HYDROGEOPHYSICAL INVESTIGATION FOR BOREHOLE DEVELOPMENT, AWO EKITI, EKITI STATE.

CLIENT: NAME WITHELD FOR PRIVACY

CONSULTANT: MUKOLAK GEOCONSULT NIG. LTD.

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EXECUTIVE SUMMARY

A pre-drilling geophysical investigation was conducted within a residential building site at Awo-Ekiti, Ekiti State for groundwater development. The survey engaged the Electrical Resistivity Geophysical Method by utilizing both the Horizontal profiling technique as well as the Schlumberger depth sounding technique. On the traverses established at the side (Traverse 1) and front of the building (Traverse 2), horizontal profiling (HP) technique was carried out along the traverse to locate prospective Vertical Electrical Sounding (VES) points along the traverse. Hence, VES point 1 was located at 5m on traverse 1, VES locations 2, 3, 4 and 5 were acquired at locations 30m, 40m, 55m and 65 from station 0 on traverse 2. The interpretation of the VES data showed that, curve type AA was delineated at VES 1 whereas HA was delineated at VES 2, 3, 4 and 5 implying that 4 geoelectric layers can be inferred for the five locations.

Further interpretation revealed that the area is underlain by Top Soil, Weathered Layer, Partially Weathered Layer, and Basement at the five locations. In addition, at the VES locations, the top soil has a resistivity value range (37 – 70 ohm-m) with thickness (1.2 – 2.4 m), the weathered layer has a resistivity value range (27 – 66 ohm-m) with thickness (4.3 – 8.1 m). Also, the partially weathered layer has a resistivity value range of (136 – 191 ohm-m) with thickness (9.2 – 12.8m) and the basement has a resistivity value range (650 – 1344 ohm-m) with infinite thickness**. The formation dominating the VES points play an important role in their suitability for groundwater prominence. As thus, VES 1 and 5 falling within the clay environment which might have been weathered from either Granite or Charnockite is unsuitable for groundwater abstraction. VES 2 and 3 fall within the Quartzite formation suggesting they might be harnessed for groundwater development whereas VES 4 fall within the boundary of the Quartzite and Clay environment. Albeit, overburden thickness as well as the indication of groundwater saturation from the resistivity value can be adopted for selecting utmost groundwater viability VES points. Consequently, VES 3 is selected as the only viable point for groundwater abstraction since it does possess higher thickness, higher overburden thickness as well as more saturation indication relative to VES 2 and 4. Nonetheless, VES 3 does not support borehole drilling as the relatively shallow depth to the partially weathered layer which served as the target layer possess drilling acquisition bottleneck at this location. As a result, it is therefore recommended that only hand dug well can be acquired at VES location 3 to a depth range of 10 – 15m (33 – 50ft).**

It should however be pointed out that the electrical resistivity survey simply identifies physical structures like (fractured layer) within a rock body but does not guarantee the occurrence of

water in it as it could be filled with ore body for example (Like electrical conductivity material) or may be a dry fracture. However, the electrical method has an excellent track record when it comes to finding useful quantities of water in hard rock. It should also be stated here that the quantity of water depends solely on the rock materials in which the water interacts over the years. A geophysicist is therefore not liable to either quantify and /or describe the quality of the groundwater obtained at a VES location as they are absolutely a function of nature.

1.0 INTRODUCTION

The use of surface geophysics in evaluating the groundwater condition of an area is important not only in reducing the wild cat search through drilling but in locating the best probable point in an area thereby allowing for comparison and scientific guidance to control the choice of location. Therefore, the geophysical investigation is employed to highlight the following objectives:

(i) **the geoelectric sequence/subsurface geology of the area**

(ii) **the geoelectric parameters of the area**

(iii) **the probable aquiferous units and the nature/characteristics of the aquifer**

(iii) **the depth to the aquifer**

This will assist greatly in borehole design, drilling and development of the well.

2.0 SITE DESCRIPTION

The study area is a residential building site located at Awo-Ekiti, Ekiti State. The use of groundwater is desirable for the domestic use of people due to its portability and sustainability. Within the study area, there is an existing failed hand dug well as well as a seasonal productive hand dug well. The indication of this reconnaissance evaluation is that if the geology is right, it may be difficult to assess viable borehole drilling point within the study area. Thus the data acquisition process was done to first assess the suitability of the geology in the study area to which horizontal profiling (HP) technique was carried out on the established traverses to locate anomalous resistivity zones for further investigation involving VES data acquisition. Thus, VES point 1 was located at 5m on traverse 1, VES locations 2, 3, 4 and 5 were acquired at locations 30m, 40m, 55m and 65 from station 0 on traverse 2 (Fig 1).

