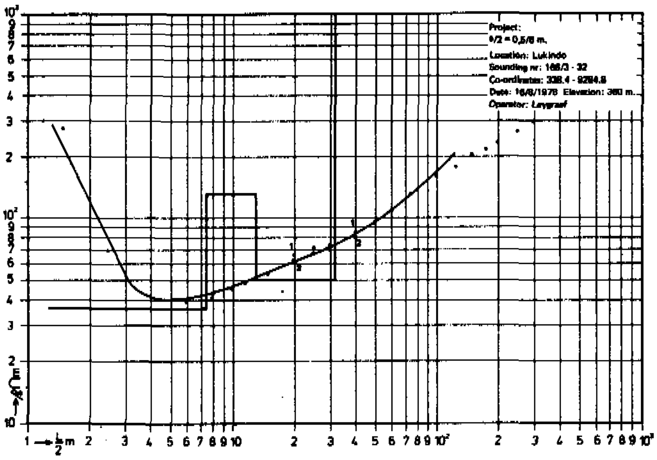

Project:
a/2 = 0,5/6/10/26 m.
Location: Wami valley
Sounding nr: 166/3 - 27
Co-ordinates: 339.2 - 9306.9
Date: 23/6/1978 Elevation: 380 m.
Operator: Leygraaf

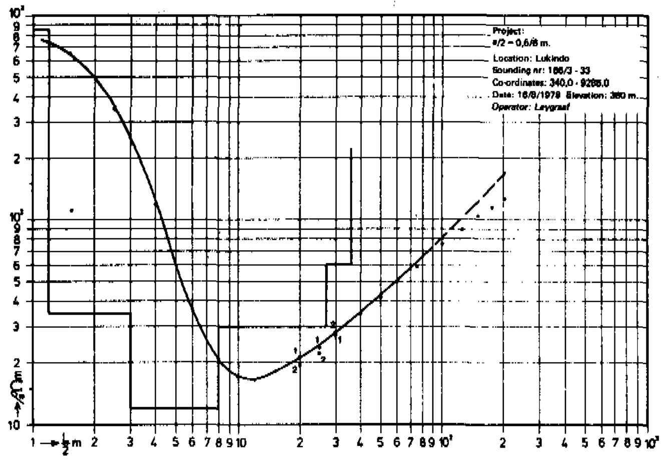

120
Project:
a/2 = 0,5/6/10/25 m.
Location: Wami valley
Sounding nr: 166/3 - 28
Co-ordinates: 338.9 - 9305.8
Date: 23/6/1978 Elevation: 380 m.
Operator: Leygraaf

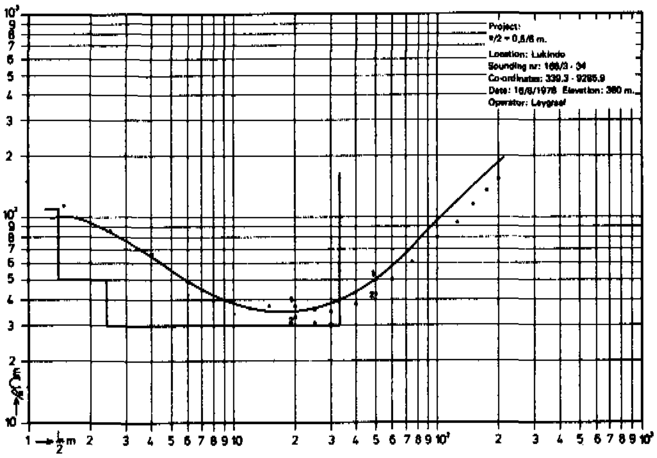

Project:
a/2 = 0,5/6/25 m.
Location: Kwadihombo
Sounding nr: 166/3 - 29
Co-ordinates: 338.6 - 9307.6
Date: 23/6/1978 Elevation: 380 m.
Operator: Leygraaf

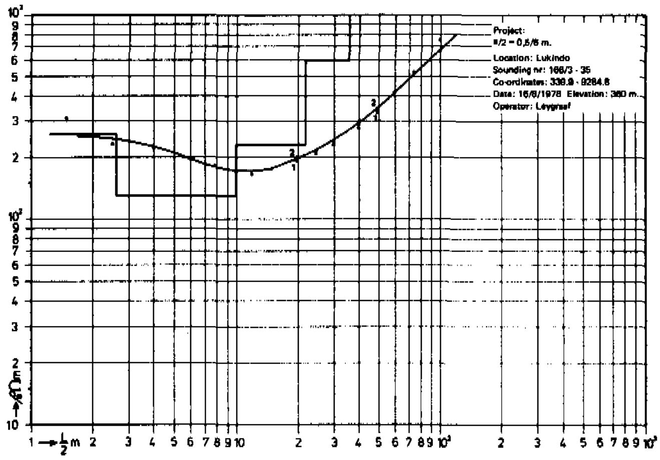

Project:
a/2 = 0,5/6/25 m.
Location: Hembeti
Sounding nr: 166/3 - 30
Co-ordinates: 337.1 - 9307.3
Date: 23/6/1978 Elevation: 365 m.
Operator: Leygraaf

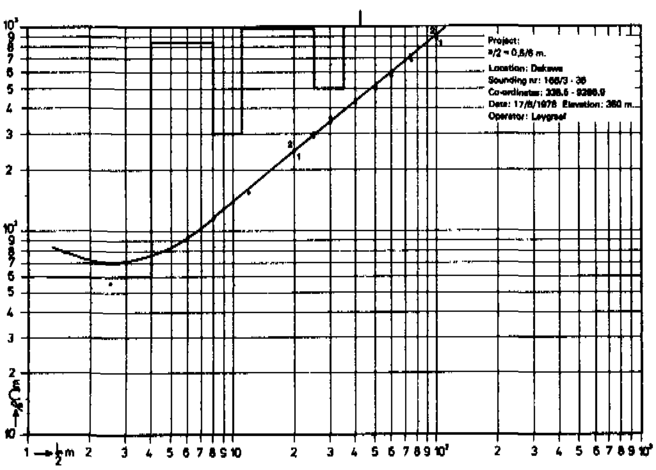

Project:
a/2 = 0,5/6 m.
Location: Lukindo
Sounding nr: 166/3 - 31
Co-ordinates: 338.9 9286.0
Date: 16/6/1978 Elevation: 380 m.
Operator: Leygraaf

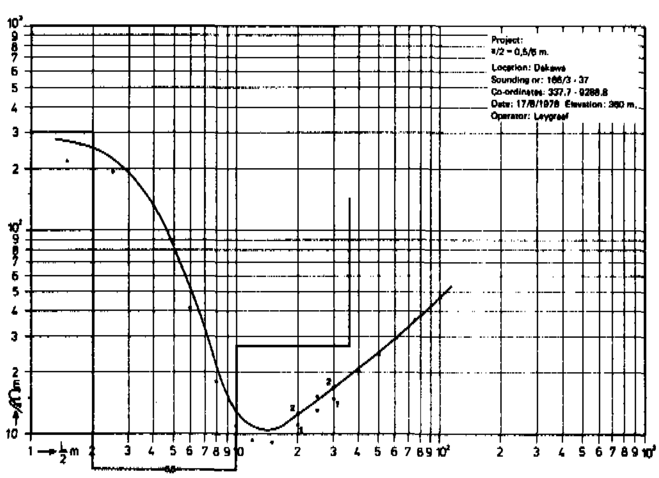

Project:
a/2 = 0,5/6 m.
Location: Lukindo
Sounding nr: 166/3 - 32
Co-ordinates: 338.4 - 9284.8
Date: 16/8/1978 Elevation: 360 m.
Operator: Leygraaf

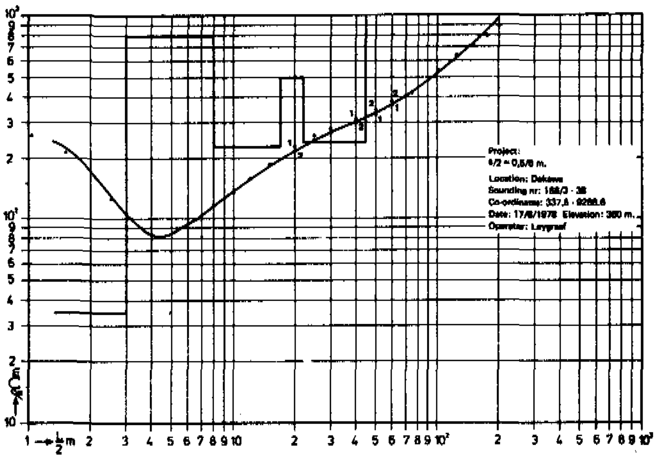

Project:
a/2 = 0,6/6 m.
Location: Lukindo
Sounding nr: 166/3 - 33
Co-ordinates: 340,0 - 9286,0
Date: 16/8/1978 Elevation: 360 m.
Operator: Leygraaf

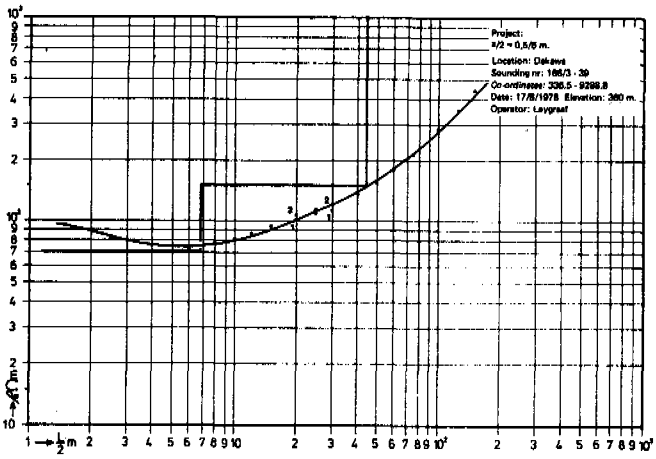

Project:
a/2 = 0,5/6 m.
Location: Lukindo
Sounding nr: 166/3 - 34
Co-ordinates: 339.3 - 9285.9
Date: 16/8/1978 Elevation: 360 m.
Operator: Leygraaf

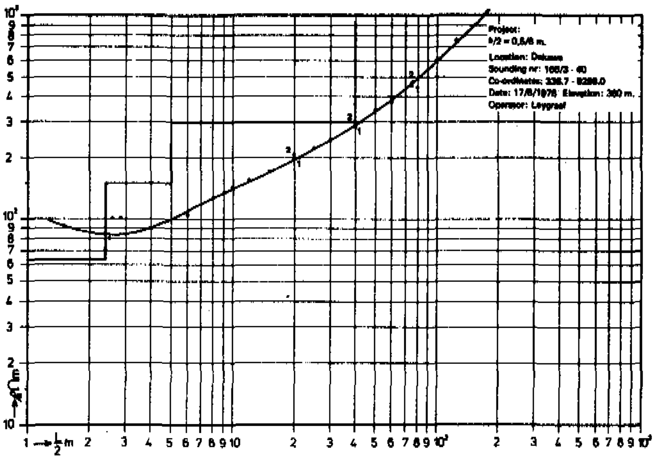

Project:
a/2 = 0,5/6 m.
Location: Lukindo
Sounding nr: 166/3 - 35
Co-ordinates: 338.9 - 9284.6
Date: 16/8/1978 Elevation: 360 m.
Operator: Leygraaf

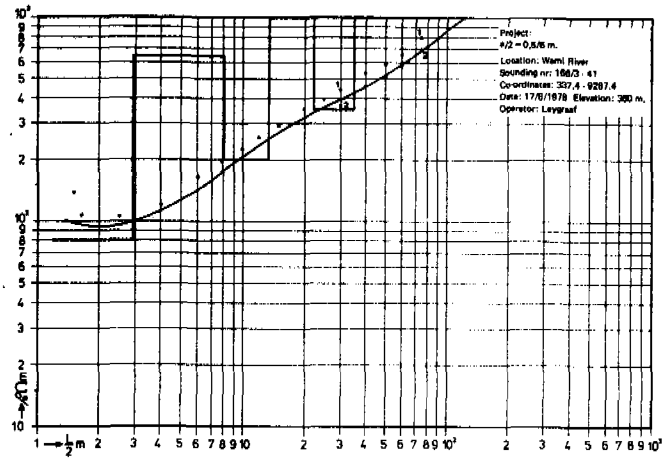

Project:
a/2 = 0,5/6 m.
Location: Dakawa
Sounding nr: 166/3 - 36
Date: 17/8/1978 Elevation: 360 m.
Operator: Leygraaf

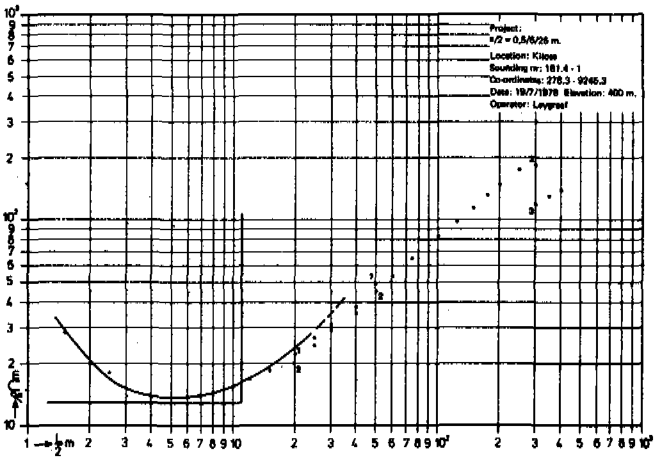

Project:
a/2 = 0,5/6 m.
Location: Dakawa
Sounding nr: 166/3 - 37
Co-ordinates: 337.7 - 9288.8
Date: 17/8/1978 Elevation: 360 m.
Operator: Leygraaf

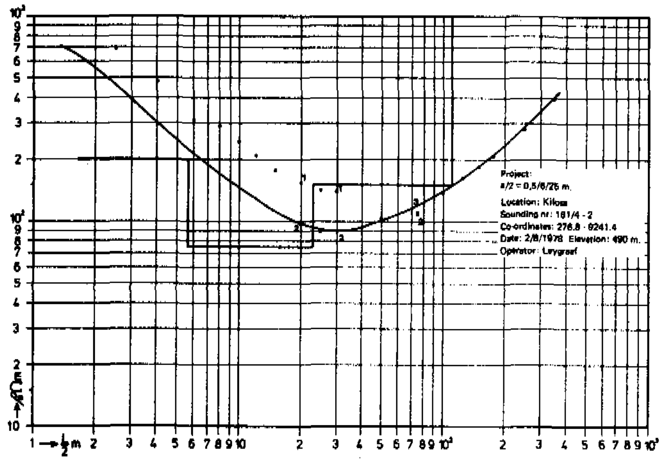

Project:
a/2 = 0,5/6 m.
Location: Dakawa
Sounding nr: 166/3 - 38
Date: 17/8/1978 Elevation: 360 m.
Operator: Leygraaf

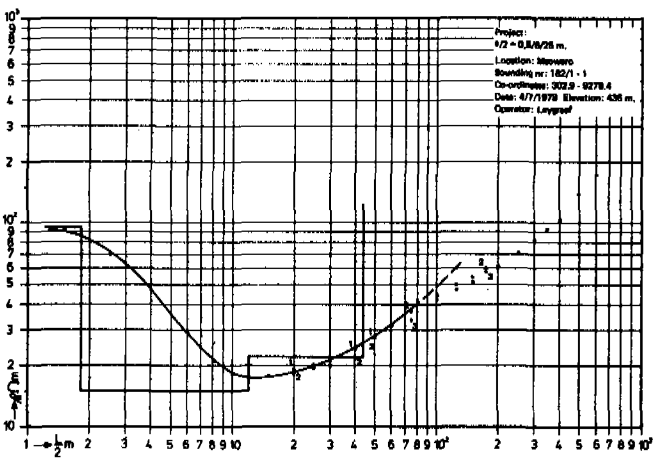

Project:
a/2 = 0,5/6 m.
Location: Dakawa
Sounding nr: 166/3 - 39
Co-ordinates: 336,5 - 9288.8
Date: 17/8/1978 Elevation: 360 m.
Operator: Leygraaf

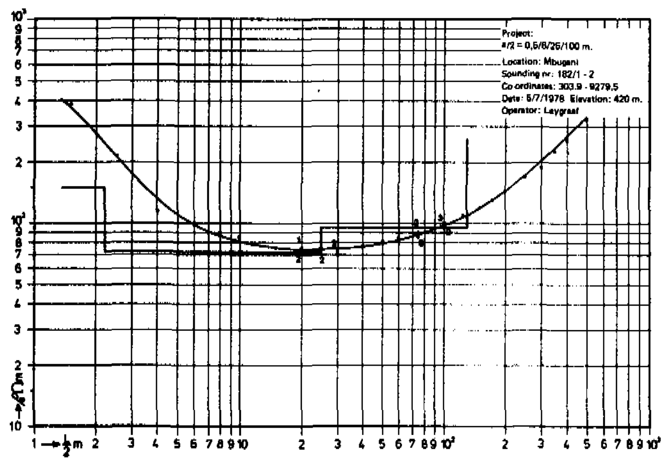

Project:
Date: 17/6/1978 Elevation: 360 m.
Operator: Leygraaf

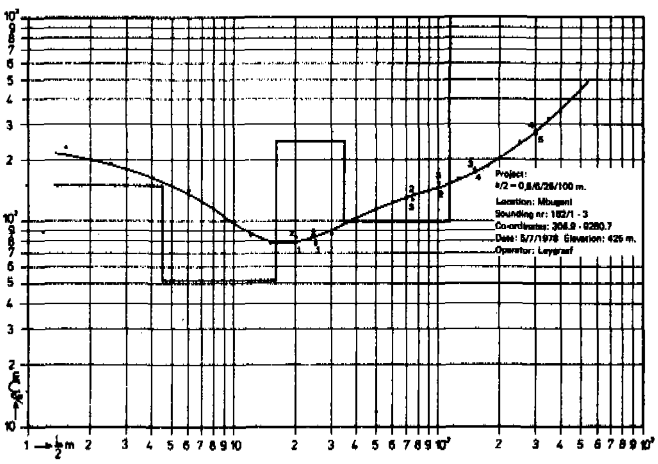

Project:
#/2 = 0,5/6 m.
Location: Wami River
Sounding nr: 166/3 - 41
Co-ordinates: 337,4 - 9287,4
Date: 17/6/1978 Elevation: 360 m.
Operator: Leygraaf

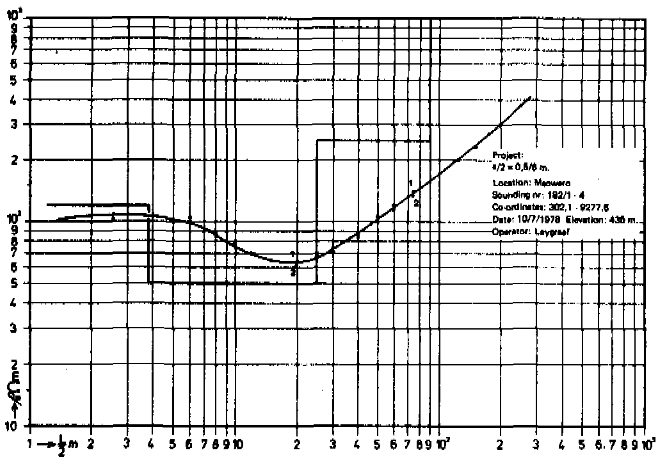

Project:
#/2 = 0,5/6/26 m.
Location: Kilosa
Sounding nr: 181.4 - 1
Date: 19/7/1978 Elevation: 400 m.
Operator: Leygraaf

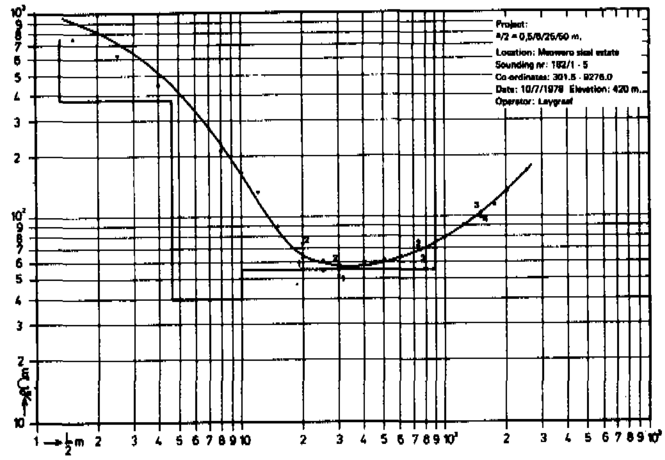

Project:
#/2 = 0,5/6/26 m.
Location: Kilosa
Sounding nr: 181/4 - 2
Co-ordinates: 276.8 - 9241.4
Date: 2/8/1978 Elevation: 490 m.
Operator: Leygraaf

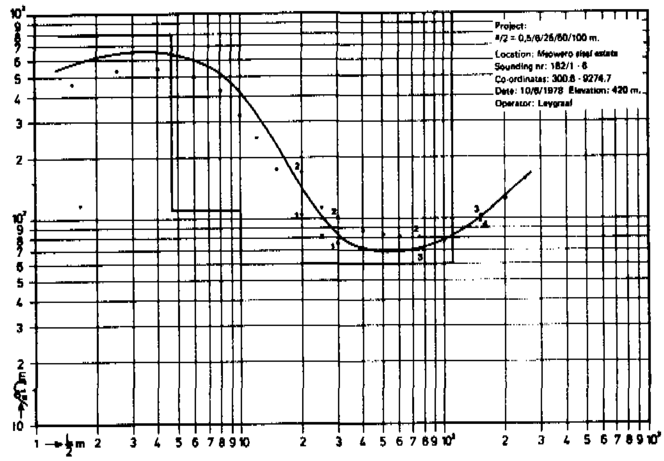

Project:
#/2 = 0,5/6/26 m.
Sounding nr: 182/1 - 1
Date: 4/7/1978 Elevation: 436 m.
Operator: Leygraaf

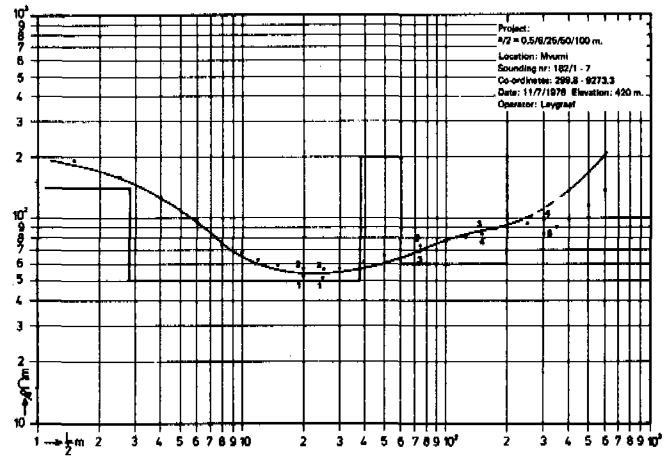

Project:
#/2 = 0,5/6/26/100 m.
Location: Mbugani
Sounding nr: 182/1 - 2
Co-ordinates: 303.9 - 9279.5
Date: 5/7/1978 Elevation: 420 m.
Operator: Leygraaf

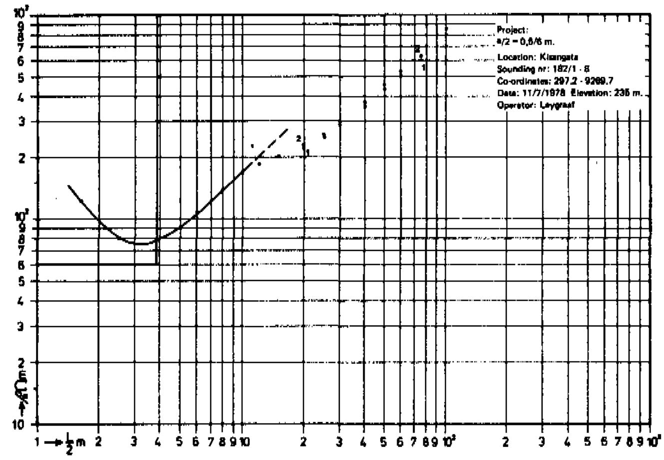

Project:
#/2 = 0,5/6/26/100 m.
Location: Mbugani
Sounding nr: 182/1 - 3
Date: 5/7/1978 Elevation: 425 m.
Operator: Leygraaf

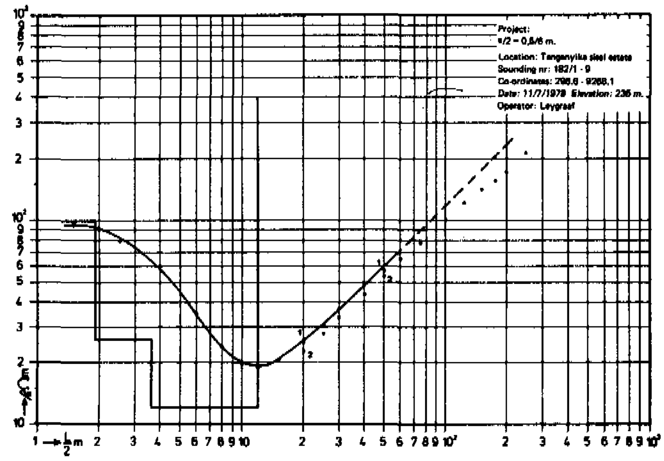

Project:
#/2 = 0,5/6 m.
Location: Mgowero
Sounding nr: 182/1 - 4
Co-ordinates: 302,1 - 9277,6
Date: 10/7/1978 Elevation: 436 m.
Operator: Leygraaf

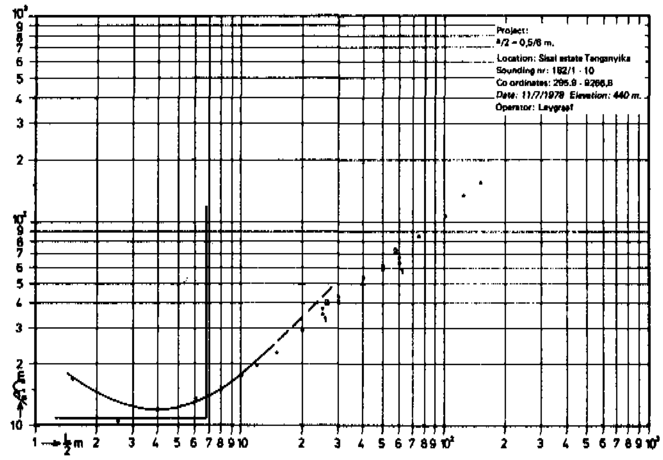

Project:
a/2 = 0,5/6/25/50 m.
Location: Mgowero sisal estate
Sounding nr: 182/1 - 5
Co-ordinatas: 301.5 - 9276.0
Date: 10/7/1978 Elevation: 420 m.
Operator: Leygraaf

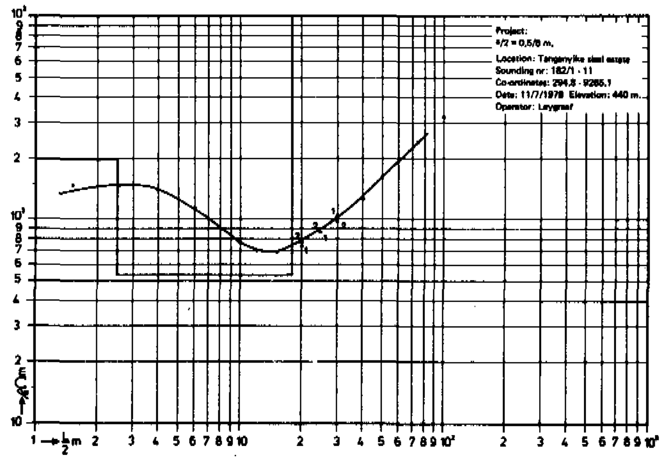

Project:
a/2 = 0,5/6/25/50/100 m.
Location: Mgowero sisal estate
Sounding nr: 182/1 - 6
Co-ordinates: 300.8 - 9274.7
Date: 10/8/1978 Elevation: 420 m.
Operator: Leygraaf

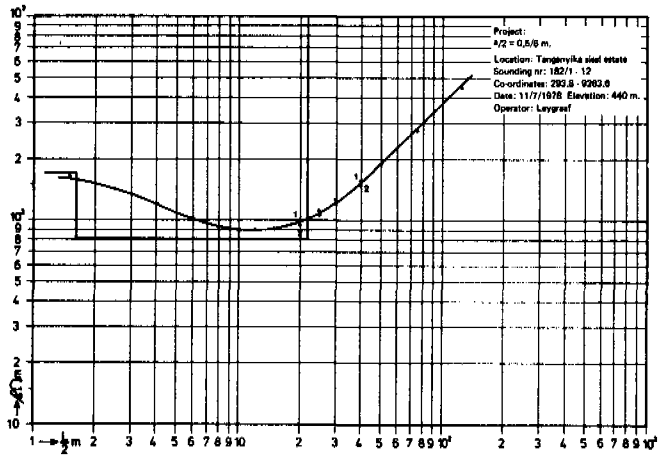

Project:
a/2 = 0.5/6/25/50/100 m.
Location: Mvumi
Sounding nr: 182/1 - 7
Co-ordinates: 299.8 - 9273.3
Date: 11/7/1978 Elevation: 420 m.
Operator: Leygraaf

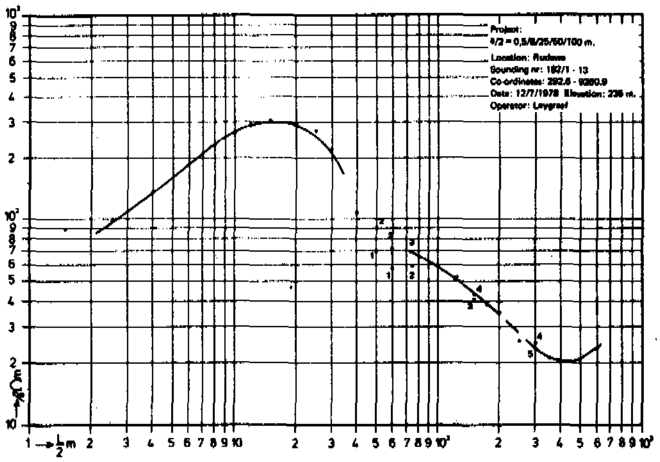

Project:
a/2 = 0,5/6 m.
Location: Kisangata
Sounding nr: 182/1 - 8
Co-ordinates: 297.2 - 9269.7
Date: 11/7/1978 Elevation: 235 m.
Operator: Leygraaf

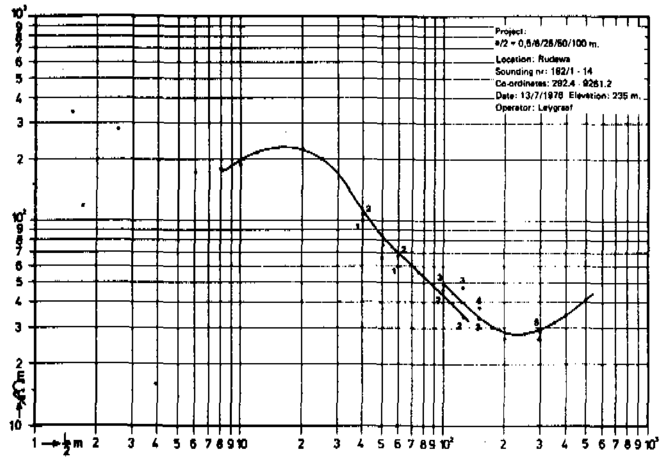

Project:
a/2 = 0,5/6 m.
Location: Tanganyika sisal estate
Sounding nr: 182/1 - 9
Co-ordinates: 298.6 - 9268.1
Date: 11/7/1978 Elevation: 235 m.
Operator: Leygraaf

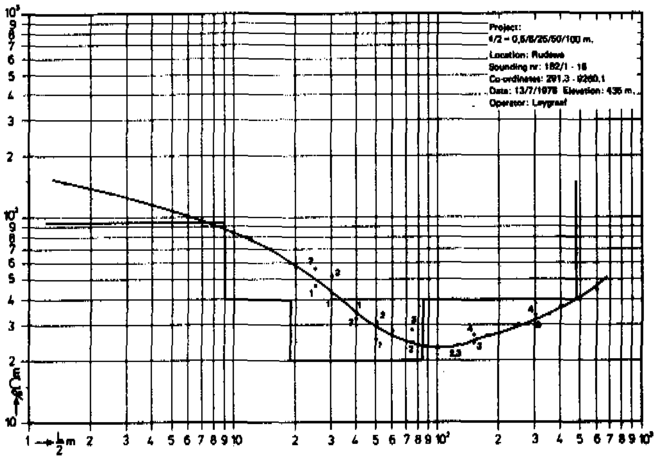

Project:
a/2 = 0,5/6 m.
Location: Sisal estate Tanganyika
Sounding nr: 182/1 - 10
Co ordinates: 295.9 - 9266,8
Date: 11/7/1978 Elevation: 440 m.
Operator: Leygraaf

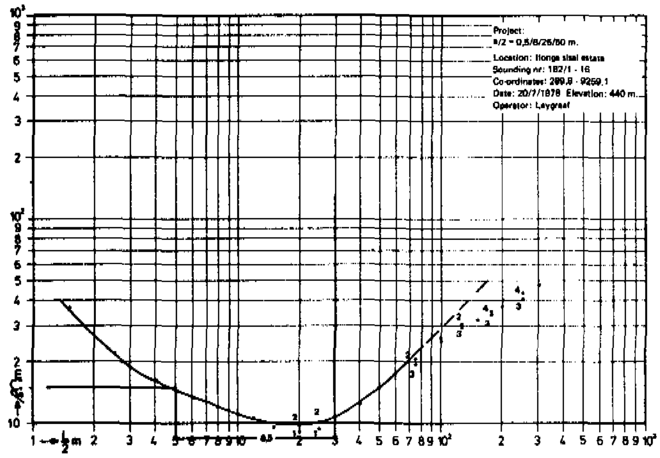

Project:
a/2 = 0,5/6 m.
Location: Tanganyika sisal estate
Sounding nr: 182/1 - 11
Co-ordinates: 294.8 - 9265.1
Date: 11/7/1978 Elevation: 440 m.
Operator: Leygraaf

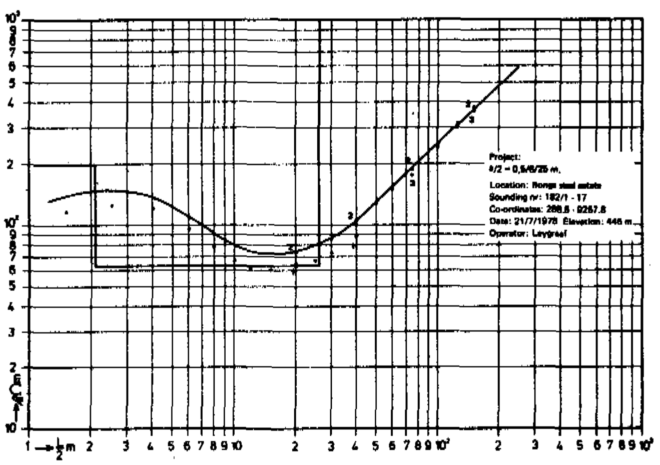

Project:
a/2 = 0,5/6 m.
Location: Tanganyika sisal estate
Sounding nr: 182/1 - 12
Co-ordinates: 293.8 - 9263.6
Date: 11/7/1978 Elevation: 440 m.
Operator: Leygraaf

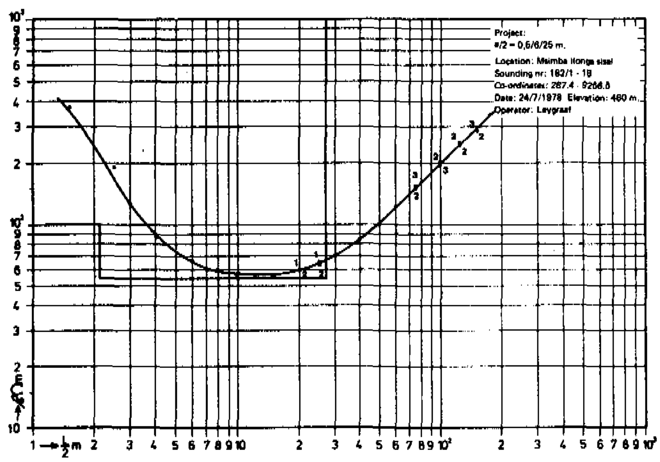

Project:
a/2 = 0,5/6/25/50/100 m.
Location: Rudewa
Sounding nr: 182/1 - 13
Co-ordinates: 292.6 - 9260.9
Date: 12/7/1978 Elevation: 236 m.
Operator: Leygraaf

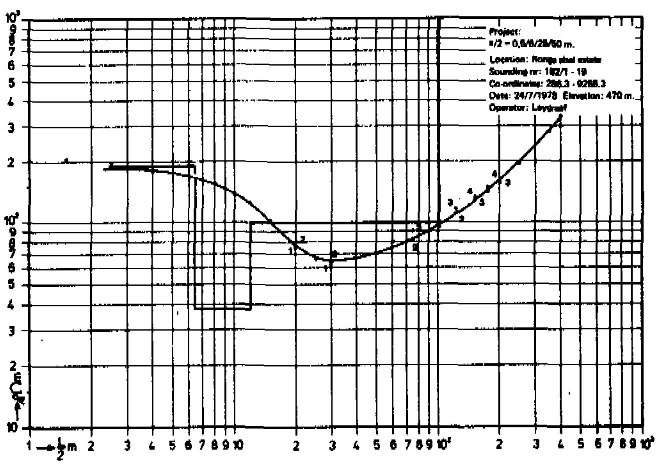

Project:
a/2 = 0,5/6/25/50/100 m.
Location: Rudewa
Sounding nr: 182/1 - 14
Co-ordinates: 292.4 - 9261.2
Date: 13/7/1978 Elevation: 235 m.
Operator: Leygraaf

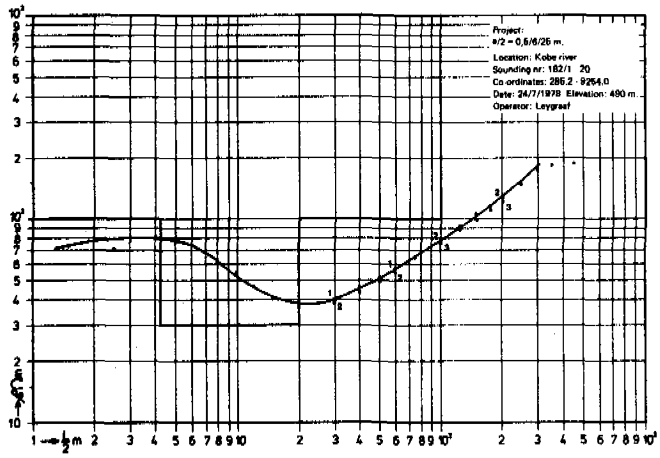

Project:
a/2 = 0,5/6/25/50/100 m.
Location: Rudewa
Sounding nr: 182/1 - 15
Co-ordinates: 291.3 - 9260.1
Date: 13/7/1978 Elevation: 435 m.
Operator: Leygraaf

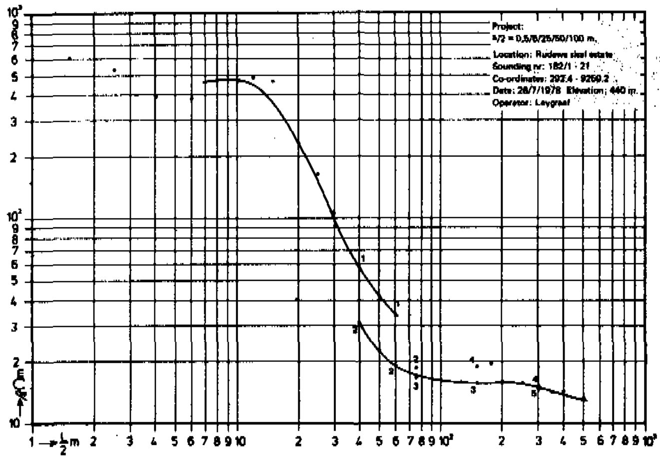

Project:
a/2 = 0,5/6/25/50 m.
Location: Ilonga sisal estate
Sounding nr: 182/1 - 16
Co-ordinates: 289.9 - 9259.1
Date: 20/7/1978 Elevation: 440 m.
Operator: Leygraaf

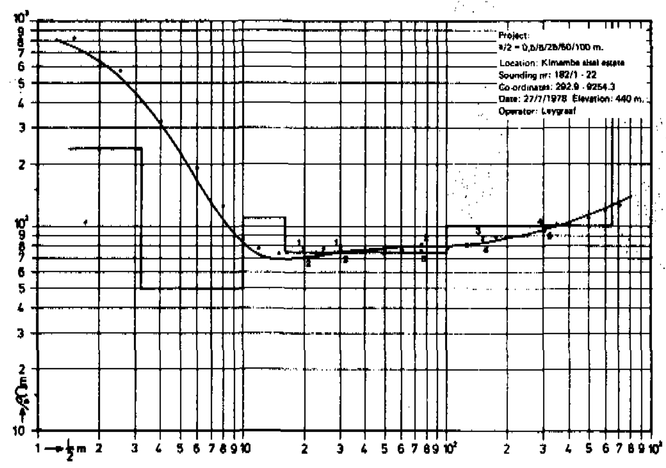

Project:
a/2 = 0,5/6/25 m.
Location: Ilonga sisal estate
Sounding nr: 182/1 - 17
Co-ordinates: 288.5 - 9257.8
Date: 21/7/1978 Elevation: 446 m.
Operator: Leygraaf

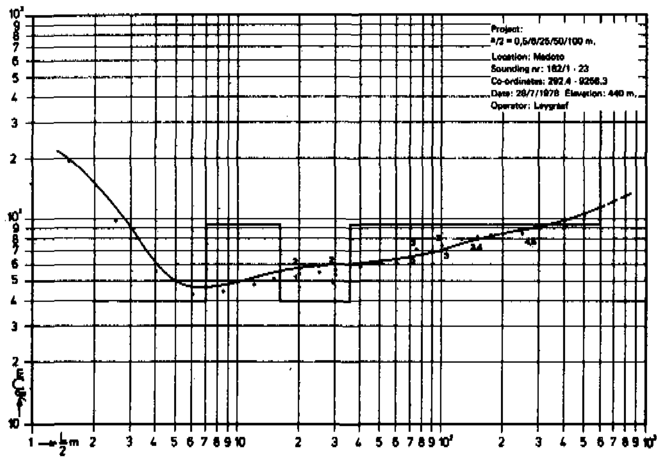

Project:
a/2 = 0,6/6/25 m.
Location: Msimba Ilonga sisal
Sounding nr: 182/1 - 18
Co-ordinates: 287.4 - 9258.8
Date: 24/7/1978 Elevation: 460 m.
Operator: Leygraaf

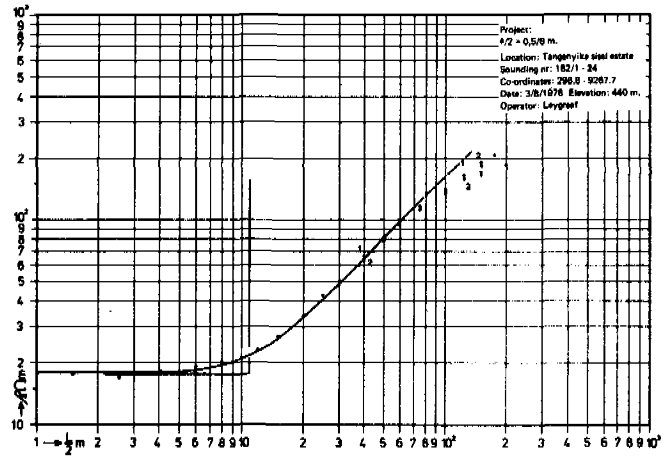

Project:
a/2 = 0,6/6/25/50 m.
Location: Ilonga sisal estate
Sounding nr: 182/1 - 19
Co-ordinates: 288.3 - 9258.3
Date: 24/7/1978 Elevation: 470 m.
Operator: Leygraaf

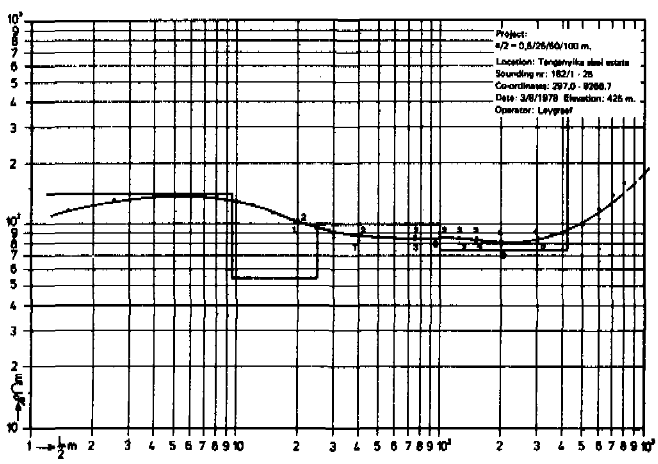

Project:
a/2 = 0,6/6/25 m.
Location: Kobe river
Sounding nr: 182/1 20
Co-ordinates: 286.2 - 9264,0
Date: 24/7/1978 Elevation: 490 m.
Operator: Leygraaf

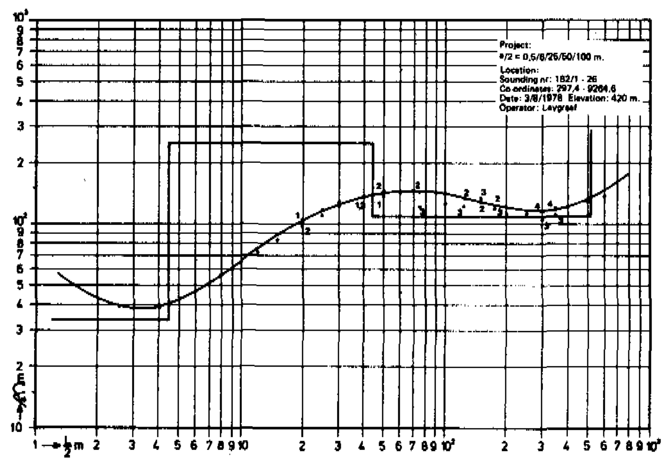

Project:
a/2 = 0,5/6/25/50/100 m.
Location: Rudewa sisal estate
Sounding nr: 182/1 - 21
Co-ordinates: 292.4 - 9260.2
Date: 28/7/1978 Elevation: 440 m.
Operator: Leygraaf

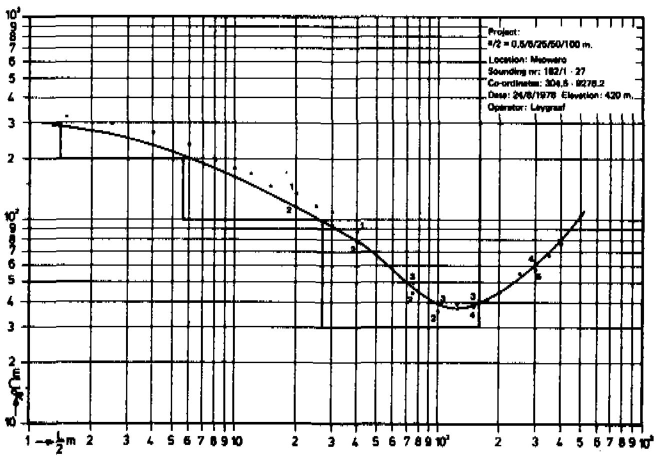

Project:
a/2 = 0,5/6/25/50/100 m.
Location: Kimamba sisal estate
Sounding nr: 182/1 - 22
Co-ordinates: 292.9 - 9254.3
Date: 27/7/1978 Elevation: 440 m.
Operator: Leygraaf

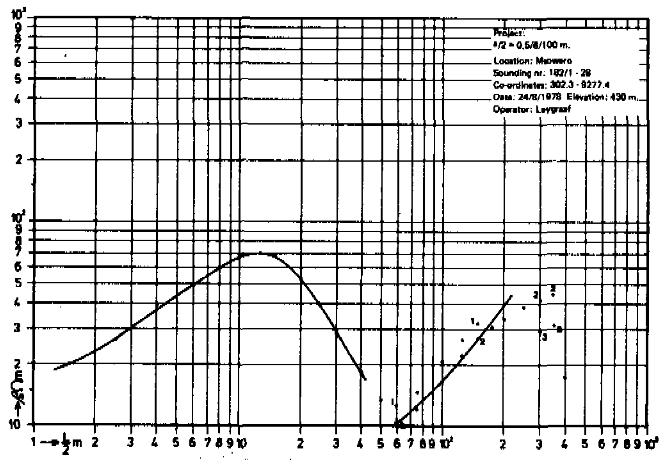

Project:
a/2 = 0,5/6/25/50/100 m.
Location: Madoto
Sounding nr: 182/1 - 23
Co-ordinates: 292.4 - 9256.3
Date: 28/7/1978 Elevation: 440 m.
Operator: Leygraaf

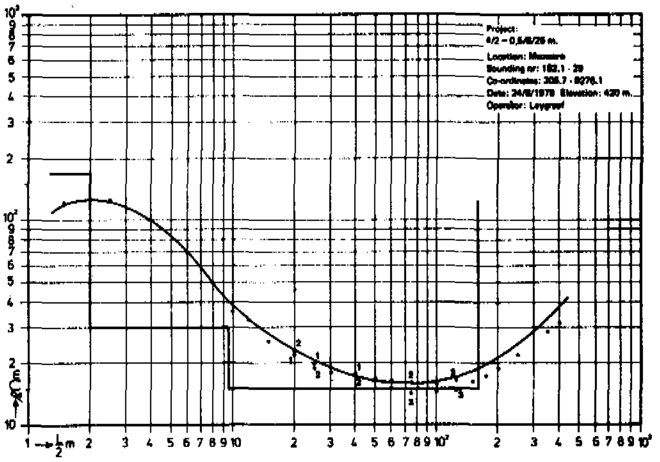

Project:
a/2 = 0,5/6 m.
Location: Tanganyika sisal estate
Sounding nr: 182/1 - 24
Co-ordinates: 298.8 - 9267.7
Date: 3/8/1978 Elevation: 440 m.
Operator: Leygraaf

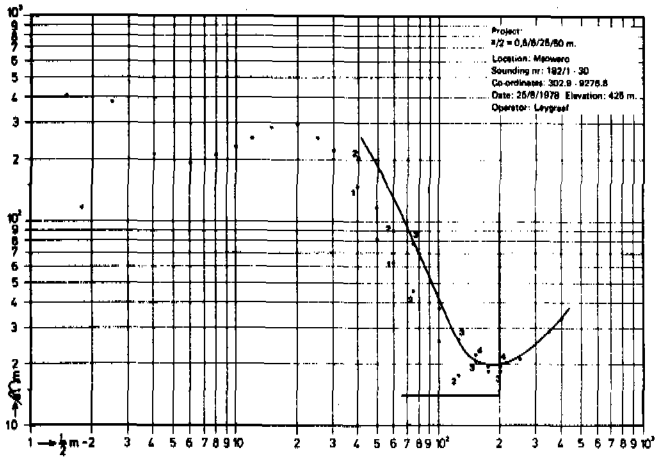

Project:
a/2 = 0,5/25/50/100 m.
Location: Tanganyika sisal estate
Sounding nr: 182/1 - 25
Co-ordinates: 297.0 - 9266.7
Date: 3/8/1978 Elevation: 425 m.
Operator: Leygraaf

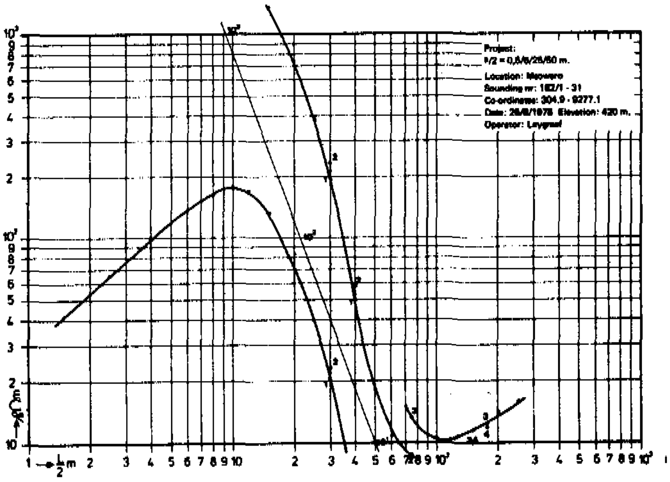

Project:
a/2 = 0,5/6/25/50/100 m.
Location:
Sounding nr: 182/1 - 26
Co-ordinates: 297.4 - 9264.6
Date: 3/8/1978 Elevation: 420 m.
Operator: Leygraaf

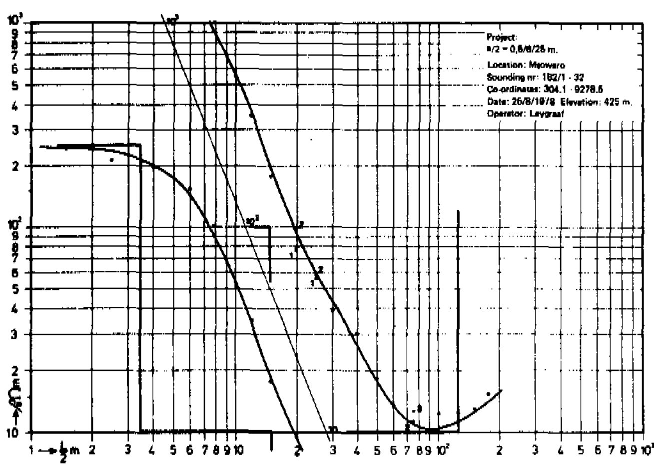

Project:
a/2 = 0,5/6/25/50/100 m.
Location: Msowero
Sounding nr: 182/1 - 27
Co-ordinates: 304.5 - 9276.2
Date: 24/8/1978 Elevation: 420 m.
Operator: Leygraaf

