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HYDROGEOLOGICAL / GEOPHYSICAL SURVEY REPORT

CLIENT: **MUNYANZA S. A. PRIMARY SCHOOL**
P. O. BOX 67,
KHWISERO

PROJECT: **MUNYANZA PRIMARY SCHOOL WATER PROJECT**
PLOT L.R NO. KISA/MUSHIANGUBU/210

LOCALITY: **MUNYANZA**

DISTRICT: **BUTERE-MUMIAS**

SELECTED BOREHOLE SITE:

Munyanza Primary School Compound

UTM 36N N 0676198 E 0015970
Altitude: 1428m.

INVESTIGATING GEOLOGIST: OBIRI, J.O.

INTRODUCTION

This is a hydrogeological survey report compiled in response to an application by the client, **MUNYANZA PRIMARY SCHOOL** who requested for a feasibility study aimed at establishing groundwater potential within the school compound. The project area is small and measures about 0.8 acres. The intention of the client is to sink one (1No.) borehole expected to meet a daily demand approximated at 20m^3 for domestic purposes for the school population and the surrounding rural community. At present the water supply situation in this area is poor with the main source being the running surface water from nearby small streams and springs. These sources are easily polluted and are unreliable especially during the dry season.

Geophysical investigation was conducted at several points within the area to identify the most suitable site for the proposed borehole. The results of geophysical investigations coupled with other relevant information gathered during the geo-survey are detailed in this report.

The objective of this study in addition to identifying a suitable location for the proposed borehole, is to assess the availability of groundwater, comment on aspects of depth to potential aquifers, possible yields and recommending optimum drilling depth at the selected site.

GEOLOGICAL UNITS

The project area consists mainly of Kavirondian system of rocks and Pleistocene to Recent formations.

Kavirondian Rocks

These are sedimentary Kavirondian rocks overlying the upturned edges of the folded Nyanzian rocks with a strong angular unconformity. The main rock types in this system include conglomerates, grits and mudstones. Pebbly grits and sandy mudstones make up a sub-ordinate part of the sequence.

Grits include several variety i.e pebbly, sandy and muddy types, in addition to the more usual medium grained feldspathic grits. They are medium to dark grey rocks in which quartz and feldspar grains are visible to the naked eye. They weather into pinkish colour and when completely broken down, yield light sandy soils. The highly feldspathic nature of the grits suggests their derivation from predominantly granitic rocks though a fair proportion of the material was contributed by the Nyanzian volcanics.

Mudstones include all the finer members of the Kavirondian series. They are usually dark grey to purplish soft rocks which are sometimes banded and weather to lighter colours. The mudstones were deposited in deeper water under quiet conditions.

Pleistocene to Recent Formation

Deposits of Pleistocene to Recent age include hill wash gravels (colluvium), semi consolidated river alluvium, quartz rubble and lateritic ironstone capping. Alluvium flats and marshes are common along the courses of rivers in the area.

Soil Cover

The red lateritised earth varies in colour but are typically deep warm brown and well drained. Breakdown of the Kavirondian grits produce buff or light brown sandy soils while the mudstones give reddish-brown clayey soils.

HYDROGEOLOGY

Groundwater normally occurs in pores and interstices of various rock formations depending on the geological conditions and physiography of the area, the permeability and porosity of the rock formations, the degree and depth of weathering, fracturing of the rock formation and the tectonic historical conditions of the area. The recharge conditions are also an important factor. It is also worth noting that due to the relatively high rainfall, local recharge to the underlying aquifers is enhanced through the thick unconsolidated overburden.

The project area is characterized by the presence of sequences of sedimentary rocks (grits and mudstones). Near surface aquifers occur in ferricrete deposits or below and sometimes within the thick overburden soils overlying the rock strata. Faults, fissures, fractures and joints where well developed may also carry water. Vegetation cover, mainly artificial, is also thick enough to enhance infiltration of water into the subsurface. Groundwater recharge is afforded mainly by the local annual precipitation of about 1600mm, in addition to regional lateral replenishment from the higher areas.

The details of the existing borehole within the area is given below. The borehole gives a high yield indicating a dependence on the local recharge condition and the underlying geological set-up.

B.H No. (c-)	Total Depth (m)	Water Struck Level (m)	Water Rest Level (m)	Tested Yield (m^3/hr)
LVNCA/BH 21	80	40	18	8.0

DRAINAGE SYSTEM

The area is situated within the Lake Victoria drainage basin, one of the five main Kenya's drainage basins. The geological, topographical and climatic factors influence the natural availability and distribution of water in this basin with rainfall distribution having the main influence. The quality and quantity of water in the basin varies with season. The basin supports nearly a half of the country's growing population. There has been an increase in agricultural and livestock activities in the area to meet the demand of the expanding human population. This has resulted into destruction of vegetation in the catchment areas and overgrazing. The extent to which these activities have affected groundwater quality and quantity of the basin is yet to be assessed.

In the immediate vicinity of the project area, small streams generally flowing in a north-westerly direction through the undulating topography drains the area. This direction is also taken to be the groundwater flow direction.

GEOPHYSICAL EXPLORATION- Electrical Resistivity Method

A great variety of geophysical methods are available to assist in the assessment of geological subsurface conditions. In the present survey, the resistivity method (also known as geo-electrical method) has been applied using an ATLAS COPCO DC resistivity set comprising an ABEM SAS 300B Terrameter. The main emphasis of the fieldwork was to detect vertical changes and in essence determine the thickness and composition of the prevailing rock formation, the presence of faults and to trace water- bearing zones. This information is obtained in the field using the resistivity method, mainly Vertical Electrical Sounding (VES).