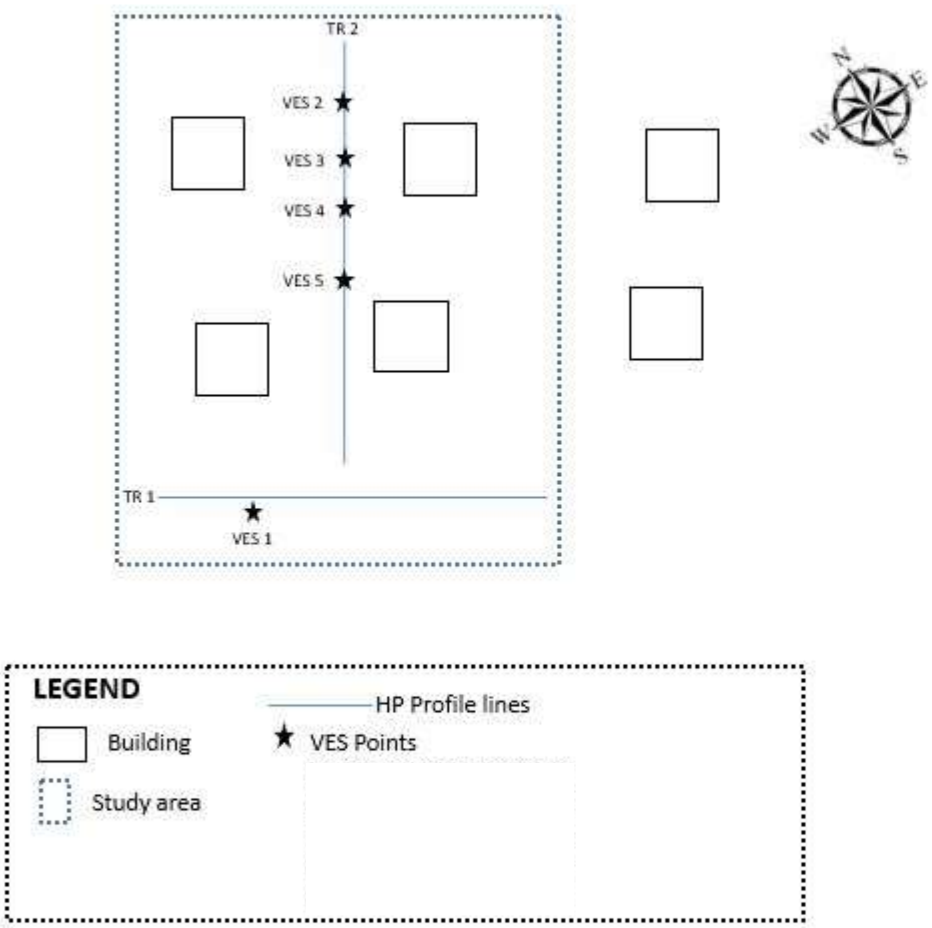

Fig. 1: Layout map of the study area, Alhaji Yemi Lawal Site, Awo Ekiti, Ekiti State

3.0 GEOLOGY AND GEOMORPHOLOGY

Mainly, Precambrian basement complex rocks such as Granite have underlain the study area. The study area is situated on a relatively high terrain (566 -574m) above the sea level with the topography being slightly undulating. There is no visible presence of outcrops in the study area. Also, there is presence of vegetation within the study area

4.0 GEOPHYSICAL INVESTIGATION

The geophysical investigation employed both the horizontal profiling (HP) using Wenner array as well as the Vertical Electrical Sounding (VES) technique employing the normal Schlumberger array (Fig. 2). In the HP technique employing wenner array, the two potential electrodes were located within the two current electrodes and an electrode spacing of 20m was adopted. Measurement were taken at each station positions which were 5m apart from each other until the whole station were exhausted within the established traverse. In the VES approach employing Schlumberger configuration, with the potential electrodes located within the current electrodes, the half current electrode (AB/2) spreading starting from 1m and reaching a maximum spread of 100m was adopted. The PASSI earth resistivity meter was used as the geophysical measuring equipment and the whole processes adopted were geared towards good and accurate data acquisition.