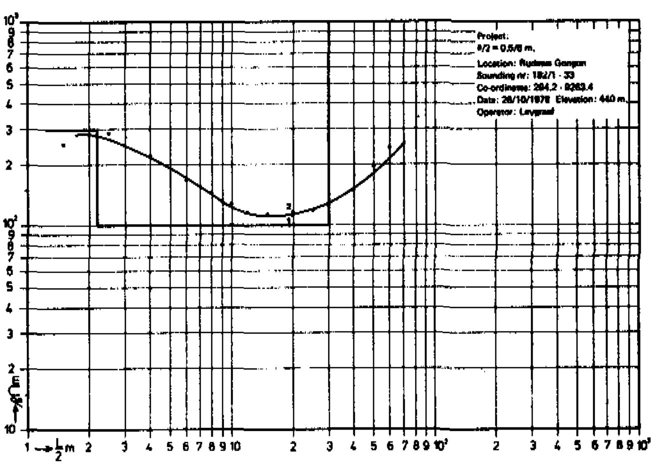

Project:
a/2 = 0,5/6/100 m.
Location: Msowero
Sounding nr: 182/1 - 28
Co-ordinates: 302.3 - 9277.4
Date: 24/8/1978 Elevation: 430 m.
Operator: Leygraaf

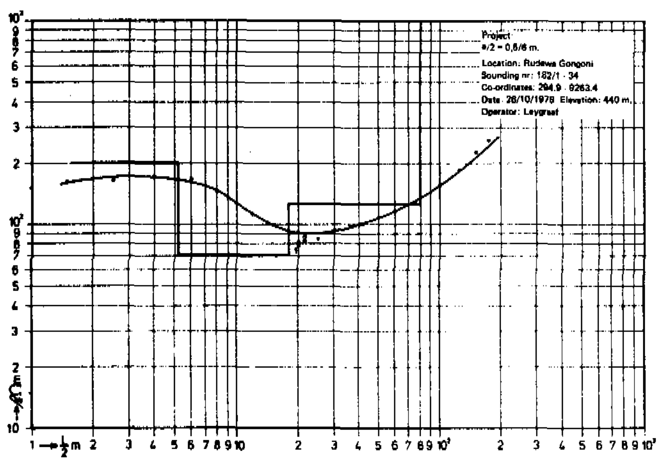

Project:
a/2 = 0,5/6/25 m.
Location: Mgowero
Sounding nr: 182.1 - 29
Co-ordinates: 303.7 - 9276.1
Date: 24/8/1978 Elevation: 420 m.
Operator: Leygraaf

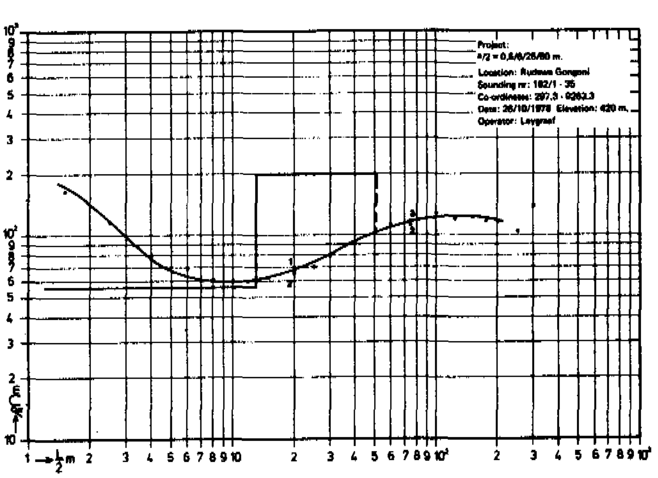

Project:
a/2 = 0,5/6/25/60 m.
Location: Mgowero
Sounding nr: 182/1 - 30
Co-ordinates: 302.9 - 9276.8
Date: 25/8/1978 Elevation: 426 m.
Operator: Leygraaf

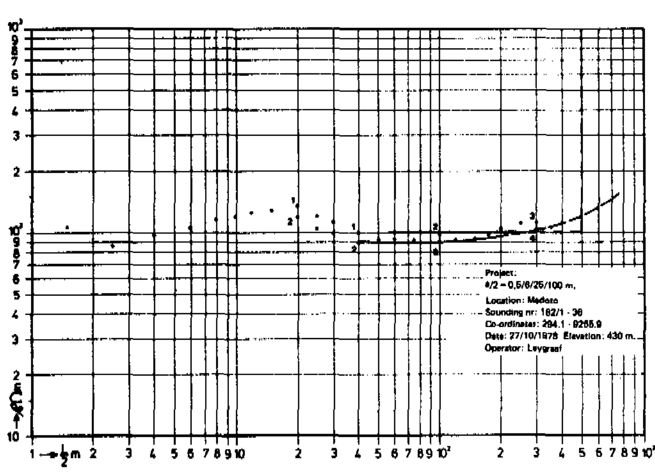

Project:
a/2 = 0,5/6/25/60 m.
Location: Mgowero
Sounding nr: 182/1 - 31
Co-ordinates: 304.9 - 9277.1
Date: 26/8/1978 Elevation: 420 m.
Operator: Leygraaf

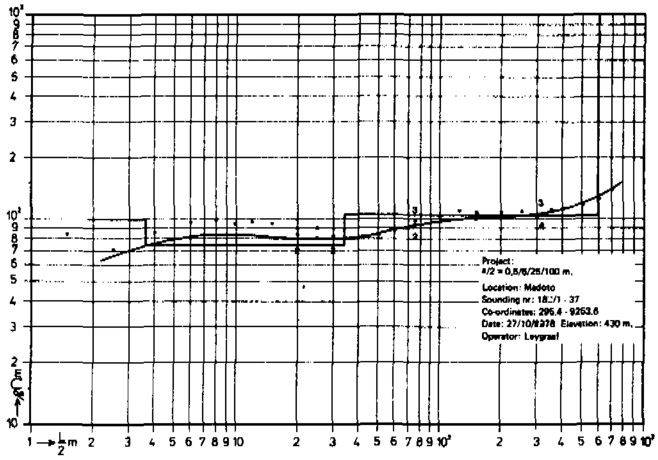

Project:
a/2 = 0,5/6/25 m.
Location: Mgowero
Sounding nr: 182/1 - 32
Co-ordinates: 304.1 - 9278.6
Date: 26/8/19/8 Elevation: 425 m.
Operator: Leygraaf

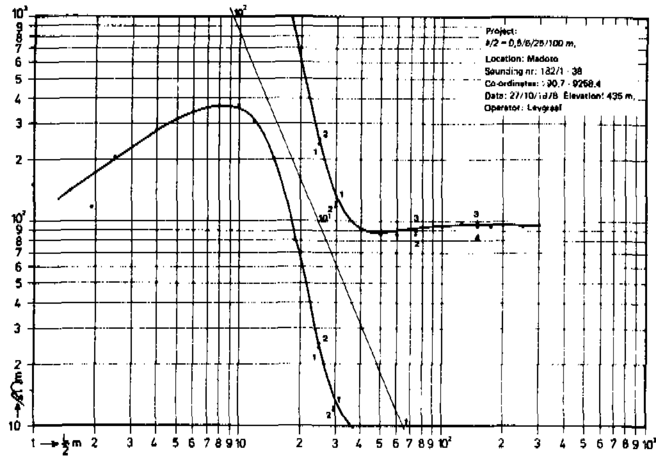

Project:
a/2 = 0,5/6 m.
Location: Rudewa Gongoni
Sounding nr: 182/1 - 33
Co-ordinates: 294.2 - 9263.4
Date: 26/10/1978 Elevation: 440 m.
Operator: Leygraaf

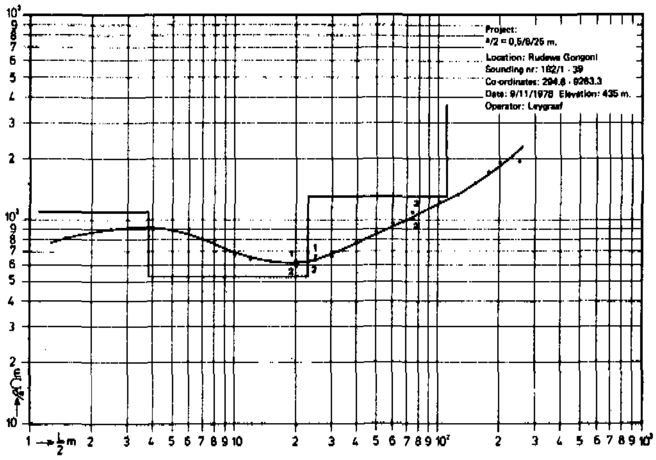

Project:
a/2 = 0,5/6 m.
Location: Rudewa Gongoni
Sounding nr: 182/1 - 34
Co-ordinates: 294.9 - 9263.4
Date 26/10/1978 Elevation: 440 m.
Operator: Leygraaf

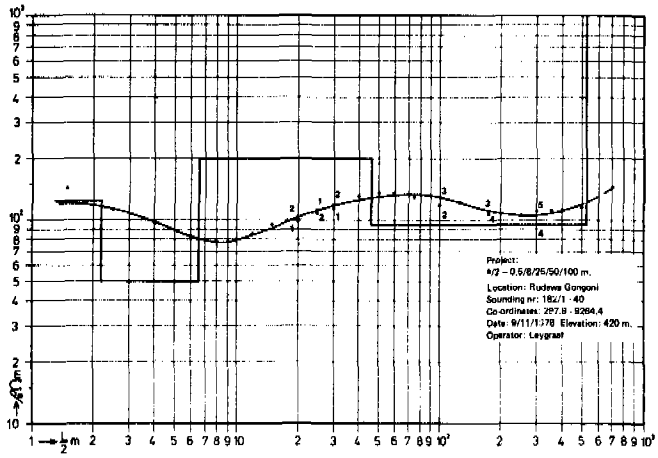

Project:
a/2 = 0,5/6/25/60 m.
Location: Rudewa Gongoni
Sounding nr: 182/1 - 35
Co-ordinates: 297.3 - 9263.3
Date: 26/10/1978 Elevation: 420 m.
Operator: Leygraaf

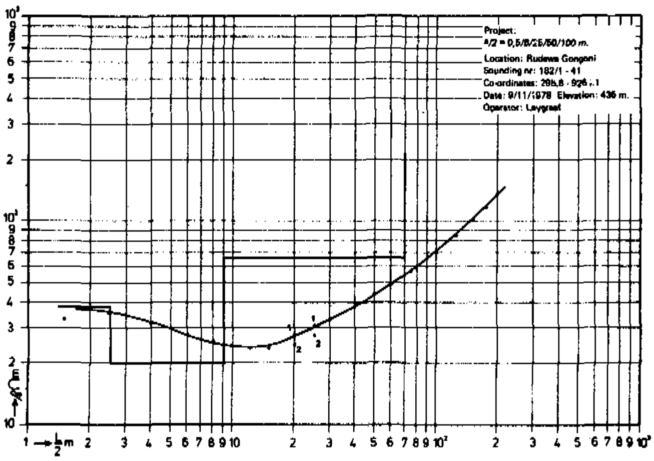

Project:
a/2 = 0,5/6/25/100 m.
Location: Madoto
Sounding nr: 182/1 - 36
Co-ordinates: 284.1 - 9265.9
Date: 27/10/1978 Elevation: 430 m.
Operator: Leygraaf

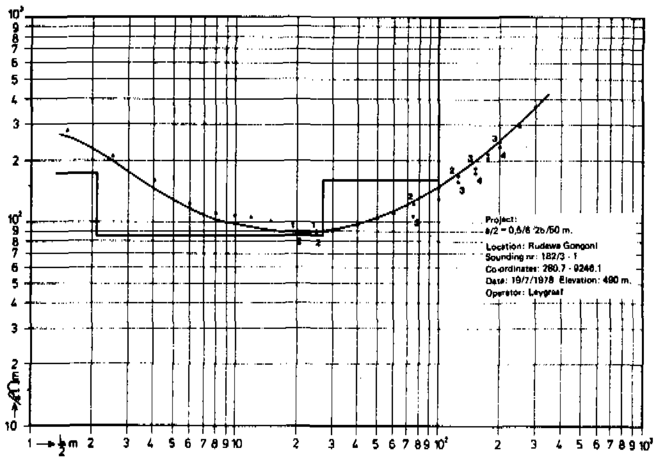

Project:
a/2 = 0,5/6/25/100 m,
Location: Madoto
Sounding nr: 182/1 - 37
Co-ordinates: 296.4 - 9253.6
Date: 27/10/1978 Elevation: 430 m,
Operator: Leygraaf

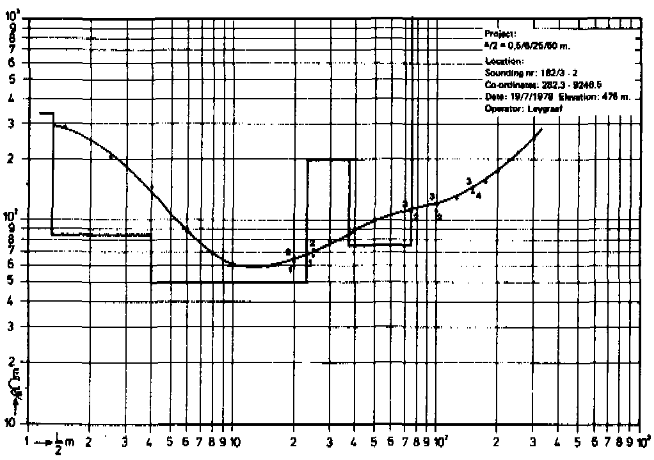

Project:
a/2 = 0,5/6/25/100 m,
Location: Madoto
Sounding nr: 182/1 - 38
Co-ordinates: 290.7 - 9268.4
Date: 27/10/1978 Elevation: 435 m,
Operator: Leygraaf

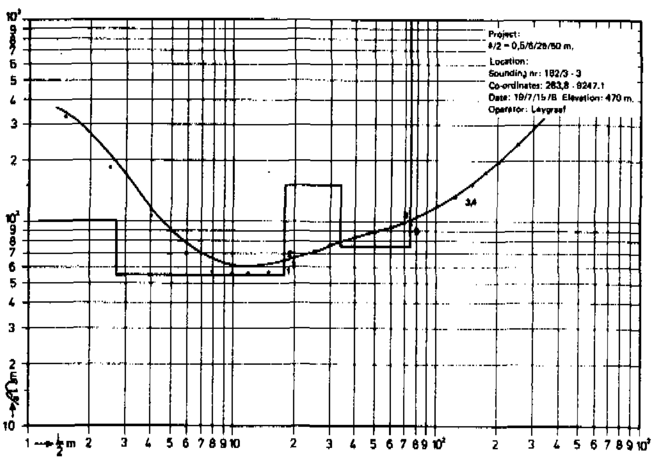

Project:
a/2 = 0,5/6/25 m.
Location: Rudewa Gongoni
Sounding nr: 182/1 - 39
Co-ordinates: 294.8 - 9263.3
Date: 9/11/1978 Elevation: 435 m.
Operator: Leygraaf

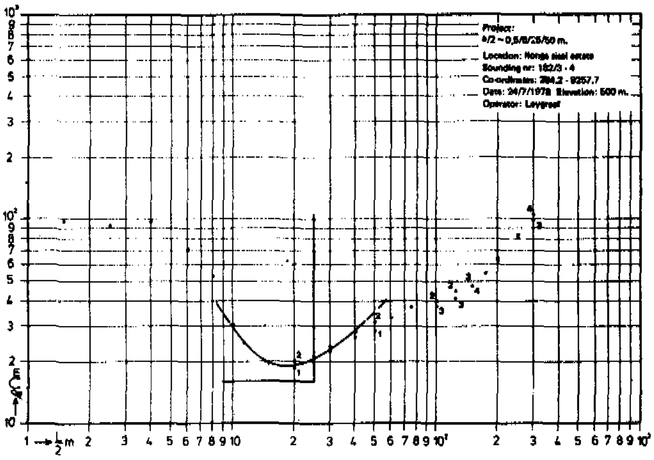

Project:
a/2 – 0.5/6/25/50/100 m.
Location: Rudewa Gongoni
Sounding nr: 182/1 - 40
Co-ordinates: 297.8 - 9284,4
Date: 9/11/1978 Elevation: 420 m.
Operator: Leygraaf

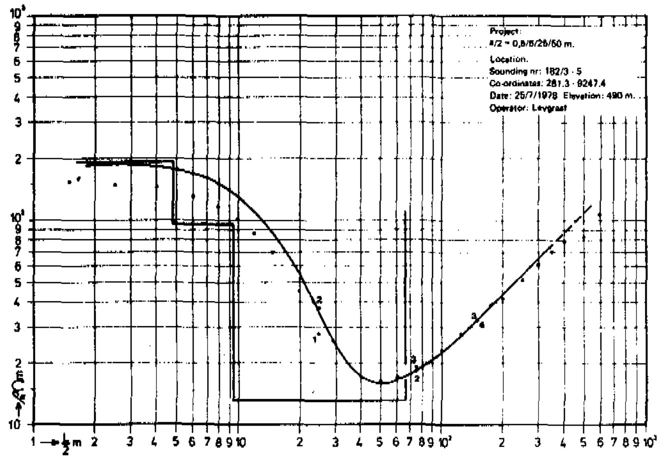

Project:
a/2 = 0,5/6/25/50/100 m.
Location: Rudewa Gongoni
Sounding nr: 182/1 - 41
Co-ordinates: 298,8 - 926 .1
Date: 9/11/1978 Elevation: 436 m.
Operator: Leygraaf

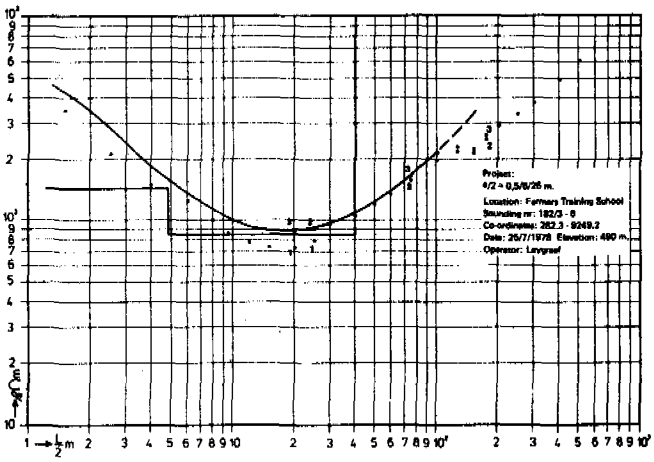

Project:
a/2 = 0,5/6/25/50 m.
Location: Rudewa Gongoni
Sounding nr: 182/3 - 1
Co-ordinates: 280.7 - 9246.1
Date: 19/7/1978 Elevation: 490 m.
Operator: Leygraaf

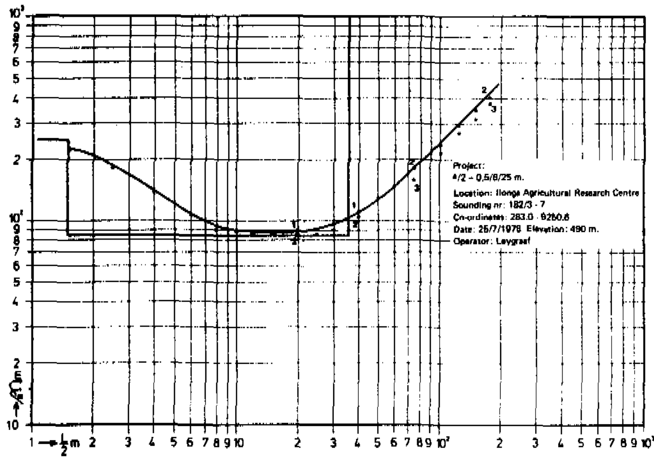

Project:
a/2 = 0,5/6/25/50 m.
Location:
Sounding nr: 182/3 - 2
Co-ordinates: 282,3 - 9246.5
Date: 19/7/1978 Elevation: 476 m.
Operator: Leygraaf

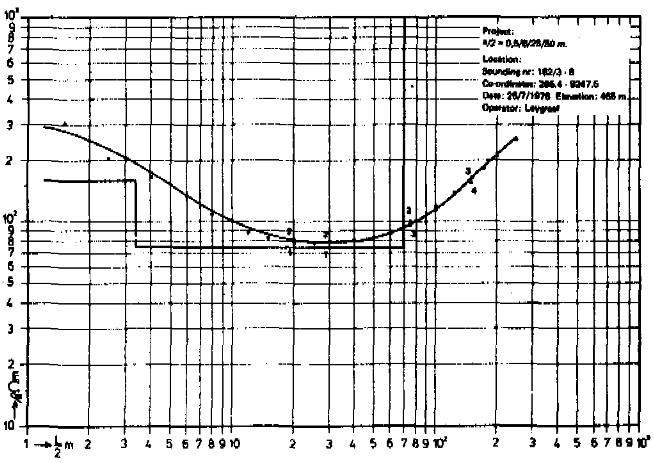

Project:
a/2 = 0,5/6/25/50 m,
Location:
Sounding nr: 182/3 - 3
Co-ordinates: 283,8 - 9247.1
Date: 19/7/1978 Elevation: 470 m.
Operator: Leygraaf

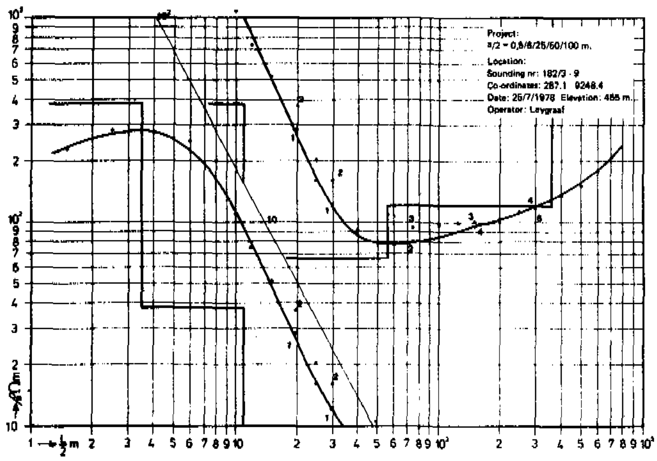

Project:
a/2 = 0,5/6/25/50 m.
Location: Ilonga sisal estate
Sounding nr: 182/3 - 4
Co-ordinates: 284.2 - 9257.7
Date: 24/7/1978 Elevation: 500 m.
Operator: Leygraaf

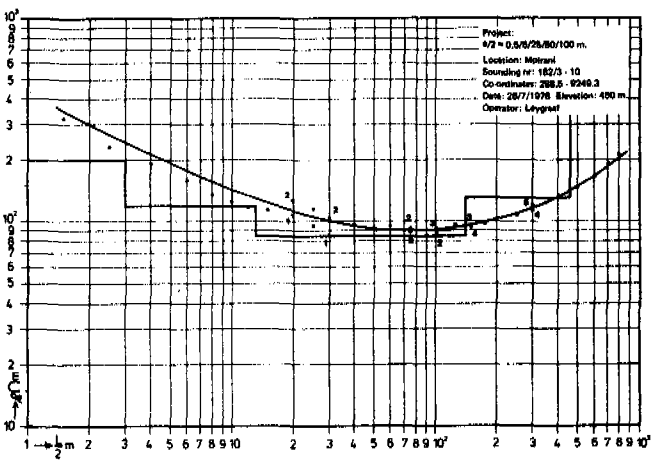

Project:
a/2 = 0,5/6/25/50 m.
Location.
Sounding nr: 182/3 - 5
Co-ordinates: 281.3 - 9247.4
Date: 25/7/1978 Elevation: 490 m.
Operator: Leygraaf

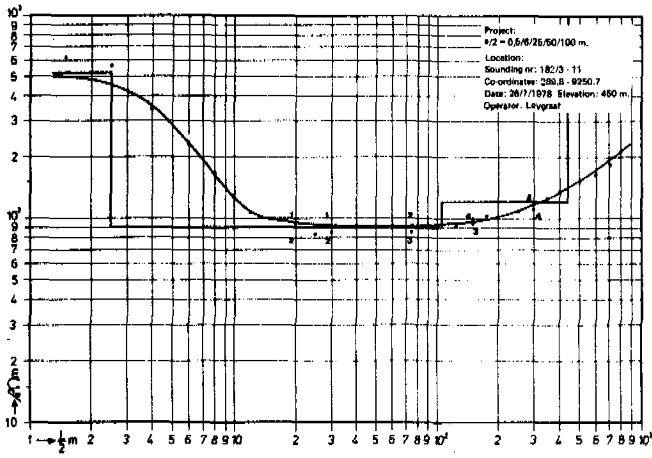

Project:
a/2 = 0,5/6/25 m.
Location: Farmers Training School
Sounding nr: 182/3 - 6
Co-ordinates: 282.3 - 9249.2
Date: 25/7/1978 Elevation: 490 m.
Operator: Leygraaf

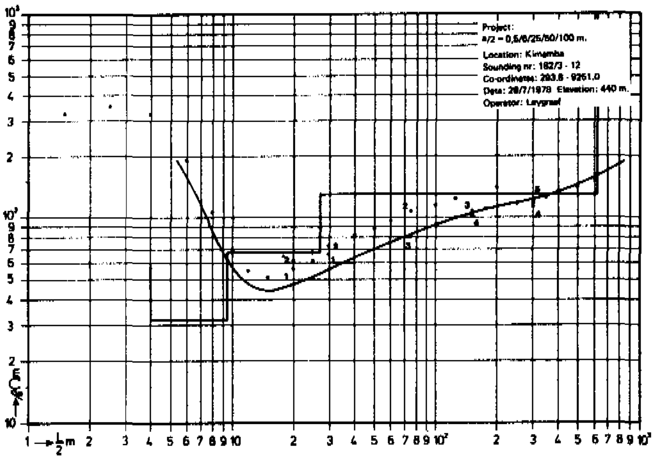

Project:
a/2 = 0,5/6/25 m.
Location: Ilonga Agricultural Research Centre
Sounding nr: 182/3 - 7
Co-ordinates: 283.0 - 9250.6
Date: 25/7/1978 Elevation: 490 m.
Operator: Leygraaf

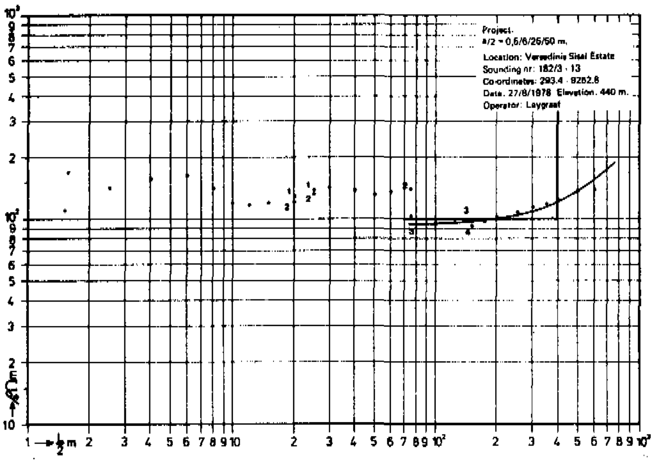

Project:
a/2 = 0,5/6/25/50 m.
Location:
Sounding nr: 182/3 - 8
Co-ordinates: 286.4 - 9247.6
Date: 26/7/1978 Elevation: 466 m.
Operator: Leygraaf

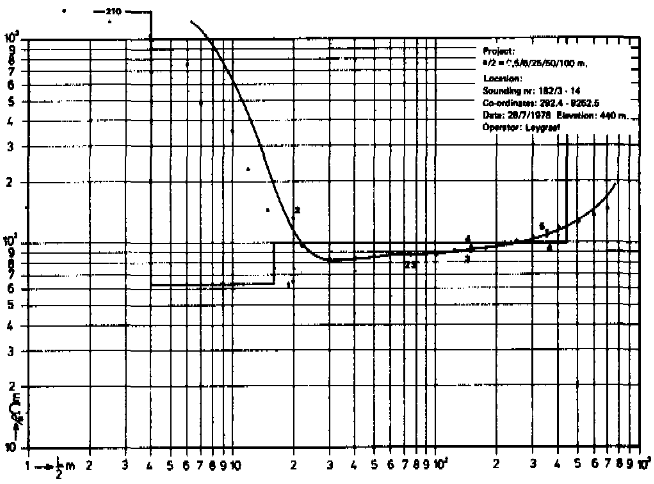

Project:
a/2 = 0,5/6/25/50/100 m.
Location:
Sounding nr: 182/3 - 9
Co-ordinates: 287.1 9248.4
Date: 25/7/1978 Elevation: 466 m.
Operator: Leygraaf

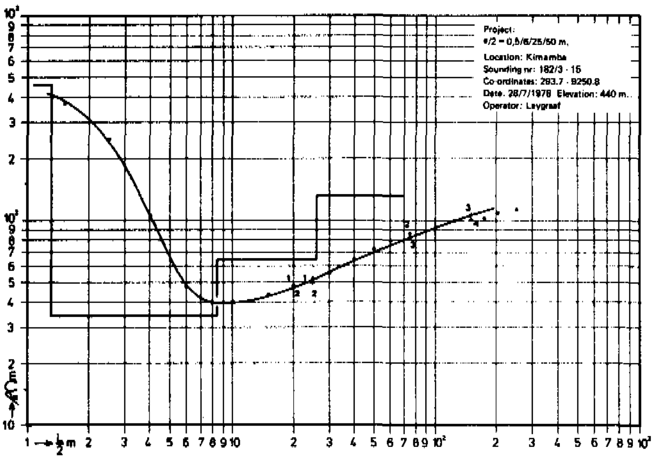

Project:
a/2 = 0,5/6/25/50/100 m.
Location: Mpirani
Sounding nr: 182/3 - 10
Co-ordinates: 288.5 - 9249.3
Date: 26/7/1978 Elevation: 450 m.
Operator: Leygraaf

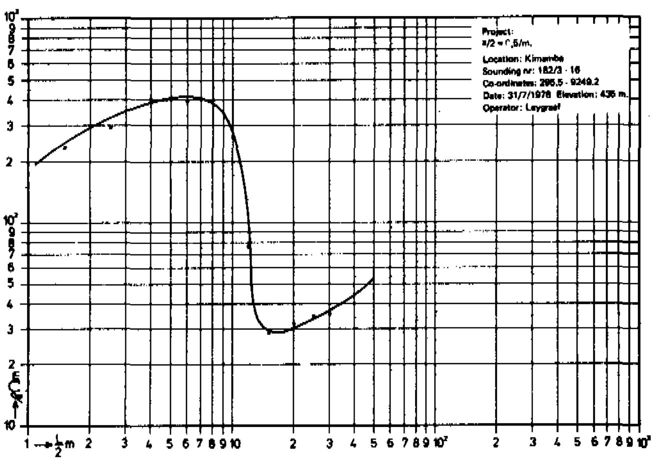

Project:
a/2 = 0,5/6/25/50/100 m.
Location:
Sounding nr: 182/3 - 11
Co-ordinates: 289,8 - 9250.7
Date: 26/7/1978 Elevation: 450 m.
Operator. Leygraaf

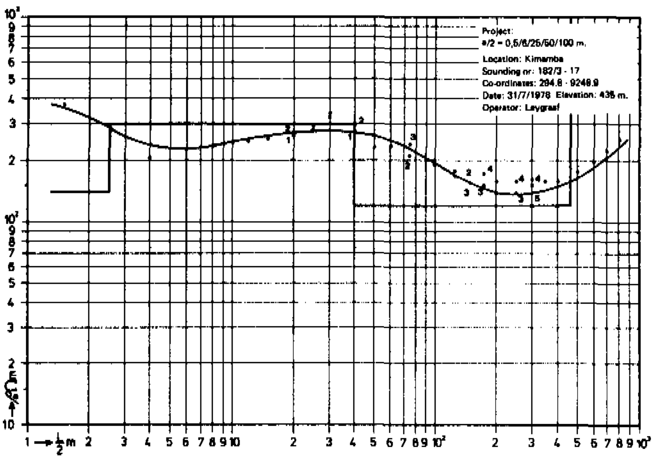

Project:
a/2 = 0,5/6/25/50/100 m.
Location: Kimamba
Sounding nr: 182/3 - 12
Co-ordinates: 293.8 - 9251.0
Date: 28/7/1978 Elevation: 440 m.
Operator: Laygraaf

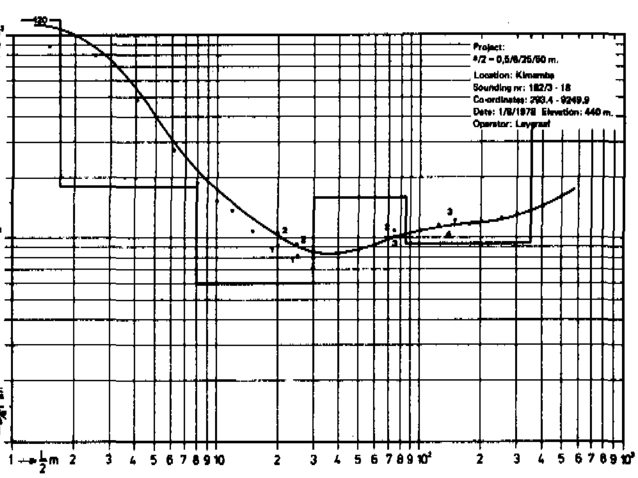

Project.
a/2 = 0,5/6/25/50 m.
Location: Veradinis Sisal Estate
Sounding nr: 182/3 - 13
Co-ordinates: 293.4 - 9262.8
Date. 27/8/1978 Elevation. 440 m.
Operator: Laygraaf

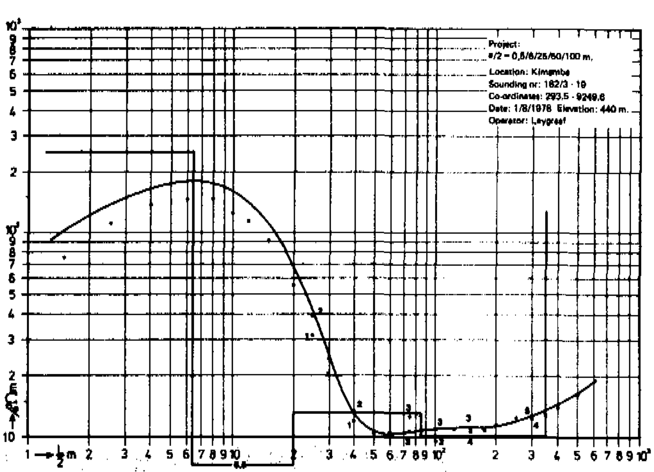

Project:
a/2 = 0,5/6/25/50/100 m.
Location:
Sounding nr: 182/3 - 14
Co-ordinates: 292.4 - 9252.5
Date: 28/7/1978 Elevation: 440 m.
Operator: Laygraaf

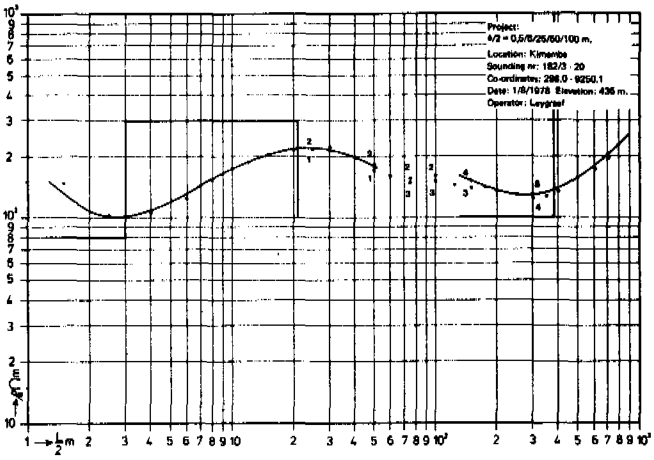

Project:
a/2 = 0,5/6/25/50 m.
Location: Kimamba
Sounding nr: 182/3 - 15
Co-ordinates: 293.7 - 9250.8
Date. 28/7/1978 Elevation: 440 m.
Operator: Laygraaf

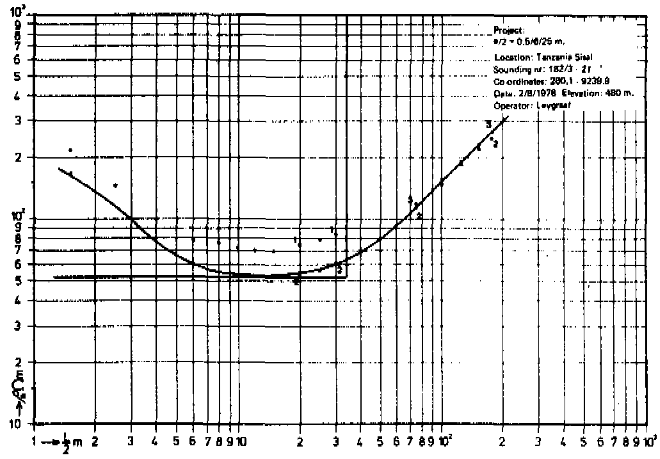

Project:
a/2 = C,5/m.
Location: Kimamba
Sounding nr: 182/3 - 16
Co-ordinates: 295.5 - 9249.2
Date: 31/7/1978 Elevation: 435 m.
Operator: Laygraaf

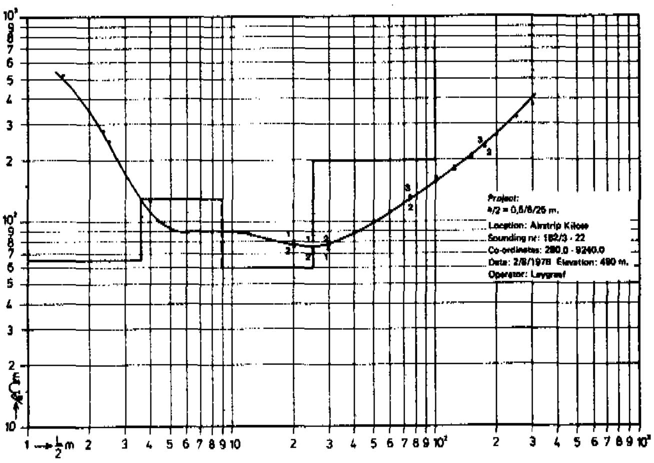

Project:
a/2 = 0,5/6/25/50/100 m.
Location: Kimamba
Sounding nr: 182/3 - 17
Co-ordinates: 294.8 - 9248.9
Date: 31/7/1978 Elevation: 435 m.
Operator: Laygraaf

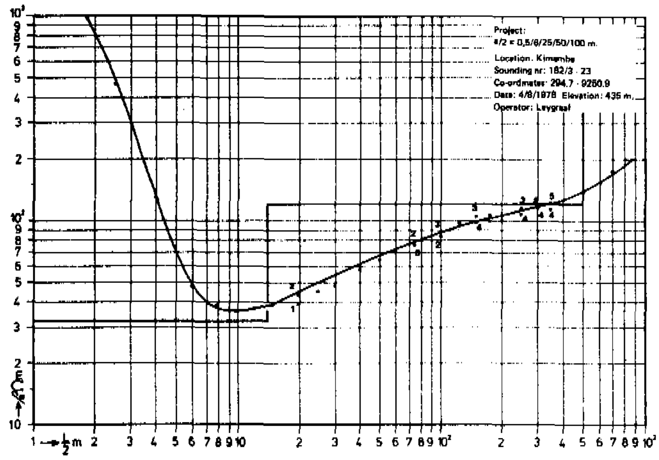

Project:
a/2 = 0,5/6/25/50 m.
Location: Kimamba
Sounding nr: 182/3 - 18
Co-ordinates: 293.4 - 9249.9
Date: 1/8/1978 Elevation: 440 m.
Operator: Laygraaf

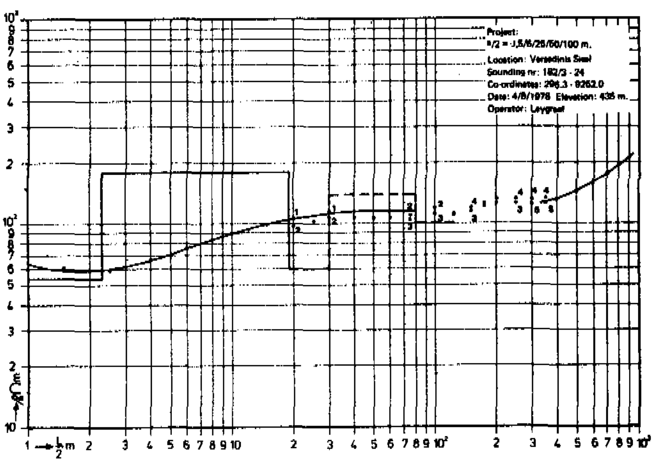

Project:
a/2 = 0,5/6/25/50/100 m.
Location: Kimamba
Sounding nr: 182/3 - 19
Co-ordinates: 293.5 - 9249.6
Date: 1/8/1978 Elevation: 440 m.
Operator: Laygraaf

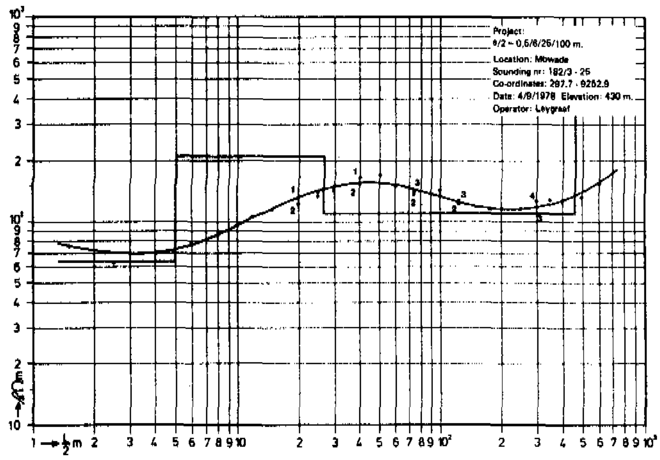

Project:
a/2 = 0,5/6/25/50/100 m.
Location: Kimambe
Sounding nr: 182/3 - 20
Date: 1/8/1978 Elevation: 435 m.
Operator: Leygraaf

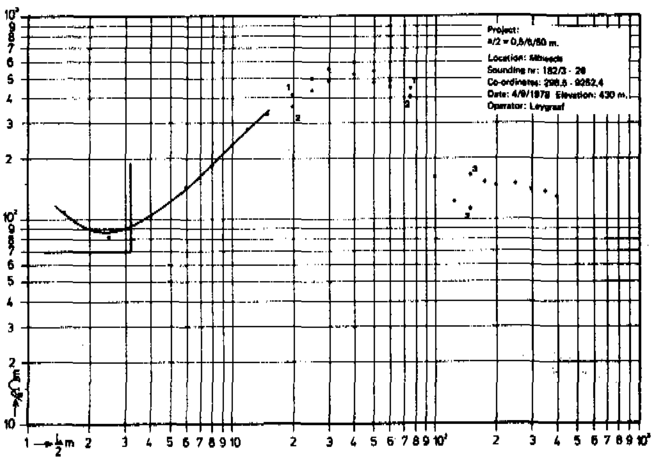

Project:
a/2 = 0.5/6/25 m.
Location: Tanzania Sisal
Sounding nr: 182/3 - 21
Co-ordinates: 280,1 - 9239.9
Date. 2/8/1978 Elevation: 480 m.
Operator: Leygraaf

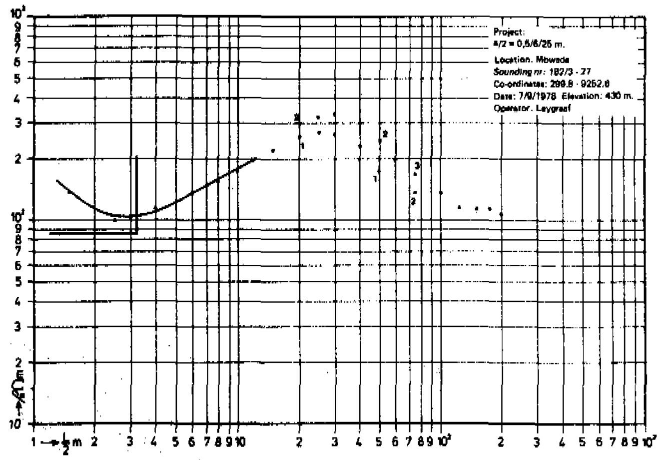

Project:
a/2 = 0,5/6/25 m.
Location: Airstrip Kilosa
Sounding nr: 182/3 - 22
Co-ordinates: 280,0 - 9240,0
Date: 2/8/1978 Elevation: 490 m.
Operator: Leygraaf

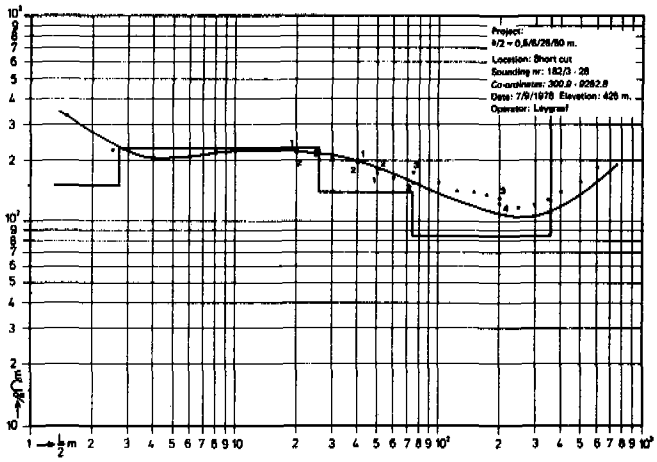

Project:
a/2 = 0,5/6/25/50/100 m.
Location. Kimambe
Sounding nr: 182/3 - 23
Co-ordinates: 294.7 - 9260.9
Date: 4/8/1978 Elevation: 435 m.
Operator: Leygraaf

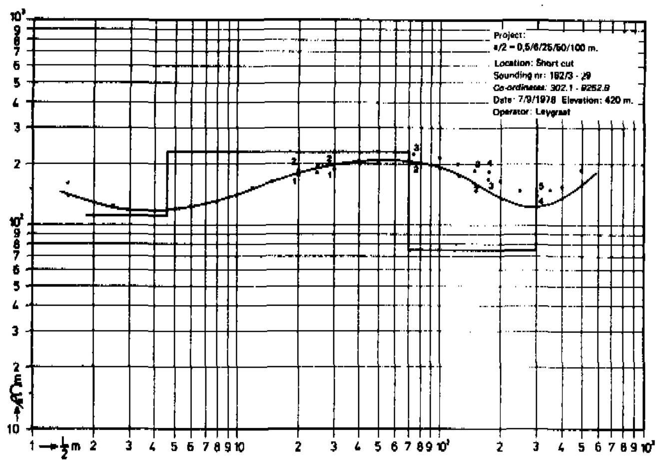

Project:
a/2 = 0,5/6/25/50/100 m.
Sounding nr: 182/3 - 24
Co-ordinates: 296.3 - 9262.0
Date: 4/8/1978 Elevation: 435 m.
Operator: Leygraaf

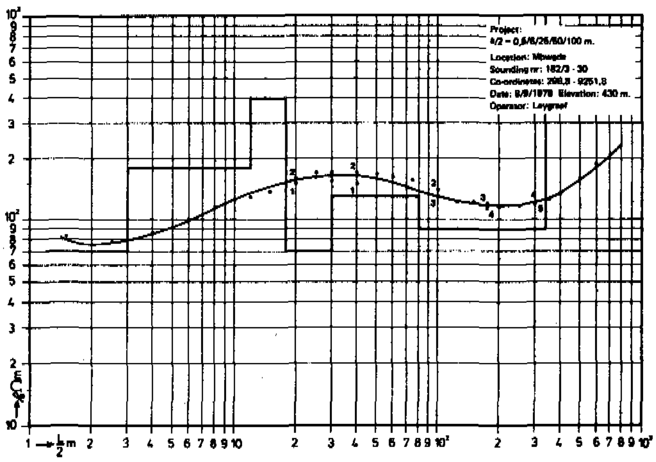

Project:
a/2 = 0,5/6/25/100 m.
Location: Mbwade
Sounding nr: 182/3 - 25
Co-ordinates: 287.7 - 9252.9
Date: 4/9/1978 Elevation: 430 m.
Operator: Leygraaf

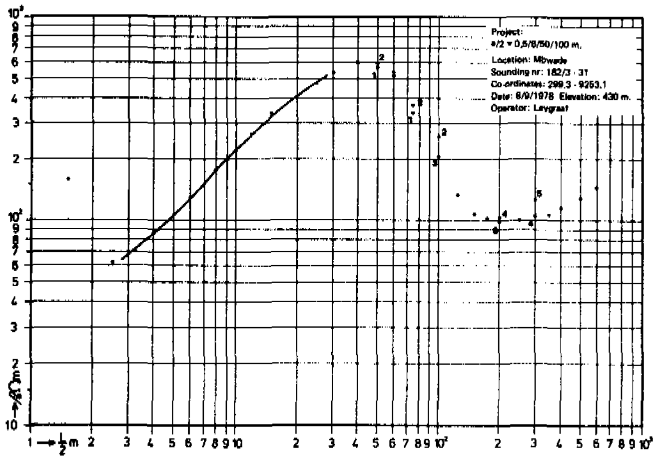

Project:
a/2 = 0,5/6/50 m.
Sounding nr: 182/3 - 26
Co-ordinates: 298.5 - 9252,4
Date: 4/9/1978 Elevation: 430 m.
Operator: Leygraaf

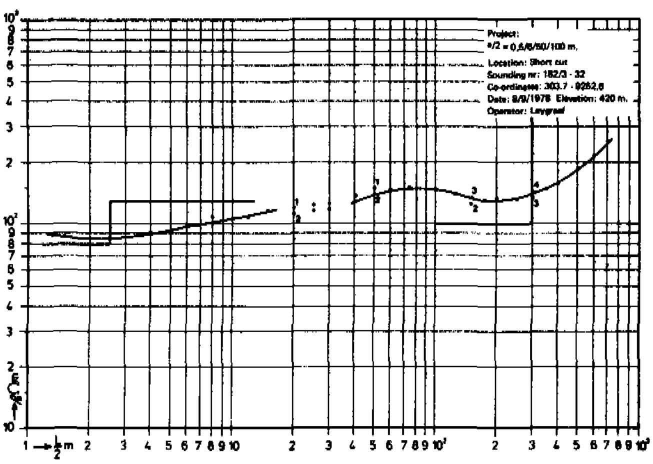

Project:
a/2 = 0,5/6/25 m.
Location. Mbwade
Sounding nr: 182/3 - 27
Co-ordinates: 289.8 - 9252,8
Date: 7/9/1978 Elevation: 430 m.
Operator. Leygraaf

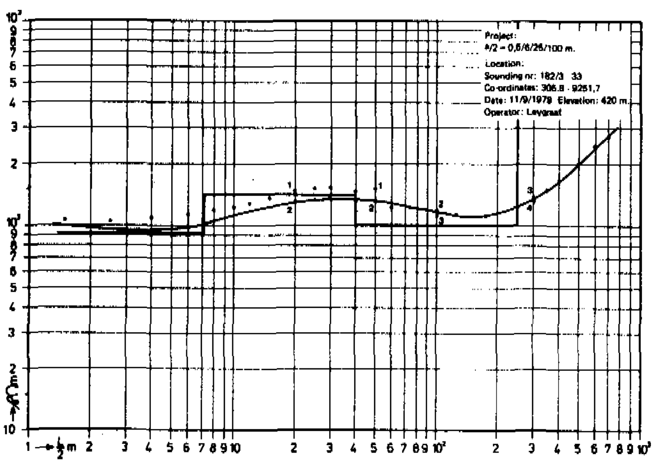

Project:
a/2 = 0,5/6/25/50 m.
Location: Short cut
Sounding nr: 182/3 - 28
Co-ordinates: 300.9 - 9252.8
Date: 7/9/1978 Elevation: 425 m.
Operator: Leygraaf

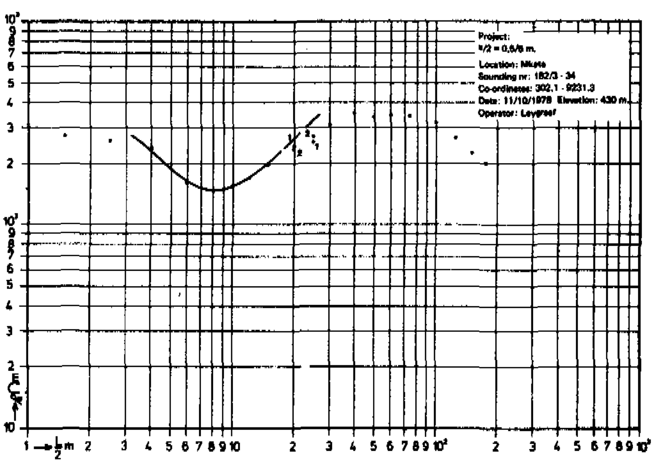

Project:
a/2 = 0,5/6/25/50/100 m.
Location: Short cut
Sounding nr: 182/3 - 29
Co-ordinates: 302.1 - 9252.8
Date: 7/9/1978 Elevation: 420 m.
Operator: Leygraaf

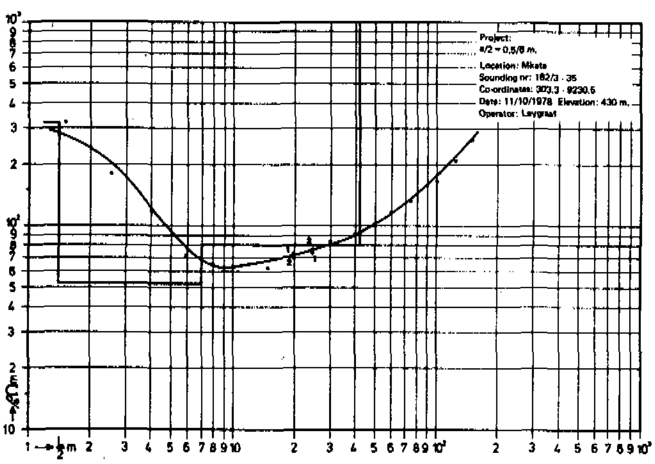

Project:
a/2 = 0,5/6/25/50/100 m.
Location: Mbwade
Sounding nr: 182/3 - 30
Co-ordinates: 298,8 - 9251,8
Date: 8/9/1978 Elevation: 430 m.
Operator: Leygraaf