The resistivity profiling method is used to trace lateral variation in resistivity to locate fractured and fault zones so as to identify sites most suitable for sounding. This is carried out with an appropriate AB and MN separations, with the right spacing between stations.
A graduated schlumberger configuration with a maximum AB separation of 160 metres was employed for the soundings. The soundings (depth probe) investigates vertical variation in lithology, porosity and degree of pore space saturation and salinity at a given point. Both the investigational approaches are expected to indicate the possible faults, fractures, weathered rock zones and contacts of different rock types which are a pointer to rock/strata variation or groundwater availability.

The geophysical data so collected are plotted in the field but qualitative interpretation is obtained with the aid of a computer. The results are compared and a possible zone of interest or location identified.

BASIC PRINCIPLE OF THE RESISTIVITY METHOD

The electrical properties of rocks in the upper part of the earth's crust are dependent upon the lithology, porosity, the degree of pore space saturation and the salinity of the pore water. Saturated rocks have lower resistivities than unsaturated and dry rocks. The higher the porosity of the saturated rock, the lower its resistivity, and the higher the salinity of the saturating fluids the lower the resistivity. The presence of clays and conductive also reduce the resistivity of the rocks. The resistivity of earth materials can be studied by measuring the electrical potential distribution produced at the earth's surface by an electric current that is passed through the earth.
The resistivity R, of a certain material is directly proportional to its length L, and cross-sectional area A, expressed as:-

$$R = \rho . L/A \qquad \text{(in Ohm)}$$

Where ρ is known as the specific resistivity, characteristic of the material and independent of its shape or size.
With Ohm's Law:-

$$R = \delta V/I \qquad \text{(in Ohm)}$$

Where δV is the potential difference across the resistor and I is the electric current through the resistor, the specific resistivity may be determined by:-

$$\rho = (A/L)*(\delta V/I) \qquad \text{(in Ohm-metre)}$$

Vertical Electrical Sounding

When carrying out a resistivity sounding, electric current is sent into the ground by means of two current electrodes. With two other electrodes situated near the centre of the array the potential field generated by the current is measured. From observations of the current strength and the potential difference, and taking into account the electrode separations, the ground resistivity can be determined.
While carrying out a resistivity sounding, the separation between the electrodes is increased stepwise (in what is known as Schlumberger Array), thus causing the flow of current to greater depths. By plotting the observed resistivity values against depth on a double logarithmic paper a graph of resistivity verses depth is obtained.

The depth by resistivity values provide a hydrogeologist with information on the geological layering and thus the occurrence of groundwater.

INTERPRETATION OF THE DATA

The resistivity data collected were correlated with mean resistivity of the rock formation as established during previous investigations in the area and other neighbouring areas but with similar geological set-up. The summaries of the resistivities of the various rock types as documented from the available literature and reports are given in the table below for comparison.

Table: Tentative correlation between lithology, degree of weathering and resistivity in Western region. (Extracted from a report compiled by Lake Basin Development Authority).

GRADE OF WEATHERING	LITHOLOGY				
	Kc	Nr	Na	Nb	G
Decomposed, altered (with fresh groundwater)	5 - 15	10 - 30	5 - 15	5 - 10	20 - 50
Weathered (with fresh groundwater)	15 - 50	30 - 100	15 - 60	10 - 25	200 - 300
Partly weathered (with fresh groundwater)	50 - 100	300 - 400	60 - 100	25 - 50	300 - 800
Weathered (Dry)	100 - 200	400 - 600	100 - 200	100	800 - 1200
Fresh	200 - 500	600 - 1000	200 - 500	200 - 400	>2000

KEY:

Kc = Kavirondian rocks
Nr = Nyanzian Rhyolites
Na = Nyanzian Andesites
Nb = Nyanzian meta-basalts
G = Granites

The table given below details the interpretation made from the field data, curve interpretation and the expected formation corresponding to each.

SITE NAME/ LOCATION	VES NO.	LAYER NO.	RESISTIVITY (Ohm-metre)	MAX. DEPTH (m)	EXPECTED FORMATION
Munyanza Primary School	1.	I.	192.14	0.33	Top soil, wet
		2	584.04	9.00	Lateritic soils, Dry
		3	162.60	14.39	Weathered formation
		4	12.25	37.84	Decomposed/ Highly weathered formation, water
		5	49.60	-	Partly weathered formation (water bearing)

CONCLUSION AND RECOMMENDATIONS

From the above hydrogeological and geophysical information the following conclusions were made:

a) The project area is underlain by sedimentary rocks of the Kavirondian systems which are in turn overlain by Pleistocene to Recent sediments.

b) Groundwater potential is good. The water bearing formation is the decomposed, highly weathered and occasionally fractured Kavirondian formation. In some areas the thick overburden act as an aquifer.

c) Data from resistivity profiling and the information obtained from the existing boreholes and dugwells indicates a high degree of weathering at certain points. This can sometime cause difficulty during well construction particularly collapsing of well walls.

RECOMMENDATIONS

In view of the aforementioned, it is therefore recommended as follows:

a) That a borehole be drilled at the selected site at the point of **VES-1** to a possible maximum depth of 80m.

b) That the proposed borehole **MUST** be equipped with a master meter and an airline/piezometer to facilitate monitoring of groundwater abstraction and water rest levels respectively.

c) That chemical, physical and bacteriological analysis of water from the borehole **MUST** be carried out before it is made available for human consumption.

d) All the standard measures must be taken into consideration to ensure proper well construction and to limit possible contaminants.

NOTE

- All drilling and construction works must be supervised by a qualified and competent hydrogeologist.
- The proposed drilling site is known to Mr. Ashira and the Headmaster of the school and it is also approximately marked on the attached map extract.

OBIRI, J.O.
FOR: REGIONAL MANAGER
LAKE VICTORIA NORTH CATCHMENT AREA