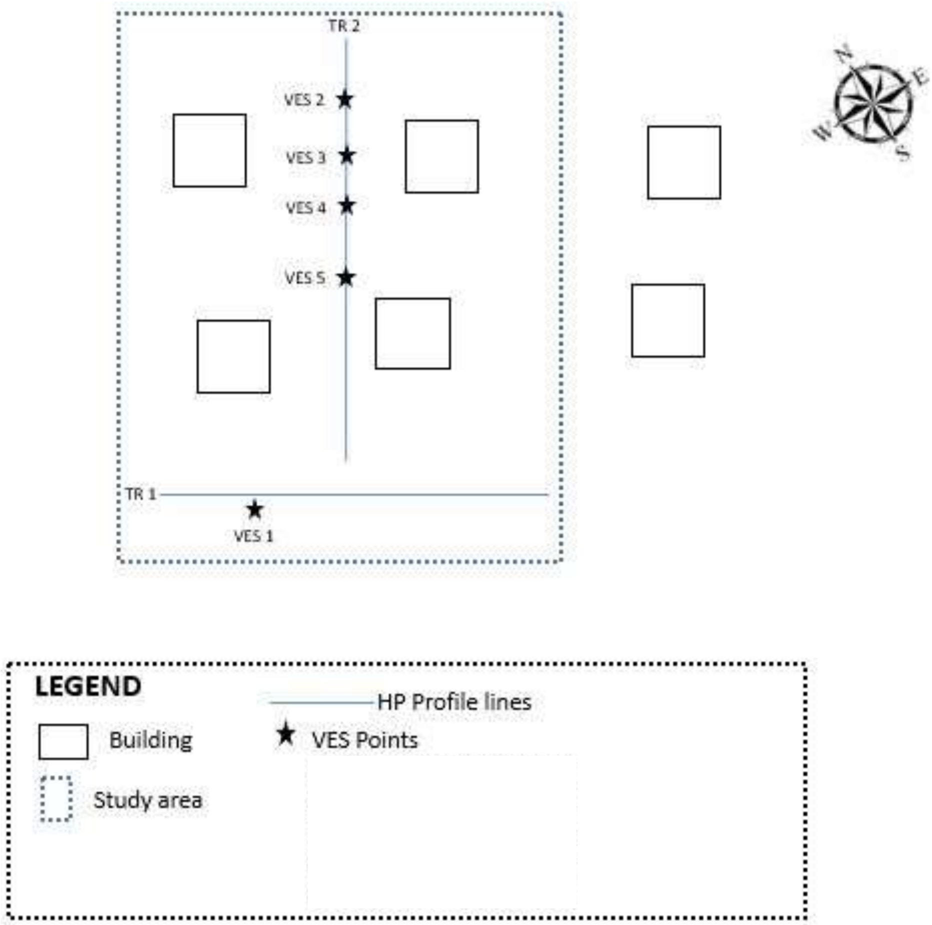

Fig. 2: Data acquisition map of the study area

5.0 DATA PRESENTATION AND INTERPRETATION

Geophysical data can be presented in the form of depth sounding curves, profiles, maps, sections and tables. For this study, the use of profile, depth sounding curves and tables in discussing and establishing the relevant subsurface layers and basement structures for the target were adopted.