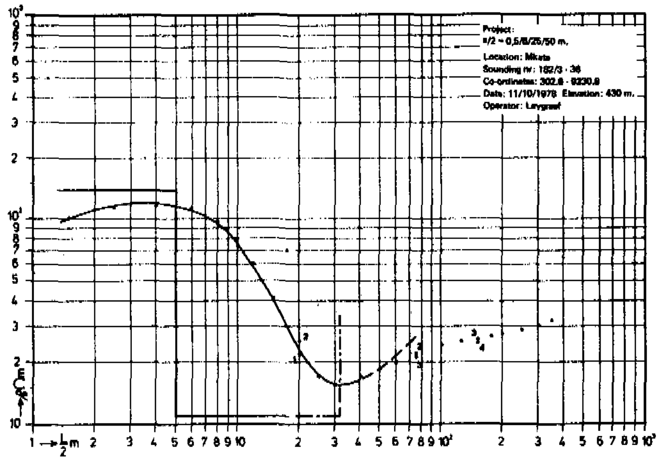

Project:
a/2 = 0,5/6/50/100 m.
Location: Mbwade
Sounding nr: 182/3 - 31
Co-ordinates: 299.3 - 9253,1
Date: 8/9/1978 Elevation: 430 m.
Operator: Leygraaf

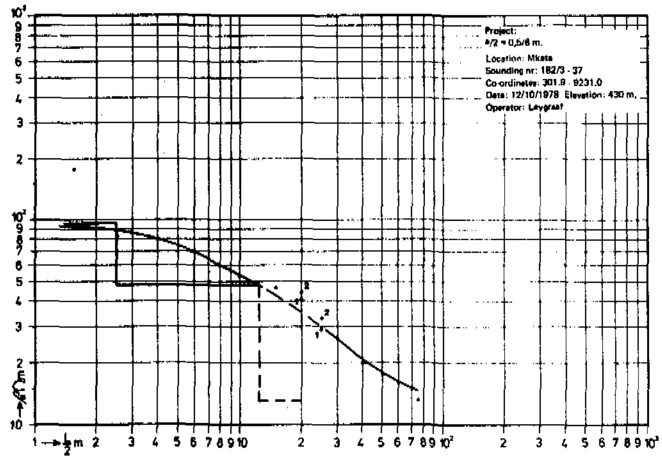

Project:
a/2 = 0,5/6/50/100 m.
Location: Short cut
Sounding nr: 182/3 - 32
Co-ordinates: 303.7 - 9252,6
Date: 8/9/1978 Elevation: 420 m.
Operator: Leygraaf

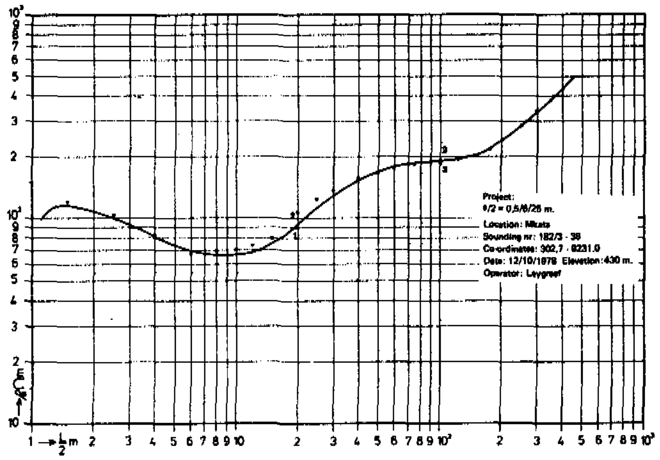

Project:
a/2 = 0,5/6/25/100 m.
Location:
Sounding nr: 182/3 33
Co-ordinates: 306.8 - 9251,7
Date: 11/9/1978 Elevation: 420 m.
Operator: Leygraaf

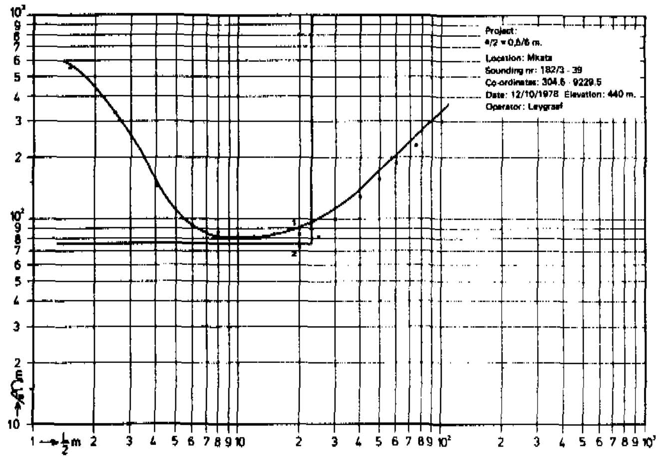

Project:
a/2 = 0,5/6 m.
Location: Mkata
Sounding nr: 182/3 - 34
Co-ordinates: 302,1 - 9231,3
Date: 11/10/1978 Elevation: 430 m.
Operator: Leygraaf

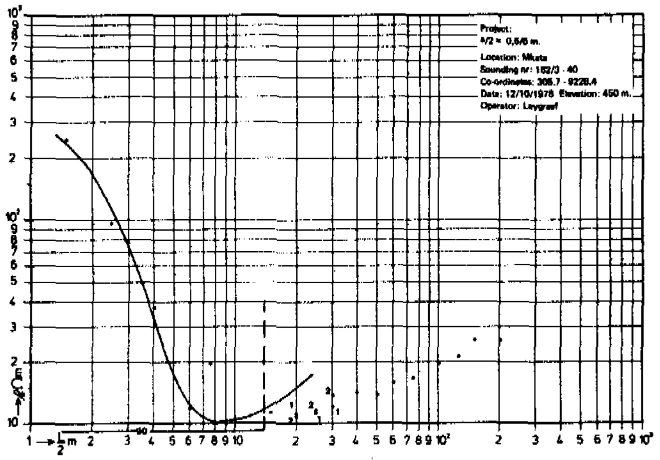

Project:
a/2 = 0,5/6 m.
Location: Mkata
Sounding nr: 182/3 - 35
Co-ordinates: 303,3 - 9230,6
Date: 11/10/1978 Elevation: 430 m.
Operator: Leygraaf

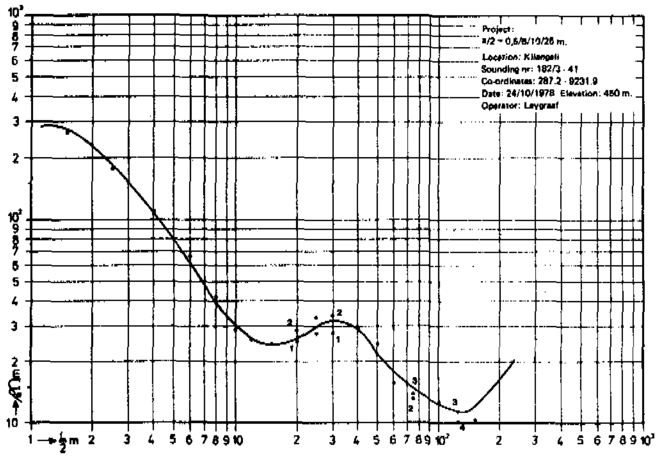

Project:
s/2 = 0,5/6/25/50 m.
Location: Mkata
Sounding nr: 182/3 - 36
Co-ordinates: 302.8 - 9230.9
Date: 11/10/1978 Elevation: 430 m.
Operator: Leygraaf

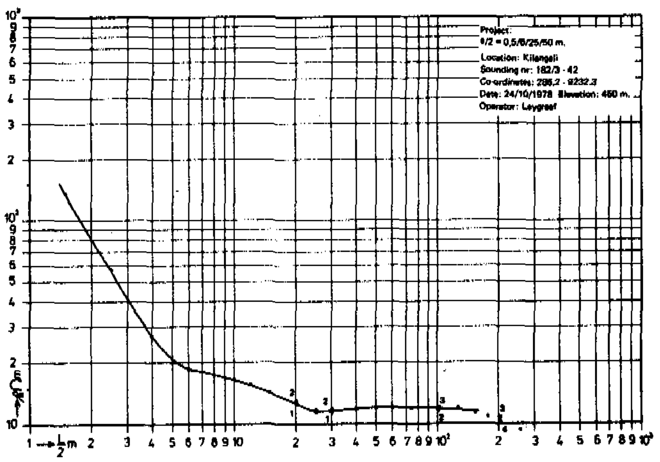

Project:
s/2 = 0,5/6 m.
Location: Mkata
Sounding nr: 182/3 - 37
Co-ordinates: 301.8 - 9231.0
Date: 12/10/1978 Elevation: 430 m.
Operator: Leygraaf

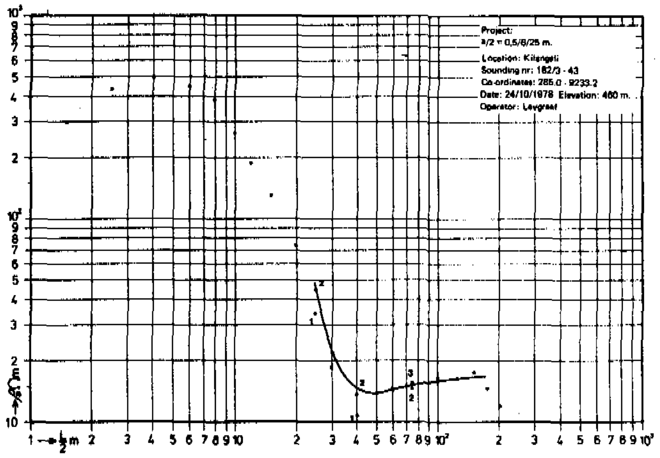

Project:
s/2 = 0,5/6/25 m.
Location: Mkata
Sounding nr: 182/3 - 38
Co-ordinates: 302,7 - 9231.0
Date: 12/10/1978 Elevation: 430 m.
Operator: Leygraaf

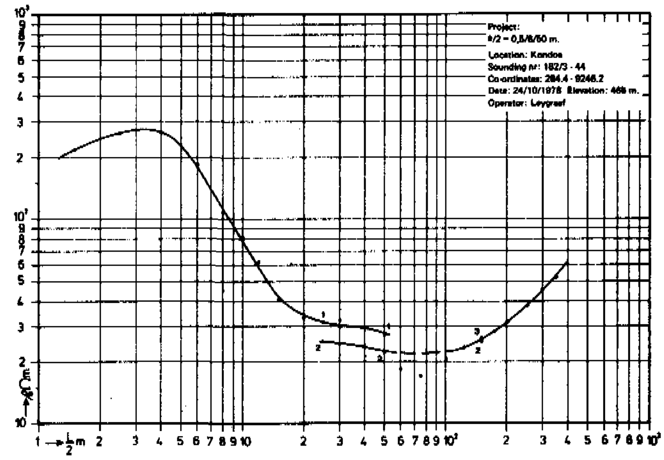

Project:
s/2 = 0,5/6 m.
Location: Mkata
Sounding nr: 182/3 - 39
Co-ordinates: 304.6 - 9229.5
Date: 12/10/1978 Elevation: 440 m.
Operator: Leygraaf

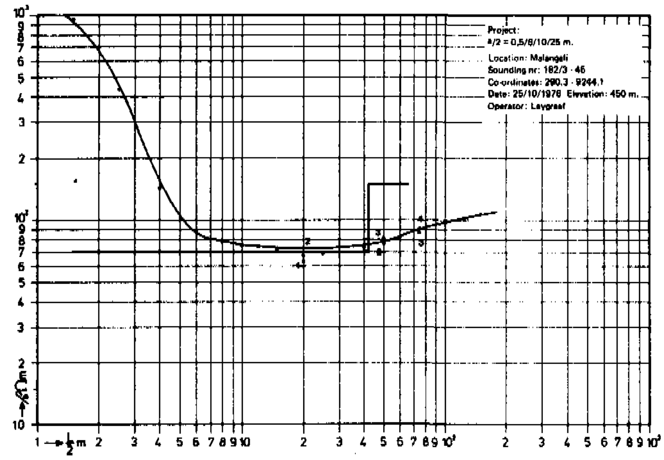

Project:
s/2 = 0,5/6 m.
Location: Mkata
Sounding nr: 182/3 - 40
Co-ordinates: 306.7 - 9228.4
Date: 12/10/1978 Elevation: 450 m.
Operator: Leygraaf

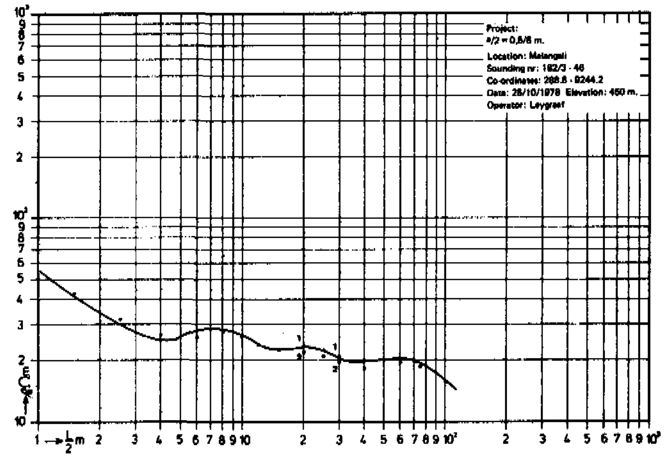

Project:
s/2 = 0,5/6/10/25 m.
Location: Kilangeli
Sounding nr: 182/3 - 41
Co-ordinates: 287.2 - 9231.9
Date: 24/10/1978 Elevation: 460 m.
Operator: Leygraaf

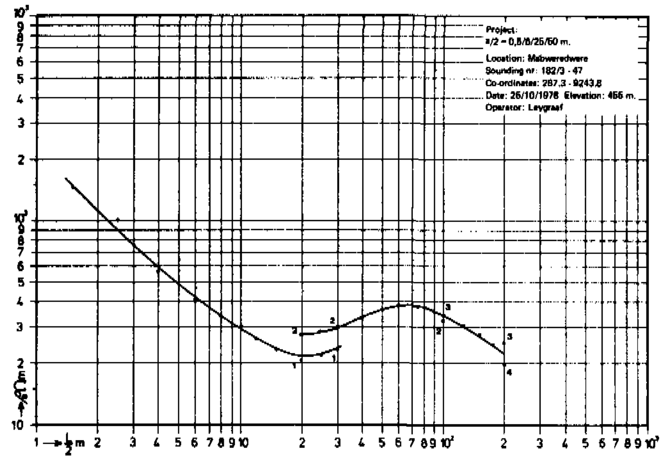

Project:
s/2 = 0,5/6/25/50 m.
Location: Kilangeli
Sounding nr: 182/3 - 42
Co-ordinates: 286,2 - 9232.3
Date: 24/10/1978 Elevation: 460 m.
Operator: Leygraaf

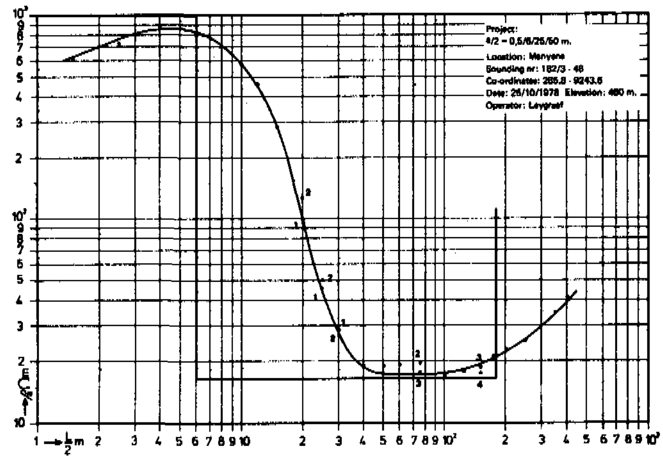

Project:
s/2 = 0,5/6/25 m.
Location: Kilangeli
Sounding nr: 182/3 - 43
Co-ordinates: 285.0 - 9233.2
Date: 24/10/1978 Elevation: 460 m.
Operator: Leygraaf

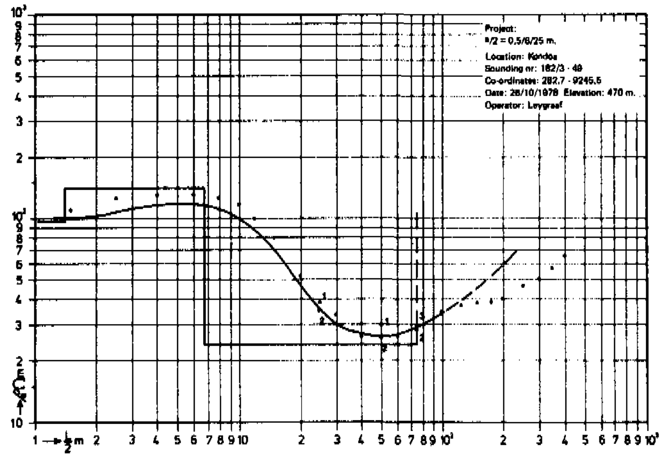

Project:
a/2 = 0,5/6/50 m.
Location: Kondoa
Sounding nr: 182/3 - 44
Co-ordinates: 284.4 - 9246.2
Date: 24/10/1978 Elevation: 468 m.
Operator: Leygraaf

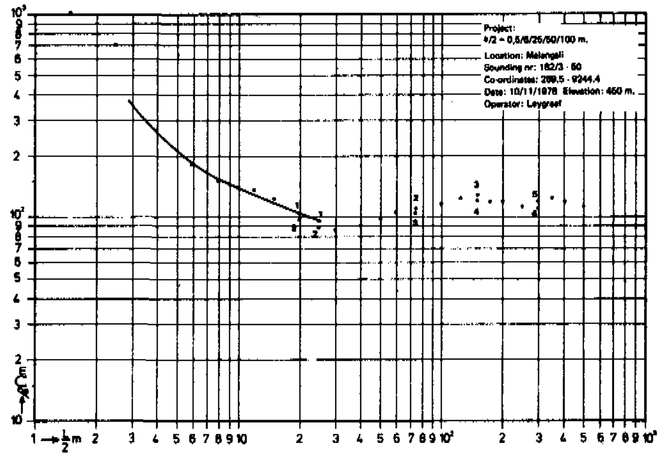

Project:
a/2 = 0,5/6/10/25 m.
Location: Malangali
Sounding nr: 182/3 - 45
Co-ordinates: 290.3 - 9244.1
Date: 25/10/1978 Elevation: 450 m.
Operator: Leygraaf

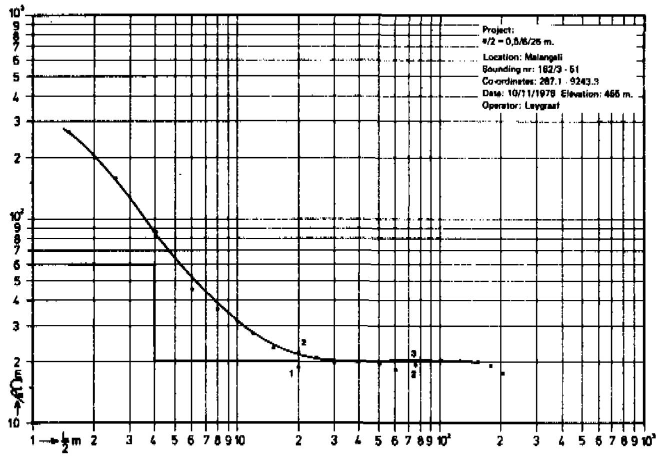

Project:
a/2 = 0,5/6 m.
Location: Malangali
Sounding nr: 182/3 - 46
Co-ordinates: 288.8 - 9244.2
Date: 25/10/1978 Elevation: 450 m.
Operator: Leygraaf

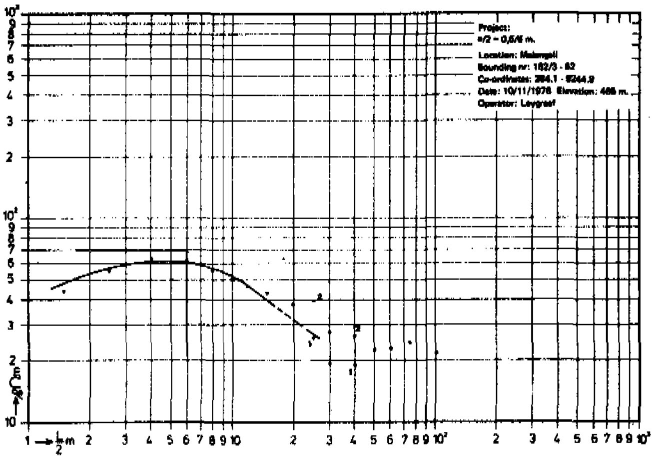

Project:
a/2 = 0,5/6/25/50 m.
Location: Mabweredwere
Sounding nr: 182/3 - 47
Co-ordinates: 287.3 - 9243.8
Date: 26/10/1978 Elevation: 455 m.
Operator: Leygraaf

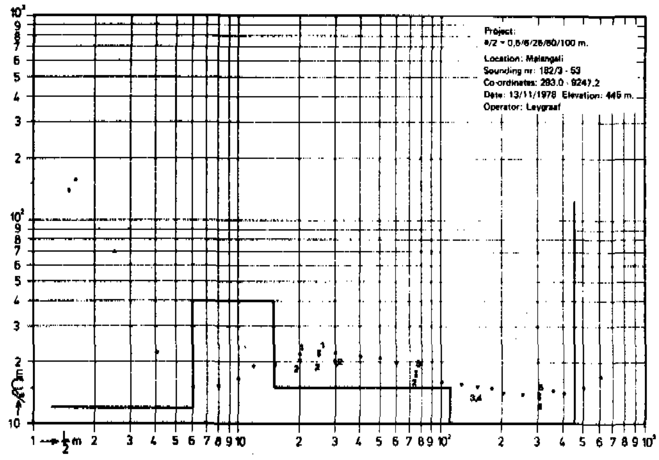

Project:
a/2 = 0,5/6/25/50 m.
Location: Manyana
Sounding nr: 182/3 - 48
Co-ordinates: 285.8 - 9243.6
Date: 26/10/1978 Elevation: 460 m.
Operator: Leygraaf

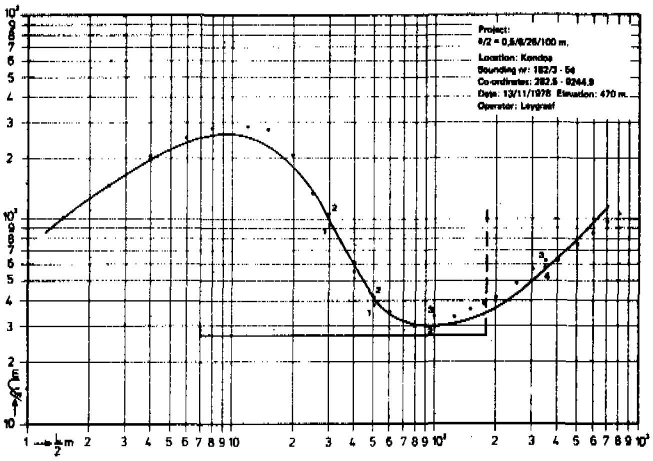

Project:
a/2 = 0,5/6/25 m.
Location: Kondoa
Sounding nr: 182/3 - 49
Co-ordinates: 282.7 - 9245.5
Date: 28/10/1978 Elevation: 470 m.
Operator: Leygraaf

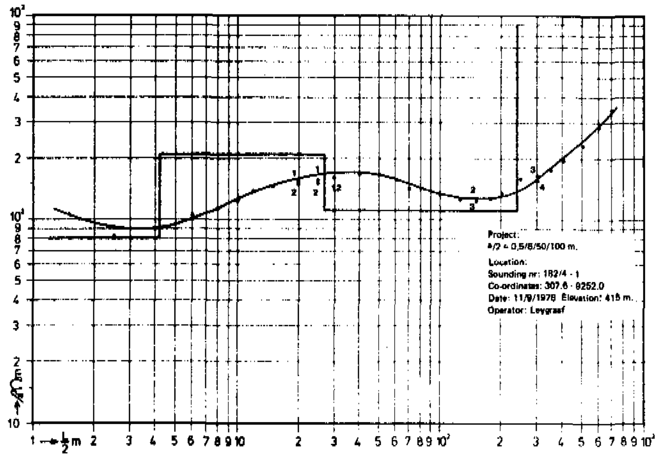

Project:
a/2 = 0,5/6/25/50/100 m.
Location: Malangali
Sounding nr: 182/3 - 50
Co-ordinates: 289.5 - 9244.4
Date: 10/11/1978 Elevation: 450 m.
Operator: Leygraaf

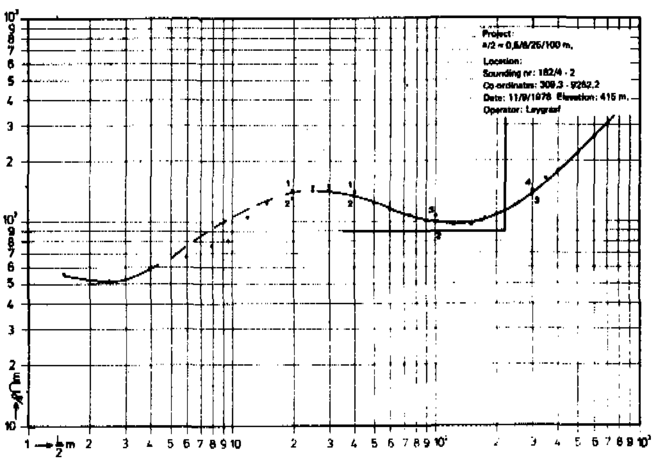

Project:
a/2 = 0,5/6/25 m.
Location: Malangali
Sounding nr: 182/3 - 51
Co-ordinates: 287.1 - 9243.3
Date: 10/11/1978 Elevation: 455 m.
Operator: Leygraaf

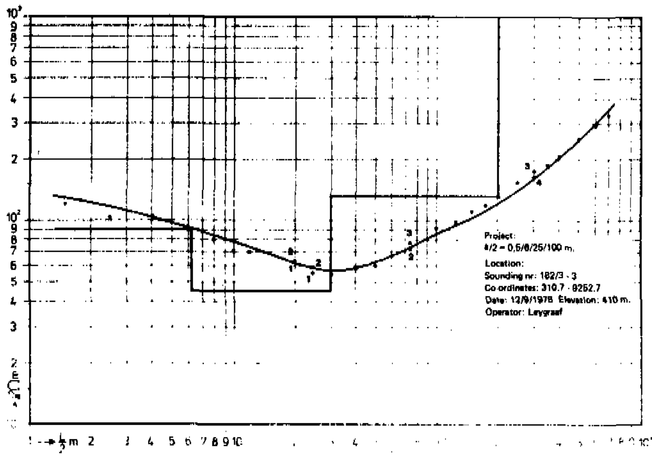

Project:
Location: Malangali
Sounding nr: 182/3 - 52
Date: 10/11/1978
Operator: Leygraaf

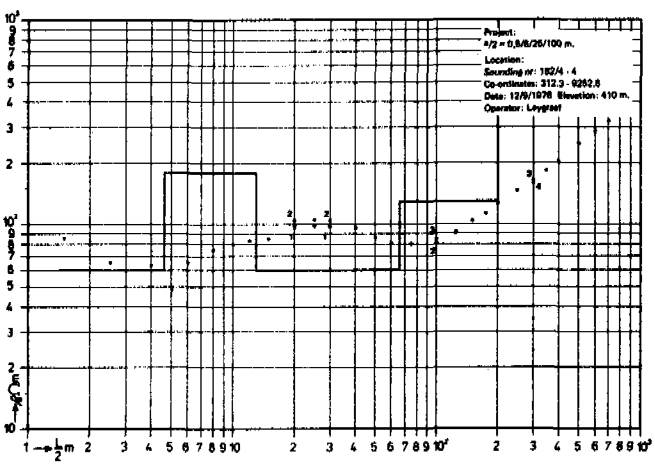

Project:
a/2 = 0,5/6/26/60/100 m.
Location: Malangali
Sounding nr: 182/3 - 53
Co-ordinates: 283.0 - 9247.2
Date: 13/11/1978 Elevation: 445 m.
Operator: Leygraaf

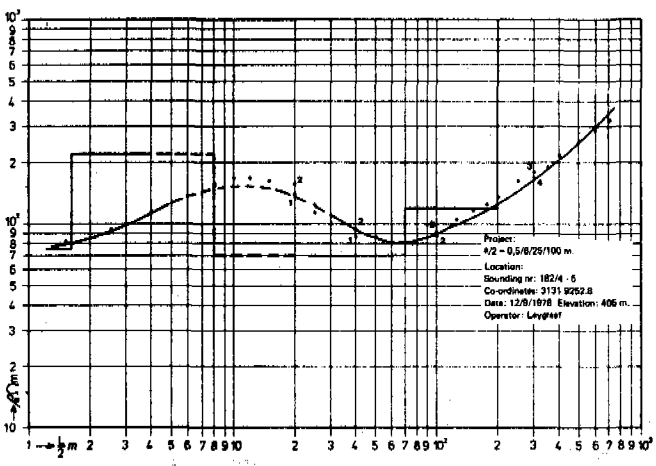

Project:
a/2 = 0,5/6/26/100 m.
Location: Kondoa
Sounding nr: 182/3 - 54
Date: 13/11/1978 Elevation: 470 m.
Operator: Leygraaf

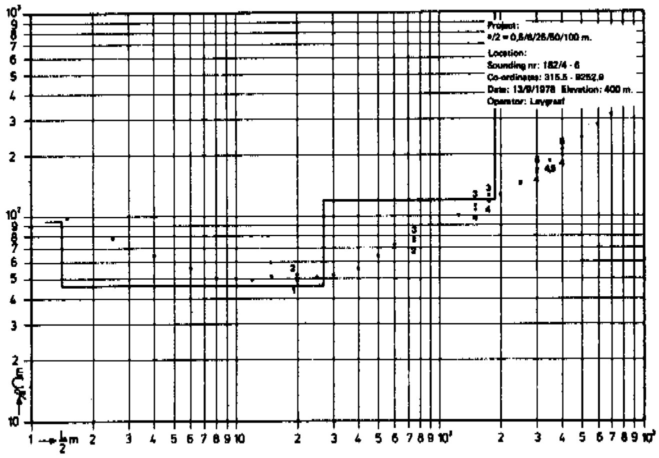

Project:
a/2 = 0,5/6/50/100 m.
Location:
Sounding nr: 182/4 - 1
Co-ordinates: 307.6 - 9252.0
Date: 11/9/1978 Elevation: 415 m.
Operator: Leygraaf

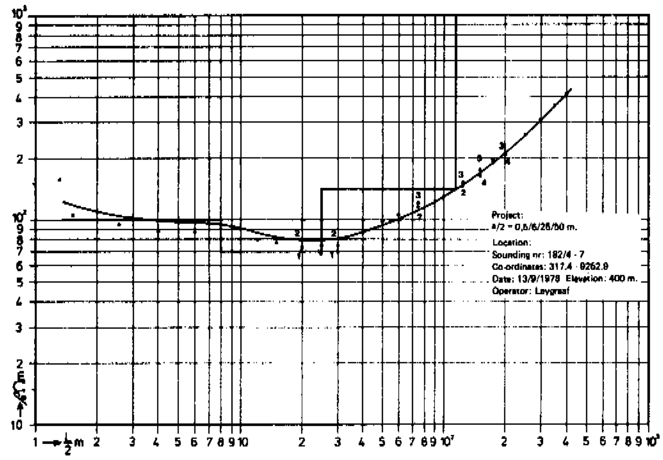

Project:
a/2 = 0,5/6/26/100 m.
Location:
Sounding nr: 182/4 - 2
Date: 11/9/1978 Elevation: 415 m.
Operator: Leygraaf

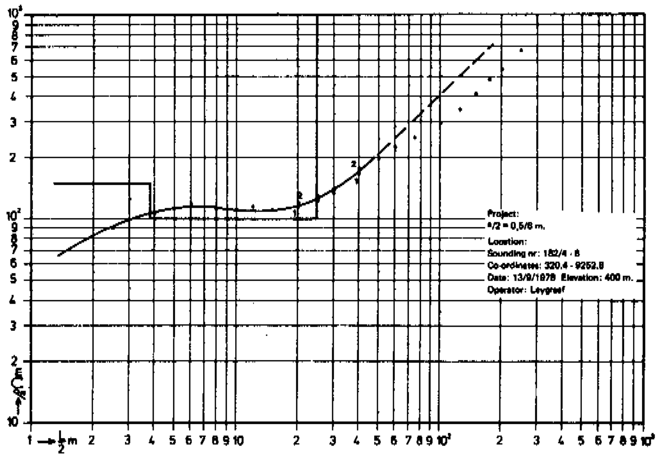

Project:
a/2 = 0,5/6/25/100 m.
Location:
Sounding nr: 182/3 - 3
Co-ordinates: 310.7 - 9252.7
Date: 12/9/1978 Elevation: 410 m.
Operator: Leygraaf

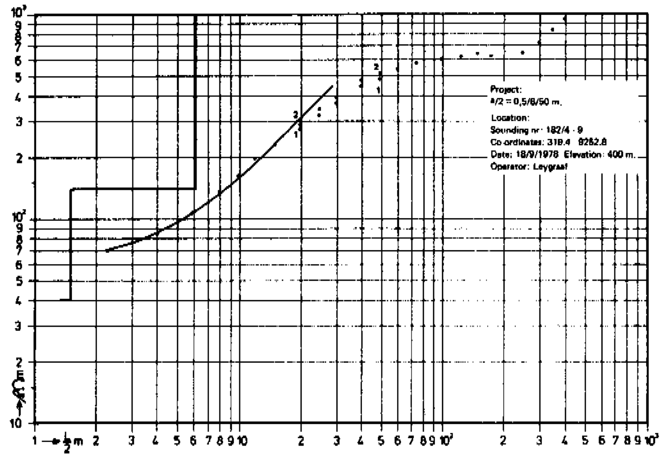

Project:
a/2 = 0,5/6/26/100 m.
Location:
Sounding nr: 182/4 - 4
Co-ordinates: 312.3 - 9252.6
Date: 12/9/1978 Elevation: 410 m.
Operator: Leygraaf

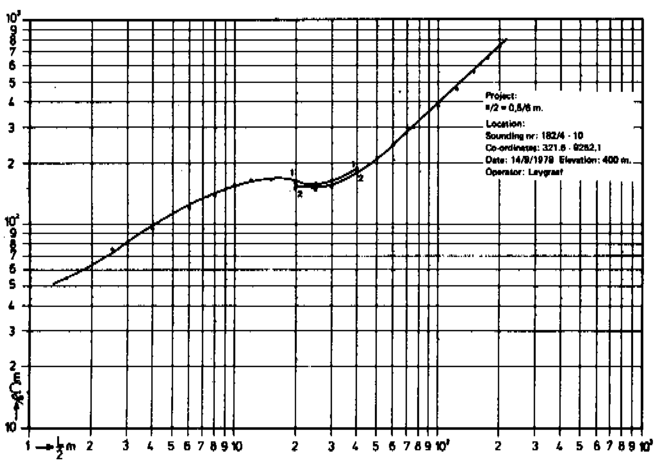

Project:
a/2 = 0,5/6/25/100 m.
Location:
Sounding nr: 182/4 - 5
Co-ordinates: 3131 9252.8
Date: 12/9/1978 Elevation: 406 m.
Operator: Leygraaf

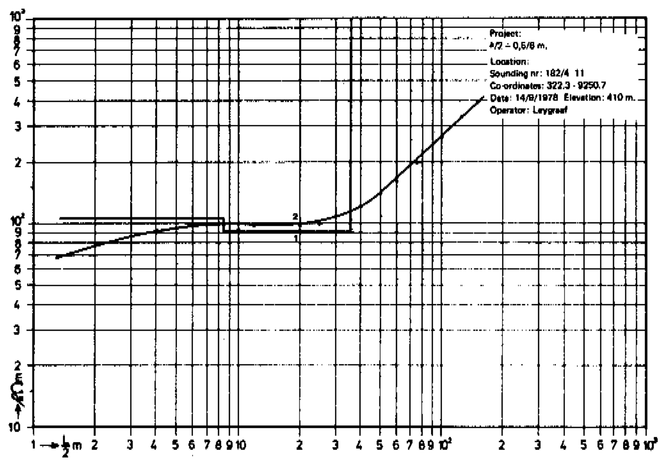

Project:
a/2 = 0,5/6/25/50/100 m.
Location:
Sounding nr: 182/4 - 6
Co-ordinates: 315.5 - 9252,9
Date: 13/9/1978 Elevation: 400 m.
Operator: Leygraaf

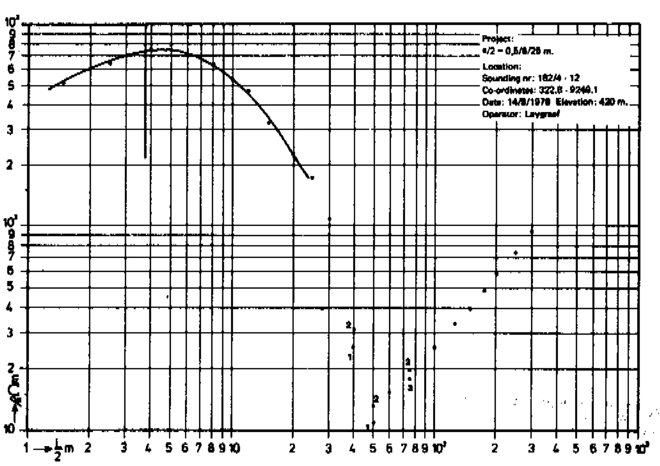

Project:
a/2 = 0,5/6/25/50 m.
Location:
Sounding nr: 182/4 - 7
Co-ordinates: 317.4 - 9262.9
Date: 13/9/1978 Elevation: 400 m.
Operator: Leygraaf

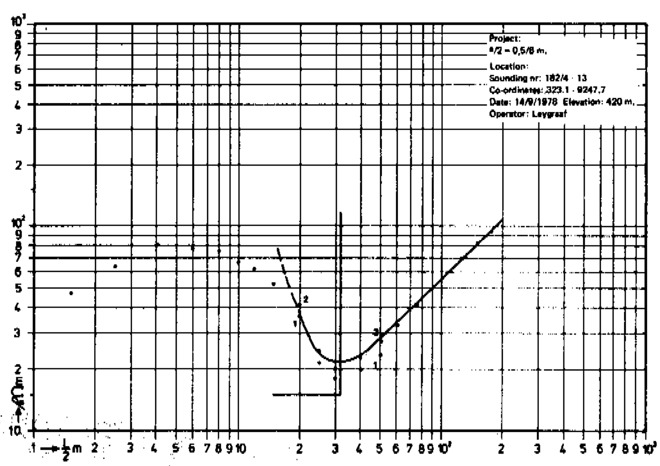

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 182/4 - 8
Co-ordinates: 320.4 - 9252.8
Date: 13/9/1978 Elevation: 400 m.
Operator: Leygraaf

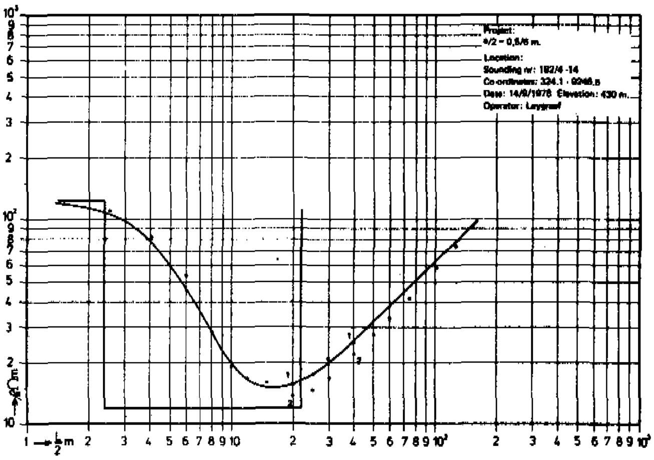

Project:
a/2 = 0,5/6/50 m.
Location:
Sounding nr: 182/4 - 9
Co-ordinates: 318.4 9262.8
Date: 18/9/1978 Elevation: 400 m.
Operator: Leygraaf

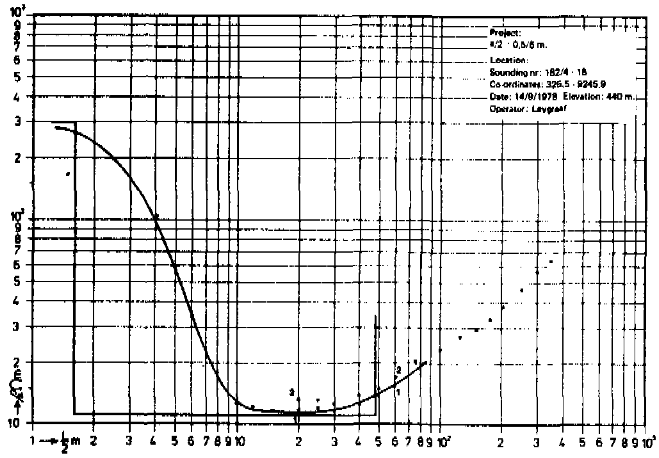

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 182/4 - 10
Co-ordinates: 321.6 - 9252,1
Date: 14/9/1978 Elevation: 400 m.
Operator: Leygraaf

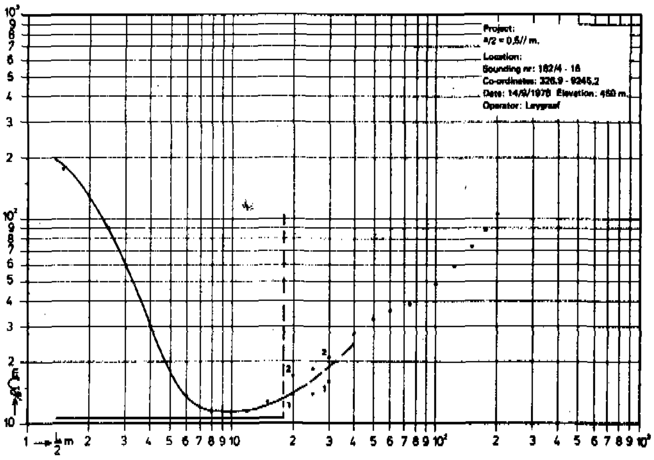

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 182/4 11
Co-ordinates: 322.3 - 9250.7
Date: 14/9/1978 Elevation: 410 m.
Operator: Leygraaf

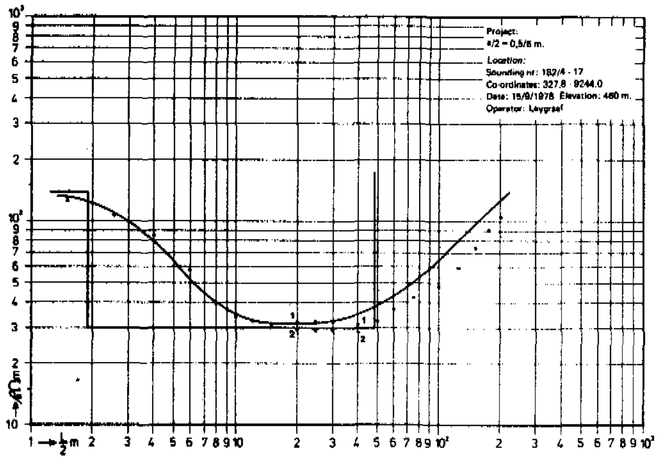

Project:
a/2 = 0,5/6/25 m.
Location:
Sounding nr: 182/4 - 12
Co-ordinates: 322.8 - 9249.1
Date: 14/9/1978 Elevation: 420 m.
Operator: Leygraaf

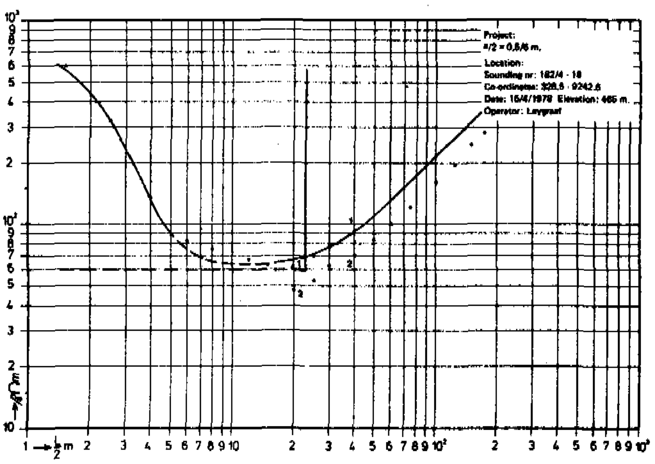

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 182/4 - 13
Co-ordinates: 323.1 - 9247.7
Date: 14/9/1978 Elevation: 420 m.
Operator: Leygraaf

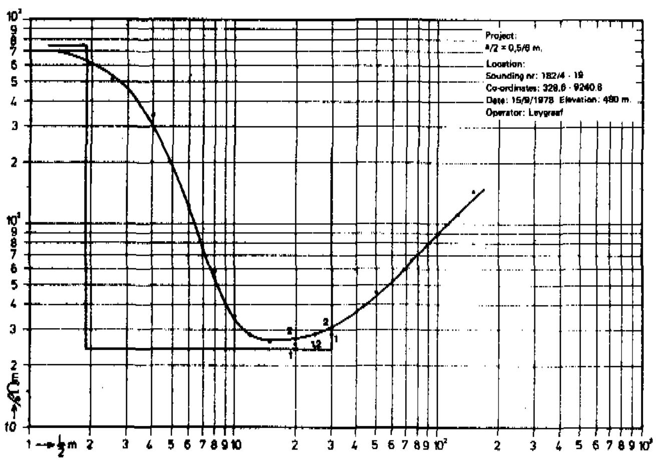

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 182/4 -14
Co-ordinates: 324.1 - 9246.5
Date: 14/9/1978 Elevation: 430 m.
Operator: Laygraaf

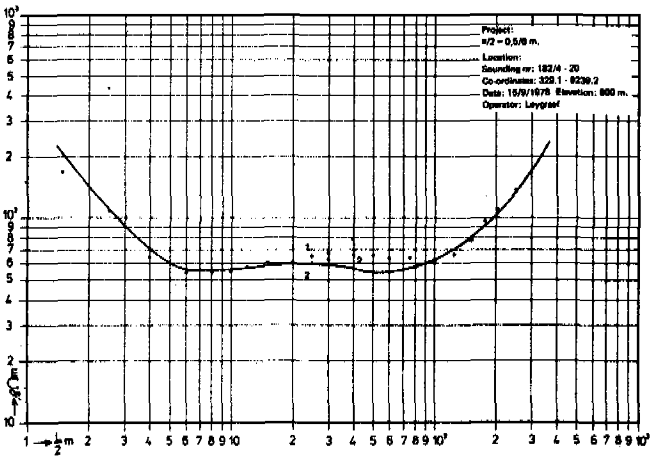

Project:
a/2 - 0,5/6 m.
Location:
Sounding nr: 182/4 - 15
Co-ordinates: 326,5 - 9245.9
Date: 14/9/1978 Elevation: 440 m.
Operator: Laygraaf

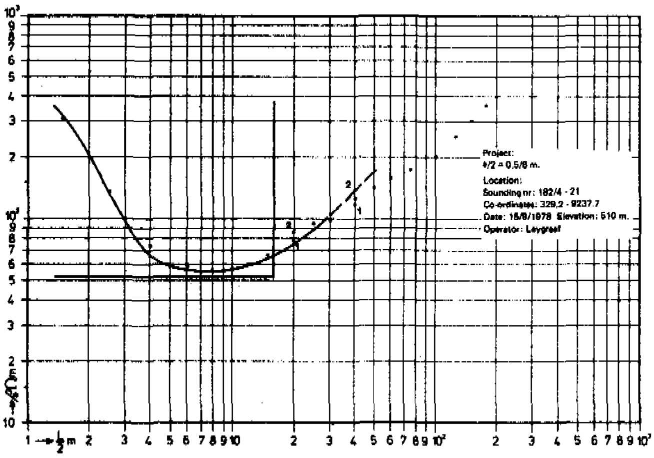

Project:
a/2 = 0,5// m.
Location:
Sounding nr: 182/4 - 16
Co-ordinates: 326.9 - 9245,2
Date: 14/9/1978 Elevation: 460 m.
Operator: Laygraaf

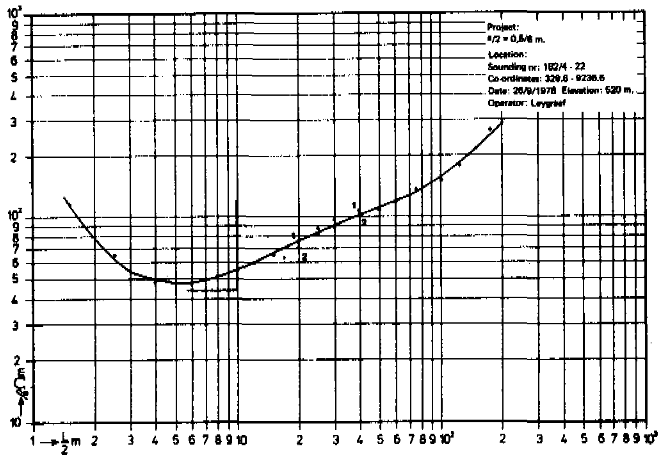

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 182/4 - 17
Co-ordinates: 327.8 - 9244.0
Date: 15/9/1978 Elevation: 460 m.
Operator: Laygraaf

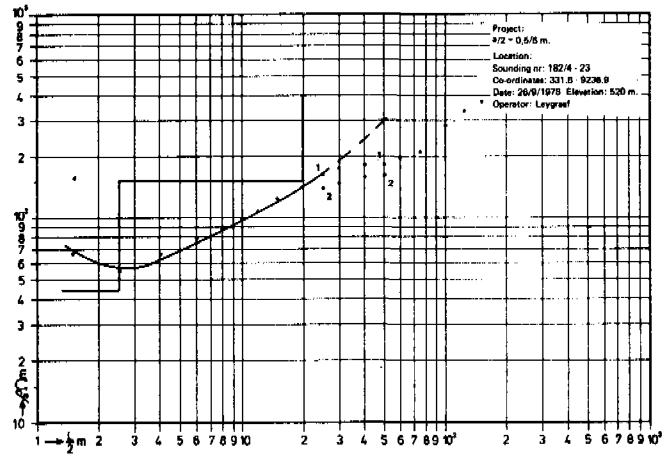

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 182/4 - 18
Co-ordinates: 328,5 - 9242.6
Date: 15/4/1978 Elevation: 465 m.
Operator: Laygraaf

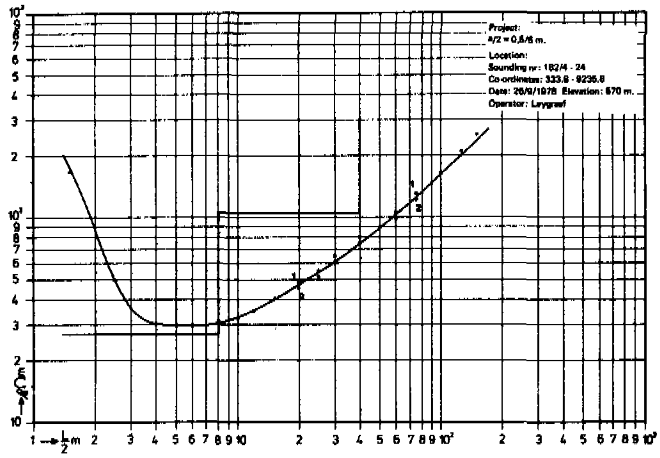

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 182/4 - 19
Co-ordinates: 328.6 - 9240.6
Date: 15/9/1978 Elevation: 480 m.
Operator: Laygraaf

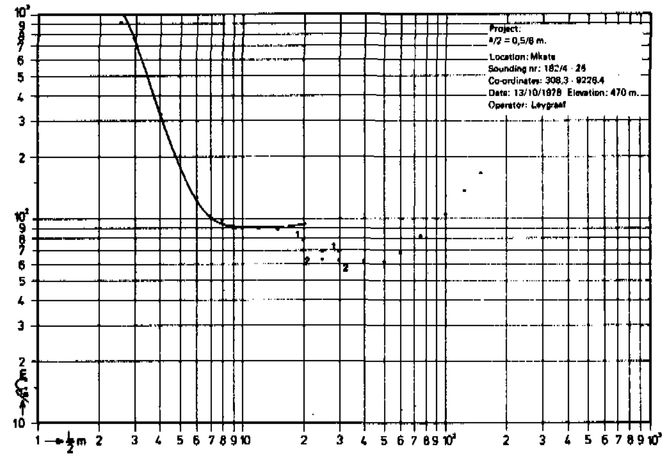

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 182/4 - 20
Co-ordinates: 329.1 - 9239.2
Date: 15/9/1978 Elevation: 800 m.
Operator: Laygraaf

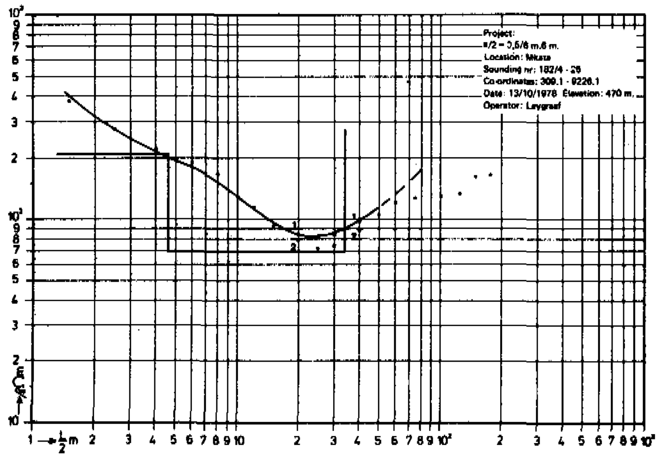

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 182/4 - 21
Co-ordinates: 329,2 - 9237.7
Date: 15/9/1978 Elevation: 510 m.
Operator: Leygraaf