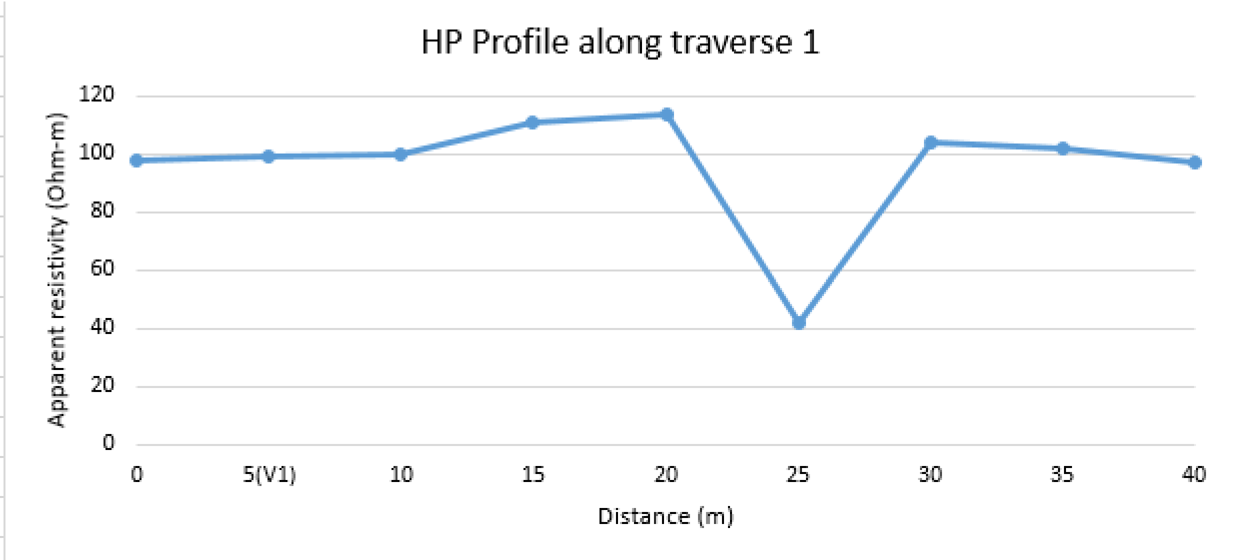

Fig. 3a: Horizontal profile along traverse 1

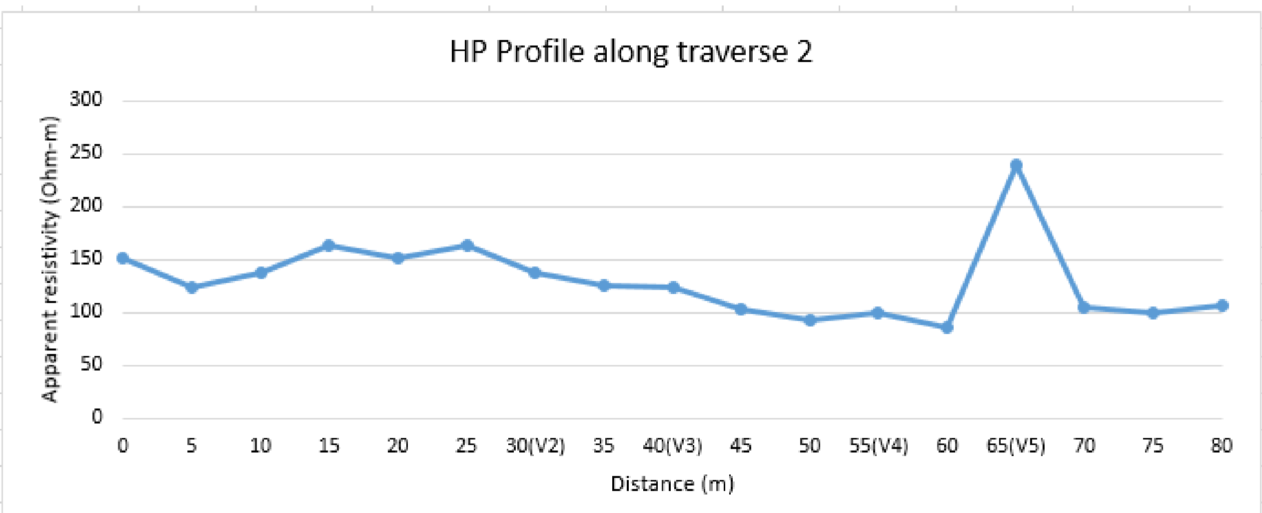

Fig. 3b: Horizontal profile along traverse 2

Figure 3a and b shows the horizontal profile (HP) along the traverses 1 and 2 respectively indicating anomalous resistivity value location to which Vertical Electrical Sounding (VES) points were acquired at the traverse. Hence, VES point 1 was located at 5m on traverse 1, VES locations 2, 3, 4 and 5 were acquired at locations 30m, 40m, 55m and 65 from station 0 on traverse 2.

The results of the VES quantitative interpretation are shown in (Tables 3a, b, c, d and e) as geoelectric parameters.