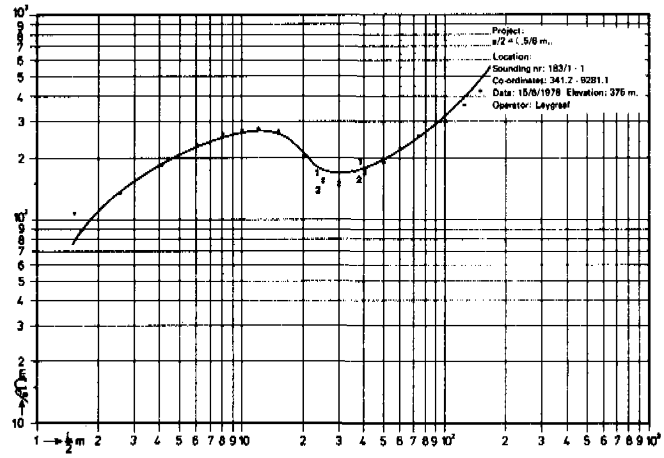

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 182/4 - 22
Co-ordinates: 329,5 - 9236.5
Date: 26/9/1978 Elevation: 520 m.
Operator: Leygraaf

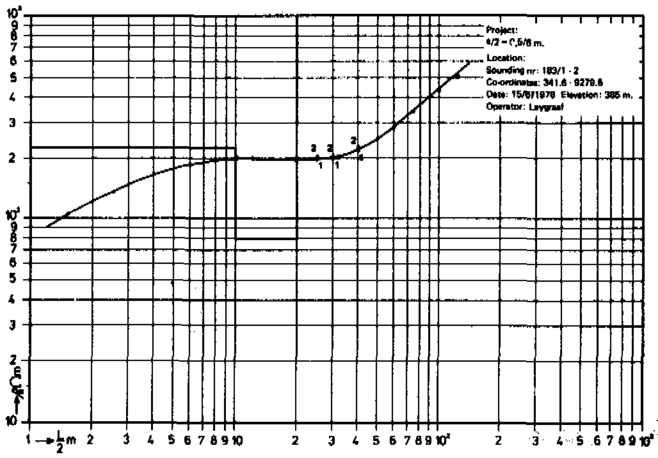

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 182/4 - 23
Co-ordinates: 331.8 - 9236.9
Date: 26/9/1978 Elevation: 520 m.
Operator: Leygraaf

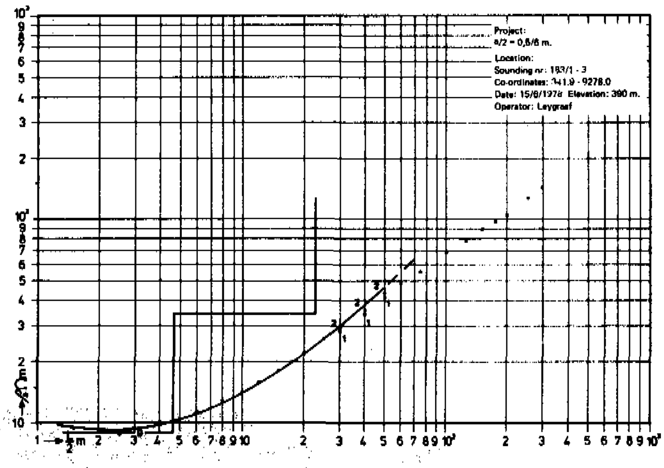

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 182/4 - 24
Co-ordinates: 333.6 - 9236.8
Date: 26/9/1978 Elevation: 670 m.
Operator: Leygraaf

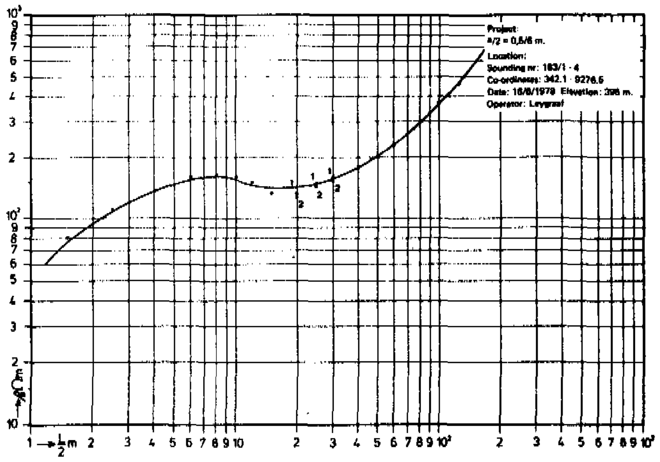

Project:
a/2 = 0,5/6 m.
Location: Mkata
Sounding nr: 182/4 - 25
Co-ordinates: 308,3 - 9226.4
Date: 13/10/1978 Elevation: 470 m.
Operator: Leygraaf

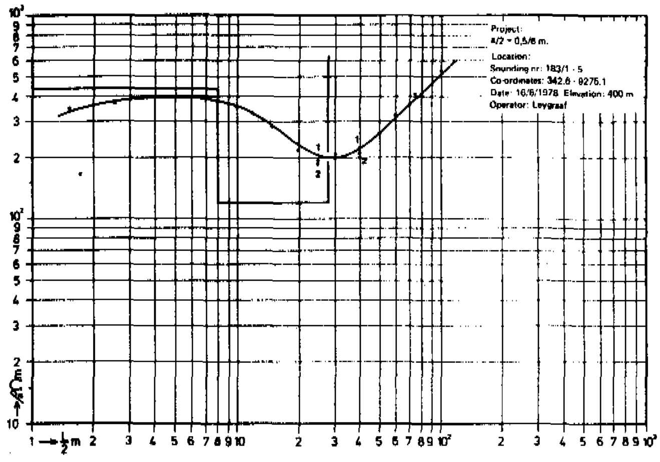

Project:
a/2 = 0,5/6 m.6 m.
Location: Mkata
Sounding nr: 182/4 - 26
Co-ordinates: 309.1 - 9226.1
Date: 13/10/1978 Elevation: 470 m.
Operator: Leygraaf

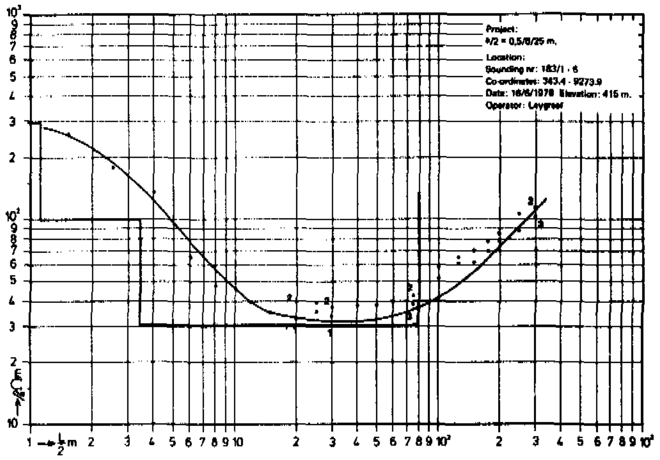

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 183/1 - 1
Co-ordinates: 341.2 - 9281.1
Date: 15/6/1978 Elevation: 375 m.
Operator: Leygraaf

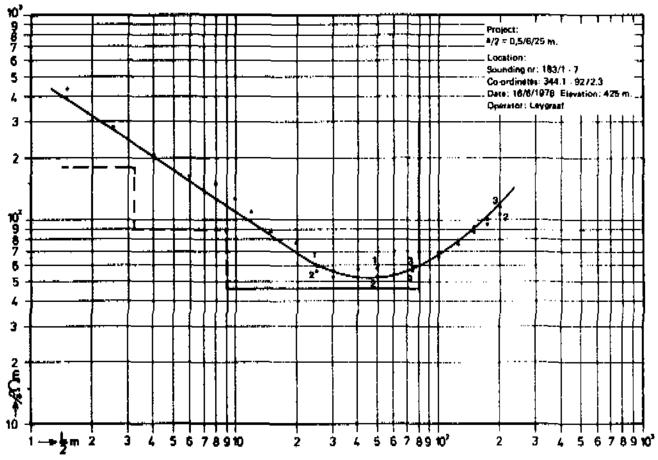

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 183/1 - 2
Co-ordinates: 341.6 - 9279.6
Date: 15/6/1978 Elevation: 385 m.
Operator: Leygraaf

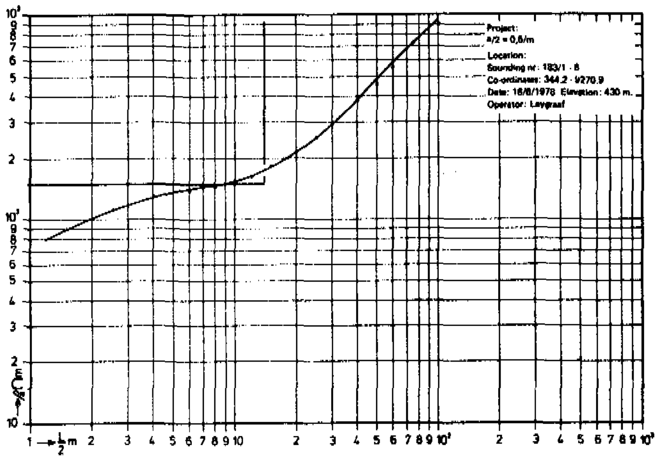

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 183/1 - 3
Co-ordinates: 341.9 - 9278.0
Date: 15/6/1978 Elevation: 390 m.
Operator: Leygraaf

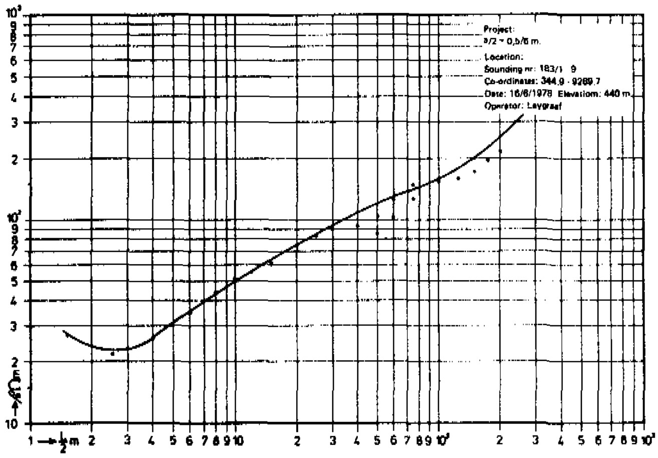

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 183/1 - 4
Co-ordinates: 342.1 · 9276.6
Date: 16/6/1978 Elevation: 396 m.
Operator: Leygraaf

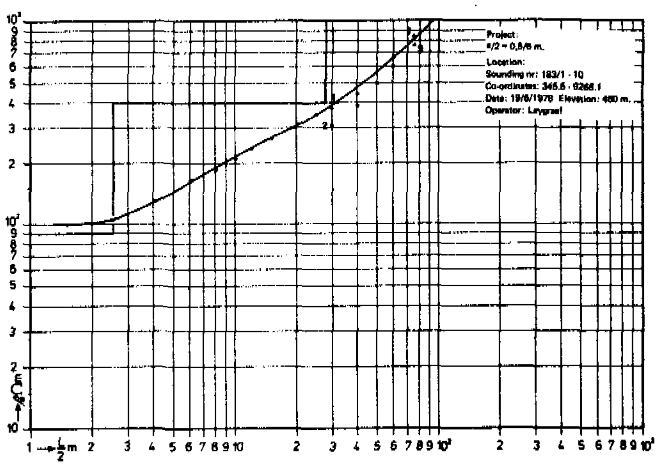

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 183/1 · 5
Co-ordinates: 342.6 · 9275.1
Date: 16/6/1978 Elevation: 400 m
Operator: Leygraaf

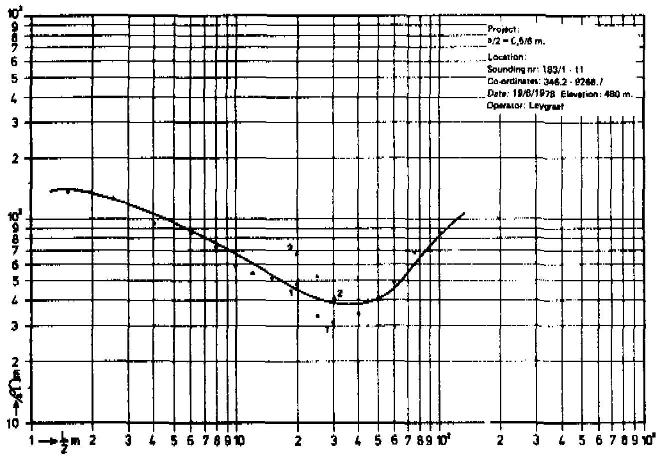

Project:
a/2 = 0,5/6/25 m.
Location:
Sounding nr: 183/1 · 6
Co-ordinates: 343.4 - 9273.9
Date: 16/6/1978 Elevation: 415 m.
Operator: Leygraaf

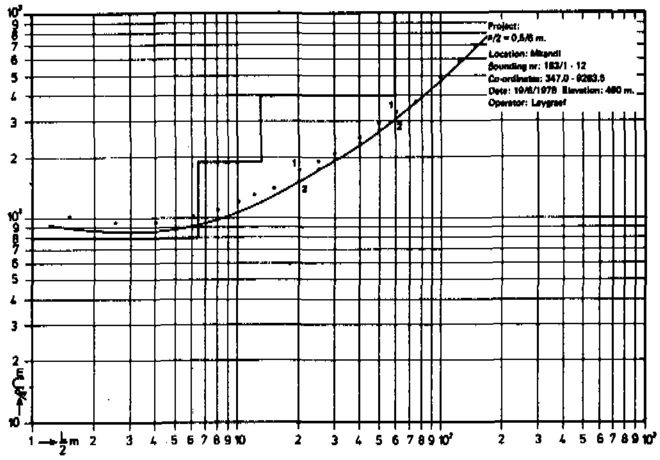

Project:
a/2 = 0,5/6/25 m.
Location:
Sounding nr: 183/1 · 7
Co-ordinates: 344.1 · 9272.3
Date: 16/6/1978 Elevation: 425 m.
Operator: Leygraaf

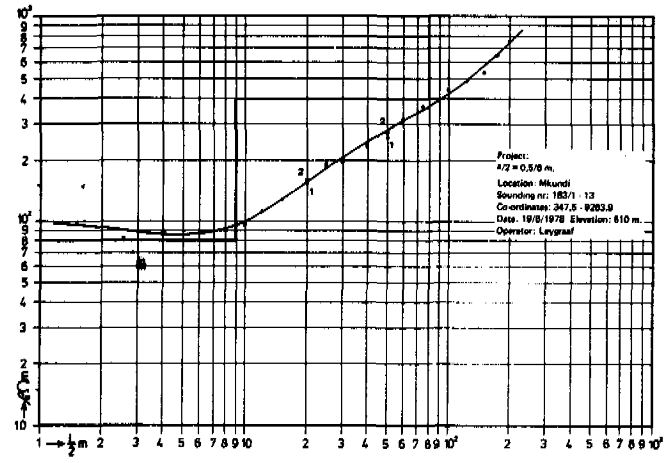

Project:
a/2 = 0,5/m
Location:
Sounding nr: 183/1 · 8
Co-ordinates: 344.2 · 9270.9
Date: 16/6/1978 Elevation: 430 m.
Operator: Leygraaf

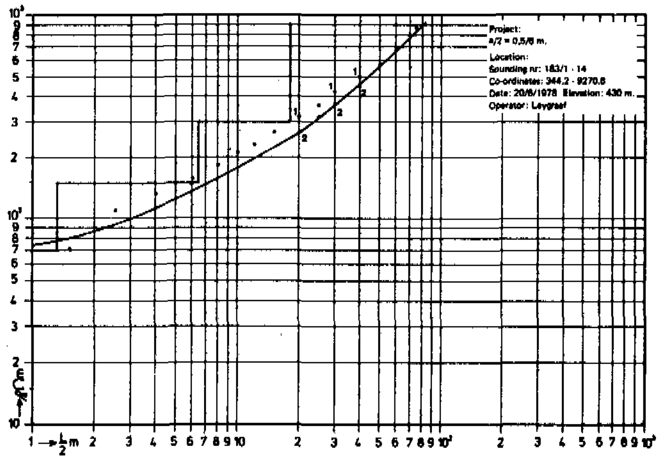

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 183/1 9
Co-ordinates: 344.9 · 9269.7
Date: 16/6/1978 Elevatiom: 440 m.
Operator: Leygraaf

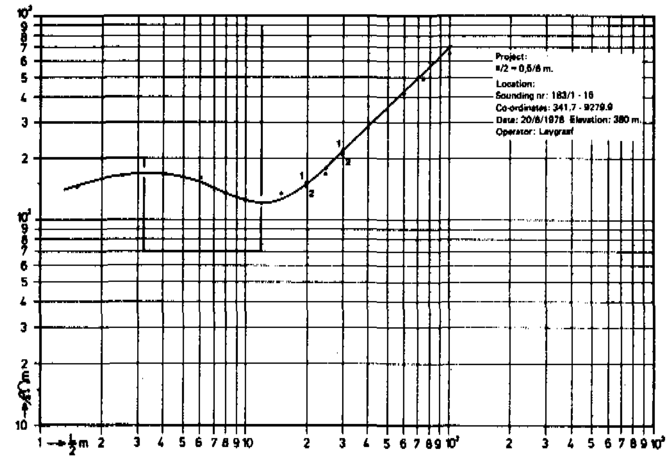

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 183/1 - 10
Co-ordinates: 345.6 · 9268.1
Date: 19/6/1978 Elevation: 460 m.
Operator: Leygraaf

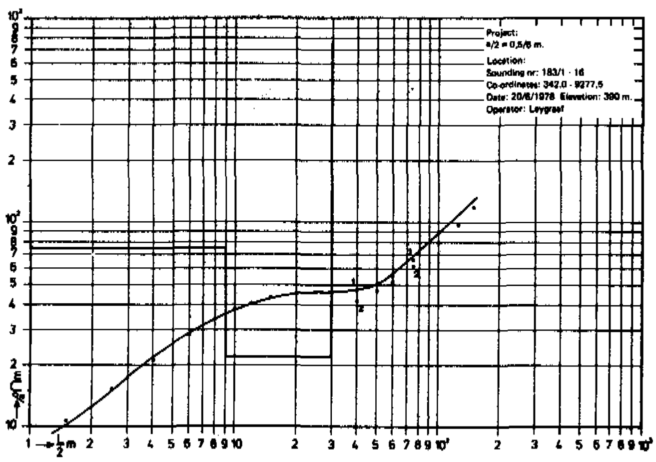

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 183/1 · 11
Co-ordinates: 346.2 · 9266.7
Date: 19/6/1978 Elevation: 480 m.
Operator: Leygraaf

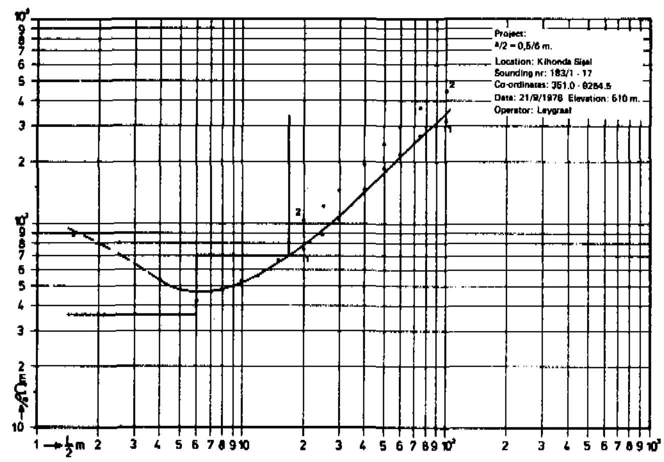

Project:
a/2 = 0,5/6 m.
Location: Mkundi
Sounding nr: 183/1 - 12
Co-ordinates: 347.0 - 9283.5
Date: 19/6/1978 Elevation: 460 m.
Operator: Leygraaf

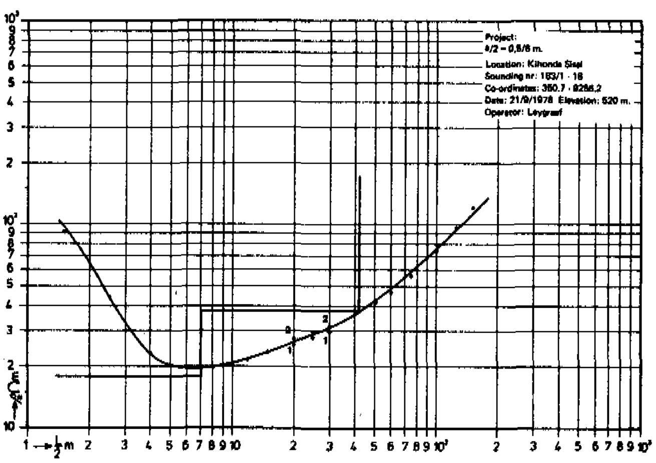

Project:
a/2 = 0,5/6 m.
Location: Mkundi
Sounding nr: 183/1 - 13
Co-ordinates: 347,5 - 9283,9
Date. 19/6/1978 Elevation: 610 m.
Operator: Leygraaf

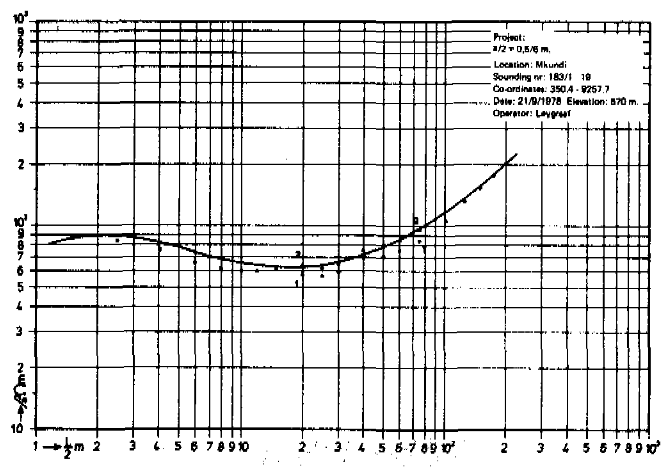

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 183/1 - 14
Co-ordinates: 344.2 - 9270.6
Date: 20/6/1978 Elevation: 430 m.
Operator: Leygraaf

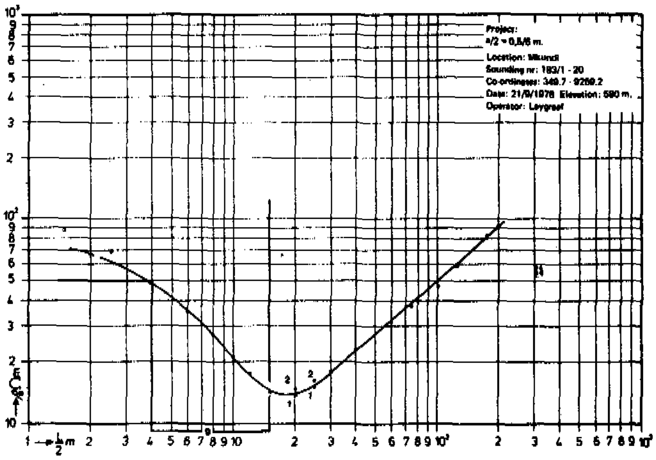

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 183/1 - 16
Co-ordinates: 341,7 - 9279.9
Date: 20/6/1978 Elevation: 380 m.
Operator: Leygraaf

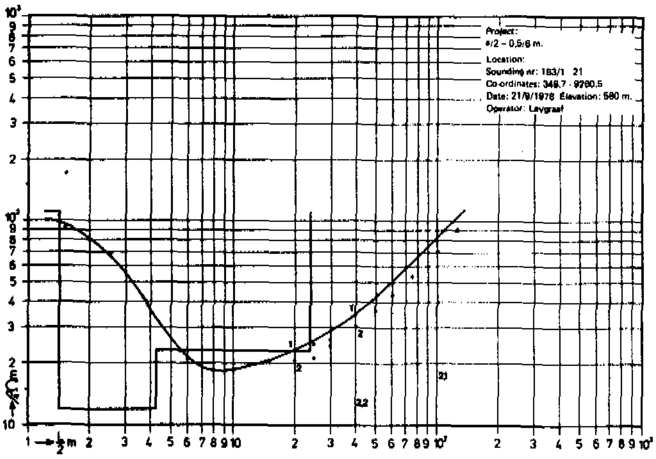

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 183/1 - 16
Co-ordinates: 342,0 - 9277,5
Date: 20/6/1978 Elevation: 380 m.
Operator: Leygraaf

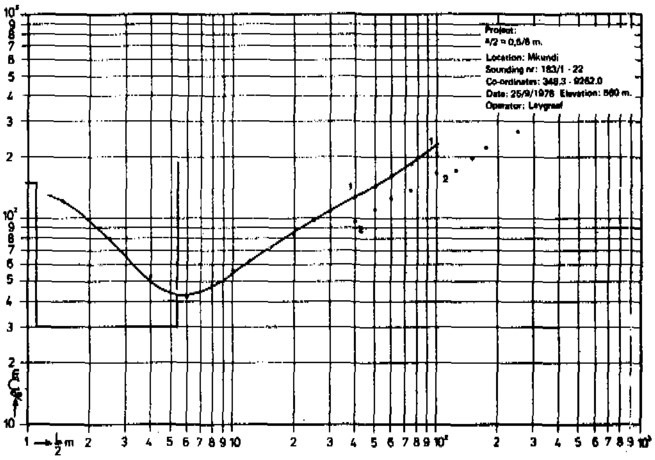

Project:
a/2 = 0,5/6 m.
Location: Kihonda Sisal
Sounding nr: 183/1 - 17
Co-ordinates: 351.0 - 9284.5
Date: 21/9/1978 Elevation: 610 m.
Operator: Leygraaf

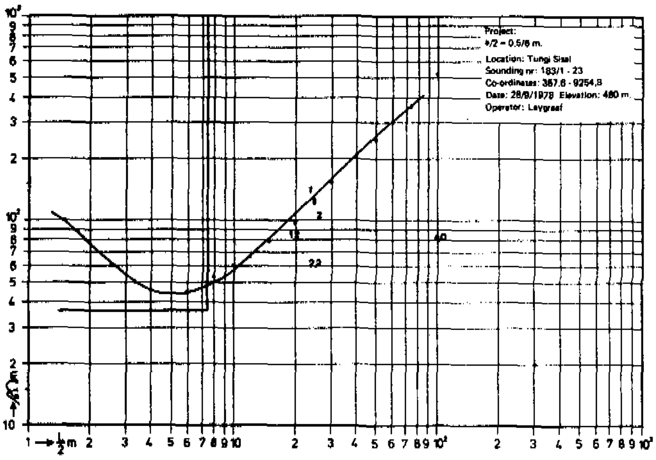

Project:
a/2 = 0,5/6 m.
Location: Kihonda Sisal
Sounding nr: 183/1 - 18
Co-ordinates: 350.7 - 9286,2
Date: 21/9/1978 Elevation: 520 m.
Operator: Leygraaf

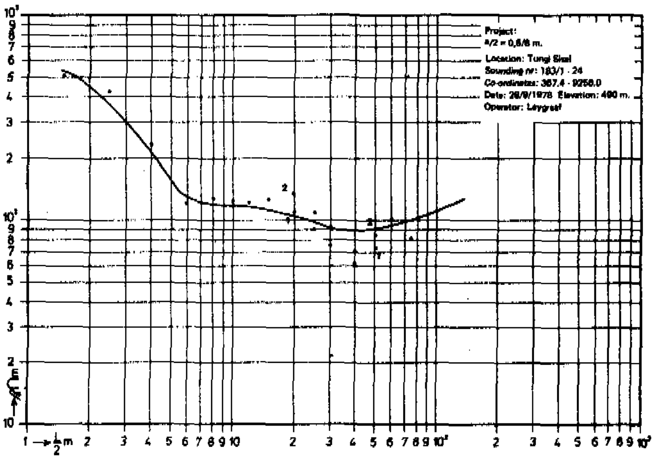

Project:
a/2 = 0,5/6 m.
Location: Mkundi
Sounding nr: 183/1 19
Co-ordinates: 350.4 - 9257.7
Date: 21/9/1978 Elevation: 570 m.
Operator: Leygraaf

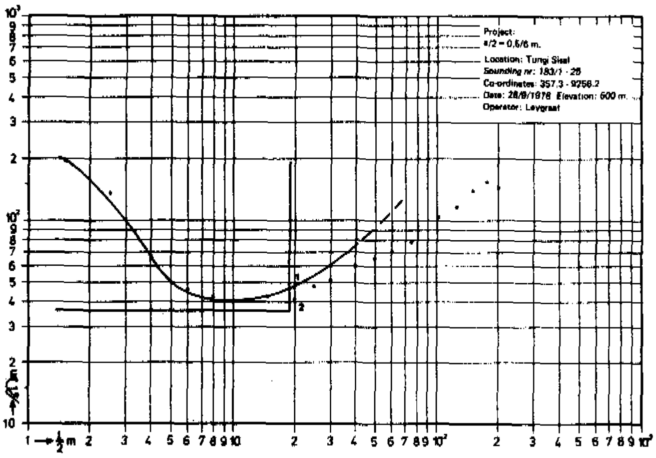

Project:
a/2 = 0,5/6 m.
Location: Mkundi
Sounding nr: 183/1 - 20
Co-ordinates: 349.7 - 9260.2
Date: 21/9/1978 Elevation: 580 m.
Operator: Løygraaf

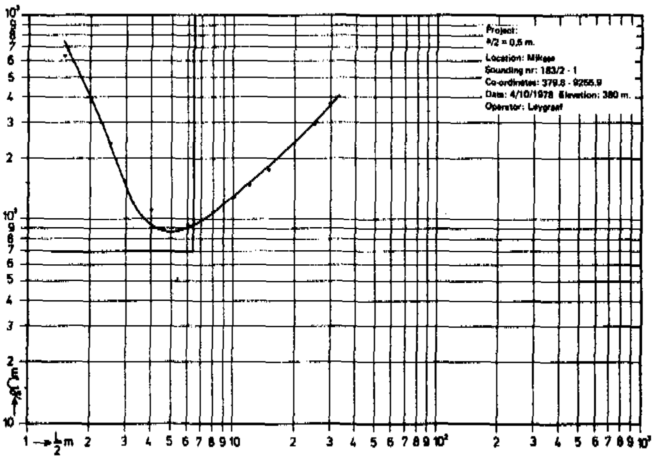

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 183/1 21
Co-ordinates: 348,7 - 9260,5
Date: 21/9/1978 Elevation: 580 m.
Operator: Løygraaf

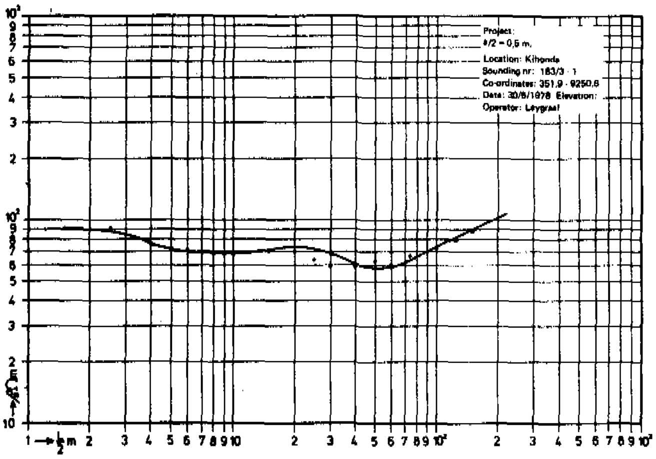

Project:
a/2 = 0,5/6 m.
Location: Mkundi
Sounding nr: 183/1 - 22
Co-ordinates: 348.3 - 9262.0
Date: 25/9/1978 Elevation: 560 m.
Operator: Løygraaf

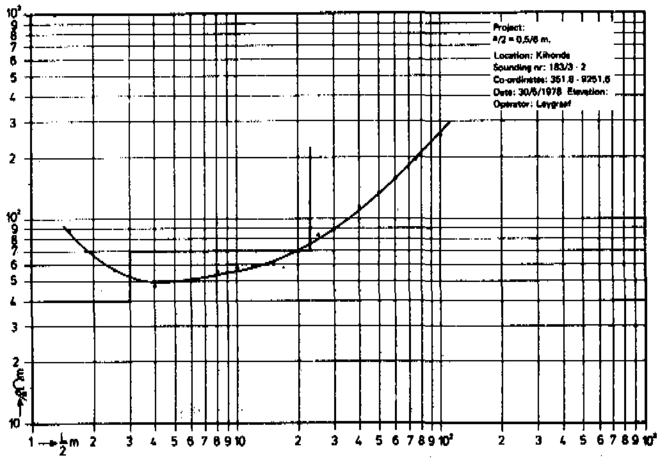

Project:
a/2 = 0.5/6 m.
Location: Tungi Sisal
Sounding nr: 183/1 - 23
Co-ordinates: 357.6 - 9254,8
Date: 28/9/1978 Elevation: 480 m.
Operator: Løygraaf

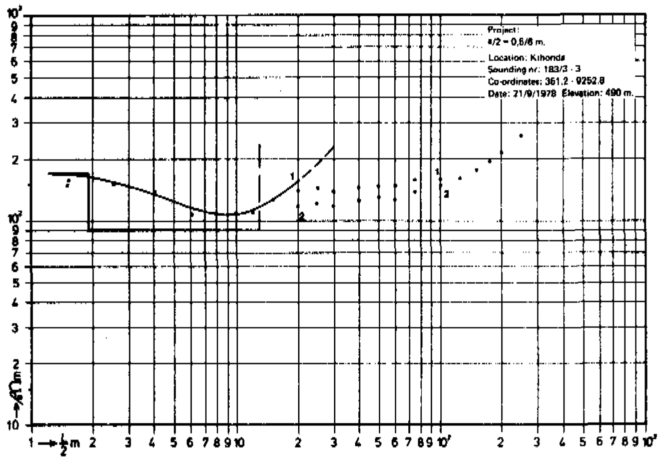

Project:
a/2 = 0,5/6 m.
Location: Tungi Sisal
Sounding nr: 183/1 - 24
Co-ordinates: 357.4 - 9256.0
Date: 28/9/1978 Elevation: 490 m.
Operator: Løygraaf

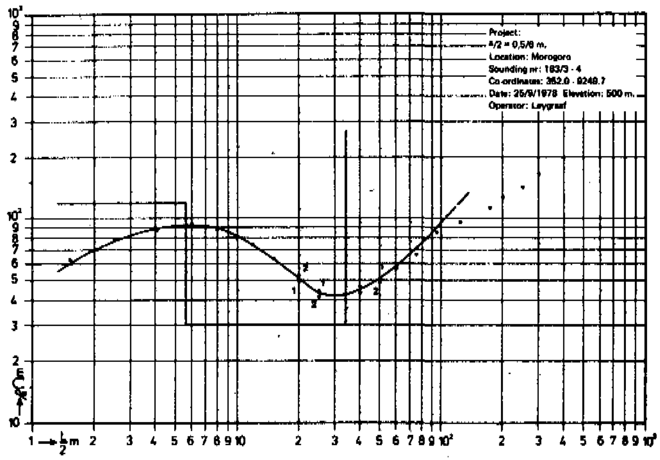

Project:
a/2 = 0,5/6 m.
Location: Tungi Sisal
Sounding nr: 183/1 - 25
Co-ordinates: 357,3 - 9258.2
Date: 28/9/1978 Elevation: 600 m.
Operator: Løygraaf

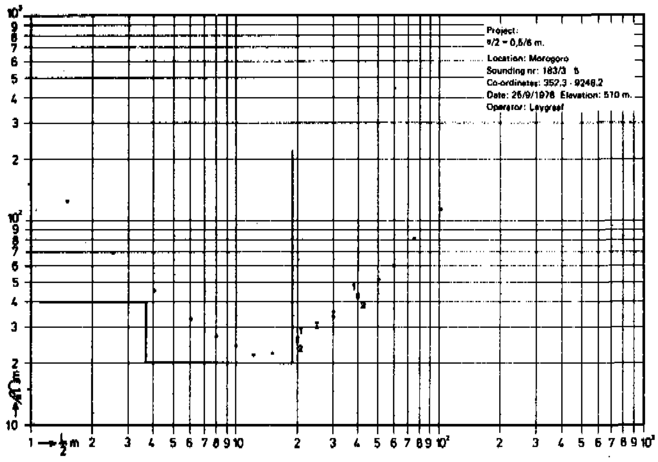

Project:
a/2 = 0,5 m.
Location: Mikese
Sounding nr: 183/2 - 1
Co-ordinates: 379.8 - 9255.9
Date: 4/10/1978 Elevation: 380 m.
Operator: Løygraaf

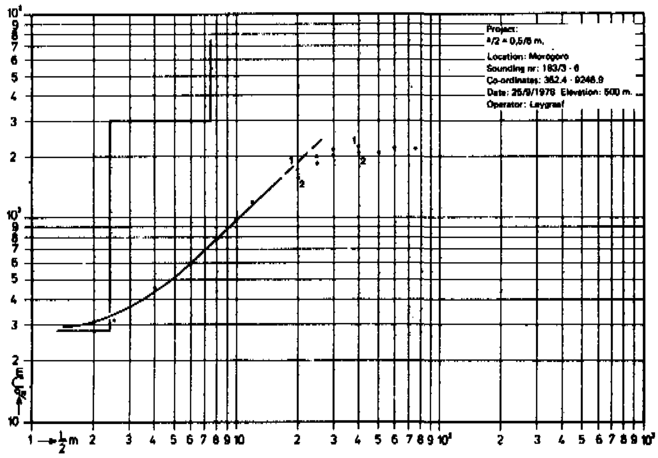

Project:
a/2 = 0,5 m.
Location: Kihonda
Sounding nr: 183/3 - 1
Co-ordinates: 351,9 - 9250,6
Date: 30/8/1978 Elevation:
Operator: Løygraaf

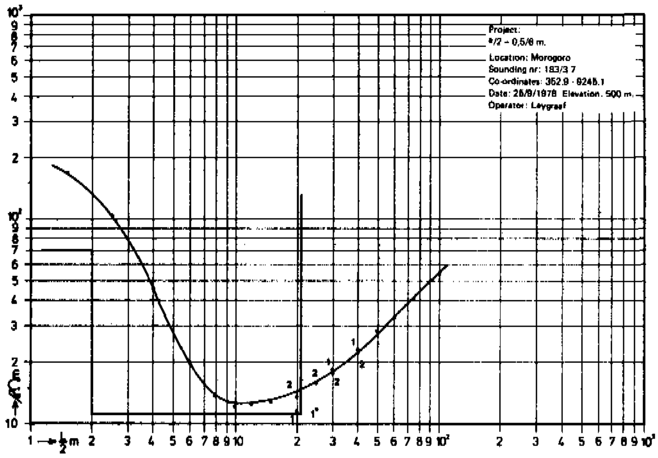

Project:
a/2 = 0,5/6 m.
Location: Kihonda
Sounding nr: 183/3 - 2
Co-ordinates: 351.8 - 9251.6
Date: 30/6/1978 Elevation:
Operator: Leygraaf

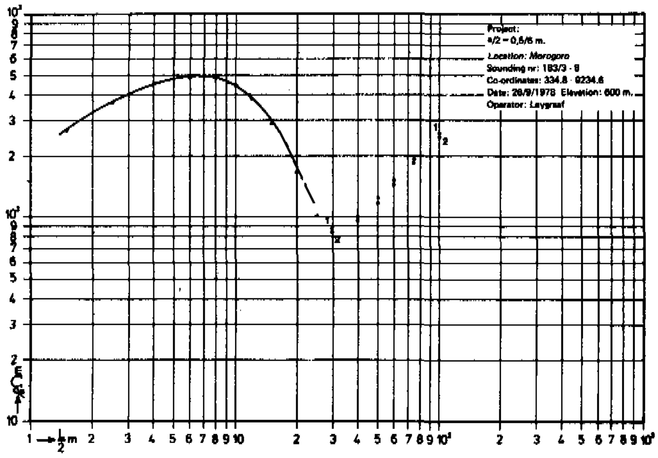

Project:
a/2 = 0,5/6 m.
Location: Kihonda
Sounding nr: 183/3 - 3
Co-ordinates: 361.2 - 9252.8
Date: 21/9/1978 Elevation: 490 m.

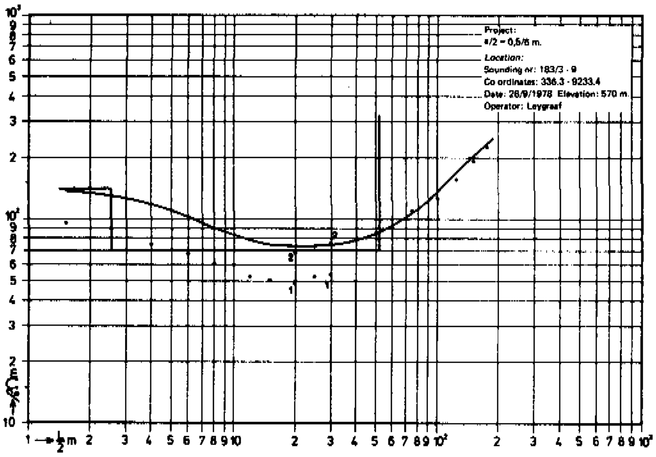

Project:
a/2 = 0,5/6 m.
Location: Morogoro
Sounding nr: 183/3 - 4
Co-ordinates: 352.0 - 9248.7
Date: 25/9/1978 Elevation: 500 m.
Operator: Leygraaf

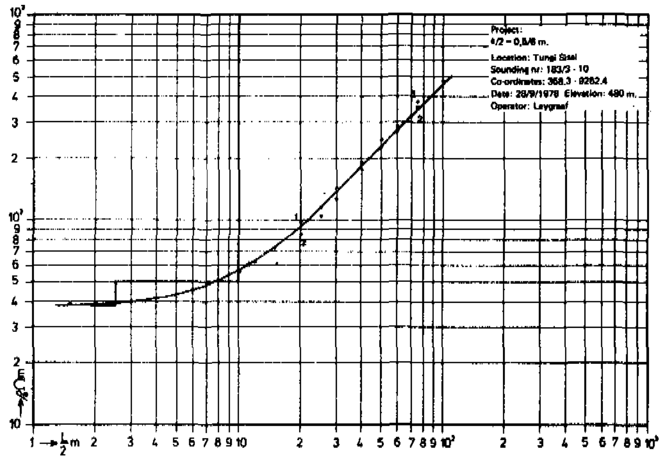

Project:
a/2 = 0,5/6 m.
Location: Morogoro
Sounding nr: 183/3 5
Co-ordinates: 352.3 - 9248.2
Date: 25/9/1978 Elevation: 510 m.
Operator: Leygraaf

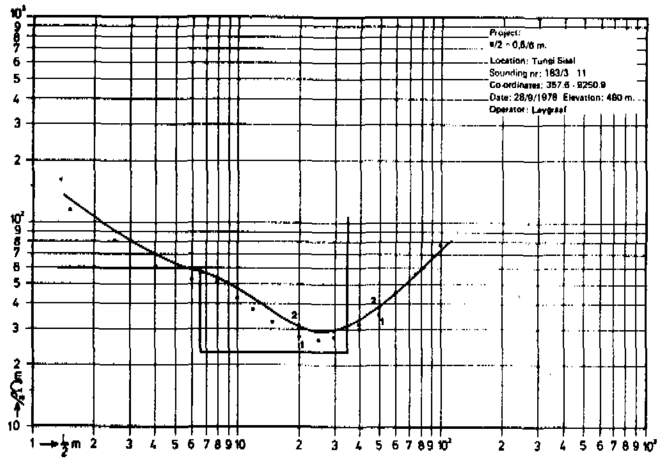

Project:
a/2 = 0,5/6 m.
Location: Morogoro
Sounding nr: 183/3 - 6
Co-ordinates: 352.4 - 9248.9
Date: 25/9/1978 Elevation: 500 m.
Operator: Leygraaf

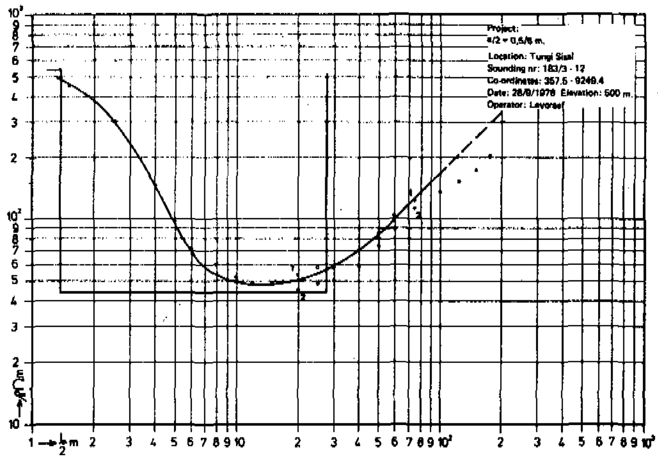

Project:
a/2 = 0,5/6 m.
Location: Morogoro
Sounding nr: 183/3 7
Co-ordinates: 352.9 - 9248.1
Date: 25/9/1978 Elevation. 500 m.
Operator: Leygraaf

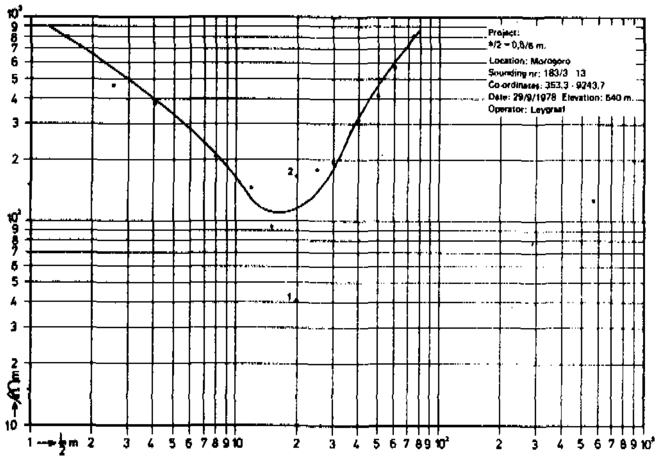

Project:
a/2 = 0,5/6 m.
Location: Morogoro
Sounding nr: 183/3 - 8
Co-ordinates: 334.8 - 9234.6
Date: 26/9/1978 Elevation: 600 m.
Operator: Leygraaf

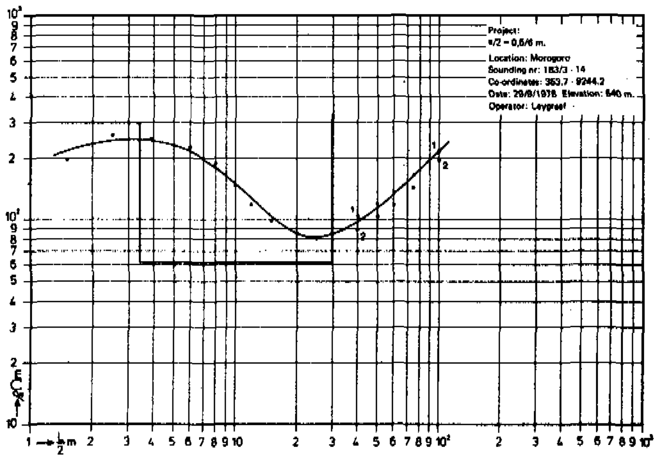

Project:
a/2 = 0,5/6 m.
Location:
Sounding nr: 183/3 - 9
Co ordinates: 336.3 - 9233.4
Date: 26/9/1978 Elevation: 570 m.
Operator: Leygraaf

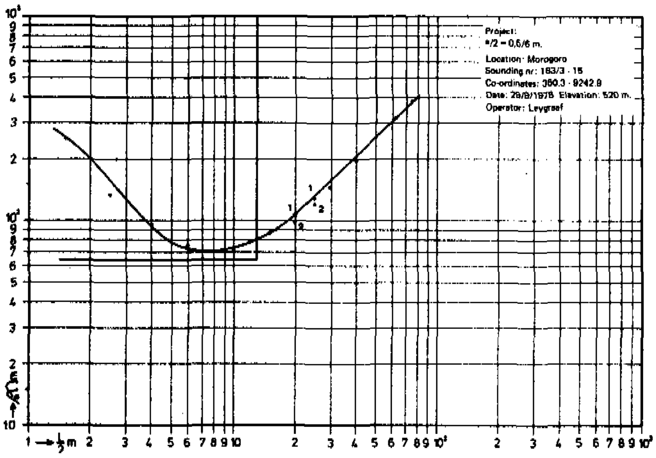

Project:
a/2 = 0,5/6 m.
Location: Tungi Sisal
Sounding nr: 183/3 - 10
Co-ordinates: 358.3 · 9262.4
Date: 28/9/1978 Elevation: 480 m.
Operator: Leygraaf

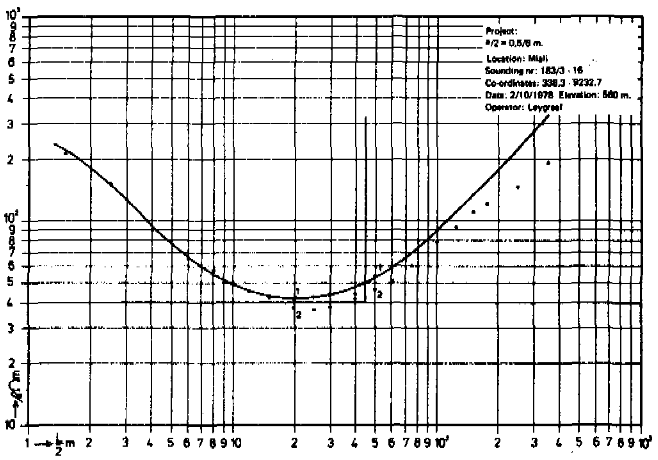

Project:
a/2 = 0,5/6 m.
Location: Tungi Sisal
Sounding nr: 183/3 11
Co-ordinates: 357.6 · 9250.9
Date: 28/9/1978 Elevation: 480 m.
Operator: Leygraaf

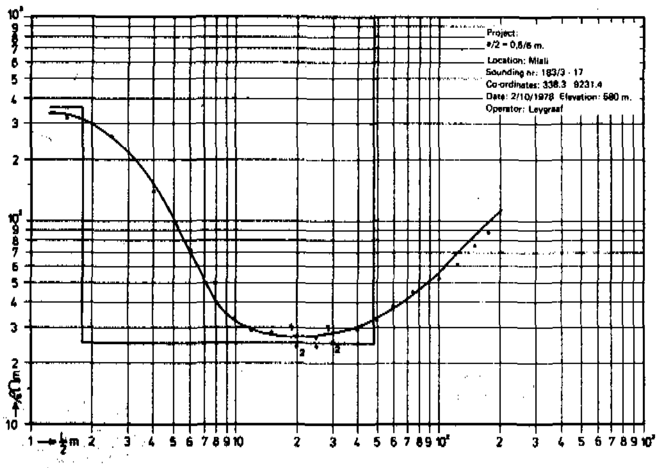

Project:
a/2 = 0,5/6 m.
Location: Tungi Sisal
Sounding nr: 183/3 - 12
Co-ordinates: 357.5 · 9249.4
Date: 28/9/1978 Elevation: 500 m.
Operator: Leygraaf

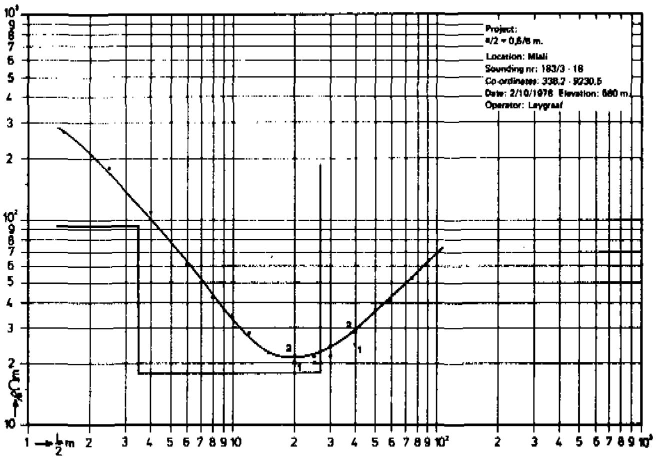

Project:
a/2 = 0,5/6 m.
Location: Morogoro
Sounding nr: 183/3 13
Co-ordinates: 353,3 · 9243,7
Date: 29/9/1978 Elevation: 540 m.
Operator: Leygraaf

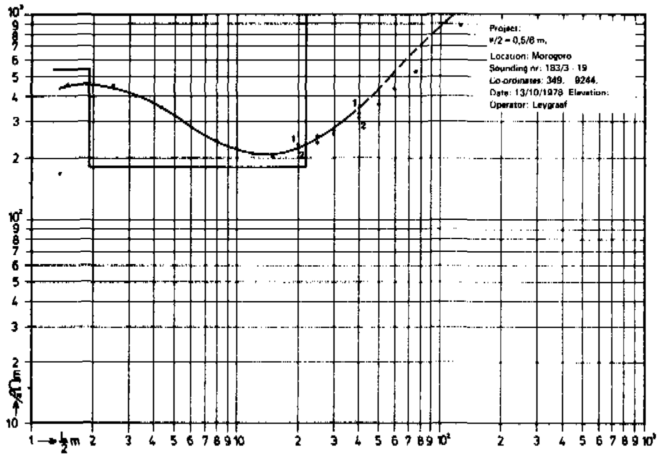

Project:
a/2 = 0,5/6 m.
Location: Morogoro
Sounding nr: 183/3 - 14
Co-ordinates: 353,7 · 9244.2
Date: 29/9/1978 Elevation: 540 m.
Operator: Leygraaf

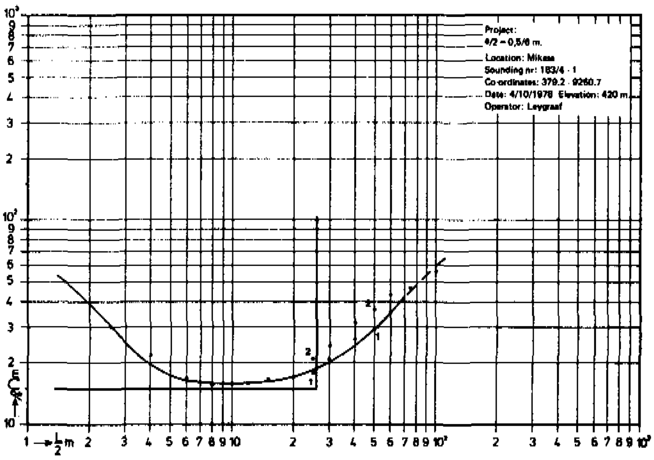

Project:
a/2 = 0,5/6 m.
Location: Morogoro
Sounding nr: 183/3 - 15
Co-ordinates: 360.3 · 9242.9
Date: 29/9/1978 Elevation: 520 m.
Operator: Leygraaf

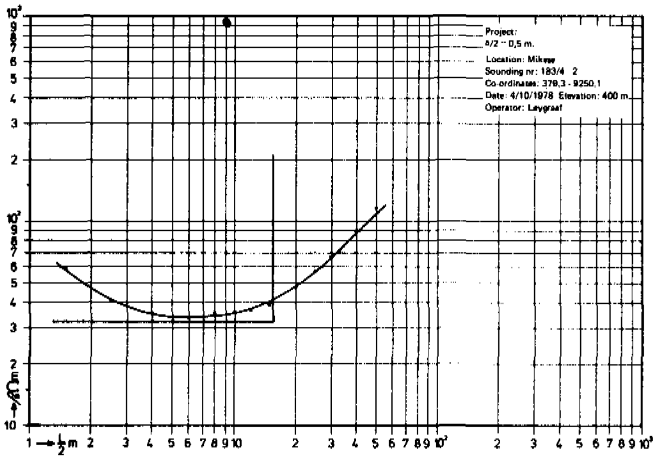

Project:
a/2 = 0,5/6 m.
Location: Mlali
Sounding nr: 183/3 - 16
Co-ordinates: 338.3 · 9232.7
Date: 2/10/1978 Elevation: 580 m.
Operator: Leygraaf

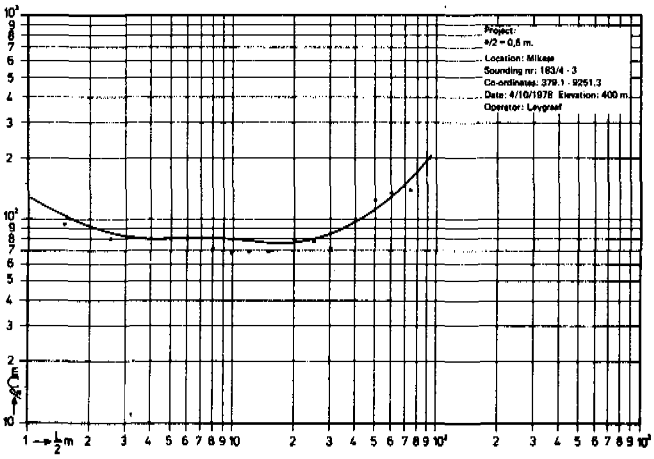

Project:
a/2 = 0,5/6 m.
Location: Mlali
Sounding nr: 183/3 - 17
Co-ordinates: 338.3 9231.4
Date: 2/10/1978 Elevation: 580 m.
Operator: Leygraaf

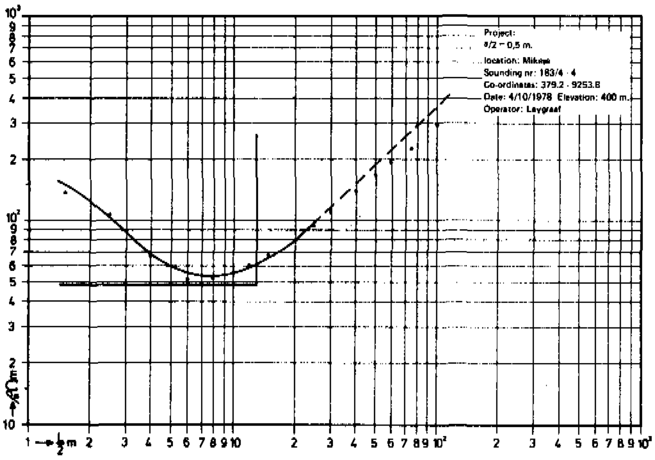

Project:
s/2 = 0,5/6 m.
Location: Mlali
Sounding nr: 183/3 - 18
Co-ordinates: 338.2 - 9230.5
Date: 2/10/1978 Elevation: 580 m.
Operator: Leygraaf

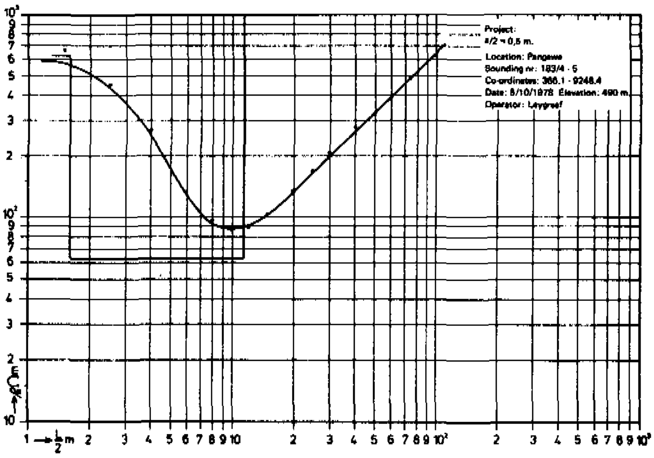

Project:
s/2 = 0,5/6 m.
Location: Morogoro
Sounding nr: 183/3 - 19
Co-ordinates: 349. 9244.
Date: 13/10/1978 Elevation:
Operator: Leygraaf

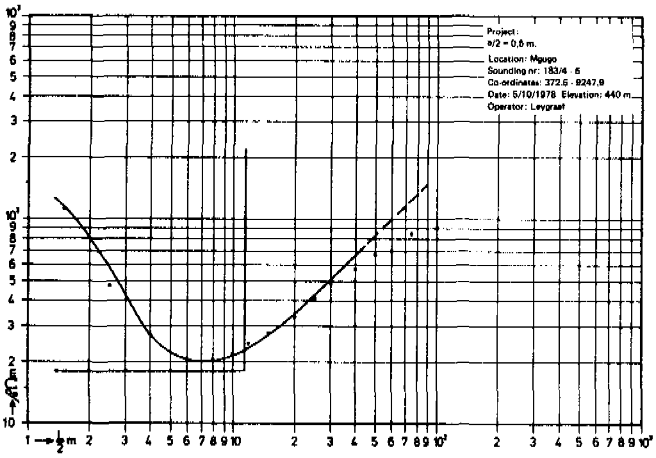

Project:
s/2 = 0,5/6 m.
Location: Mikese
Sounding nr: 183/4 - 1
Co-ordinates: 379.2 - 9260.7
Date: 4/10/1978 Elevation: 420 m.
Operator: Leygraaf

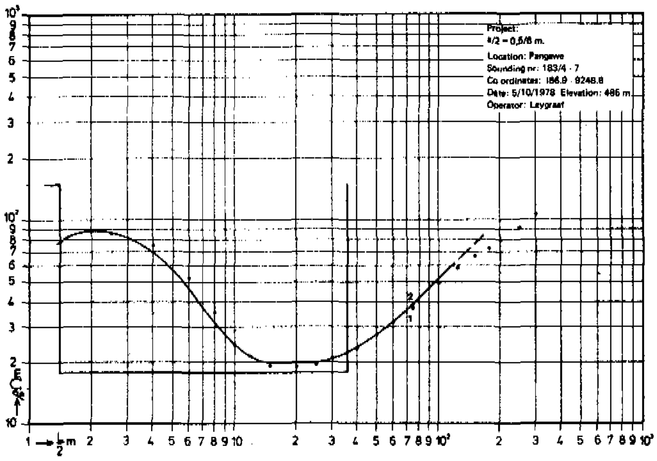

Project:
s/2 = 0,5 m.
Location: Mikese
Sounding nr: 183/4 2
Co-ordinates: 379,3 - 9250,1
Date: 4/10/1978 Elevation: 400 m.
Operator: Leygraaf

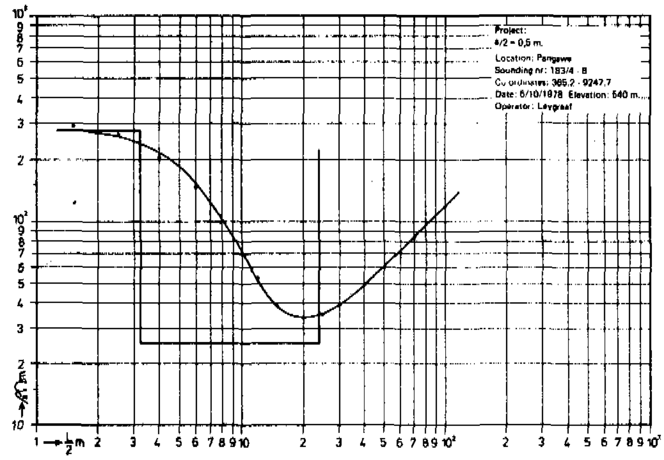

Project:
s/2 = 0,5 m.
Location: Mikese
Sounding nr: 183/4 - 3
Co-ordinates: 379.1 - 9251,3
Date: 4/10/1978 Elevation: 400 m.
Operator: Leygraaf

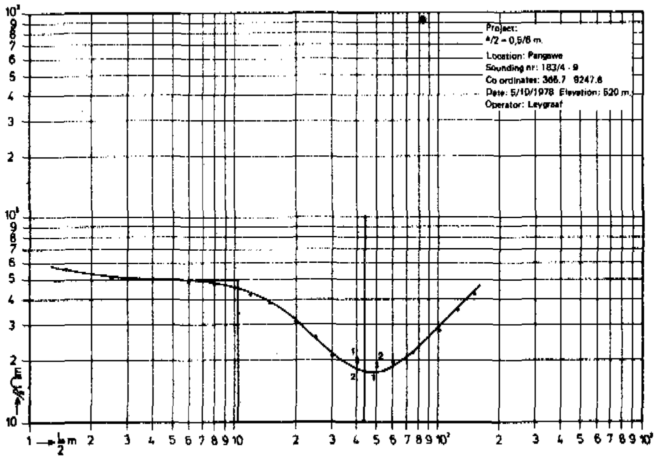

Project:
s/2 = 0,5 m.
location: Mikese
Sounding nr: 183/4 - 4
Co-ordinates: 379.2 - 9253.8
Date: 4/10/1978 Elevation: 400 m.
Operator: Leygraaf

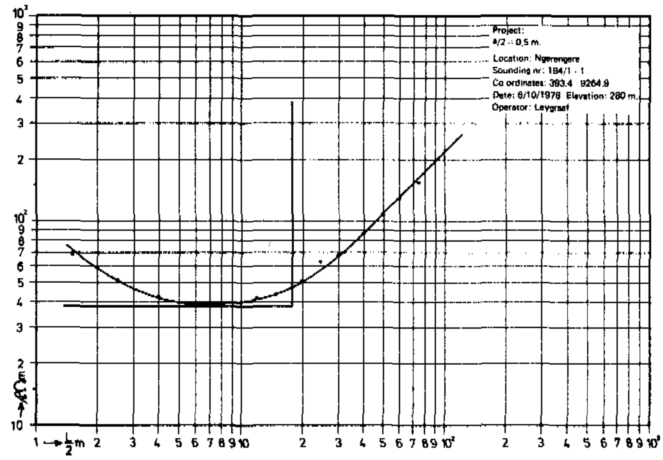

Project:
s/2 = 0,5 m.
Location: Pangawe
Sounding nr: 183/4 - 5
Co-ordinates: 366.1 - 9248.4
Date: 5/10/1978 Elevation: 490 m.
Operator: Leygraaf

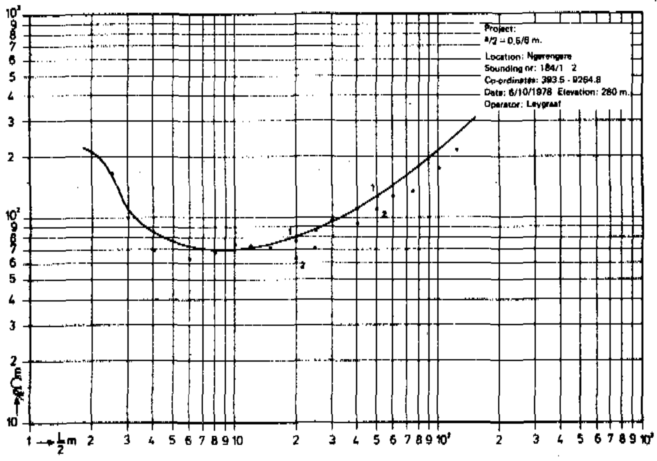

Project:
s/2 = 0,5 m.
Location: Mgugo
Sounding nr: 183/4 - 6
Co-ordinates: 372.6 - 9247,9
Date: 5/10/1978 Elevation: 440 m.
Operator: Leygraaf

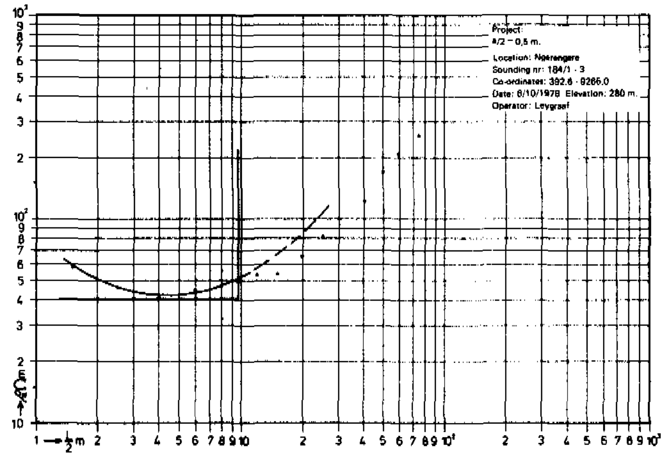

Project:
a/2 = 0,5/6 m.
Location: Pangawe
Sounding nr: 183/4 - 7
Co ordinates: 186.9 - 9248.8
Date: 5/10/1978 Elevation: 486 m.
Operator: Leygraaf

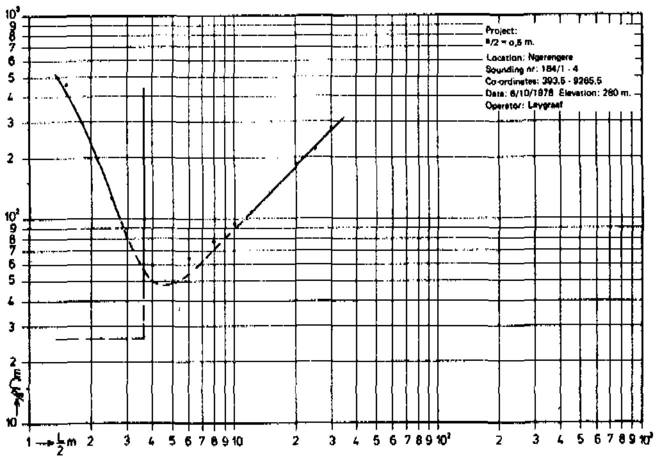

Project:
a/2 = 0,5 m.
Location: Pangawe
Sounding nr: 183/4 - 8
Co ordinates: 365,2 - 9247,7
Date: 6/10/1978 Elevation: 540 m.
Operator: Leygraaf

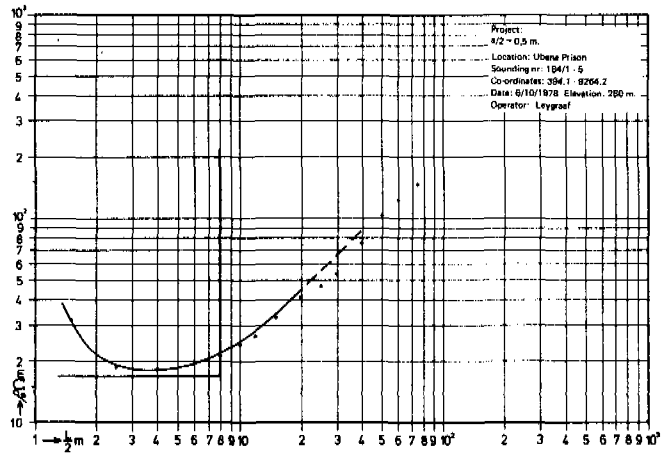

Project:
a/2 = 0,5/6 m.
Location: Pangawe
Sounding nr: 183/4 - 9
Co ordinates: 366.7 9247.6
Date: 5/10/1978 Elevation: 520 m.
Operator: Leygraaf

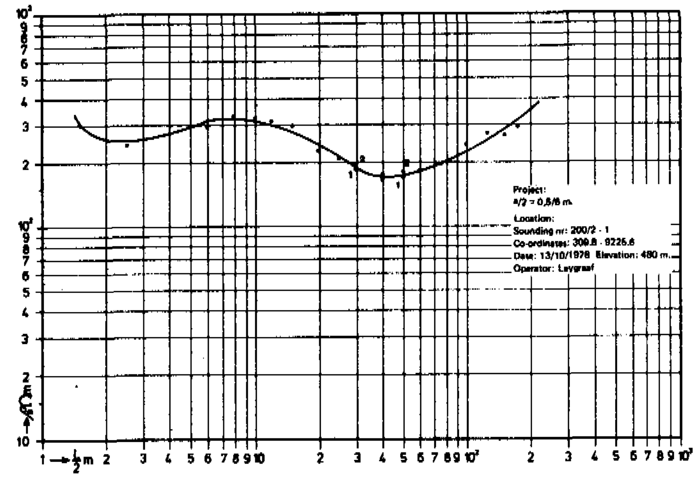

Project:
a/2 = 0,5 m.
Location: Ngerengere
Sounding nr: 184/1 - 1
Co ordinates: 393.4 9264.9
Date: 6/10/1978 Elevation: 280 m.
Operator: Leygraaf


Project:
a/2 = 0,5/6 m.
Location: Ngerengere
Sounding nr: 184/1 2
Co-ordinates: 393.5 - 9264.8
Date: 6/10/1978 Elevation: 280 m.
Operator: Leygraaf


Project:
a/2 = 0,5 m.
Location: Ngerengere
Sounding nr: 184/1 - 3
Co-ordinates: 392.6 - 9266.0
Date: 6/10/1978 Elevation: 280 m.
Operator: Leygraaf

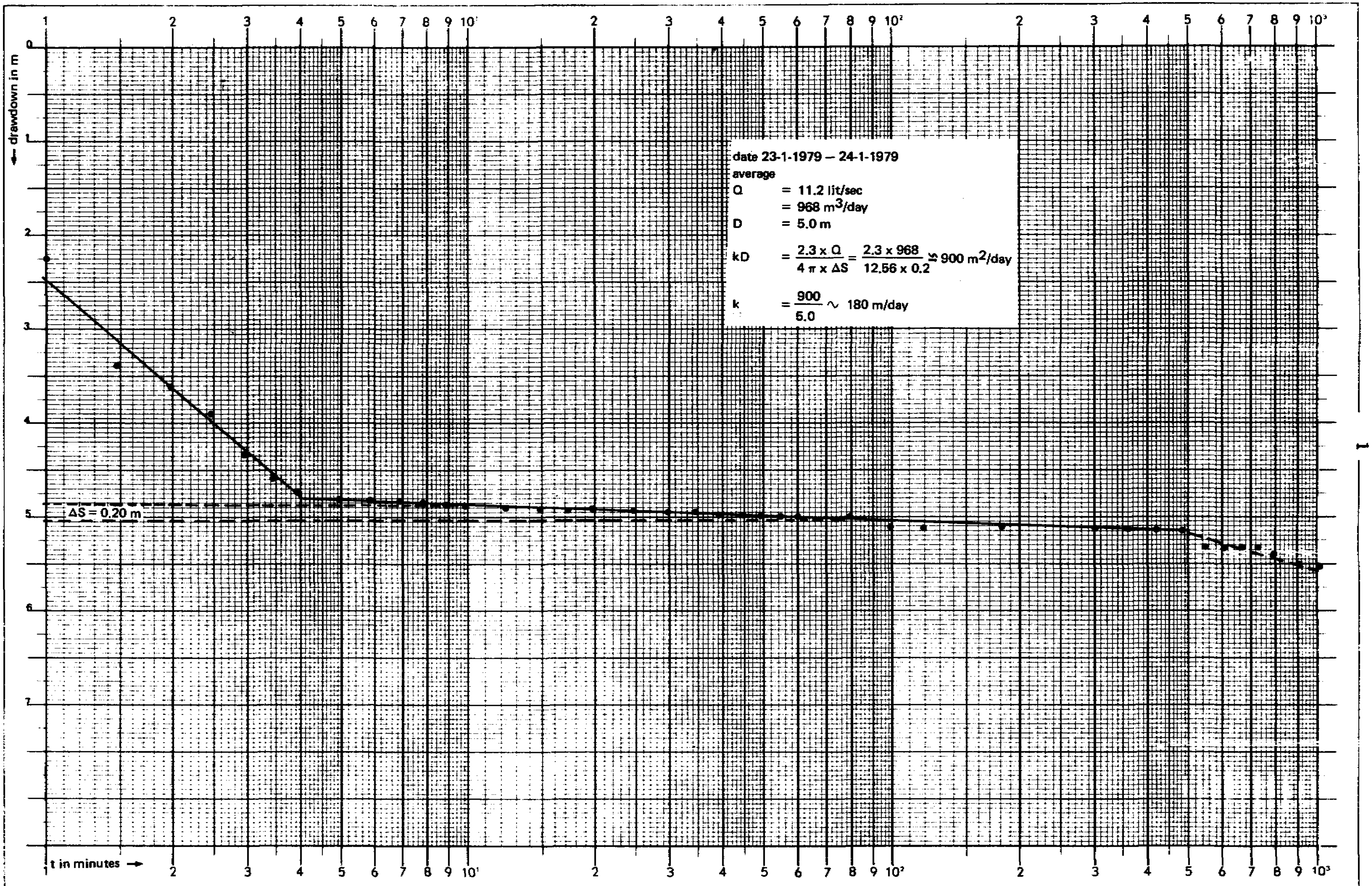

Project:
a/2 = o,5 m.
Location: Ngerengere
Sounding nr: 184/1 - 4
Co-ordinates: 393.5 - 9265.5
Date: 6/10/1978 Elevation: 280 m.
Operator: Leygraaf


Project:
a/2 = 0,5 m.
Location: Ubena Prison
Sounding nr: 184/1 - 5
Co-ordinates: 394.1 - 9264.2
Date: 6/10/1978 Elevation: 280 m.
Operator: Leygraaf


Project:
a/2 = 0,6/6 m.
Location:
Sounding nr: 200/2 - 1
Co-ordinates: 309.8 - 9225.6
Date: 13/10/1978 Elevation: 480 m.
Operator: Leygraaf

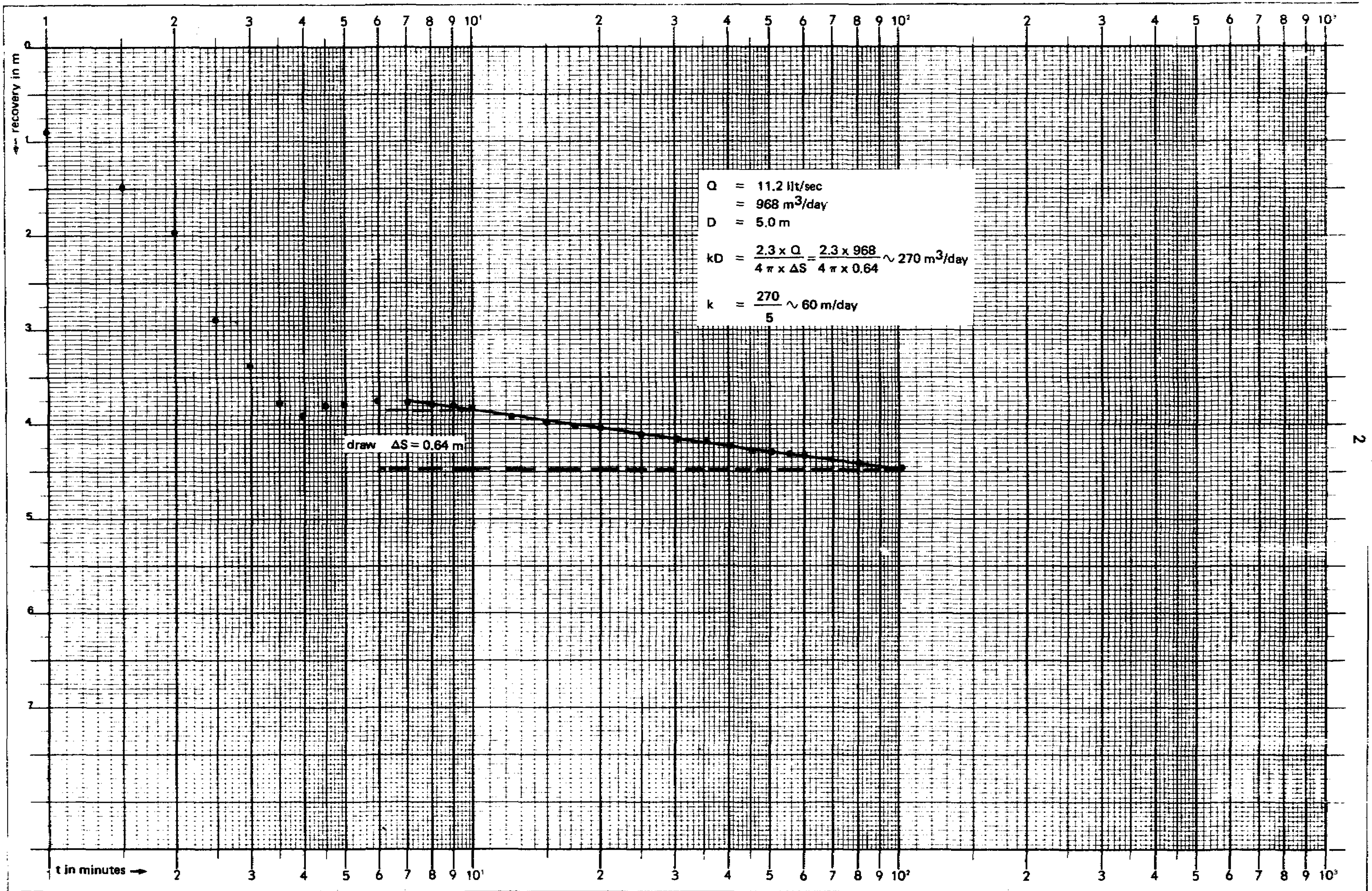
DATA DD 8

TIME-DRAWDOWN AND TIME-RECOVERY GRAPHS OF PUMPING TESTS
FROM MDWSP-BOREHOLES

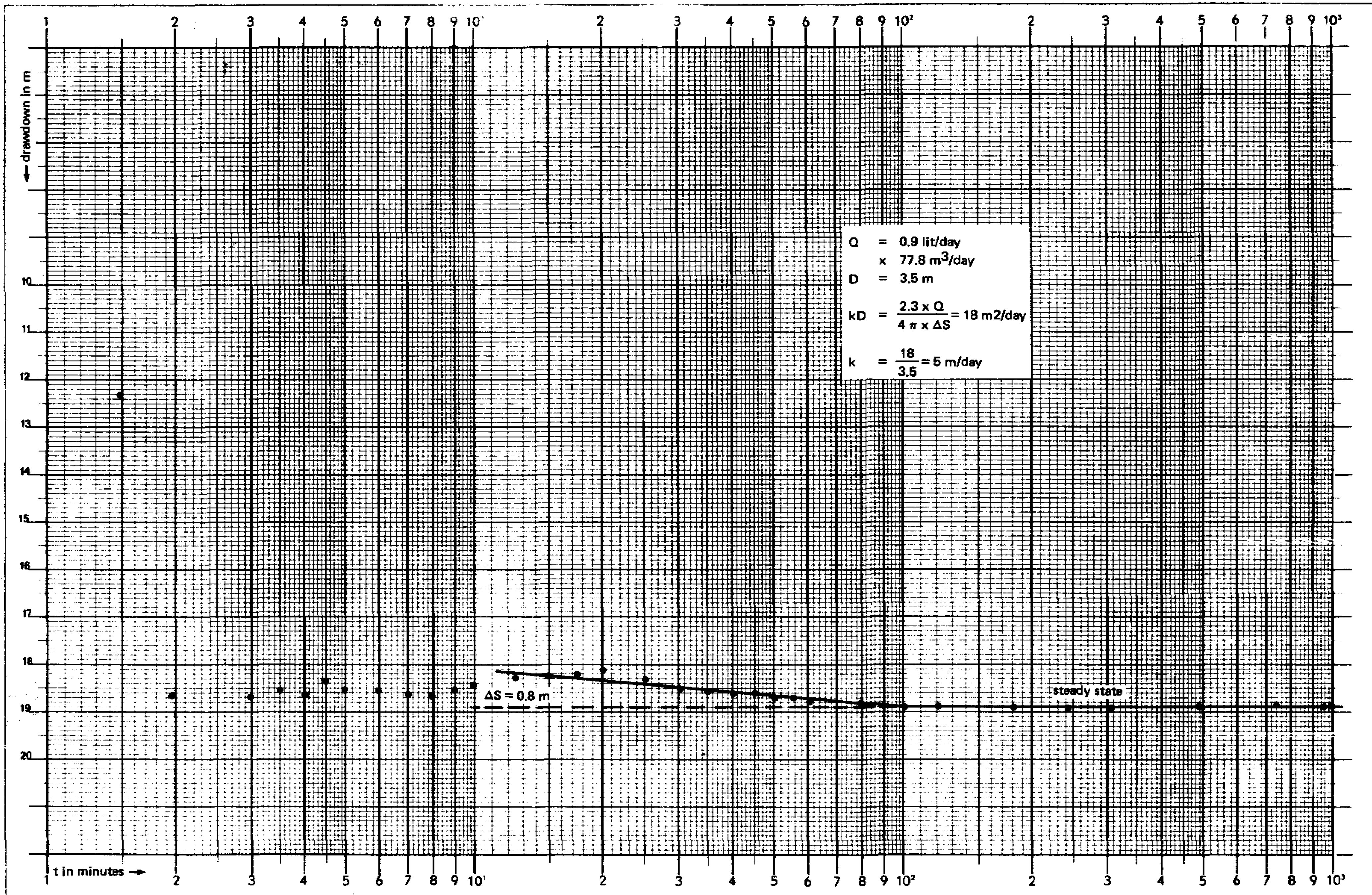


PUMPING TEST OF BOREHOLE 7/79, MBWADE

meetpapier - wormerveer 17 Tr X-as log. verdeeld 1-10³ Eenheid 90 mm Y-as verdeeld in mm.

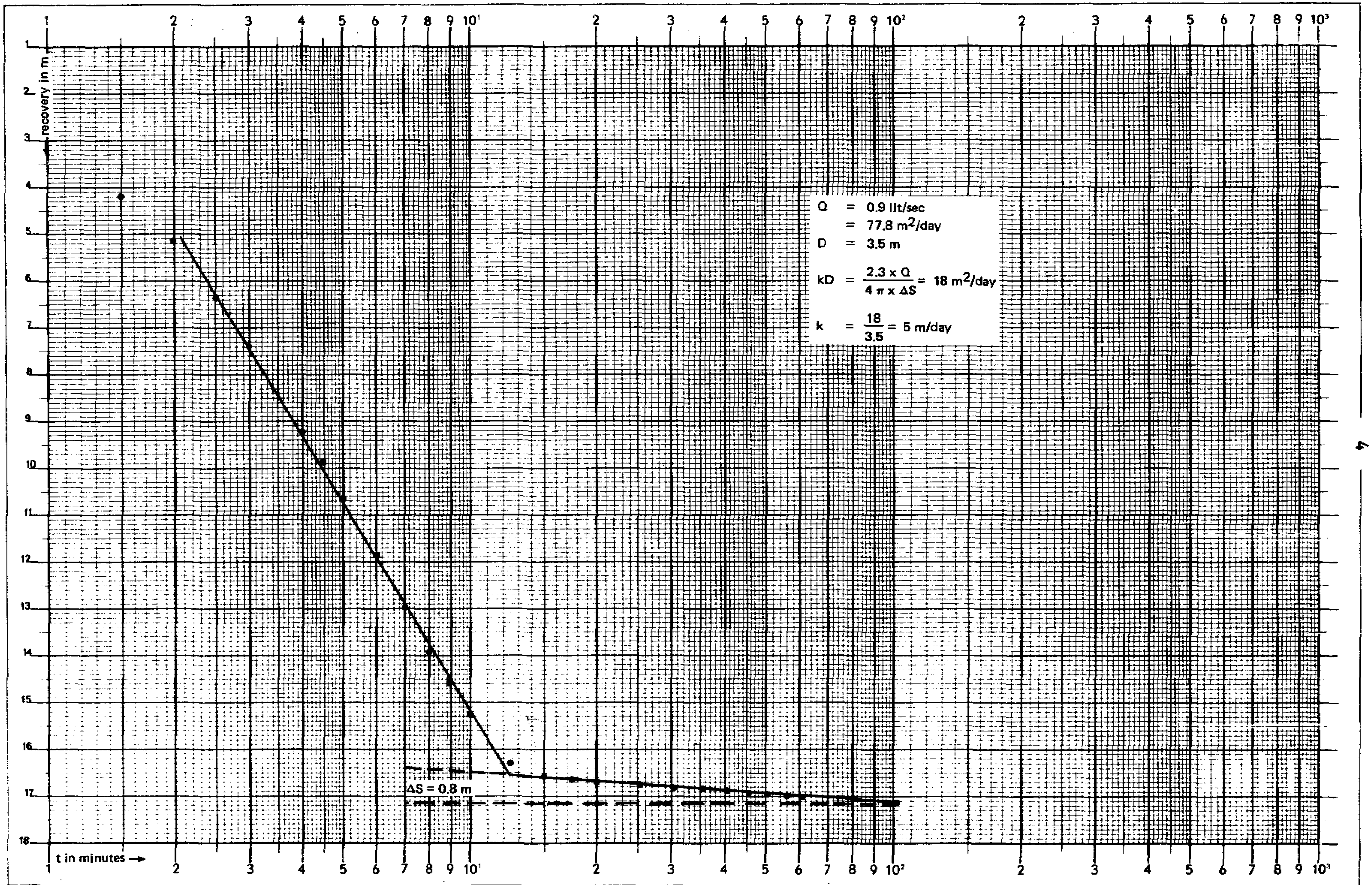


RECOVERY TEST OF BOREHOLE 7/79, MBWADE



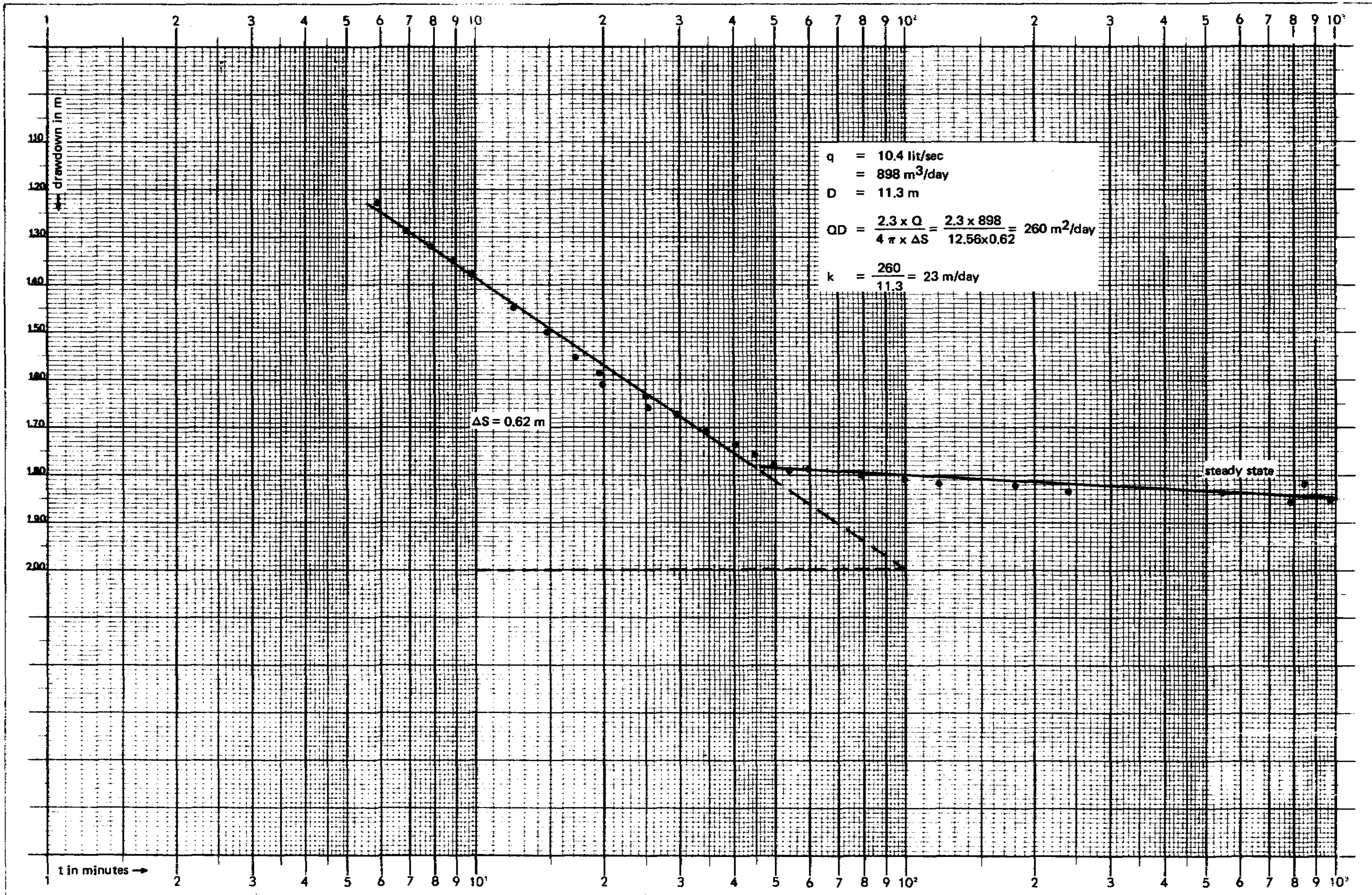
PUMPING TEST OF BOREHOLE 27/79, MADOTO

 17 Tr



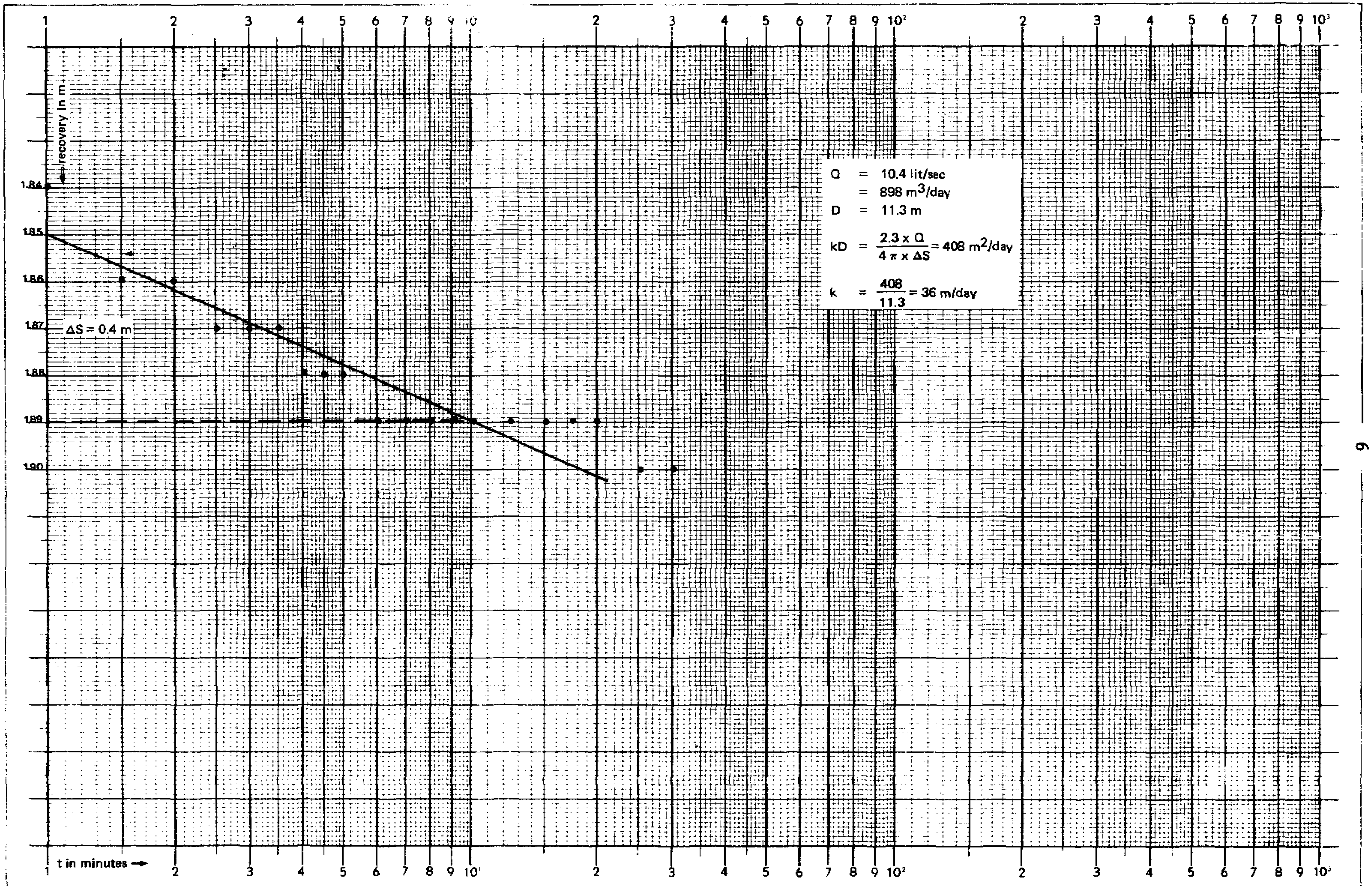
RECOVERY TEST OF BOREHOLE 27/79, MADOTO

meetpapier - wormerveer 17 Tr X-as log. verdeeld 1-10³ Eenheid 90 mm. Y-as verdeeld in mm.



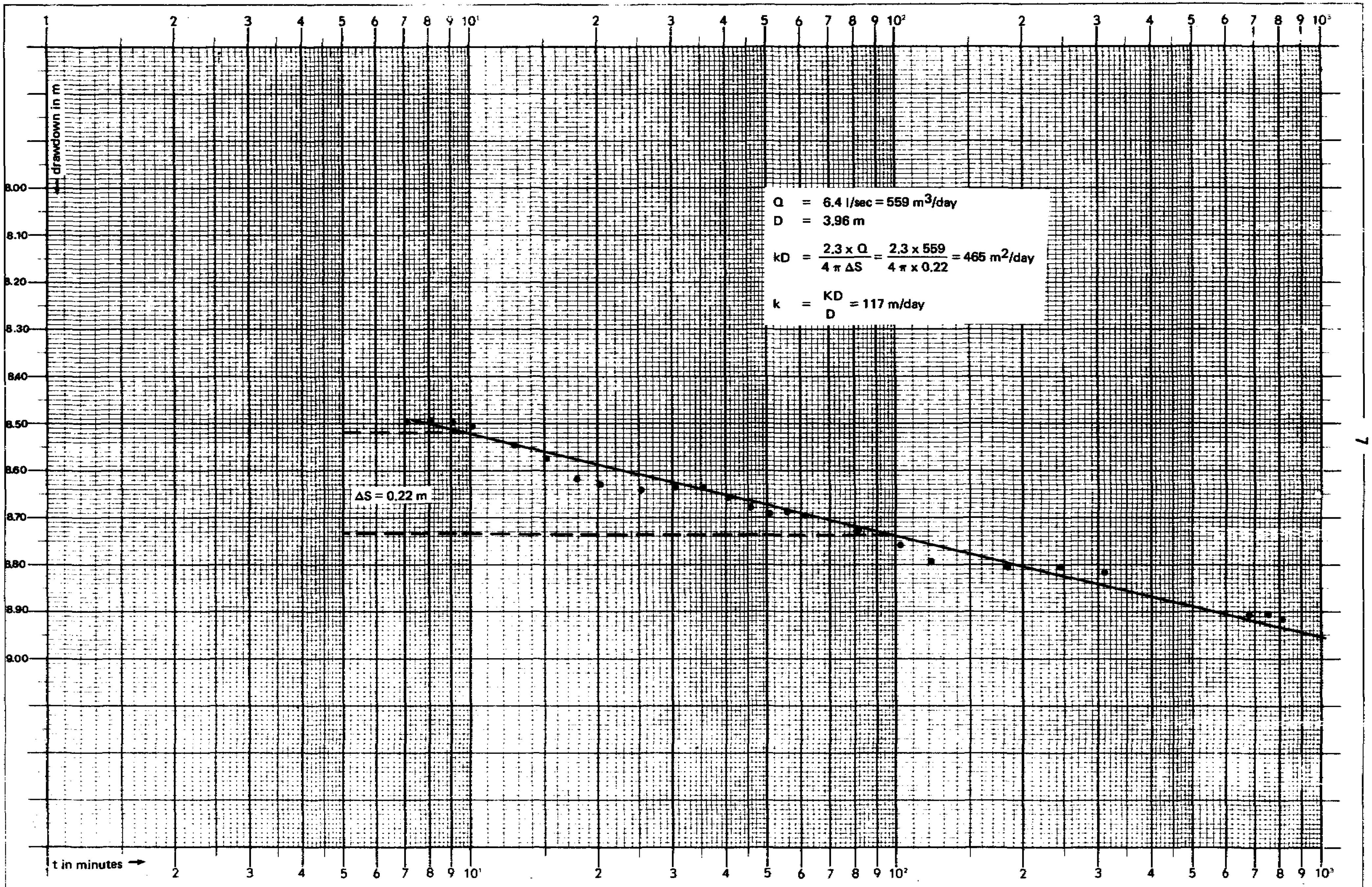
PUMPING TEST OF BOREHOLE 28/79, RUDEWA

meetpapier - wormerveer 17 Tr X-as log. verdeeld 1-10³ Eenheid 90 mm. Y-as verdeeld in mm.

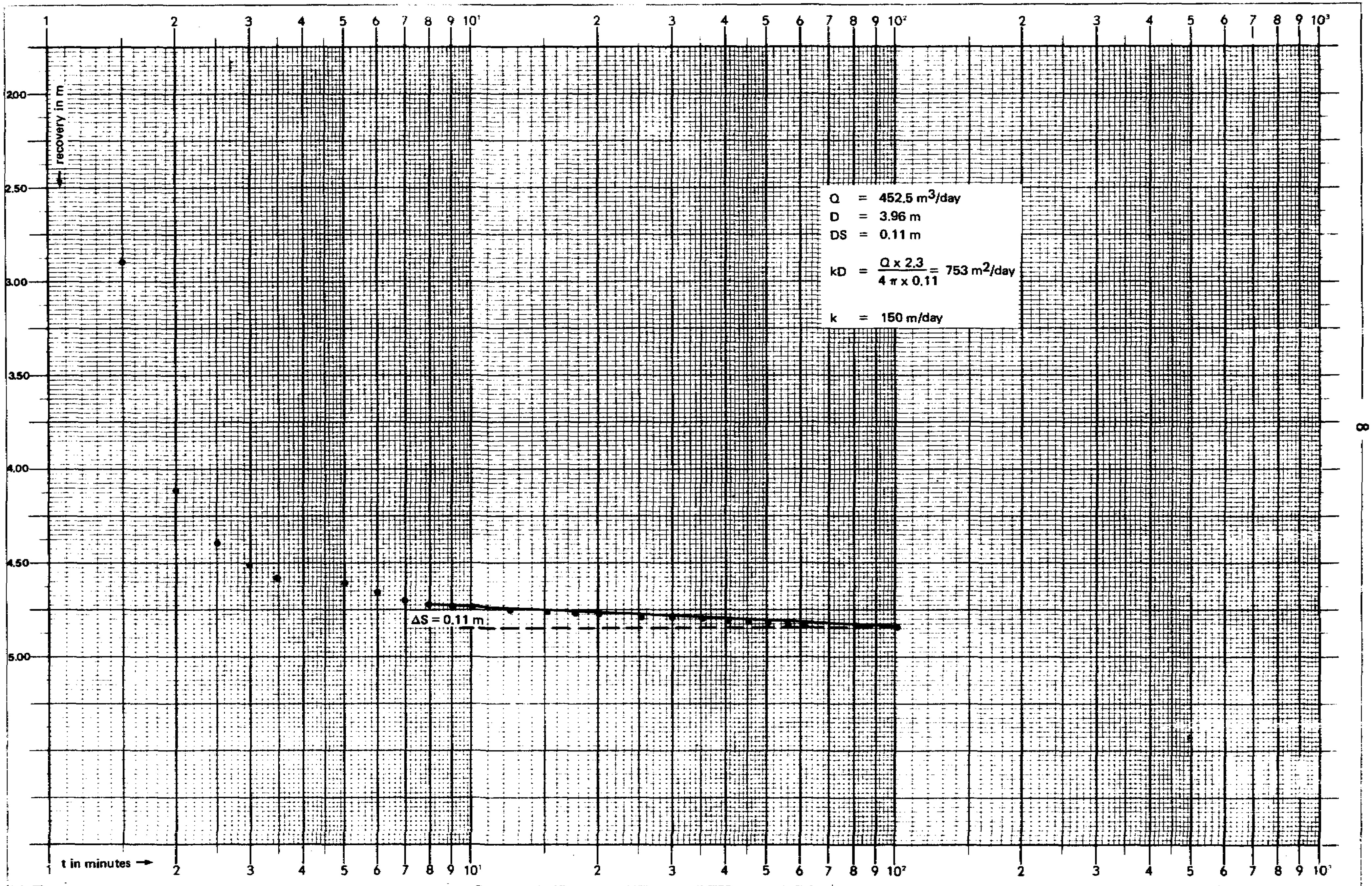


RECOVERY TEST OF BOREHOLE 28/79, RUDEWA

meetpapier wormerveer 17 Tr X-as log verdeeld 1-10³ Eenheid 90 mm. Y-as verdeeld in mm

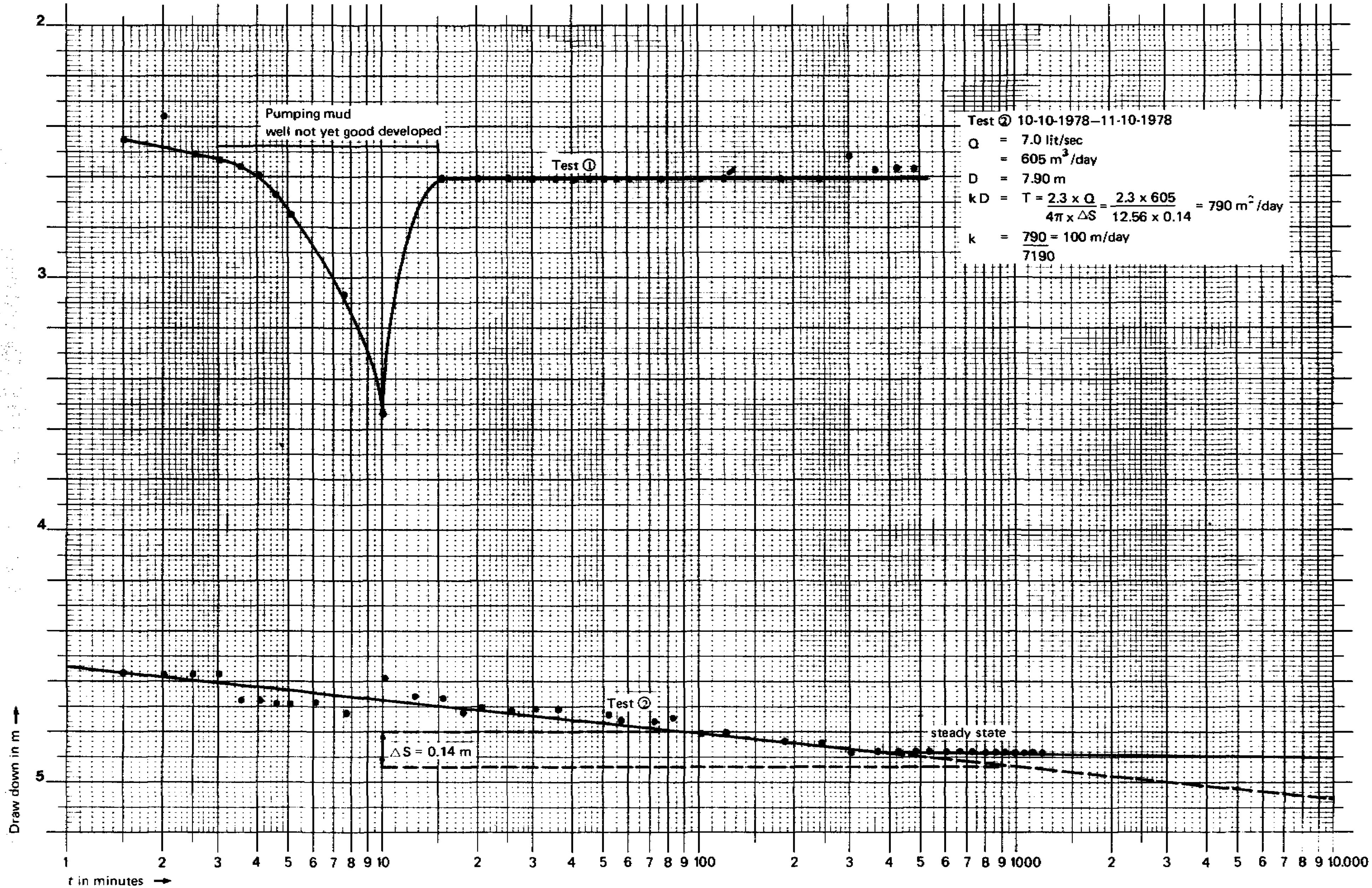


PUMPING TEST OF BOREHOLE 41/79, IKONDOA

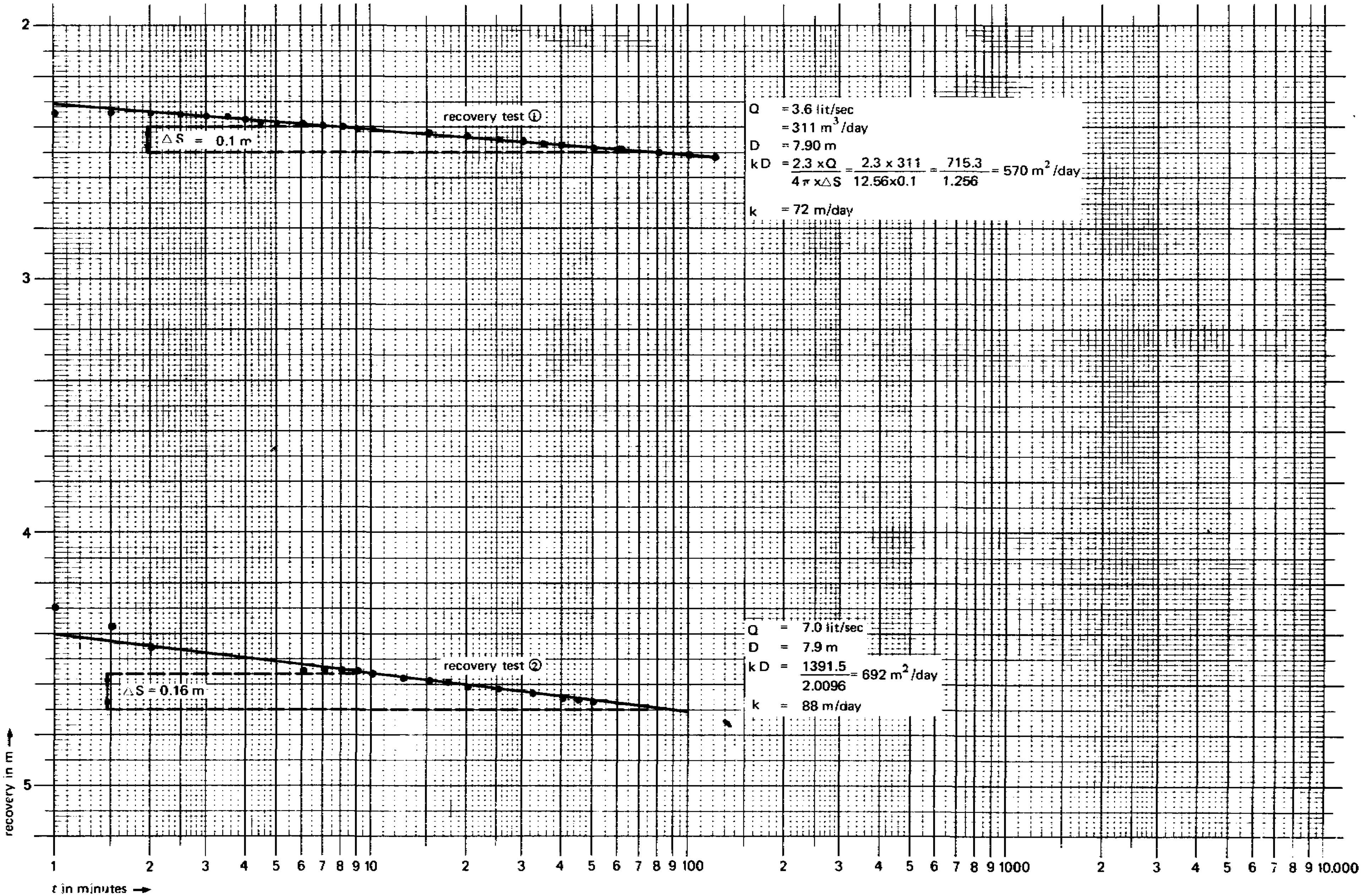


RECOVERY TEST OF BOREHOLE 41/79, IKONDOA

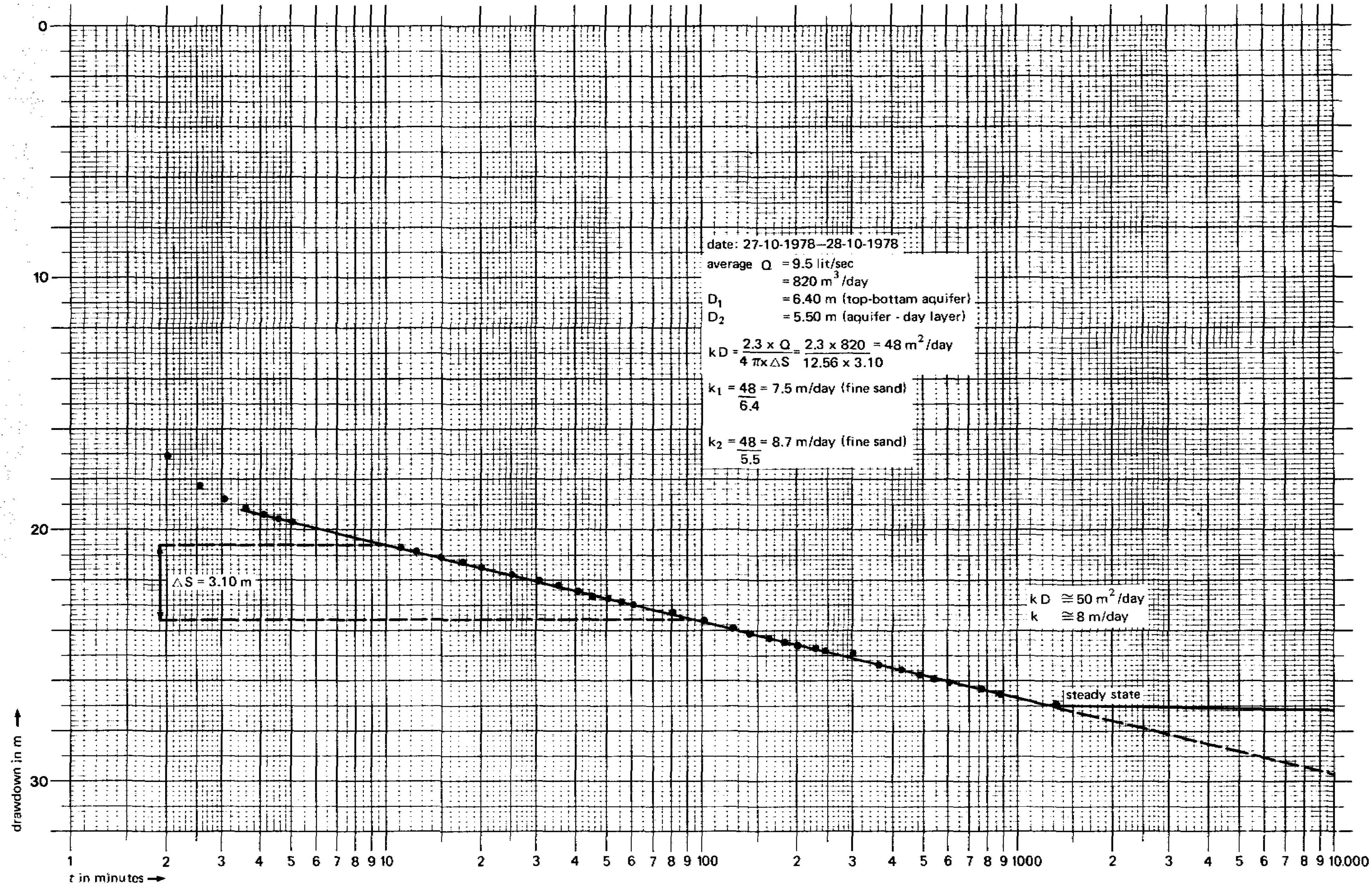
meetpapier - wormerveer 17 Tr X-as log. verdeeld 1-10³ Eenheid 90 mm. Y-as verdeeld in mm



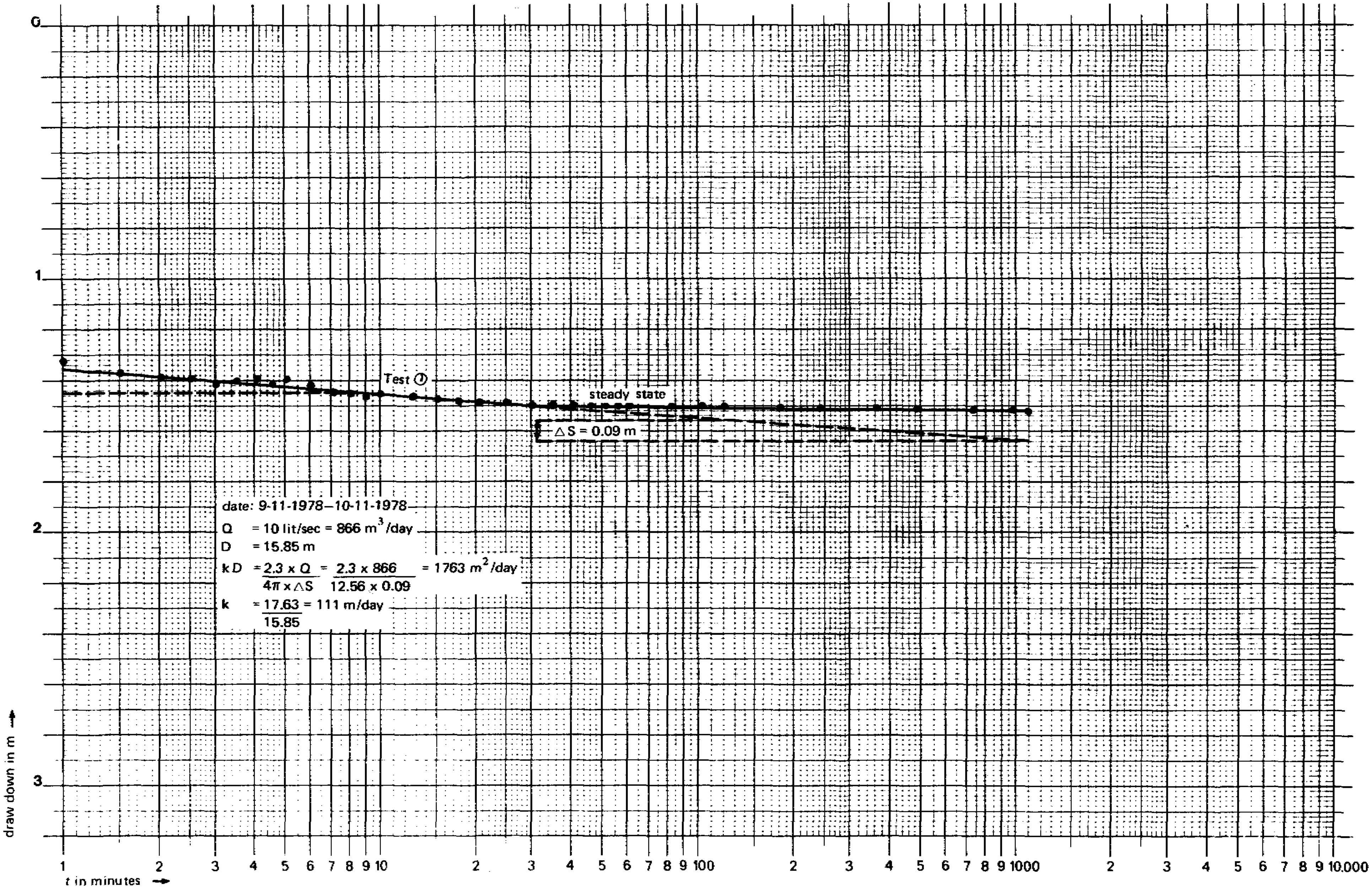
PUMPING TESTS ① AND ② OF BOREHOLE 135c/78, DAKAWA



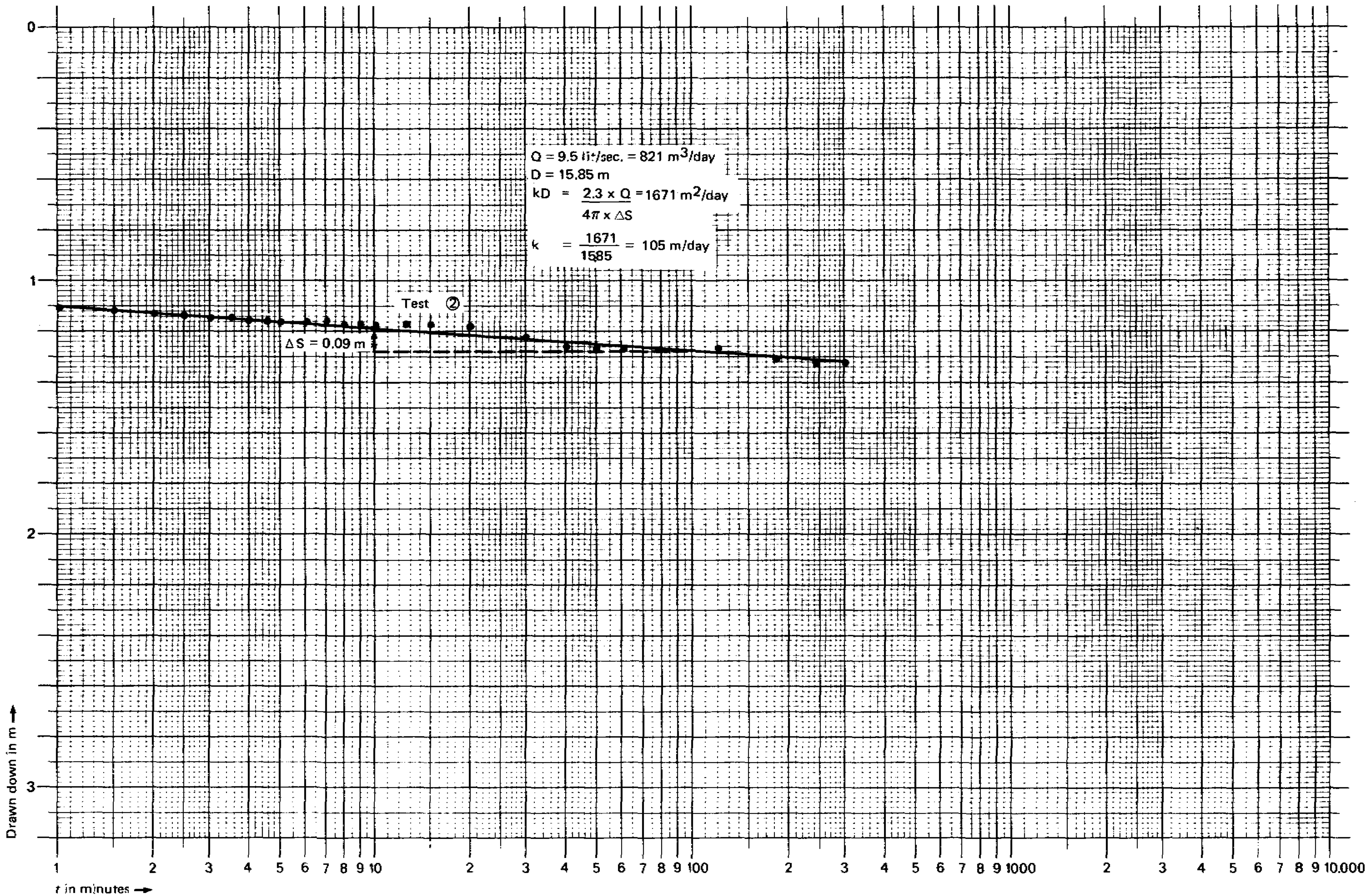
RECOVERY TESTS ① AND ② OF BOREHOLE 135e/78, DAKAWA



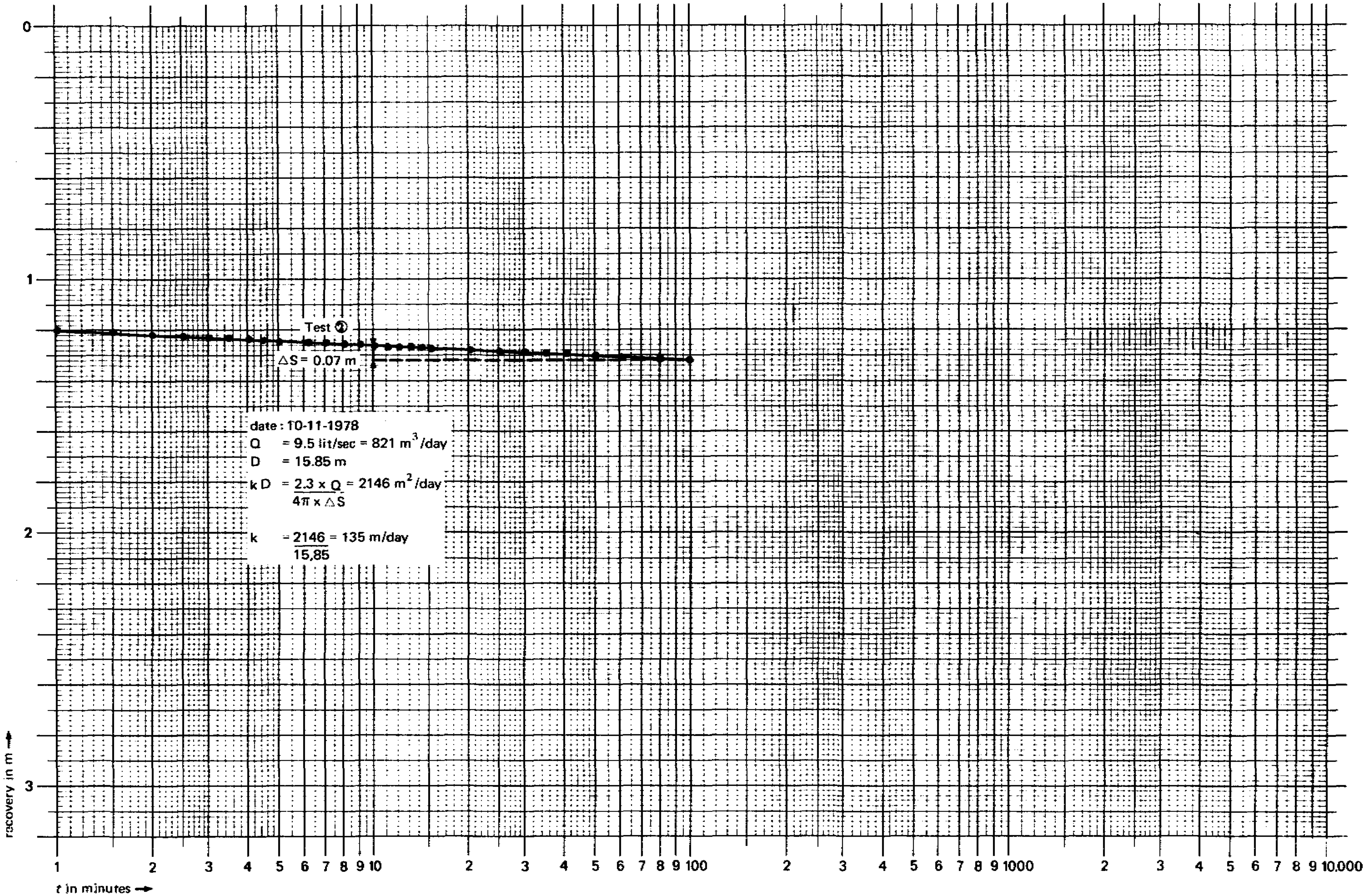
PUMPING TEST OF BOREHOLE 151/78, DIBAMBA



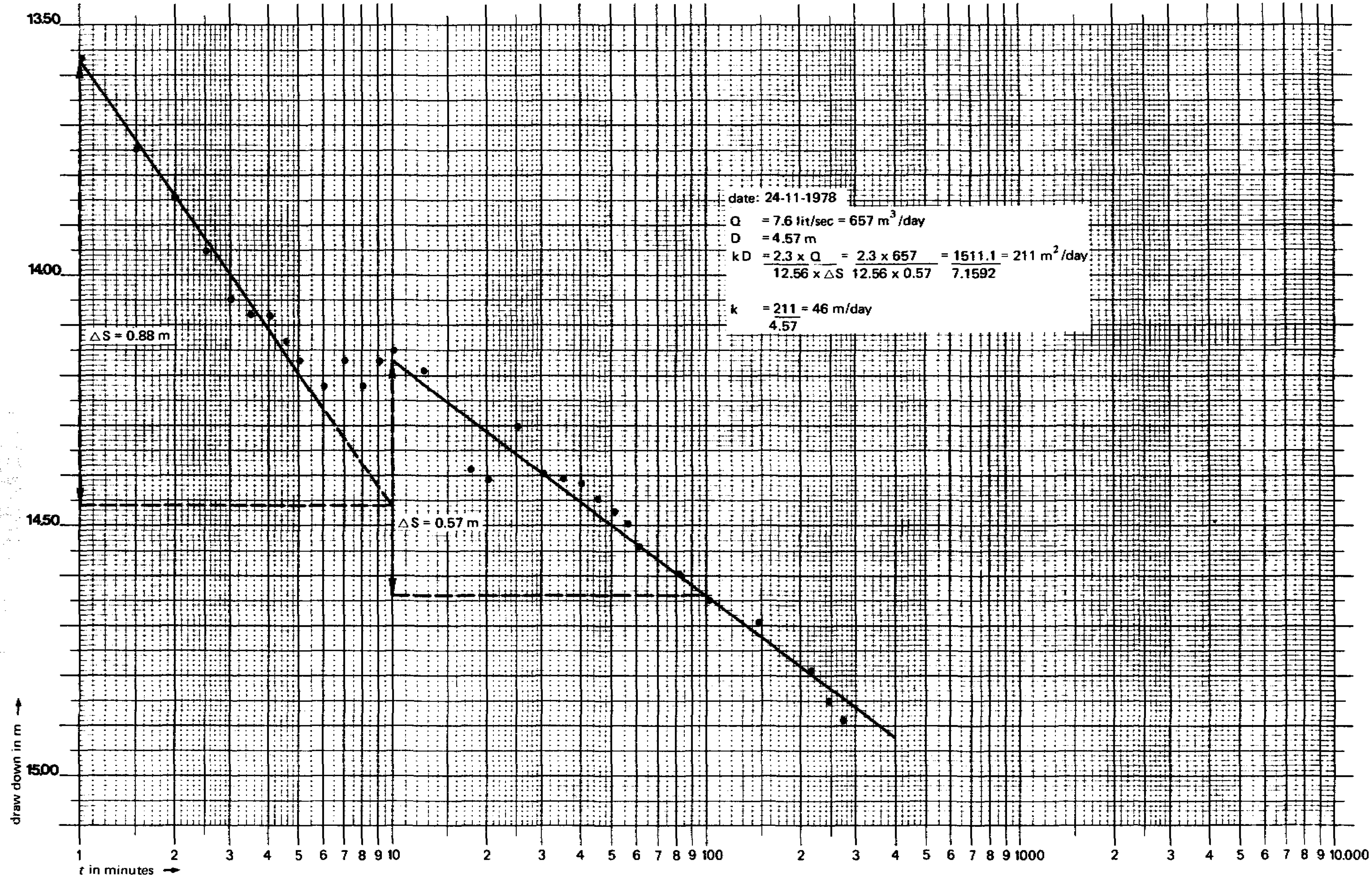
PUMPING TEST ① OF BOREHOLE 162/78, MANDELA



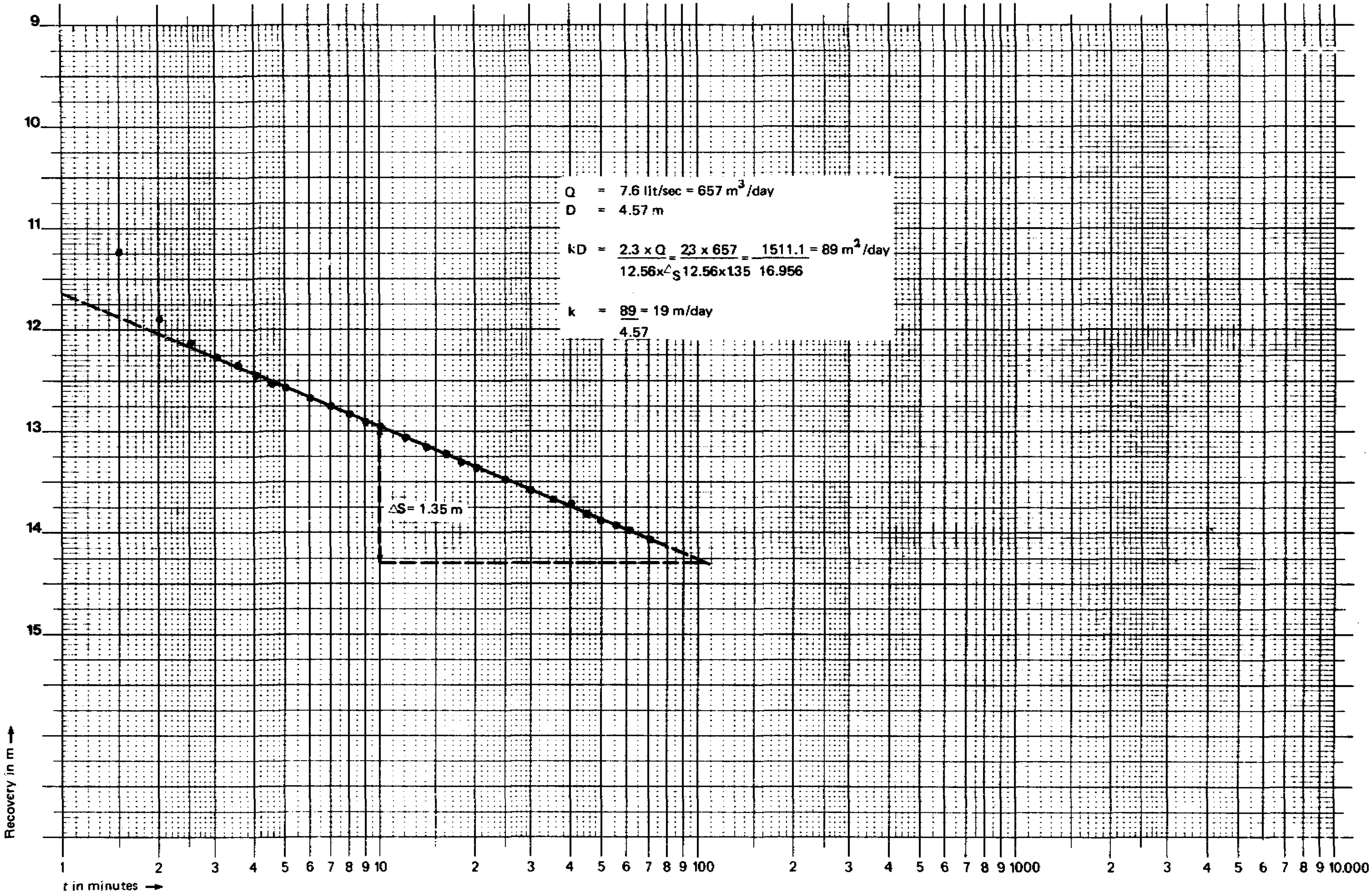
PUMPING TEST ② OF BOREHOLE 162/78, MANDELA



RECOVERY TEST ② OF BOREHOLE 162/78, MANDELA



PUMPING TEST OF BOREHOLE 173/78, MAKUYU



RECOVERY TEST OF BOREHOLE 178/78, MAKUYU

DATA DD 9

SUMMARY OF HAND DRILLINGS IN THE NGERENGERE AREA

DD 9 - Summary of MWCP hand drillings in the Ngerengere area

village	hand drilling no.	total depth (m-GL)	aquifer depth from - to (m-GL)	aquifer thickness (m)	aquifer type	water level during drilling (m-GL)	tested yield (l/HR)	maximum drawdown	KD (m^2/day)	K (m/day)	EC during drilling (mS/m)	remarks
Kihonda	A-4	2.1	1.3- 2.1	0.8	loamy sand	1.3	-	-	-	-	750	
	A-5	4.0	2.0- 3.0	1.0	fine sand	1.0	-	-	-	-	750	
	A-6	5.0	1.9- 4.5	2.6	median sand	0.6	-	-	-	-	350	
	A-7	6.0	1.5- 3.0	1.5	median sand	0.6	-	-	-	-	1375	
	A-8	11.5	1.3- 3.5	2.2	median sand	0.6	-	-	-	-	7350	
			5.9-11.5	5.6	fine sand							
	A-9	10.0	2.0- 2.7	0.7	clay sand	0.3	-	-	-	-	7400	
			8.2- 8.8	0.6	fine sand							
	A-10	3.0	0.0- 0.5	0.5	fine sand	0.2	-	-	-	-	150	
			2.8- 3.0	0.2	coarse sand							
	A-11	1.7	0.8- 1.7	0.9	clay sand	1.26	-	-	-	-	100	
	A-13	10.0	1.6- 3.0	1.4	median fine	0.3	-	-	-	-	290	
	A-14	11.0	3.0- 4.0	1.0	median coarse	0.8	-	-	-	-	1000	
			9.0-11.0	2.0	loamy sand							
Tungi	B-6	4.0	3.6- 4.0	0.4	coarse sand	3.6	-	-	-	-	800	
	B-9	2.8	1.7- 2.8	1.1	loamy sand	1.75	-	-	-	-	2050	
	B-10	6.0	2.0- 6.0	4.0	median coarse	1.3	-	-	-	-	1300	
	B-11	8.0	2.0- 3.0	1.0	median sand	0.8	-	-	-	-	1050	
	B-12	7.6	3.0- 4.0	1.0	median sand	0.7	-	-	-	-	1200	
	B-13	10.0	1.5- 2.0	0.5	median sand	0.5	-	-	-	-	1900	
	B-14	10.2	3.0- 3.5	0.5	median sand	0.5	-	-	-	-	2500	
	B-15	10.0	0.0- 4.1	4.1	median sand	0.5	-	-	-	-	2350	
			7.0-10.0	3.0	median sand							
	B-16	8.0	2.0- 5.2	3.2	median sand	0.3	-	-	-	-	1100	
	B-17	2.0	1.5- 2.0	0.5	clay sand	0.4	-	-	-	-	800	
	B-19	7.0	3.0- 7.0	4.0	median fine	0.3	-	-	-	-	700	
	B-20	7.0	1.2- 1.8	0.6	fine sand	0.3	-	-	-	-	600	
			3.4- 7.0	4.0	median coarse							
Mkambarani	C^1-1	6.0	2.8- 5.6	2.8	median fine	0.5	-	-	-	-	650	
	C^1-2	4.0	3.6- 4.0	0.4	fine sand	0.3	-	-	-	-	580	
	C^1-3	4.5	3.0- 4.5	1.5	clay sand	0.2	-	-	-	-	380	
	C^1-4	5.0	2.3- 3.5	1.2	fine sand	0.4	-	-	-	-	160	
	C^1-5	5.2	4.5- 5.2	0.7	median coarse	0.6	-	-	-	-	350	
	C^1-6	2.0	1.4- 2.0	0.6	fine sand	0.8	-	-	-	-	120	
	C^1-7	5.0	3.0- 5.0	2.0	median coarse	0.5	-	-	-	-	135	
	C^2-1	5.0	4.0- 4.5	1.5	median fine	0.7	-	-	-	-	72	
	C^2-2	6.5	1.3- 2.3	1.0	median fine	0.6	-	-	-	-	20	

village	hand drilling no.	total depth (m-GL)	aquifer depth from - to (m-GL)	aquifer thickness (m)	aquifer type	water level during drilling (m-GL)	tested yield (1/HR)	maximum drawdown	KD (m^2/day)	K (m/day)	EC during drilling (mS/m)	remarks
Kihonda	A-4	2.1	1.3- 2.1	0.8	loamy sand	1.3	-	-	-	-	750	
	C^2-3	6.0	3.5- 5.5	2.0	median fine	0.5	-	-	-	-	72	
	C^2-4	8.0	5.0- 7.6	2.6	median fine	0.6	-	-	-	-	210	
	C^3-1	5.0	0.5- 2.5	2.0	fine sand	0.2	-	-	-	-	80	
	C^3-2	4.0	1.0- 3.5	2.5	fine sand	0.4	-	-	-	-	58	
Mkono wamari	D^1-1	4.2	3.5- 3.9	0.4	median coarse	3.75	-	-	-	-	1900	
	D^2-1	8.0	0.0- 8.0	8.0	median fine	2.25	-	-	-	-	650	
	D^2-2	7.0	0.8- 7.0	6.2	fine sand	3.0	-	-	-	-	1900	
	D^2-3	5.5	0.5- 1.8	1.3	fine sand	3.0	-	-	-	-	1700	
			3.2- 5.5	2.3	median coarse							
Mikese	E^1-4	6.0	1.8- 4.0	2.2	median coarse	0.2	-	-	-	-	120	
			5.0- 6.0	1.0	median coarse							
	E^1-5	6.0	0.0- 1.0	1.0	fine sand	0.2	-	-	-	-	120	
	E^2-1	7.0	2.0- 6.5	4.5	median fine	0.5	-	-	-	-	120	
	E^2-2	8.0	2.0- 3.6	1.6	median sand	0.3	-	-	-	-	840	
			4.0- 7.6	3.6	median fine							
	E^2-3	5.0	3.0- 4.6	1.6	coarse sand	1.4	-	-	-	-	90	
	E^2-4	6.7	2.0- 6.7	4.7	median sand	1.5	-	-	-	-	115	
Lubungo	F^1-1	3.0	1.0- 1.5	0.5	median fine	0.6	-	-	-	-	55	
	F^1-2	3.3	2.4- 3.0	0.6	median coarse	2.5	-	-	-	-	65	
	F^1-4	8.0	3.0- 8.0	5.0	fine sand	3.0	-	-	-	-	750	
	F^1-5	6.0	4.0- 6.0	2.0	median fine	0.1	-	-	-	-	220	
	F^2-3	4.0	1.0- 1.5	0.5	median fine	0.8	-	-	-	-	120	
Ngerengere Darajani	G-3	5.0	4.0- 5.0	1.0	median fine sand	3.15	-	-	-	-	110	
	G-4	4.0	2.3- 4.0	1.7	coarse sand	1.65	-	-	-	-	90	
	G-5	3.0	1.2- 1.7	0.5	median fine sand	0.8	-	-	-	-	50	
	G-6	5.0	3.0- 4.0	1.0	fine sand	3.0	-	-	-	-	150	
Kinonka Station	H-2	5.0	3.0- 5.0	2.0	median fine	2.5	-	-	-	-	75	
	H-3	3.5	1.5- 3.5	2.0	coarse sand	0.8	-	-	-	-	80	
	H-4	7.0	2.2- 7.0	4.8	median coarse	2.6	-	-	-	-	155	
Muhangam-kola	I-3	5.5	0.9- 4.0	3.1	median coarse		0.7	-	-	-	-	150
	I-4	6.2	2.2- 6.2	4.0	median coarse	0:6	-	-	-	-	75	
	I-5	8.0	1.8- 2.4	0.6	median sand	1.0	-	-	-	-	180	
			5.9- 8.0	2.1	median fine							

village	hand drilling no.	total depth (m-GL)	aquifer depth from - to (m-GL)	aquifer thickness (m)	aquifer type	water level during drilling (m-GL)	tested yield (1/HR)	maximum drawdown	KD (m^2/day)	K (m/day)	EC during drilling (mS/m)	remarks
	I-6	6.0	1.5- 2.0	0.5	coarse sand	1.4	-	-	-	-	500	
			5.0- 6.0	1.0	coarse sand							
Visaraka	J-1	7.0	1.0- 4.0	3.0	fine sand	0.3	-	-	-	-	75	
			4.9- 7.0	2.1	fine sand							
	J-2	10.0	1.7-10.0	8.3	median coarse sand	0.6	-	-	-	-	75	
	J-3	10.0	2.0-10.0	8.0	median coarse sand	2.3	-	-	-	-	75	
	J-4	8.0	2.2- 8.0	5.8	median sand	2.25	-	-	-	-	70	
	J-5	6.0	3.0- 3.2	0.2	fine sand	2.5	-	-	-	-	500	
			4.0- 6.0	2.0	median coarse sand							
	J-6	7.0	0.4- 7.0	6.6	clay sand	2.7	-	-	-	-	1000	
	J-8	5.0	3.2- 5.0	1.8	clay sand	1.75	-	-	-	-	800	
Masimbu	K-1	8.0	3.0- 4.5	1.5	median fine	2.5	-	-	-	-	70	
	K-2	10.0	3.0- 5.0	2.0	fine sand	3.25	-	-	-	-	40	
			6.2- 6.5	0.3	median coarse							
	K-3	11.0	3.5- 5.0	1.5	median fine	2.8	1224				40	
			6.0-11.0	5.0	coarse sand							
	K-4	7.0	4.0- 5.0	1.0	fine sand	3.0	-	-	-	-	110	
	K-5	9.0	4.8- 5.2	0.4	fine sand	2.5	-	-	-	-	90	
	K-7	7.5	3.0- 4.0	1.0	median fine	2.0	-	-	-	-	90	
	K-8	7.0	4.5- 5.0	0.5	median fine	2.25	-	-	-	-	75	
	K-9	10.2	5.0- 6.0	1.0	median coarse	1.75	-	-	-	-	120	
	K-10	4.0	3.2- 4.0	0.8	coarse sand	2.25	-	-	-	-	210	
	K-11	6.0	4.4- 6.0	1.6	median coarse	2.0	560				60	
	K-12	5.0	3.0- 5.0	2.0	median fine	2.75	480				150	
Mkundii	L-6	5.0	2.0- 5.0	3.0	median coarse	0.8	-	-	-	-	35	
	L-4	2.2	1.0- 2.2	1.2	coarse sand	0.3	-	-	-	-	42	
	L-5	5.0	5.2- 5.5	0.3	coarse sand	1.5	-	-	-	-	50	

DATA DD 10

CHEMICAL ANALYSES OF GROUND WATER FROM HAND DRILLINGS
IN THE NGERENGERE AREA

DD 10 - <u>Chemical analyses of ground water from hand drillings in the Ngerengere area</u>

location		Kihonda	Kihonda	Kihonda	Kihonda	Kihonda	Kinhonda	Kihonda	Kihonda				
borehole nr.		A-4	A-6	A-7	A-8	A-9	A-11	A-13	A-14				
date of sampling		12-12-78	13-12-78	13-12-78	19-12-78	19-12-78	18-12-78	18-12-78	18-12-78				
date of analysis		14-12-78	14-12-78	14-12-78	20-12-78	20-12-78	20-12-78	11-01-78	11-01-78				
sample method		bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer
Water analysis	**unit**												
electrical conductivity	mS/m (25°C)	925	300	1475	400	400	127	295	1000				
pH		8.0	7.1	7.3	7.8	8.2	7.5	7.1	7.5				
calcium	mg/I Ca^{2+}	52	128	300	40	112	40	112	120				
magnesium	mg/Mg^{2+}	182	115	349	55	350	24.3	112	364				
sodium	mg/I Na^{+}	1564	161	2737	805	-	299	322	1449				
total hardness	mg/I$CaCO_3$	880	795	2180	324	1640	200	740	1800				
iron	mg/I Fe	0.03	0.2	0.15	1.0	0.23	0.58	0.05	0.09				
manganese	mg/I Mn							0.9	1.6				
fluoride	mg/I F^-	1.0	0.5	0.7	3.0	1.1	0.5	0.8	1.5				
chloride	mg/I Cl^-	2525	630	5150	1050	513	200	700	3050				
bicarbonate	mg/I HCO_3^-	915	305	1098	610	671	440	560	790				
nitrate	mg/I HO_3^-	2,7	2.2	5.3	3.1	3.1	12.4	4	8.5				
sulphate	mg/I SO_4^{2-}	28	17	54	50	52	180	14	17				
phosphate (ortho)	mg/I PO_4^{3-}	1.4	1.1	0.25	1.5	0.3	1.8	0.5	0.2				

Continued 1

location		Tungi	Tungi	Tungi	Tungi	Tungi	Tungi	Tungi	Tungi	Tungi	Tungi	Tungi	Tungi
borehole nr.		B-6	B-9	B-10	B-11	B-12	B-13	B-14	B-15	B-16	B-17	B-19	B-20
date of sampling		29-12-78	1-01-79	2-01-79	3-01-79	4-01-79	5-01-79	8-01-79	10-01-79	Feb. 79	Feb. 70	Feb. 79	Feb. 79
date of analysis		8-01-79	8-01-79	8-01-79	8-01-79	8-01-79	8-01-79	11-01-79	11-01-79	Feb. 79	Feb. 79	Feb. 79	Feb. 79
sample method		bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer
<u>Water analysis</u>	<u>unit</u>												
electrical conductivity	mS/m (25°C)	800	1980	1100	1320	1325	3800	2550	2345	725	525	800	500
pH		7.7	7.1	8.0	7.2	7.8	7.0	7.5	7.3	8.2	8.3	8.1	7.9
calcium	mg/I Ca^{2+}	720	1000	160	930	240	1440	200	350	170	60	150	100
magnesium	mg/Mg^{2+}	425	364	61	164	18	486	152	304	151.88	400.95	115.43	255.2
sodium	mg/I Na^{+}	1840	3588		2116	2714	6233		4531	1104	621	851	230
total hardness	mg/I$CaCO_3$	3550	4000	650	3000	675	5600	1125	2125	1050	1800	850	1300
iron	mg/I Fe	1.5	3.2	0.65	1.2	0.2	1.0	0.5	1.3	0.04	0.06	0.08	1.3
manganese	mg/I Mn	0.4	0.5	2.4	10.0	0.6	1.6	0.04	5	0.4	0.7	0.8	0.2
fluoride	mg/I F^{-}	0.4	0.2	0.5	0.3	0.6	0.2	0.3	0.3	0.9	1.0	0.7	1.0
chloride	mg/I Cl^{-}	4800	7900	3200	4875	3700	1275	6625	6375	1750	450	1550	200
bicarbonate	mg/I HCO_3^{-}	976	732	854	824	1460	1220		1677	976	3050	488	1830
nitrate	mg/I NO_3^{-}	8.4	24	4.4	7	8	4.4	8.4	20	8.86	27.46	8.42	22.15
sulphate	mg/I SO_4^{2-}	4	55	30	17	125	125	180	520	200	3	145	2
phosphate (ortho)	mg/I PO_4^{3-}	0.7	0.3	0.5	0.5	0.95	0.4	0.15	0.1	0.8	1.1	0.3	0.3

Continued 2

location		Mkambarani	Mkambarani	Mkambarani	Mkambarani	Mkambarani	Mkambarani	Mkambarani	Mkambarani				
borehole nr.		C^1-1	C^1-2	C^1-3	C^1-4	C^2-1	C^2-2	C^2-3	C^2-4				
date of sampling		Feb. 79	Feb. 79	Feb. 79	Feb. 79	Feb. 79	Feb. 79	Feb. 79	Feb. 79				
date of analysis		Feb. 79	Feb. 79	Feb. 79	Feb. 79	Feb. 79	Feb. 79	Feb. 79	Feb. 79				
sample method		bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer
Water analysis	unit												
electrical conductivity	mS/m (25°C)	625	575	401	130	80	28	81	200				
pH		7.3	7.3	7.5	7.5	7.6	5.8	6.8	6.1				
calcium	mg/I Ca^{2+}	410	400	270	112				144				
magnesium	mg/Mg^{2+}	176.2	109.35	115.43	38.88				32.48				
sodium	mg/I Na^+	483	483	391	46								
total hardness	mg/I$CaCO_3$	1750	1450	1150	440				720				
iron	mg/I Fe	0.04	0.05	0.2	0.35	0.95		1.9	0.8				
manganese	mg/I Mn	3.0	5.0	1.8	1.4	0.4		0.8	2.5				
fluoride	mg/I F^-	0.5	0.2	0.4	0.2		0.1		0.2				
chloride	mg/I Cl^-	1600	1650	1200	310	0.3		0.1	150				
bicarbonate	mg/I HCO_3^-	732	244	396.5	97.6				134.2				
nitrate	mg/I NO_3^-	0.89	1.33	1.77	0.89	0.89		0.89	0.89				
sulphate	mg/I SO_4^{2-}	30	40	45	5	10		5	10				
phosphate (ortho)	mg/I PO_4^{3-}	0.4	0.1	0.2	0.35				0.25				

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Continued 3

location		Lubungo	Lubungo	Lubungo									
borehole nr.		F-2	F-4	F-5									
date of sampling		March 79	March 79	March 79									
date of analysis		March 79	March 79	March 79									
sample method		bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer
<u>Water analysis</u>	<u>unit</u>												
electrical conductivity	mS/m (25°C)	450	577	147									
pH		6.5	6.6	6.7									
calcium	mg/I Ca^{2+}	210	200	152									
magnesium	mg/Mg^{2+}	151.88	145.8	48.6									
sodium	mg/I Na^{+}	391	690	46									
total hardness	mg/I$CaCO_3$	1150	1100	580									
iron	mg/I Fe	0.1	3.0	3.2									
manganese	mg/I Mn	1.0	4.5	4.3									
fluoride	mg/I F^{-}	0.2	0.4	0.3									
chloride	mg/I Cl^{-}	1200	1500	180									
bicarbonate	mg/I HCO_3^{-}	183	448	561.2									
nitrate	mg/I HO_3^{-}	10.19	10.63	17.72									
sulphate	mg/I SO_4^{2-}	200	130	0									
phosphate (ortho)	mg/I PO_4^{3-}	0.25	1.0	1.1									

Continued 4

location		Visalaka	Visalaka										
borehole nr.		J-5	J-8										
date of sampling		March 79	March 79										
date of analysis		March 79	March 79										
sample method		bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer
<u>Water analysis</u>	<u>unit</u>												
electrical conductivity	mS/m (25°C)	350	320										
pH		7.5	7.8										
calcium	mg/I Ca^{2+}	152	32										
magnesium	mg/Mg^{2+}	82.62	14.5										
sodium	mg/I Na^+	575	805										
total hardness	mg/I$CaCO_3$	720	140										
iron	mg/I Fe	0.1	0.15										
manganese	mg/I Mn	0.08	0.02										
fluoride	mg/I F^-	0.5	3.0										
chloride	mg/I Cl^-	820	760										
bicarbonate	mg/I HCO_3^-	805.2	732										
nitrate	mg/I NO_3^-	39.43	31										
sulphate	mg/I SO_4^{2-}	200	220										
phosphate (ortho)	mg/I PO_4^{3-}	1.3	0.4										

Continued 5

location		Masimbu	Masimbu	Masimbu	Masimbu	Masimbu							
borehole nr.		K-3	K-4	K-10	K-11	K-12							
date of sampling		March 79	March 79	14-3-79	14-3-79	14-3-79							
date of analysis		March 79	March 79	20-3-79	20-3-70	20-3-79							
sample method		bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer
<u>Water analysis</u>	<u>unit</u>												
electrical conductivity	mS/m (25°C)	450	93	175	80	275							
pH		6.8	7.3	6.8	7.1	7.0							
calcium	mg/I Ca^{2+}	220	188	100	64	140							
magnesium	mg/Mg^{2+}	182.25	36.45	97.2	48.6	103.28							
sodium	mg/I Na^{+}	414		138		207							
total hardness	mg/I$CaCO_3$	1300	400	650	360	775							
iron	mg/I Fe	0.5	0.32	1.0	0.14	0.6							
manganese	mg/I Mn	9.2	2.2	2.5	0.6	0							
fluoride	mg/I F^{-}	0.2	0.4	0.6	0.6	0.5							
chloride	mg/I Cl^{-}	1200	75	325	50	625							
bicarbonate	mg/I HCO_3^{-}	610	366	488	268	427							
nitrate	mg/I HO_3^{-}	8.86	4.43	3.1	22.2	4.43							
sulphate	mg/I SO_4^{2-}	4	24	100	10	35							
phosphate (ortho)	mg/I PO_4^{3-}	7.6	1.8	0.6	0.4	0.9							

location		Mkambarani	Morogoro	Morogor						
borehole nr.		Lokobe River	Tennis Court	Golf Court						
date of sampling		Feb. 79	Feb. 79	Feb. 79						
date of analysis		Feb. 79	Feb. 79	Feb. 79						
sample method		bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer	bailer
<u>Water analysis</u>	<u>unit</u>									
electrical conductivity	mS/m (25°C)	520	190	182						
pH		7.9	8.0	7.6						
calcium	mg/I Ca^{2+}	300	66	86						
magnesium	mg/Mg^{2+}	121.5	96	127.58						
sodium	mg/I Na^{+}	1725	184	92						
total hardness	mg/I$CaCO_3$	1250	560	740						
iron	mg/I Fe	0.2	0.03	0.01						
manganese	mg/I Mn	0.5	0.4	0.3						
fluoride	mg/I F^-	0.2	1.3	1.2						
chloride	mg/I Cl^-	1600	260	50						
bicarbonate	mg/I HCO_3^-	335,5	732	1122.4						
nitrate	mg/I HO_3^-	2.66	8.86	0.89						
sulphate	mg/I SO_4^{2-}	20	15	20						
phosphate (ortho)	mg/I PO_4^{3-}	0.9	0.6	0.46						

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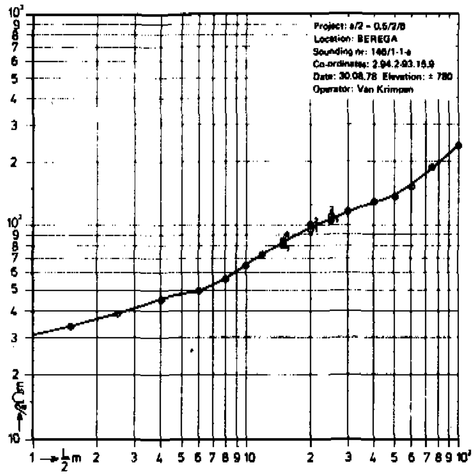
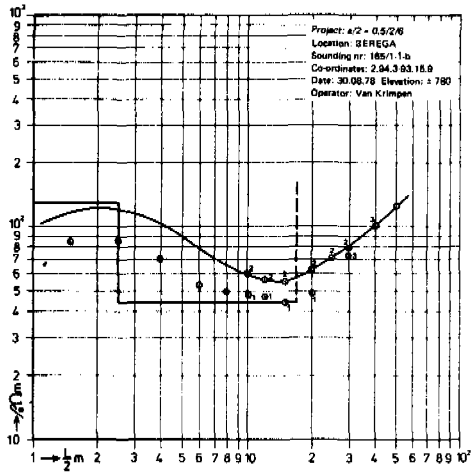
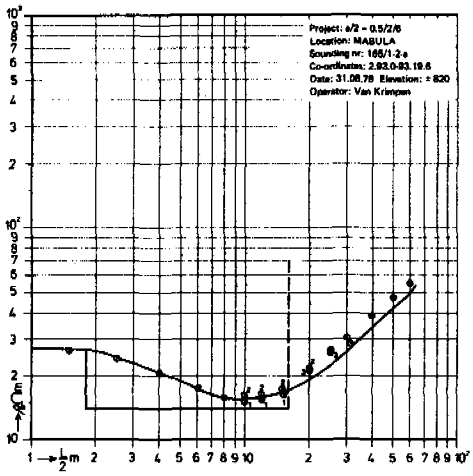
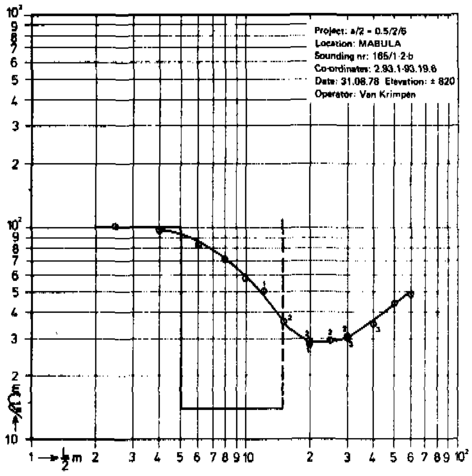
DATA DD 11

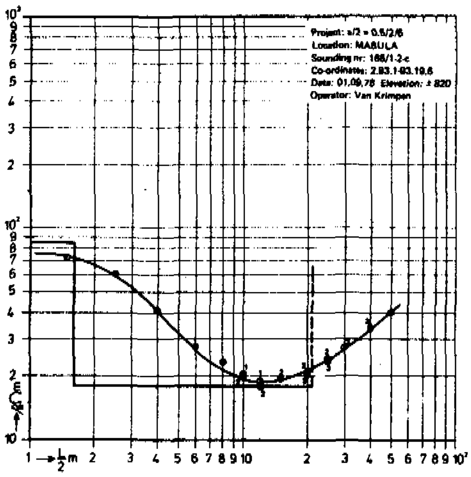
THE GEO-ELECTRICAL SOUNDINGS IN THE BEREGA AREA AND THEIR INTERPRETATIONS

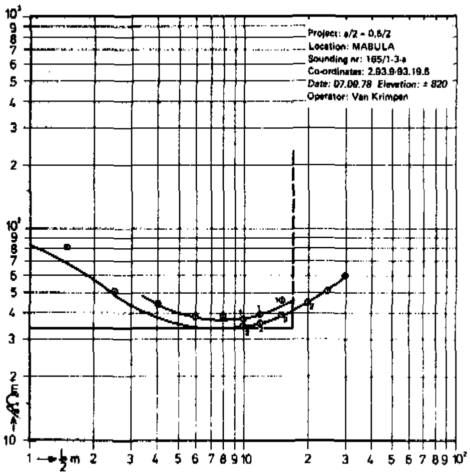

Project: a/2 = 0.5/2/6
Location: BEREGA
Sounding nr: 146/1-1-a
Co-ordinates: 2.94.2-93.15.9
Date: 30.08.78 Elevation: ± 780
Operator: Van Krimpen

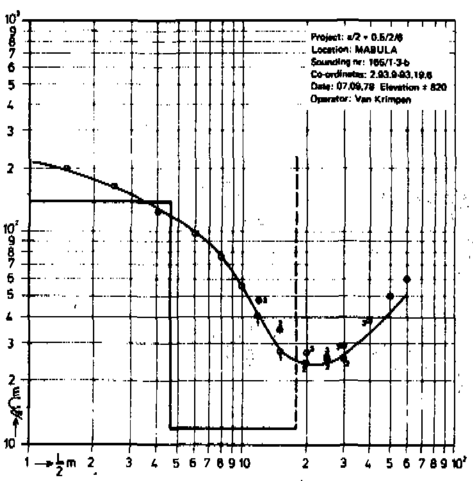

Project: a/2 = 0.5/2/6
Location: BEREGA
Sounding nr: 165/1-1-b
Co-ordinates: 2.94.3-93.15.9
Date: 30.08.78 Elevation: ± 780
Operator: Van Krimpen

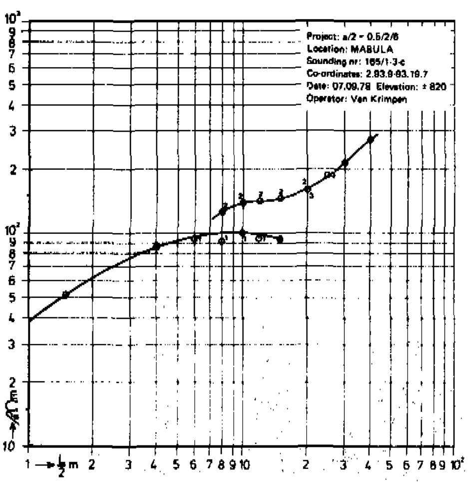

Project: a/2 = 0.5/2/6
Location: MABULA
Sounding nr: 165/1-2-a
Co-ordinates: 2.93.0-93.19.6
Date: 31.08.78 Elevation: ± 820
Operator: Van Krimpen

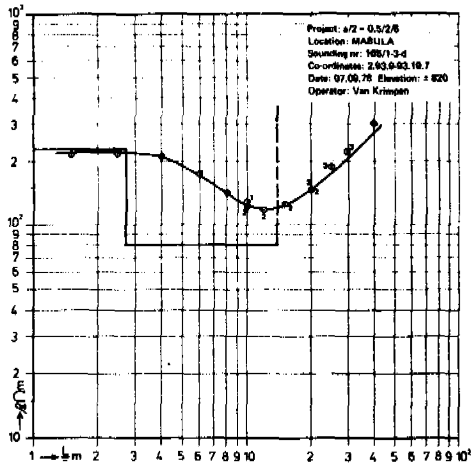

Project: a/2 = 0.5/2/6
Location: MABULA
Sounding nr: 165/1-2-b
Co-ordinates: 2.93.1-93.19.6
Date: 31.08.78 Elevation: ± 820
Operator: Van Krimpen

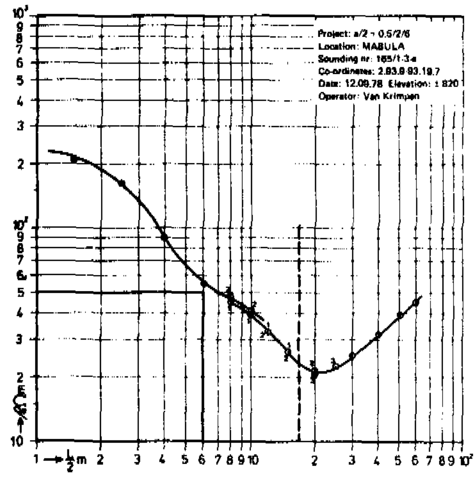

Project: a/2 = 0.5/2/6
Location: MABULA
Sounding nr: 165/1-2-c
Co-ordinates: 2.93.1-93.19.6
Date: 01.09.78 Elevation: ± 820
Operator: Van Krimpen

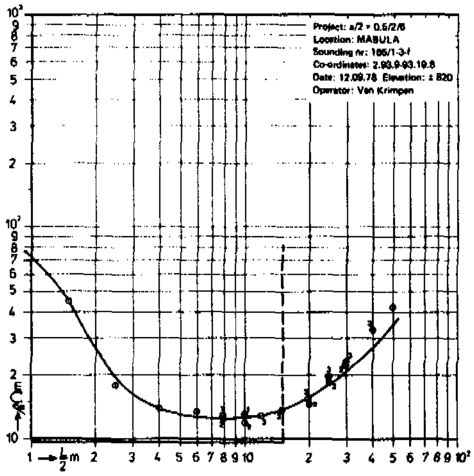

Project: a/2 = 0.5/2
Location: MABULA
Sounding nr: 165/1-3-a
Co-ordinates: 2.93.9-93.19.6
Date: 07.09.78 Elevation: ± 820
Operator: Van Krimpen

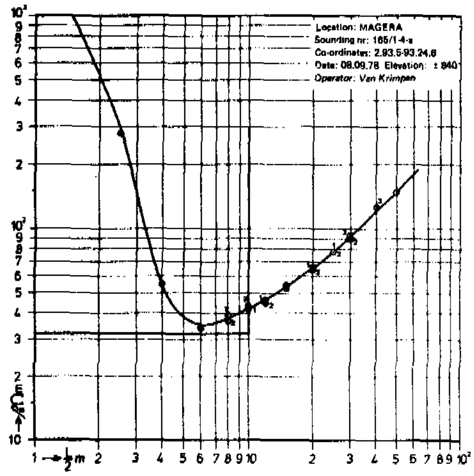

Project: a/2 = 0.5/2/6
Location: MABULA
Sounding nr: 165/1-3-b
Co-ordinates: 2.93.9-93.19.6
Date: 07.09.78 Elevation ± 820
Operator: Van Krimpen

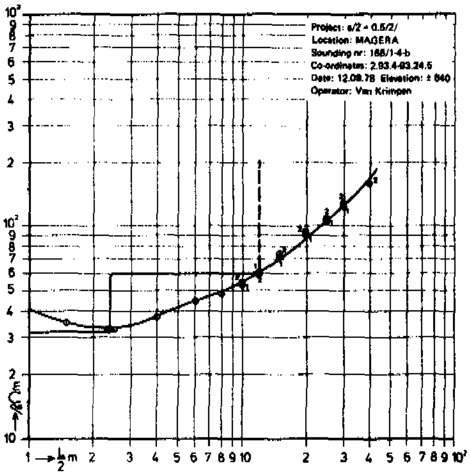

Project: a/2 = 0.5/2/6
Location: MABULA
Sounding nr: 165/1-3-c
Co-ordinates: 2.93.9-93.19.7
Date: 07.09.78 Elevation: ± 820
Operator: Van Krimpen

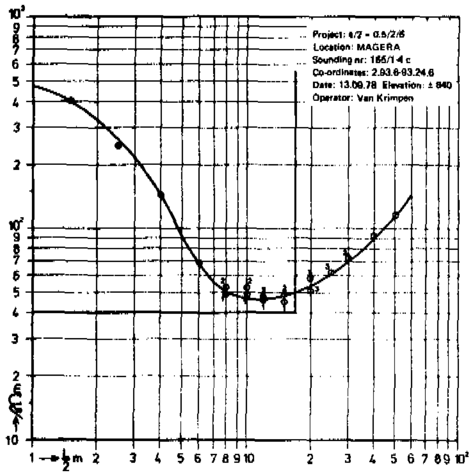

Project: a/2 = 0.5/2/6
Location: MABULA
Sounding nr: 165/1-3-d
Co-ordinates: 2.93.9-93.19.7
Date: 07.09.78 Elevation: ± 820
Operator: Van Krimpen

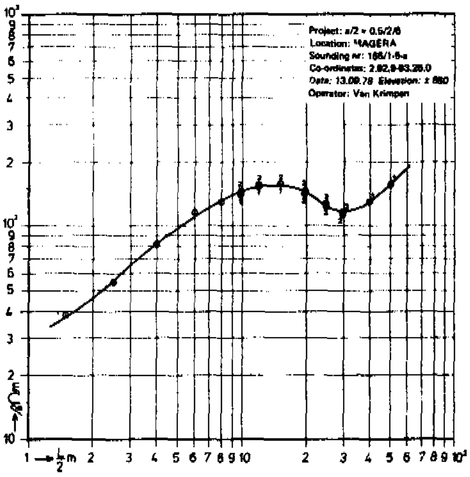

Project: a/2 = 0.5/2/6
Location: MABULA
Sounding nr: 165/1-3-e
Co-ordinates: 2.93.9-93.19.7
Date: 12.09.78 Elevation: ± 820
Operator: Van Krimpen

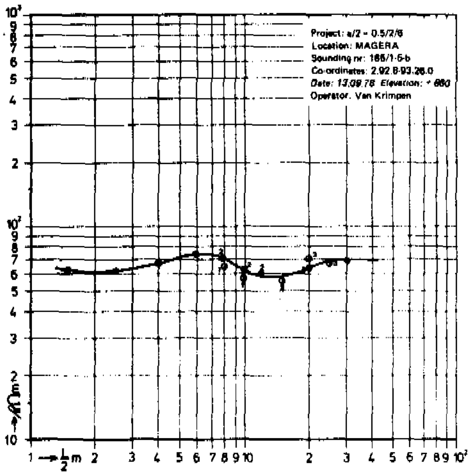

Project: a/2 = 0.5/2/6
Location: MABULA
Sounding nr: 165/1-3-f
Co-ordinates: 2.93.9-93.19.8
Date: 12.09.78 Elevation: ± 820
Operator: Van Krimpen

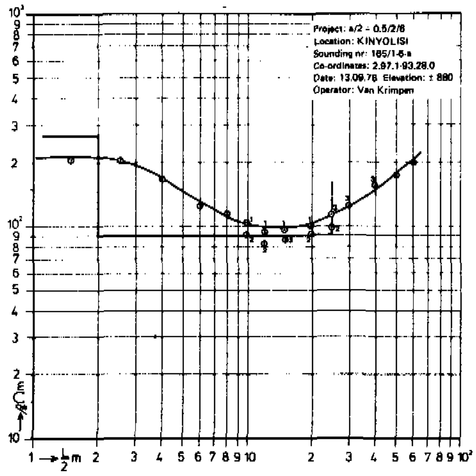

Location: MAGERA
Sounding nr: 165/1-4-a
Co-ordinates: 2.93.5-93.24.6
Date: 08.09.78 Elevation: ± 840
Operator: Van Krimpen

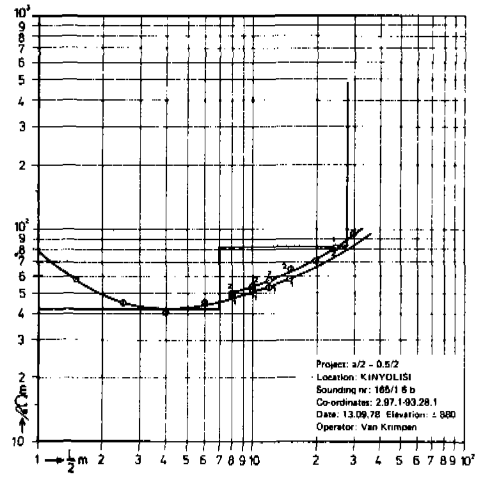

Project: a/2 = 0.5/2/
Location: MAGERA
Sounding nr: 165/1-4-b
Co-ordinates: 2.93.4-93.24.5
Date: 12.09.78 Elevation: ± 840
Operator: Van Krimpen

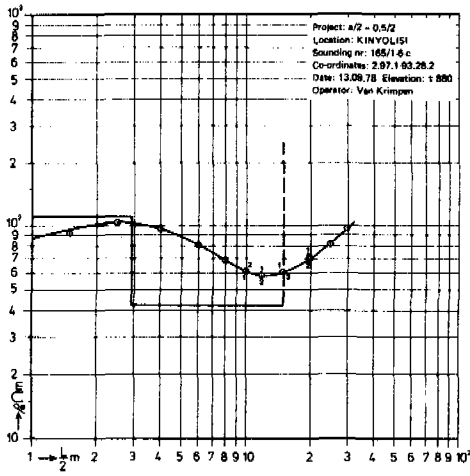

Project: a/2 = 0.5/2/6
Location: MAGERA
Sounding nr: 165/1-4 c
Co-ordinates: 2.93.6-93.24.6
Date: 13.09.78 Elevation: ± 840
Operator: Van Krimpen

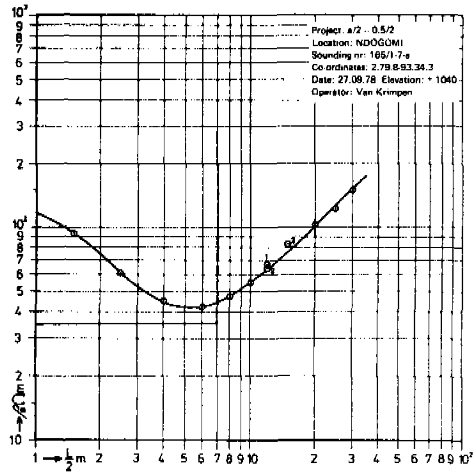

Project: a/2 = 0.5/2/6
Location: MAGERA
Sounding nr: 165/1-5-a
Co-ordinates: 2.92.9-93.26.0
Date: 13.09.78 Elevation: ± 860
Operator: Van Krimpen

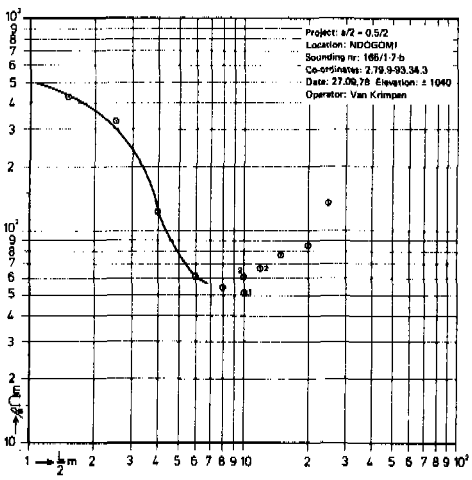

Project: a/2 = 0.5/2/6
Location: MAGERA
Sounding nr: 165/1-5-b
Co-ordinates: 2.92.8-93.26.0
Date: 13.09.78 Elevation: ± 860
Operator: Van Krimpen

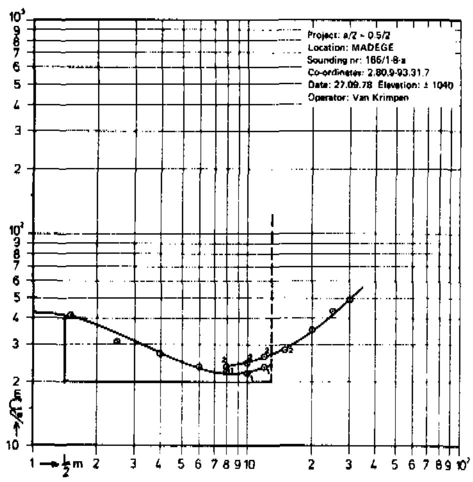

Project: a/2 - 0.5/2/8
Location: KINYOLISI
Sounding nr: 165/1-6-a
Co-ordinates: 2.87.1-93.28.0
Date: 13.09.78 Elevation: ± 880
Operator: Van Krimpen

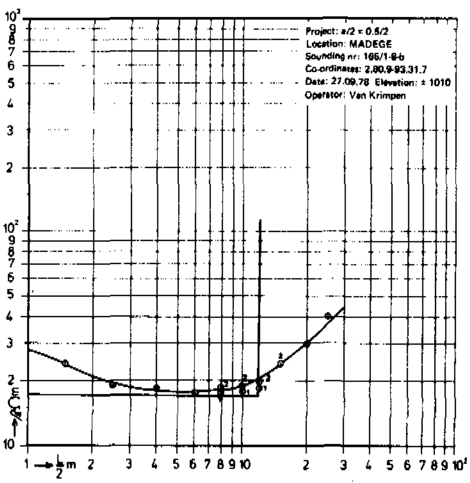

Project: a/2 - 0.5/2
Location: KINYOLISI
Sounding nr: 165/1 6 b
Co-ordinates: 2.87.1-93.28.1
Date: 13.09.78 Elevation: ± 880
Operator: Van Krimpen

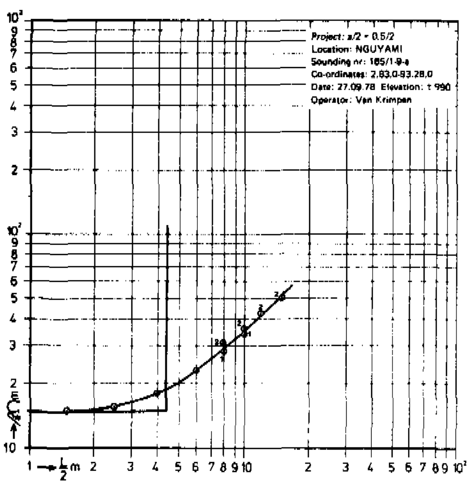

Project: a/2 - 0.5/2
Location: KINYOLISI
Sounding nr: 165/1-6-c
Co-ordinates: 2.87.1-93.28.2
Date: 13.09.78 Elevation: ± 880
Operator: Van Krimpen


Project: a/2 - 0.5/2
Location: NDOGOMI
Sounding nr: 165/1-7-a
Co-ordinates: 2.79.8-93.34.3
Date: 27.09.78 Elevation: + 1040
Operator: Van Krimpen

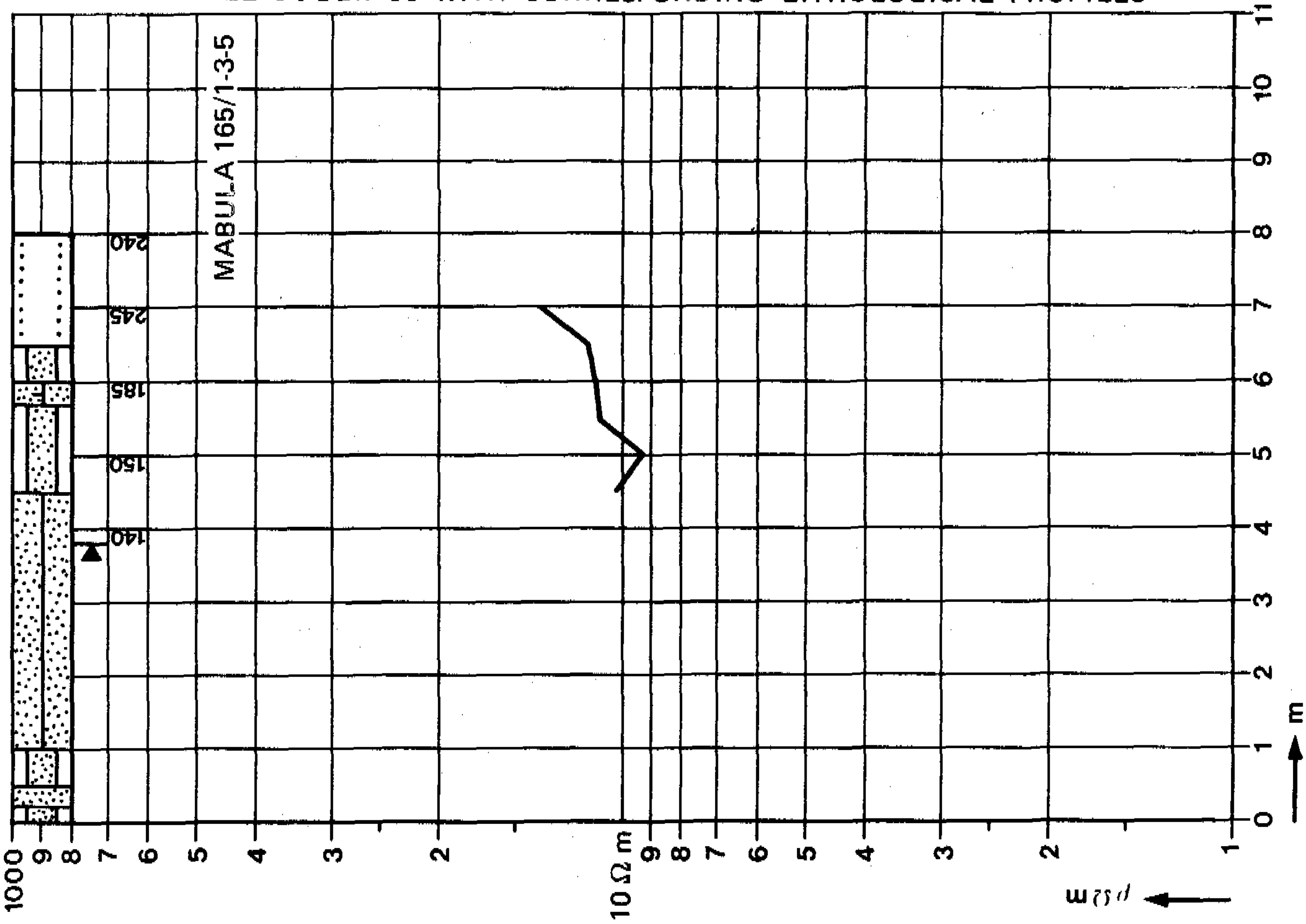

Project: a/2 - 0.5/2
Location: NDOGOMI
Sounding nr: 165/1-7-b
Co-ordinates: 2.79.9-93.34.3
Date: 27.09.78 Elevation: ± 1040
Operator: Van Krimpen

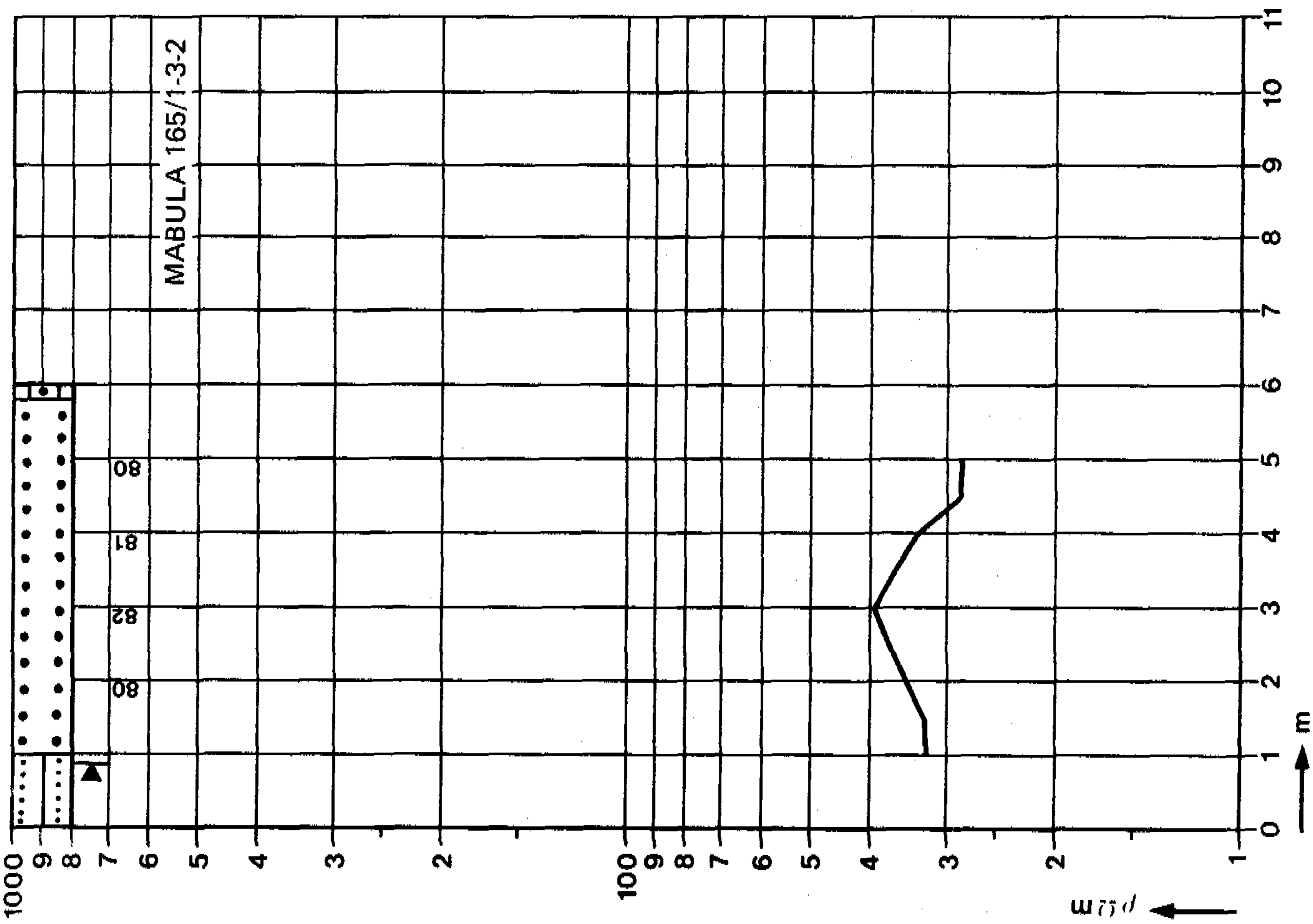

Project: a/2 - 0.5/2
Location: MADEGE
Sounding nr: 165/1-8-a
Co-ordinates: 2.80.9-93.31.7
Date: 27.09.78 Elevation: ± 1040
Operator: Van Krimpen

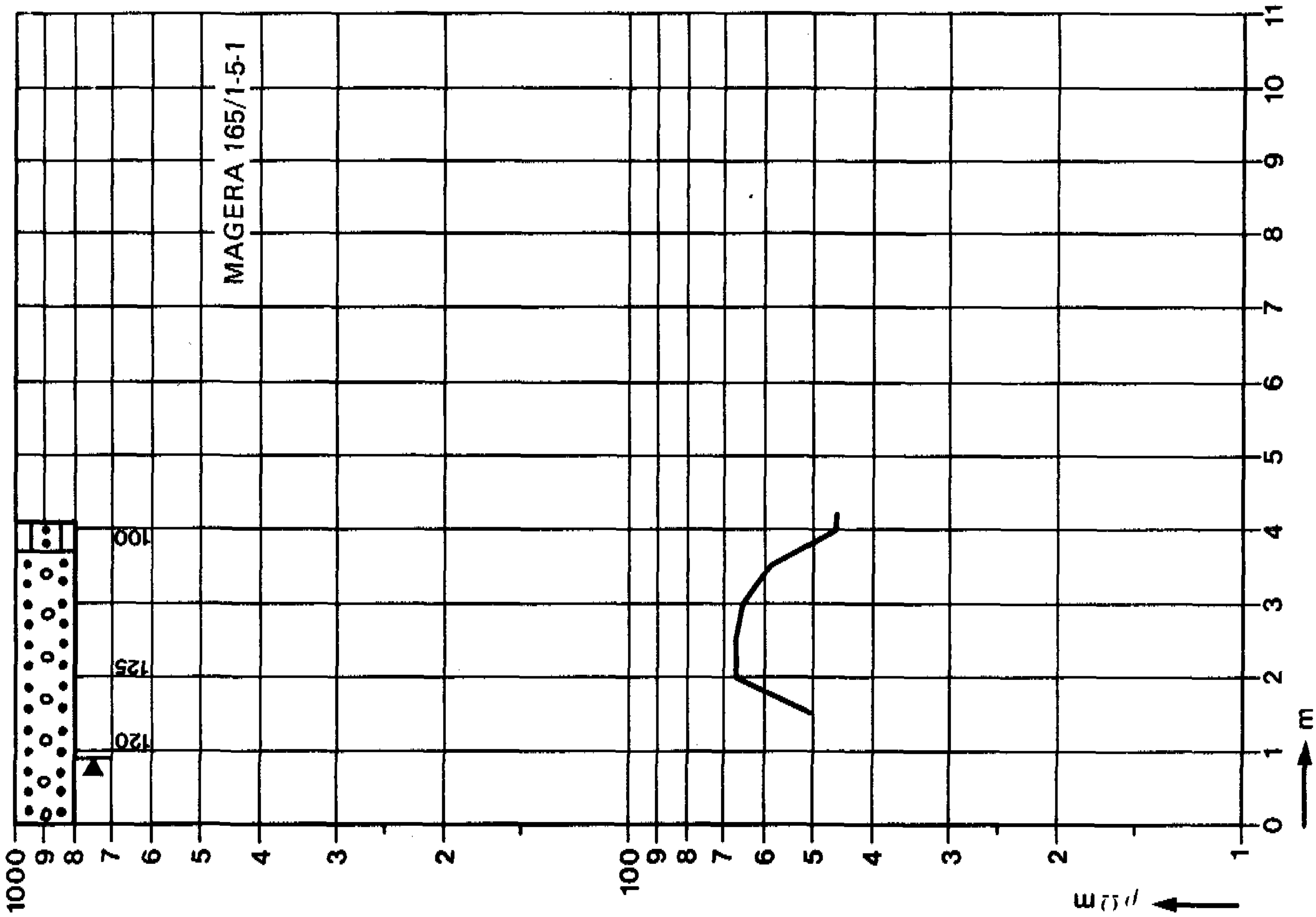

Project: a/2 = 0.5/2
Location: MADEGE
Sounding nr: 165/1-8-b
Co-ordinates: 2.80.9-93.31.7
Date: 27.09.78 Elevation: ± 1010
Operator: Van Krimpen

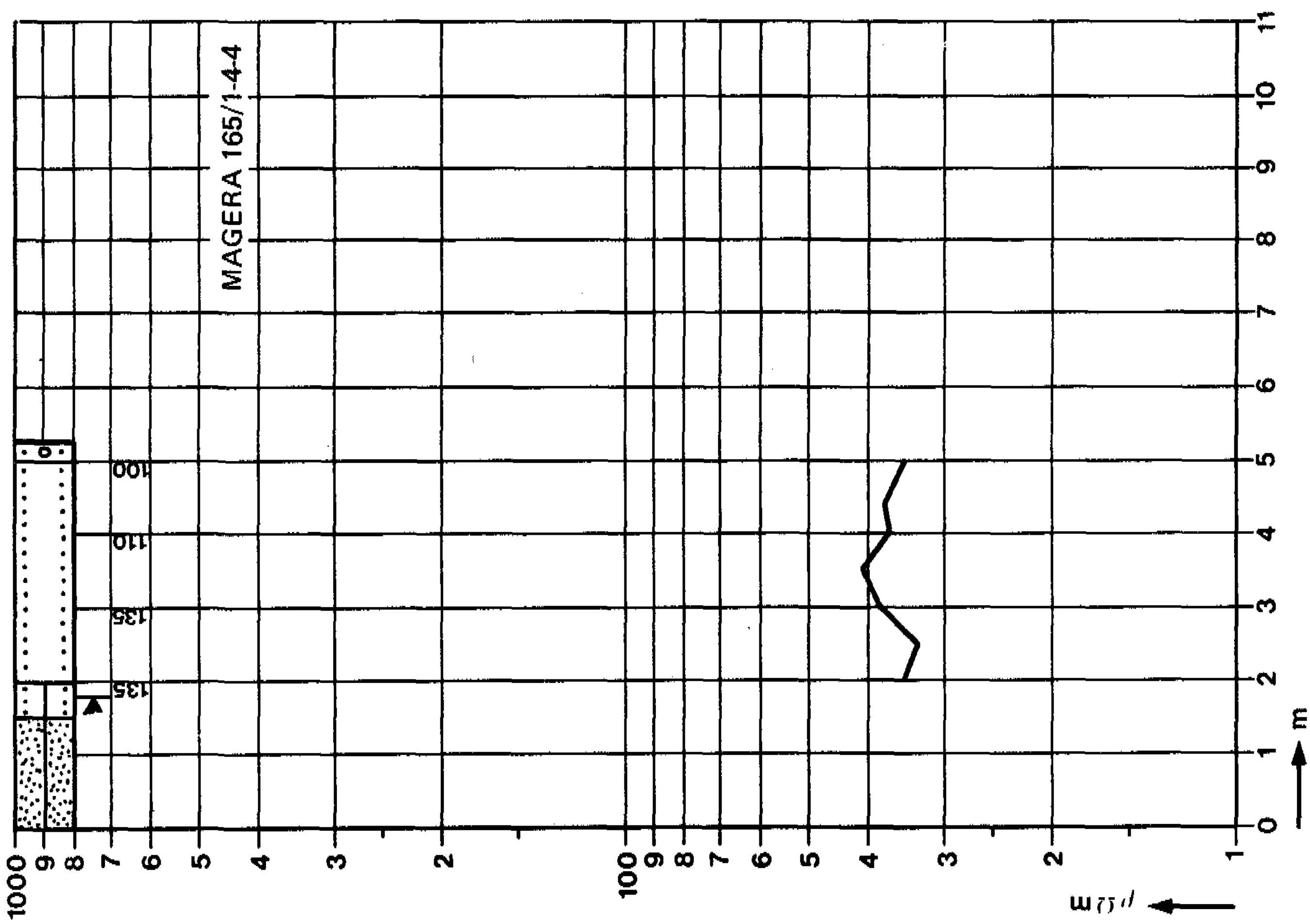

Project: a/2 = 0.5/2
Location: NGUYAMI
Sounding nr: 165/1-9-a
Co-ordinates: 2.83.0-93.28.0
Date: 27.09.78 Elevation: ± 990
Operator: Van Krimpen

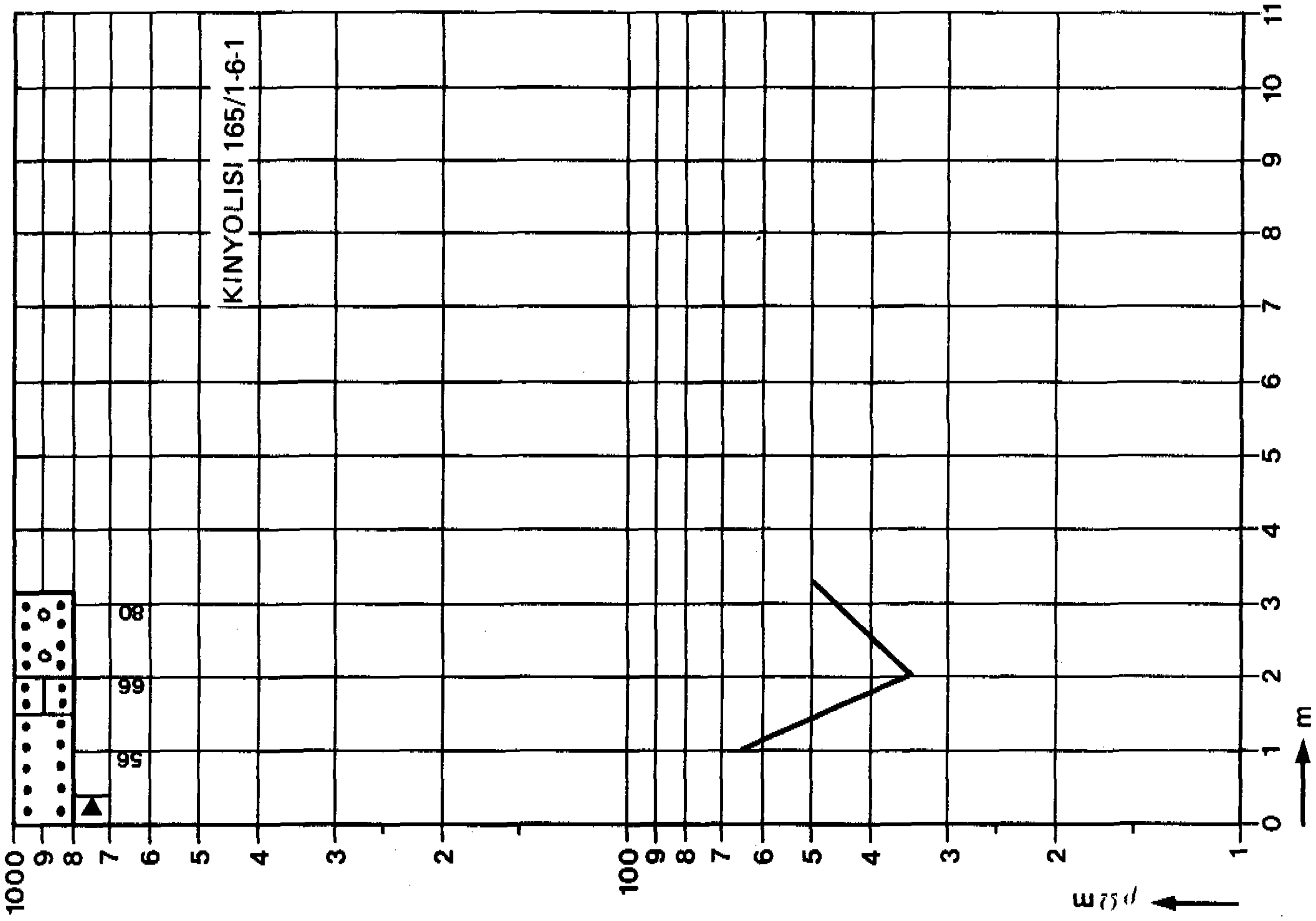
WELL LOGGINGS WITH CORRESPONDING LITHOLOGICAL PROFILES

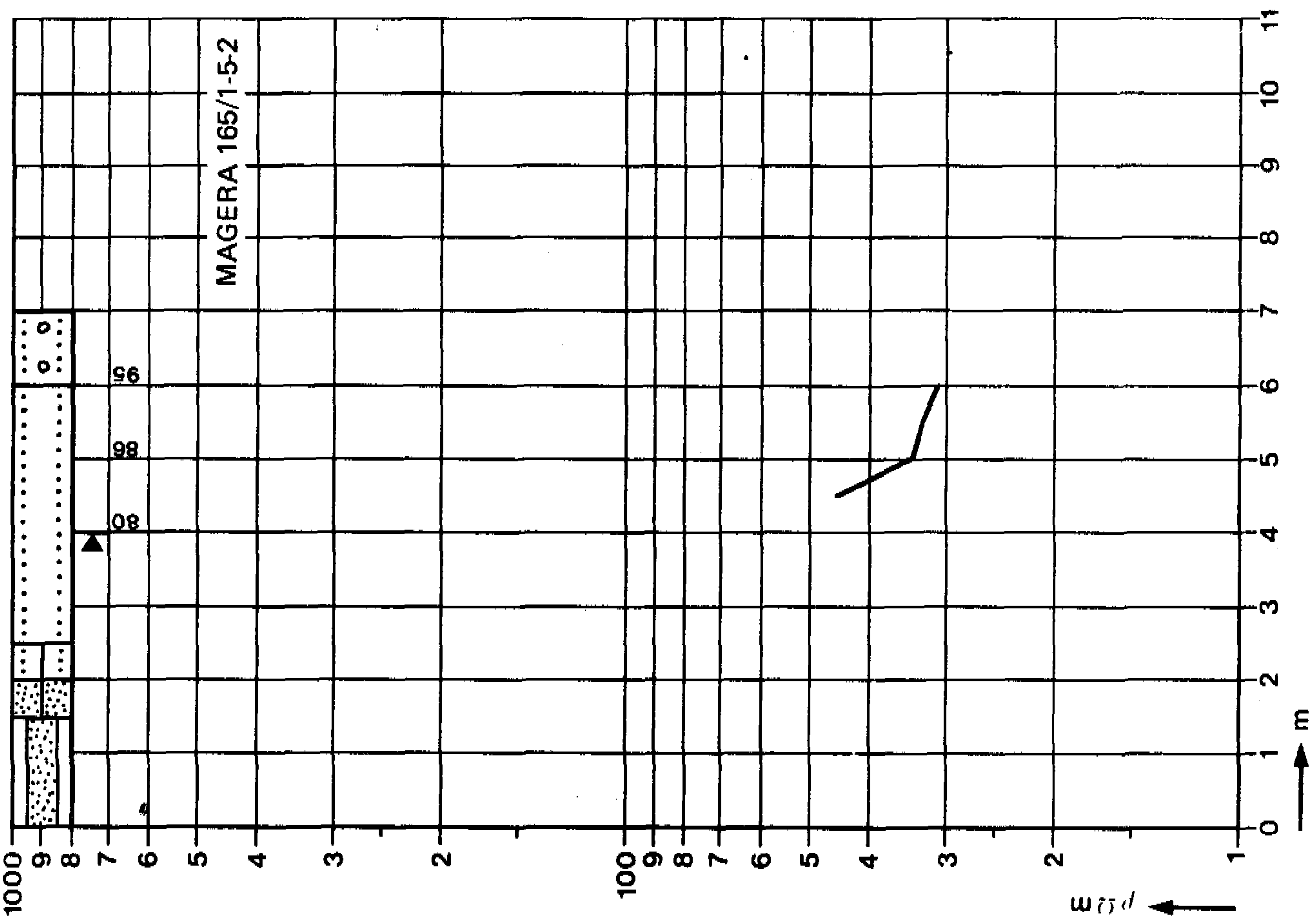


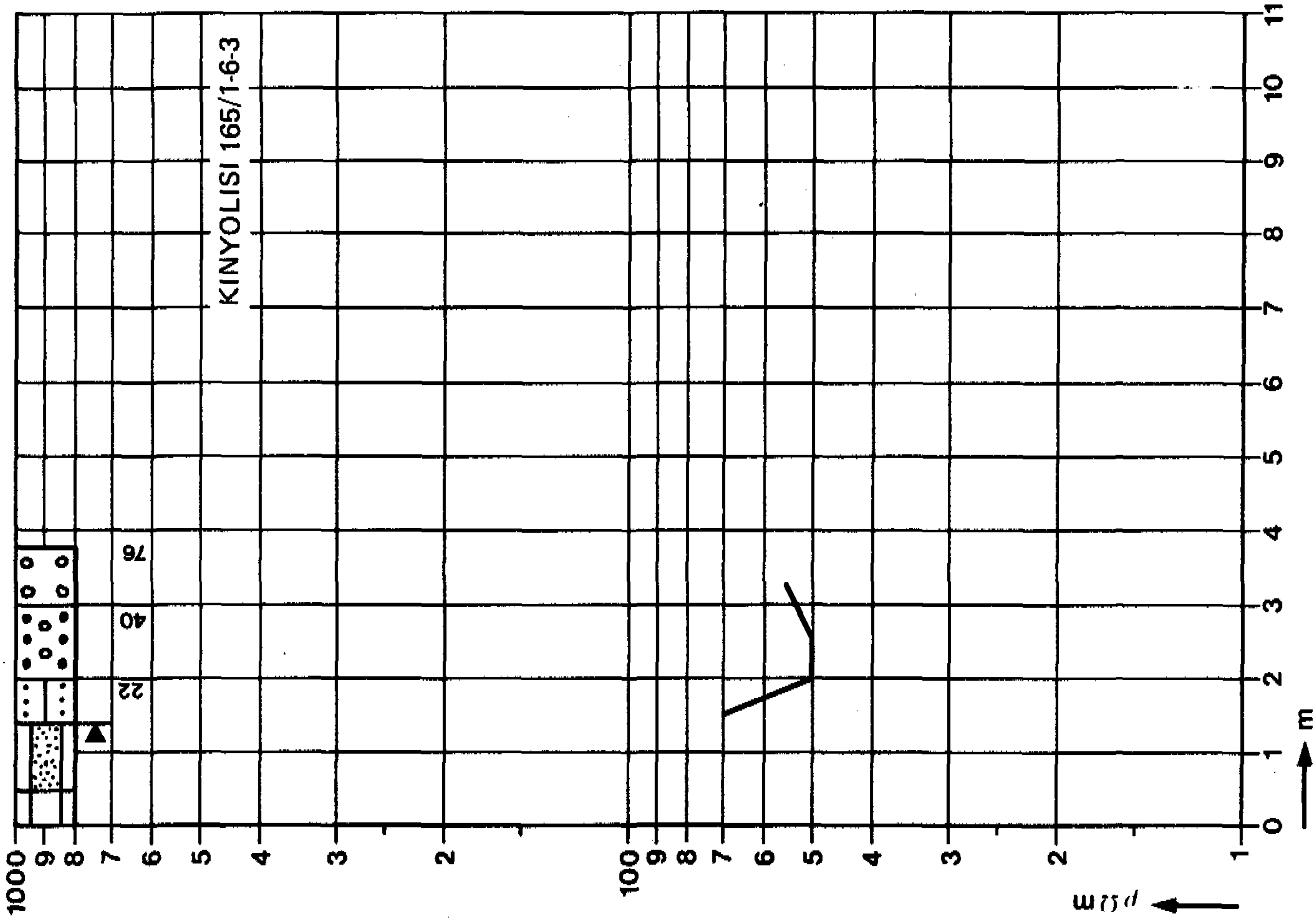


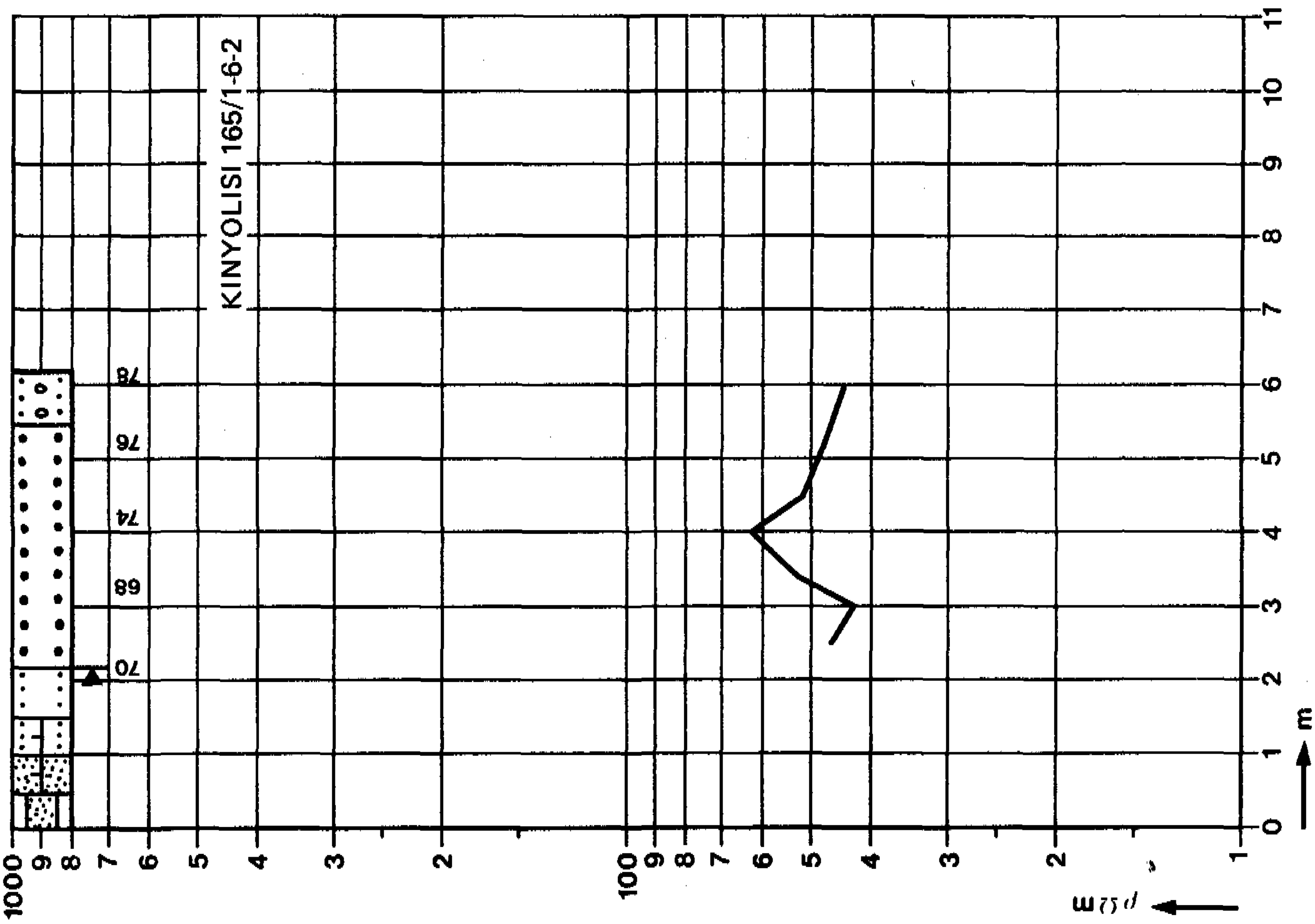

MAGERA 165/1-5-1
100
125
120
m
ρ Ω m

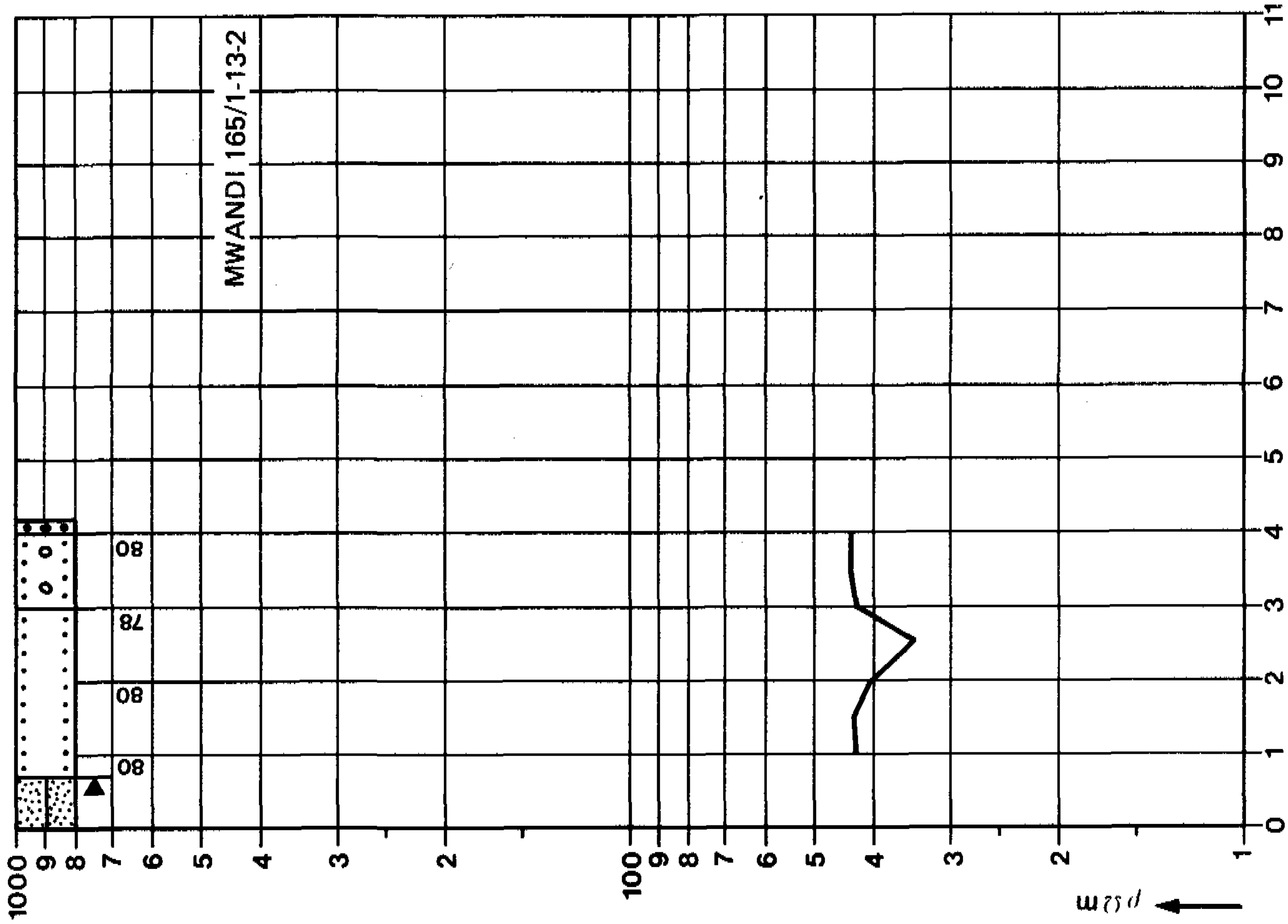

MAGERA 165/1-4-4
100
110
135
135
m
ρ Ω m

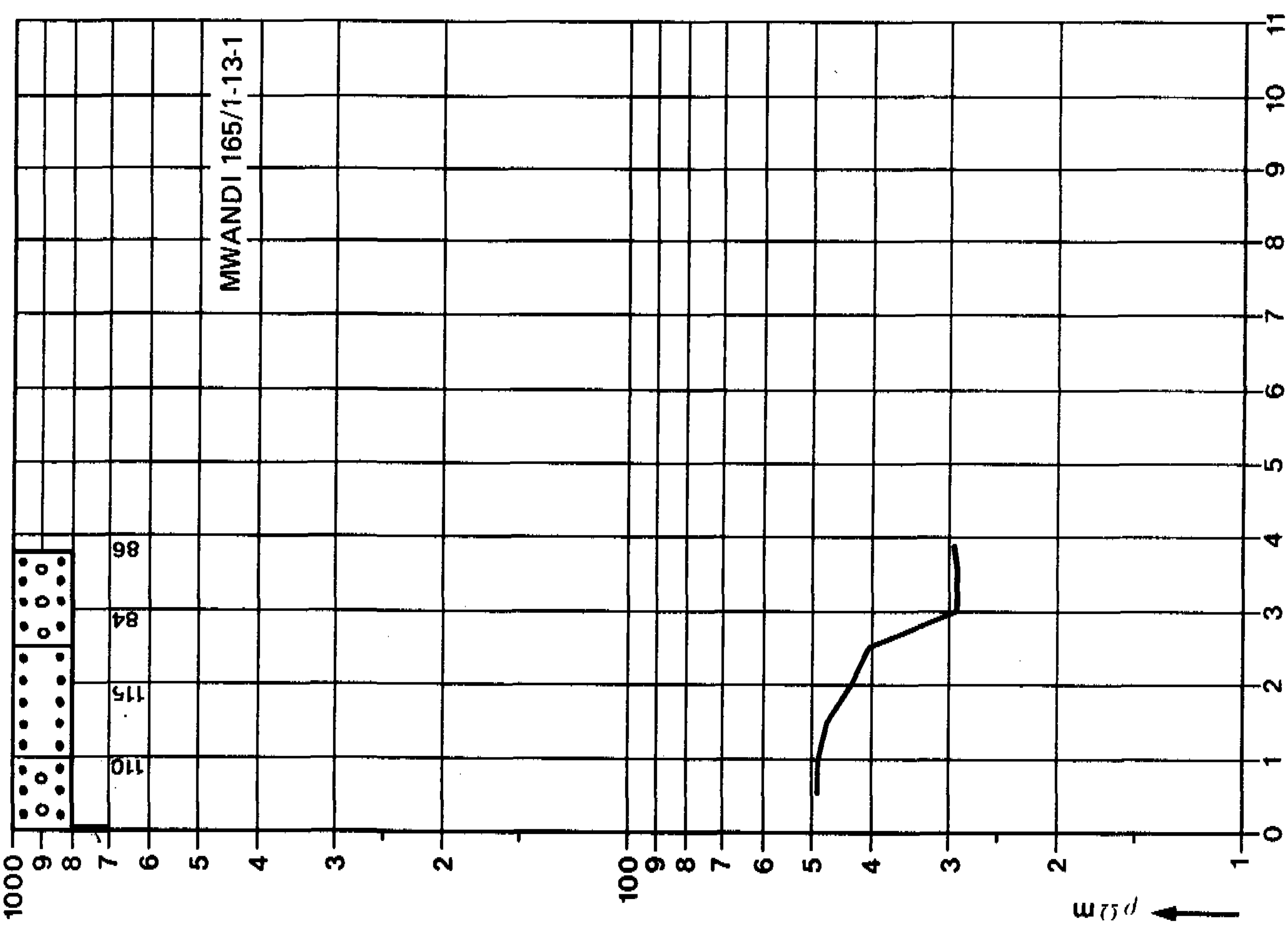

KINYOLISI 165/1-6-1
80
99
95
m
ρ_{2} m

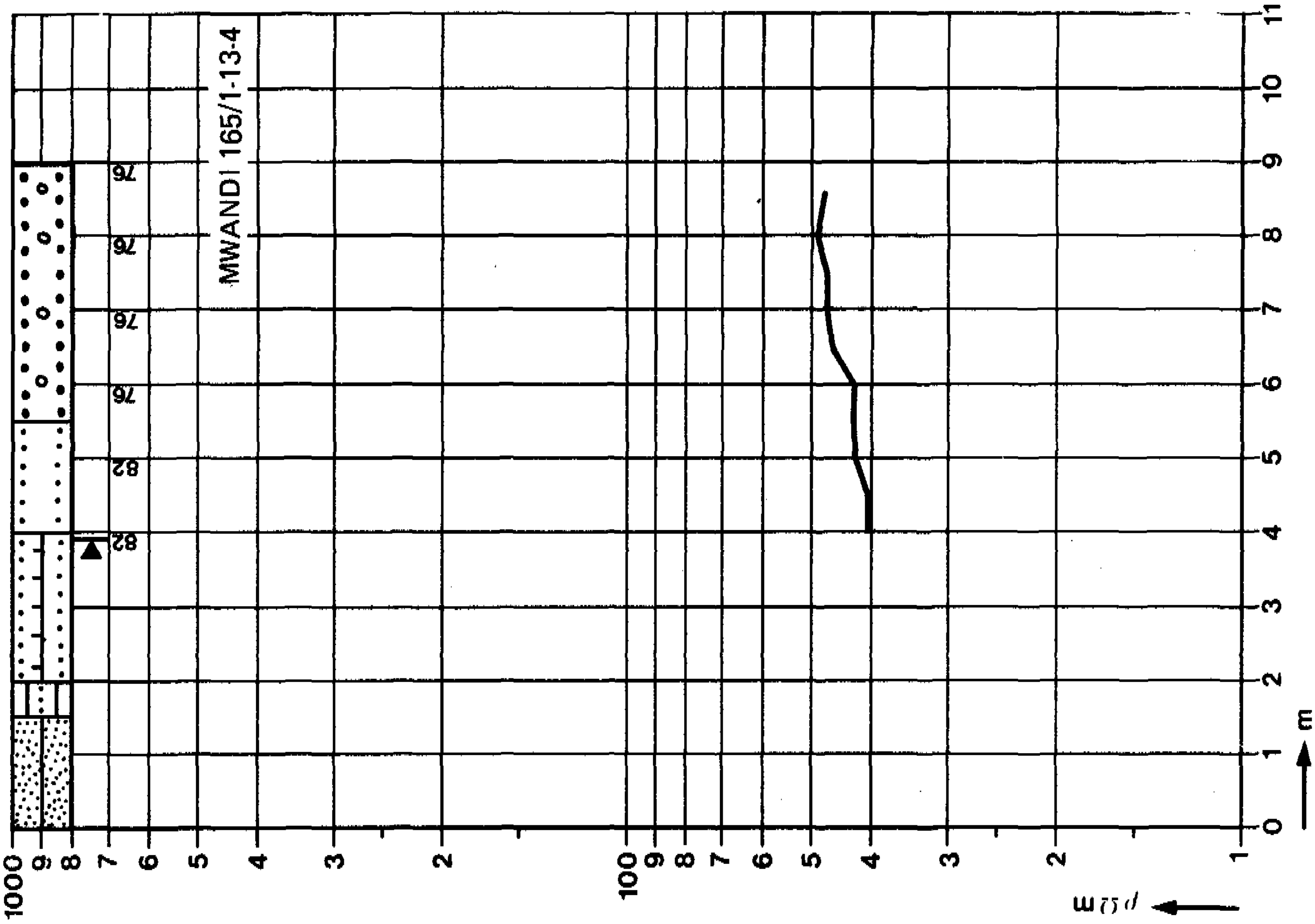

MAGERA 165/1-5-2
95
98
80
m
ρ_{2} m

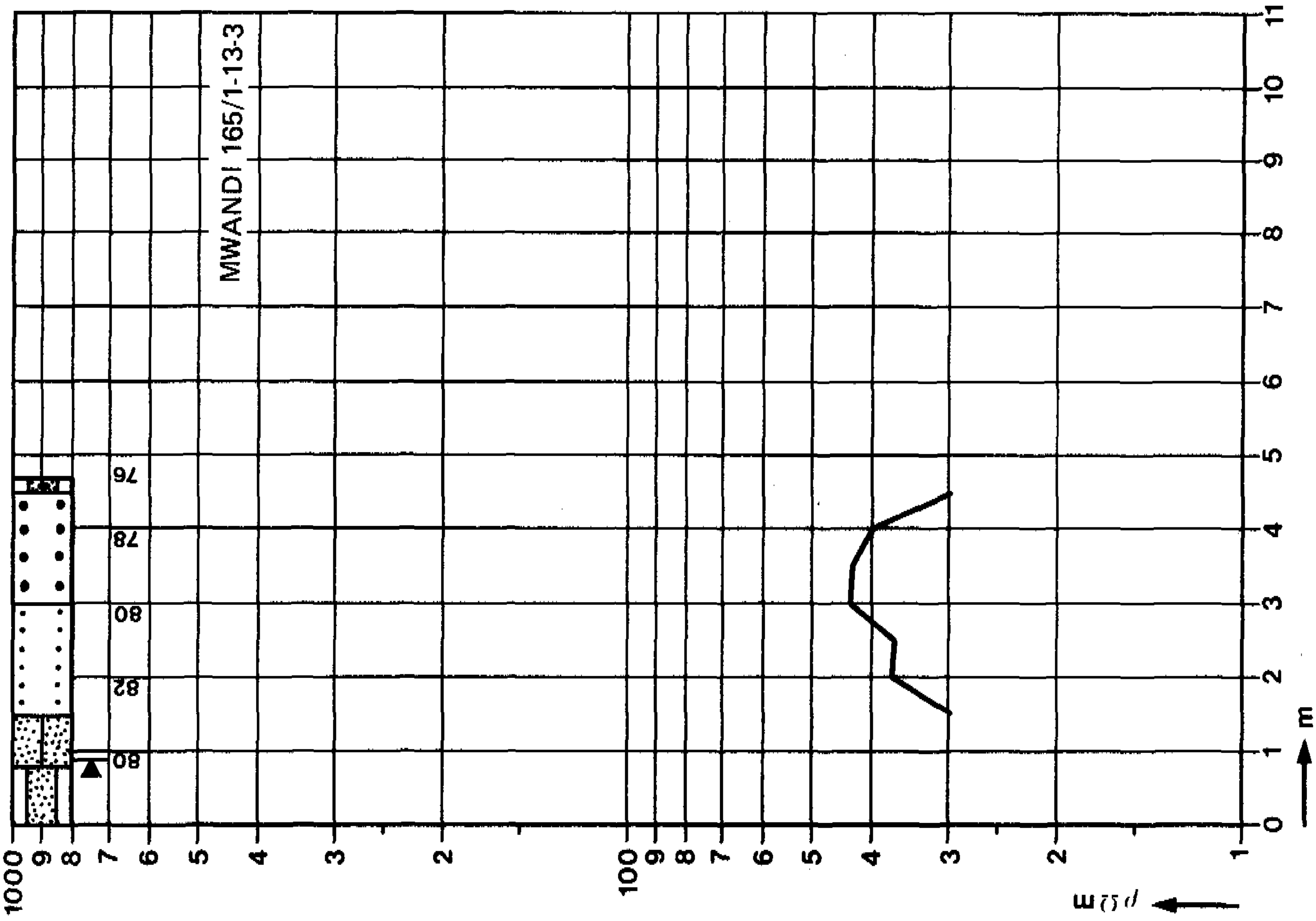

KINYOLISI 165/1-6-3
22
40
76
ρΩm
m


KINYOLISI 165/1-6-2
70
68
74
76
78
ρΩm
m


MWANDI 165/1-13-2
ρΩm
m
80
78
80
80


MWANDI 165/1-13-1
ρΩm
m
110
115
84
86

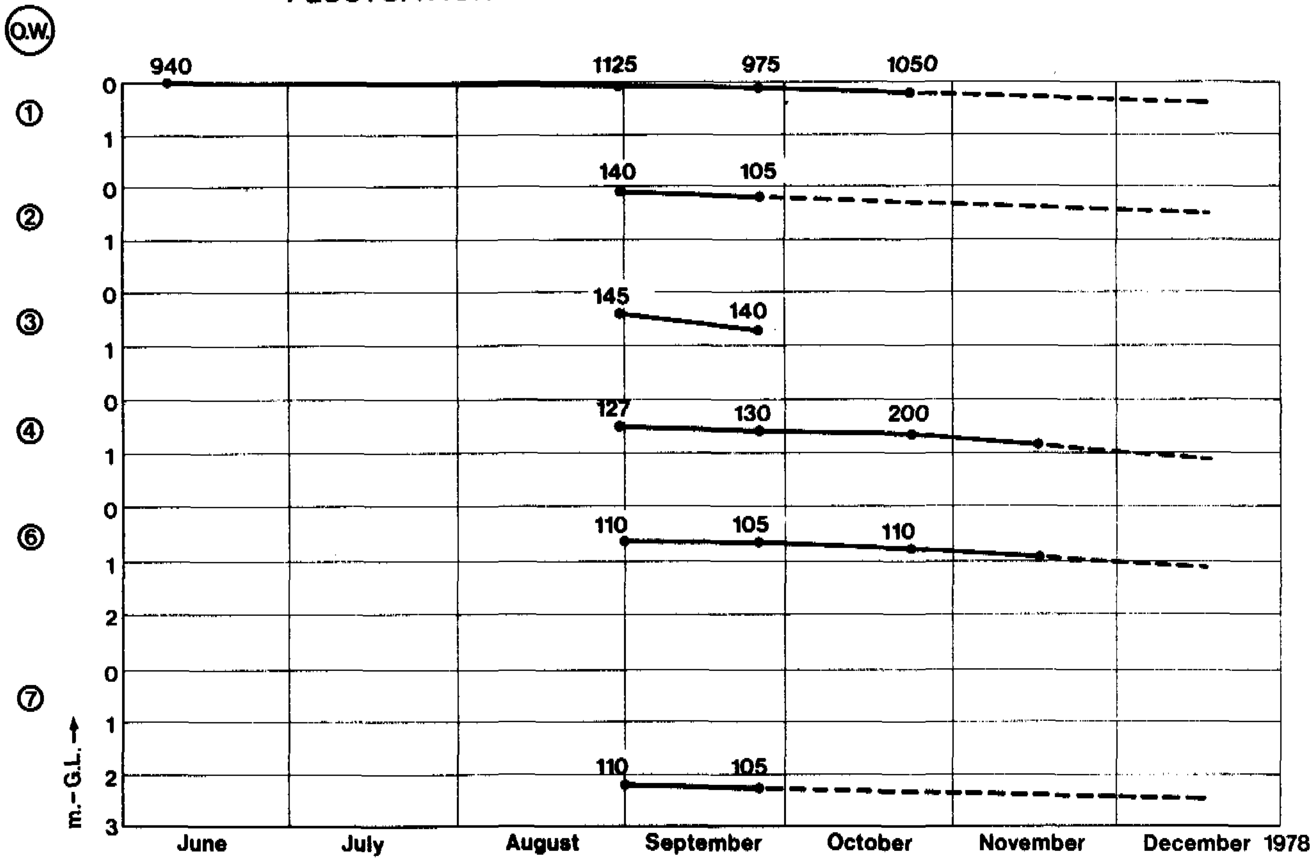

MWANDI 165/1-13-4
ρ Ω m
m


MWANDI 165/1-13-3
ρ Ω m
m

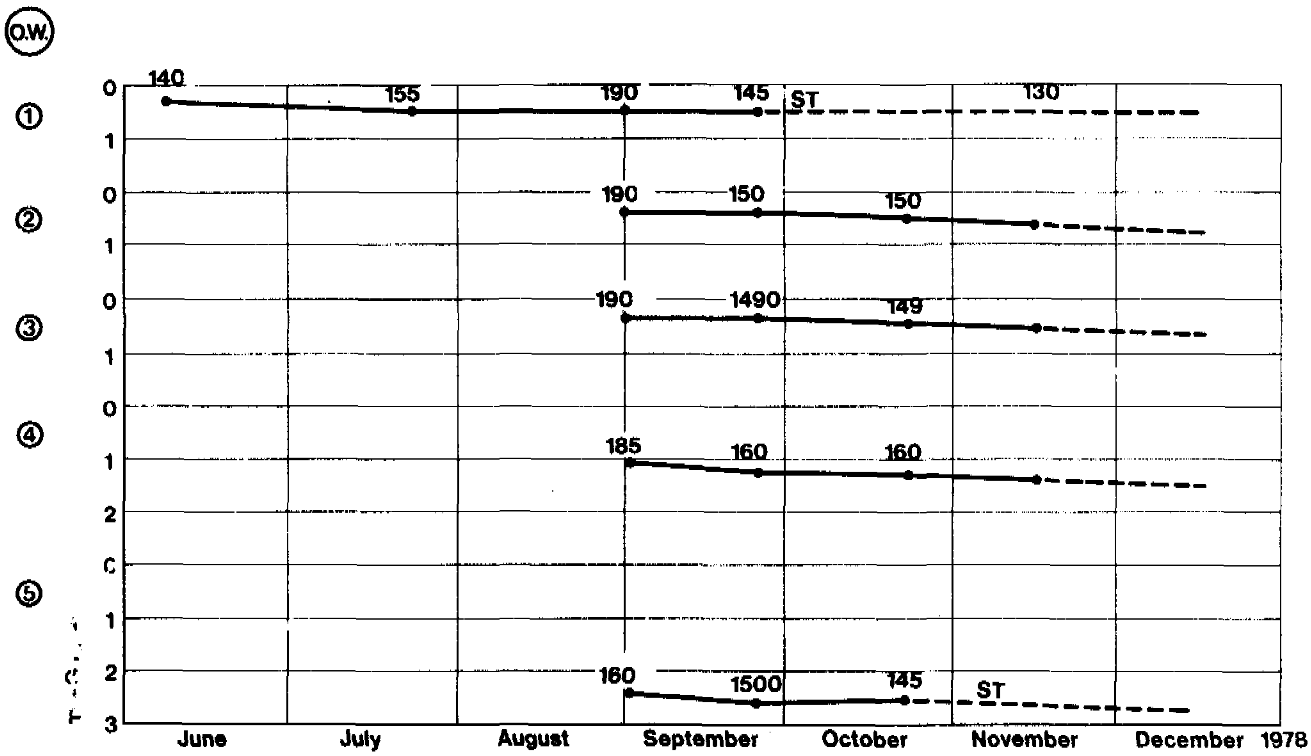
DATA DD 13

FLUCTUATIONS OF GROUND WATER LEVELS AND EC'S, MEASURED IN PIEZOMETERS; BEREGA AREA

FLUCTUATIONS OF GROUNDWATERLEVELS AND EC'S

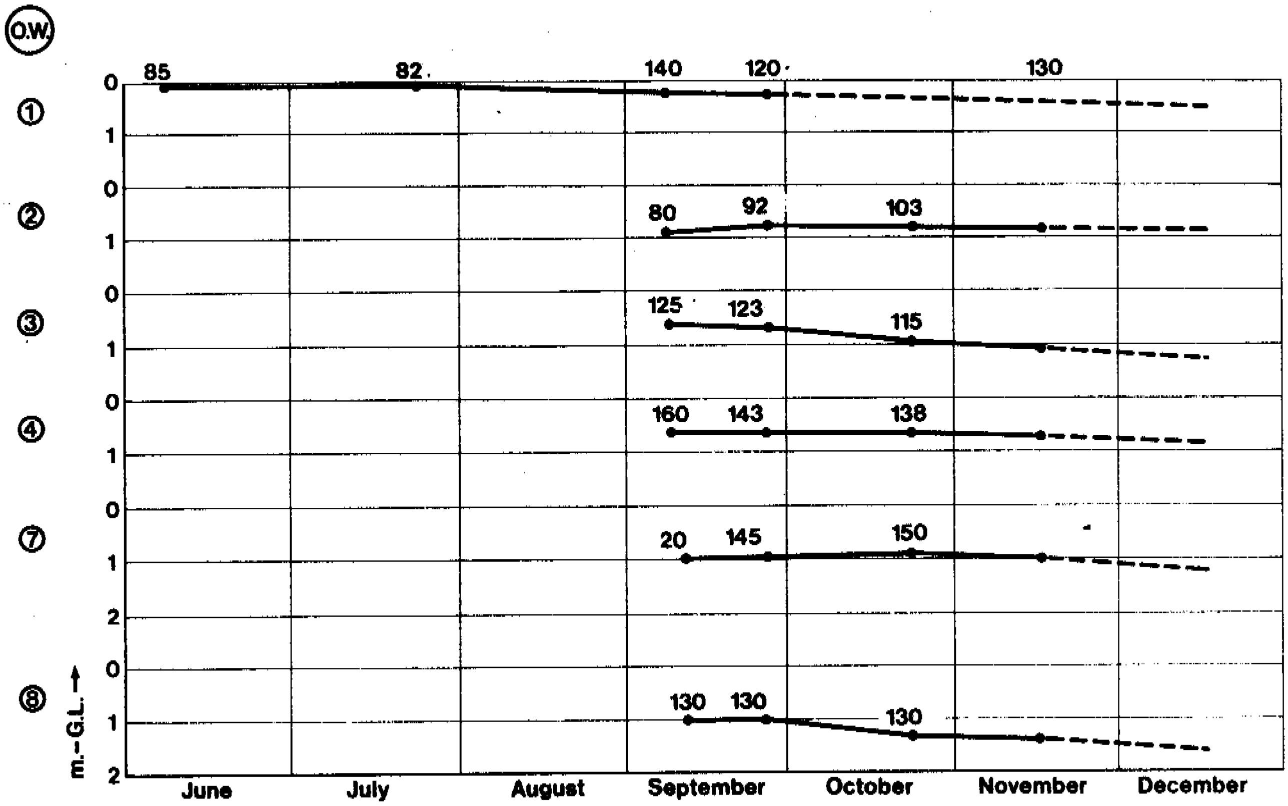


CROSS SECTION 165/1-1, BEREGA

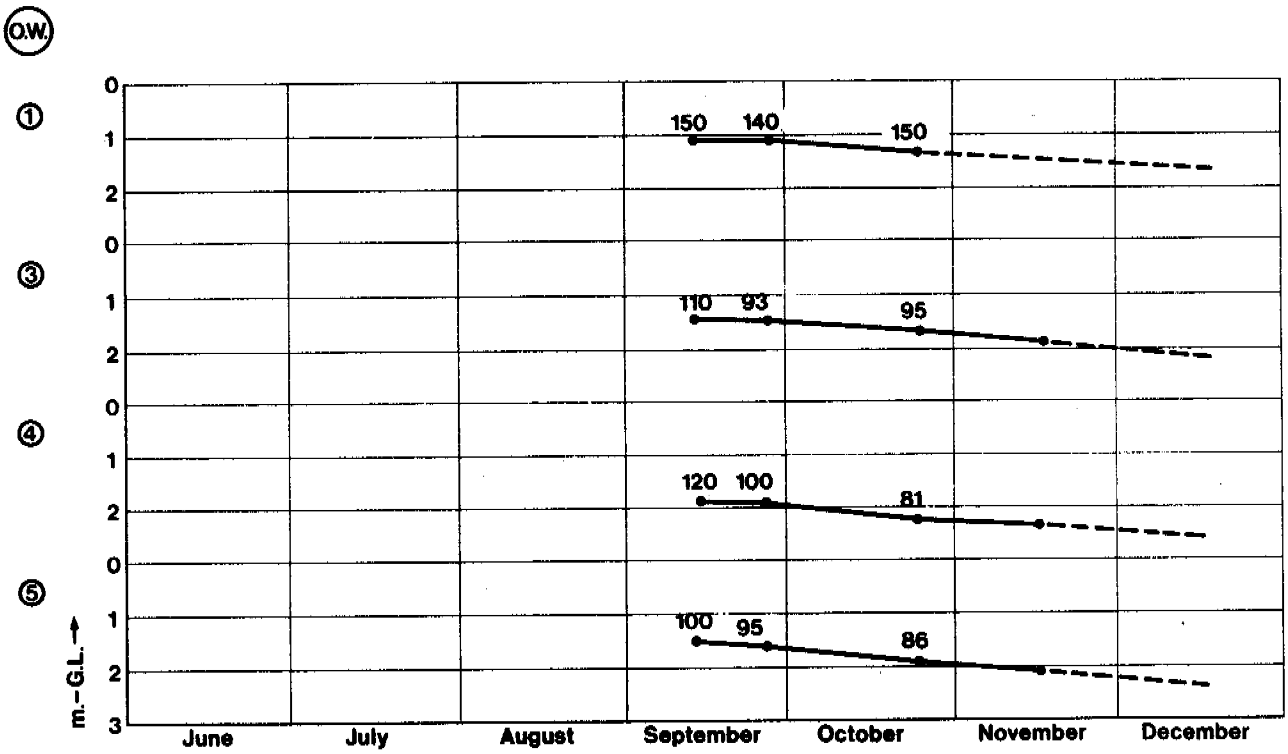


CROSS SECTION 165/1-2, MABULA

FLUCTUATIONS OF GROUNDWATERLEVELS AND EC'S

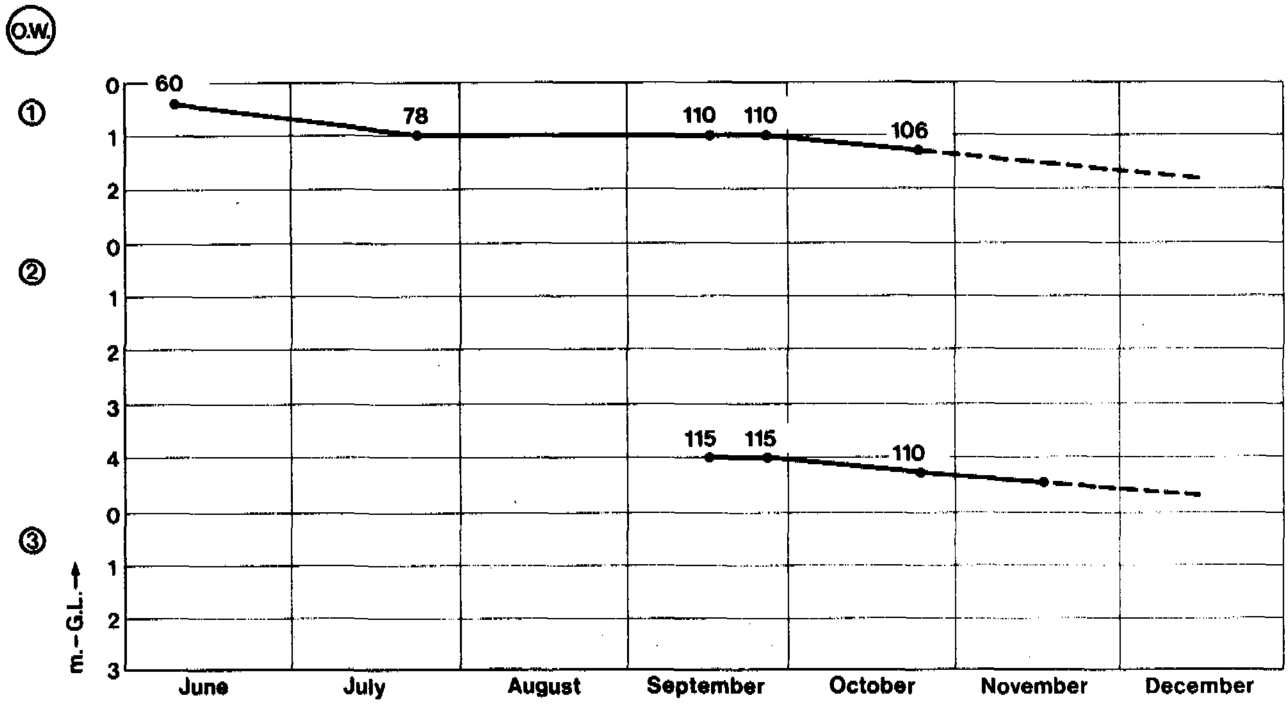


CROSS SECTION 165/1-3, MABULA

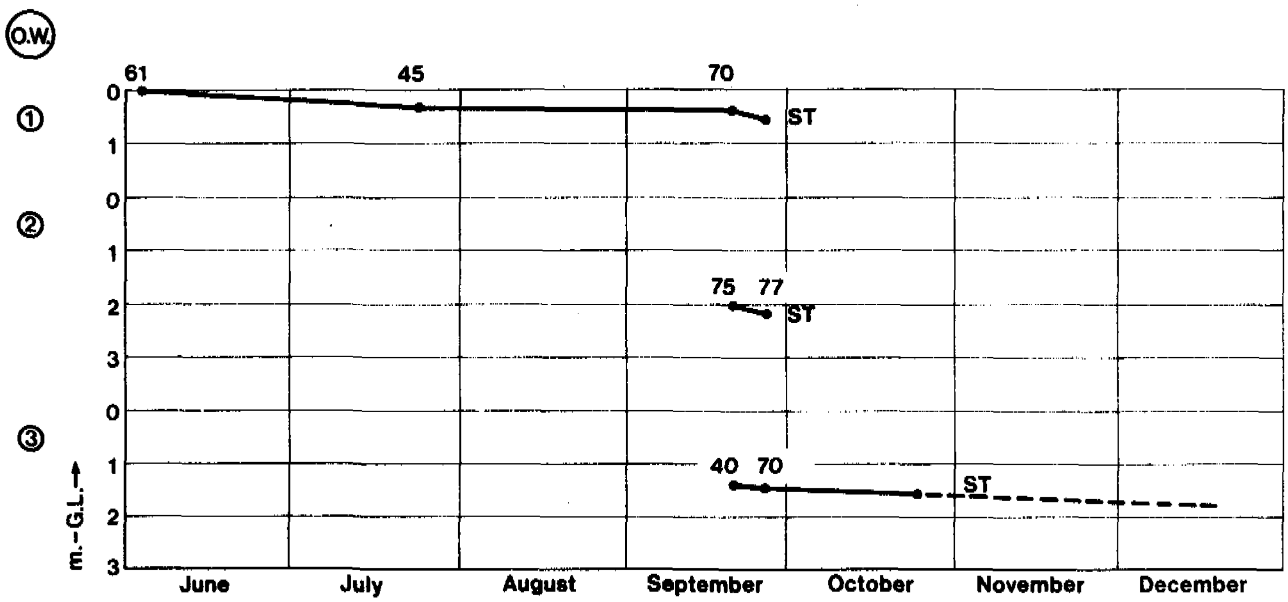


CROSS SECTION 165/1-4, MAGERA

FLUCTUATIONS OF GROUNDWATERLEVELS AND EC'S

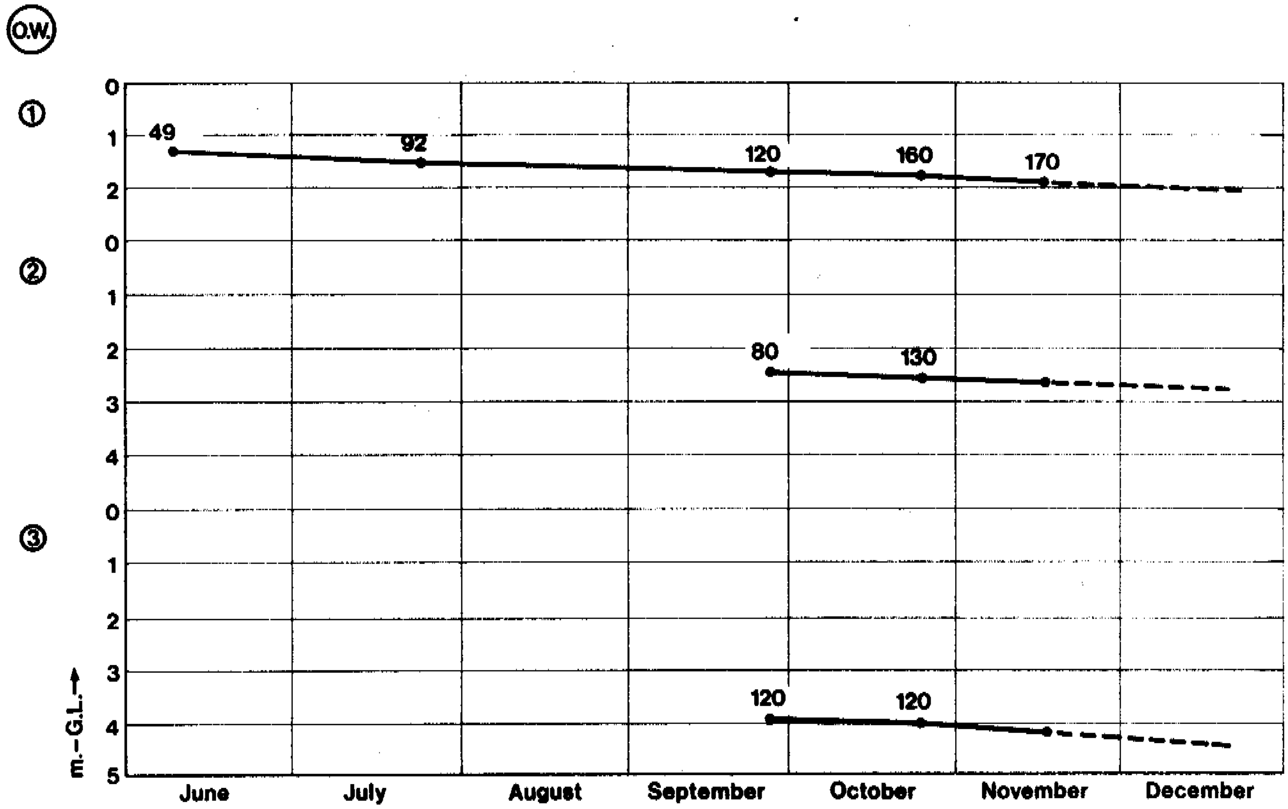


CROSS SECTION 165/1-5, MAGERA

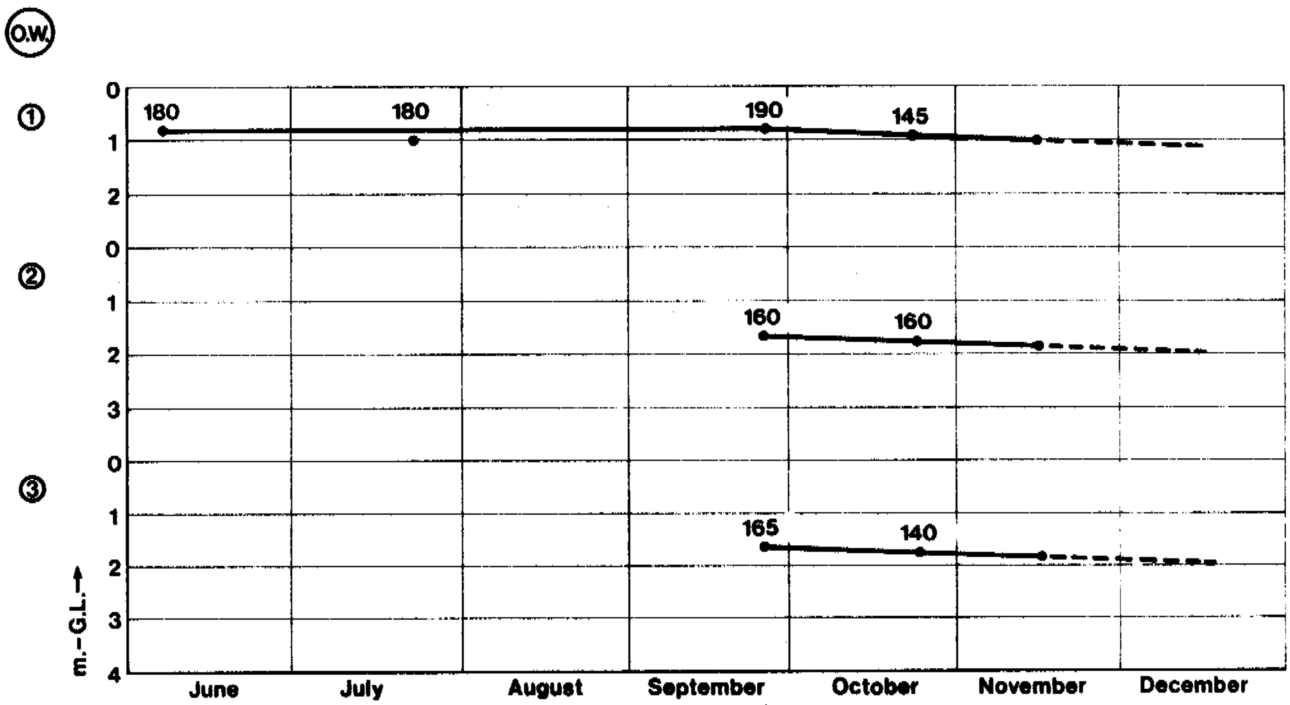


CROSS SECTION 165/1-6, KINYOLISII

FLUCTUATIONS OF GROUNDWATERLEVELS AND EC'S

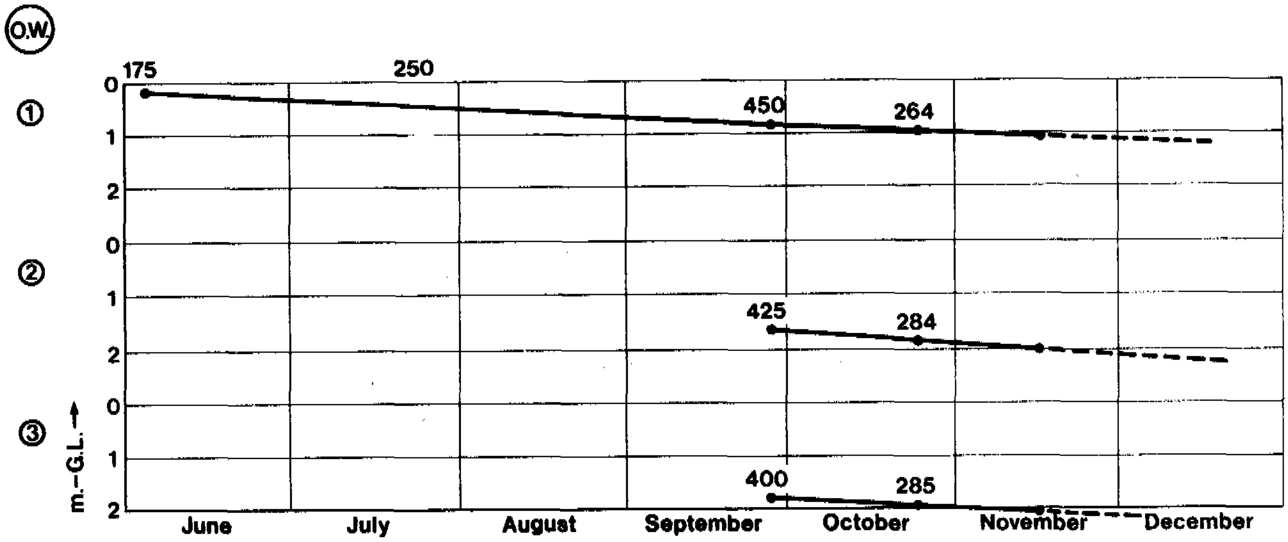


CROSS SECTION 165/1-7, NDOGOMI

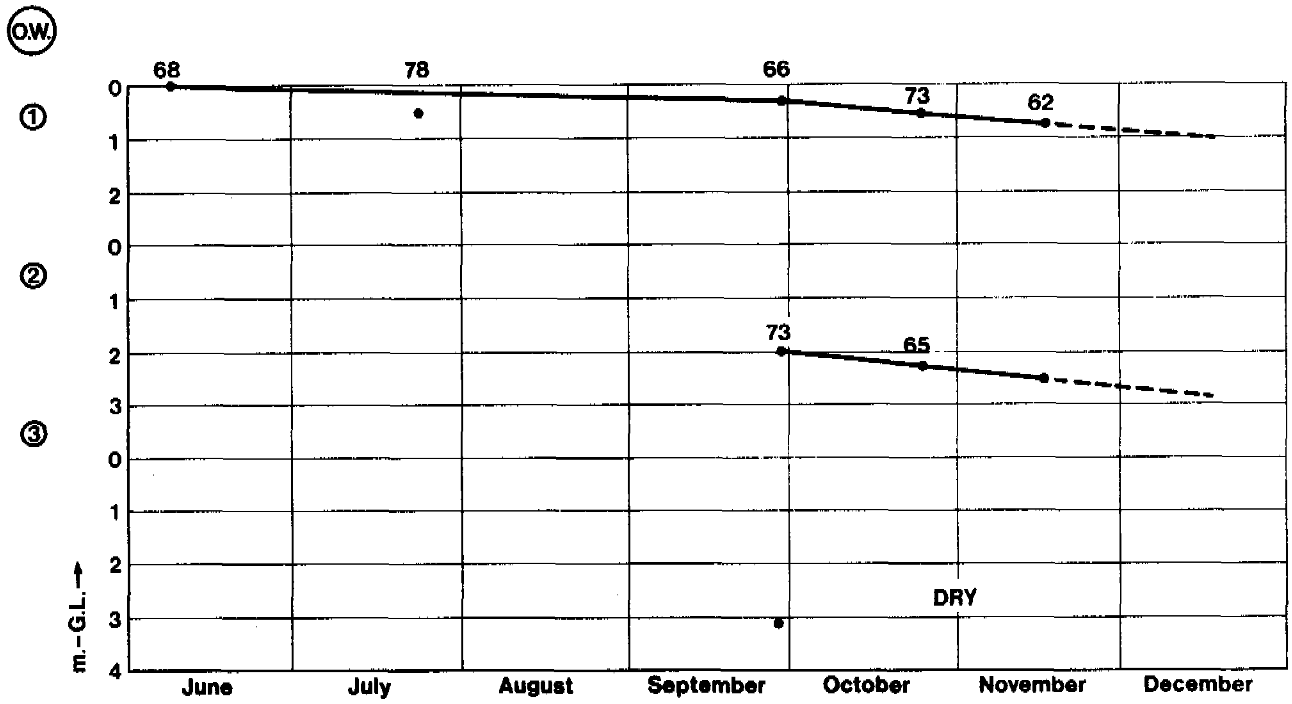


CROSS SECTION 165/1-8, MADEGE

FLUCTUATIONS OF GROUNDWATERLEVELS AND EC'S

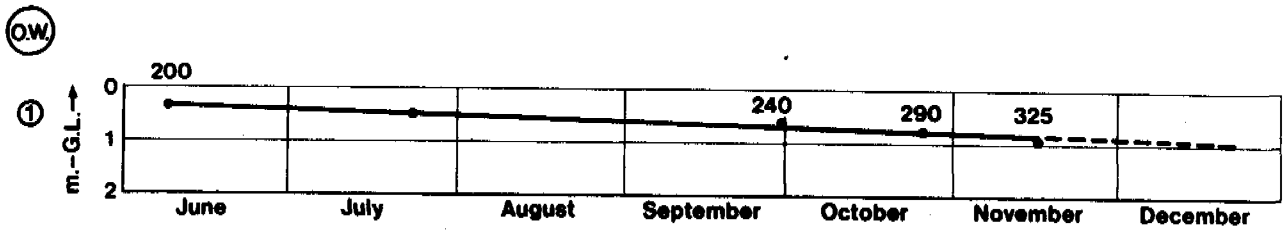


CROSS SECTION 165/1-9, NGUYAMI

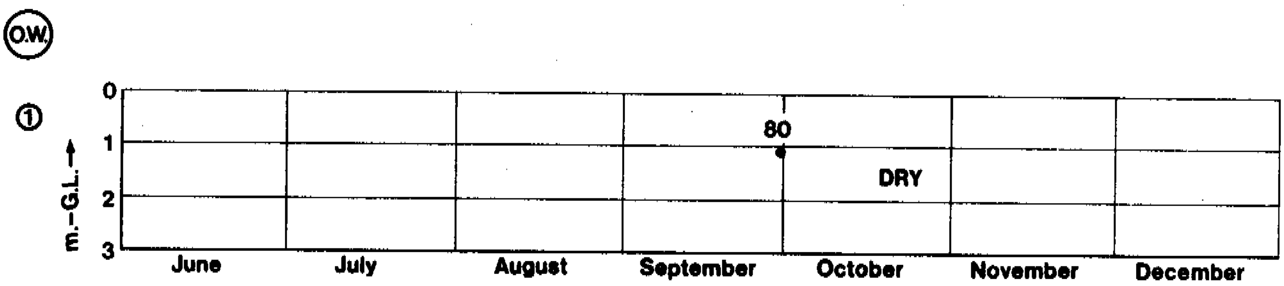


CROSS SECTION 165/1-10, IDIBO

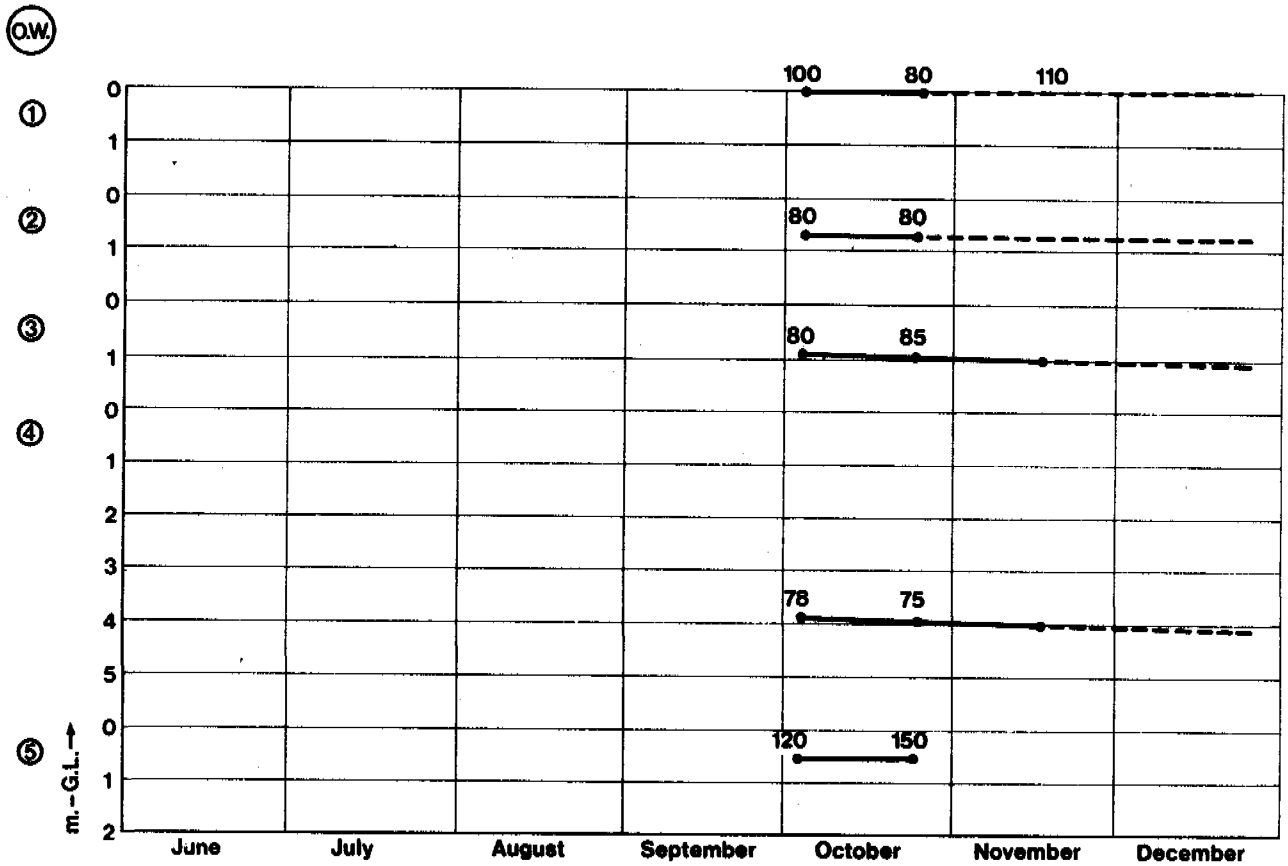
FLUCTUATIONS OF GROUNDWATERLEVELS AND EC'S



CROSS SECTION 165-1-11, MBILI

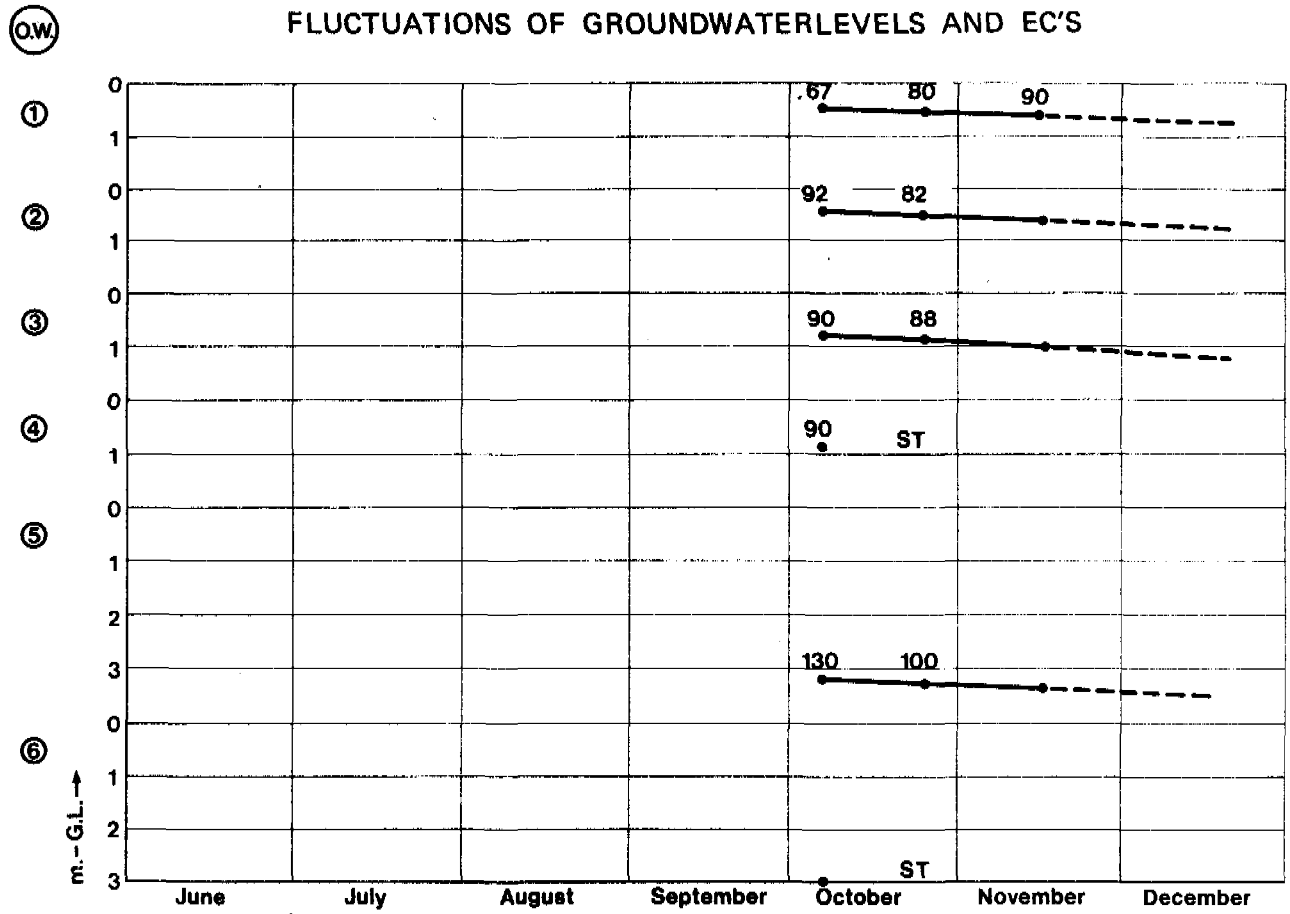


CROSS SECTION 165/1-12 MBILI

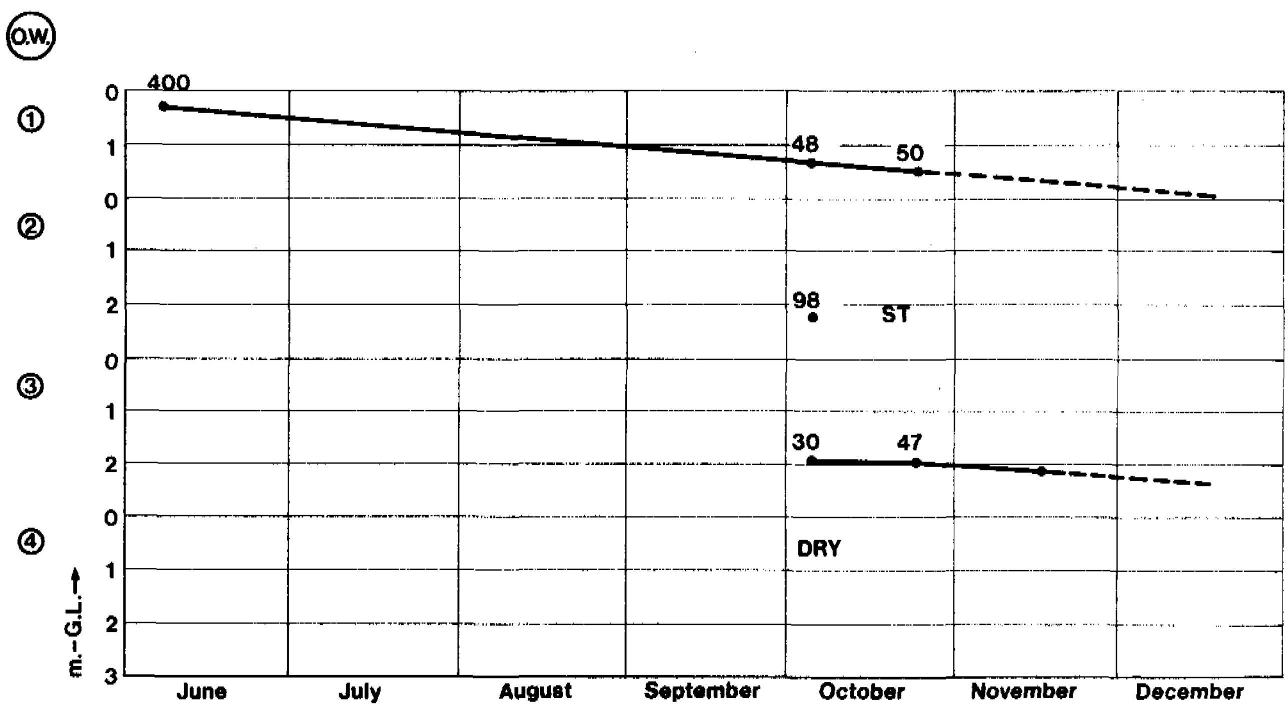


CROSS SECTION 165/1-13, MWANDI

FLUCTUATIONS OF GROUNDWATERLEVELS AND EC'S



CROSS SECTION 165/1-14, IBINDO



CROSS SECTION 146/3-1, LESHATA