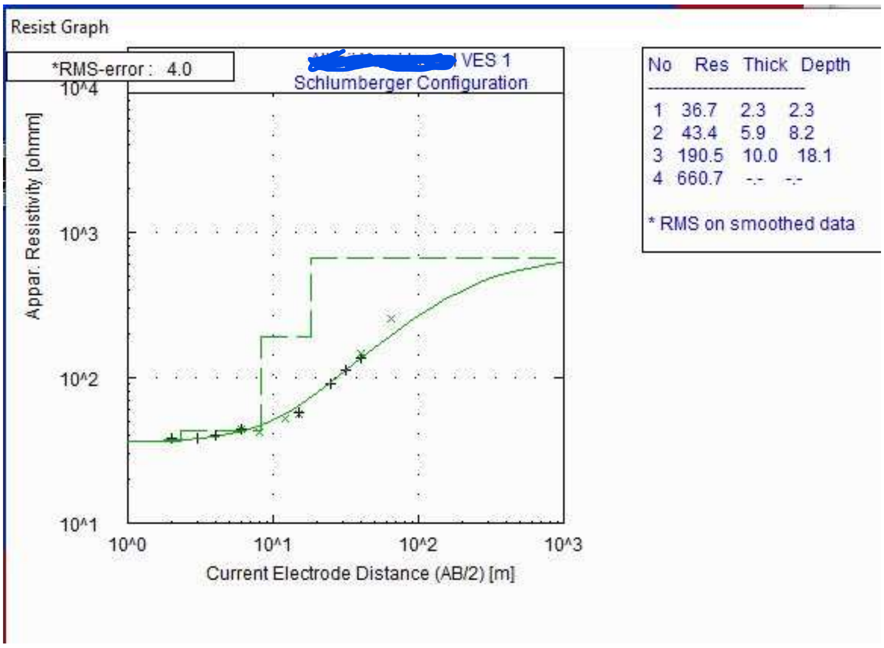

Fig. 4a: Depth sounding curve for VES 1

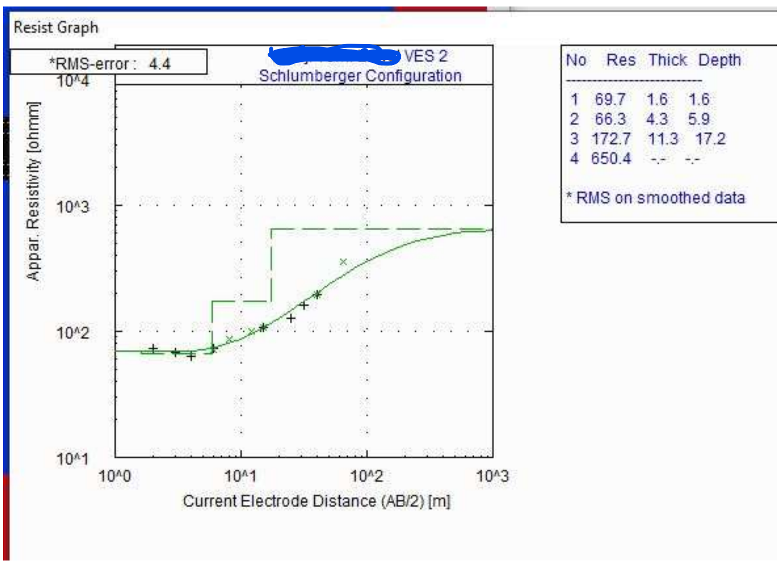

Fig. 4b: Depth sounding curve for VES 2

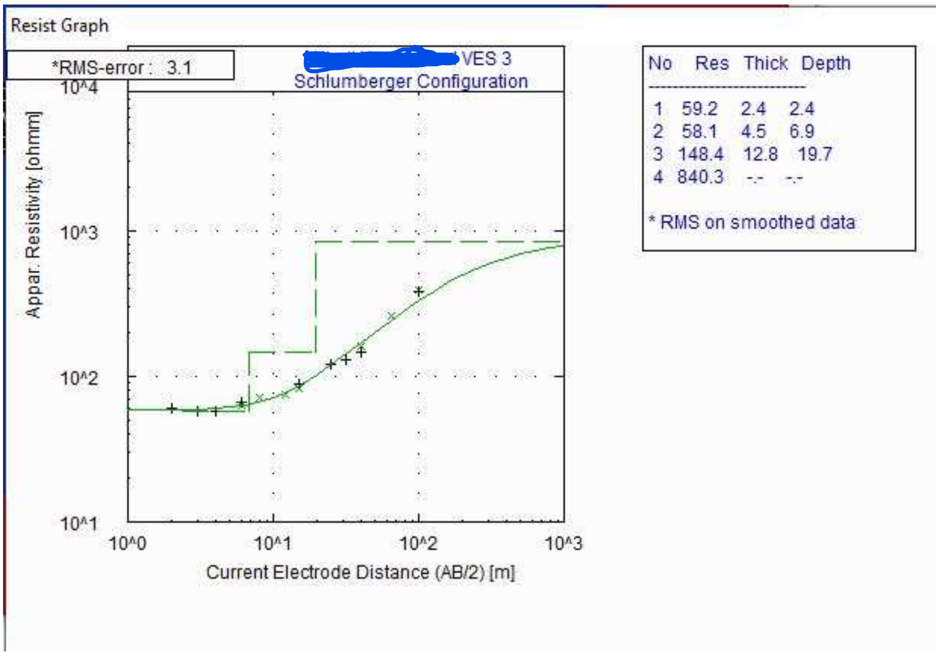

Fig. 4c: Depth sounding curve for VES 3

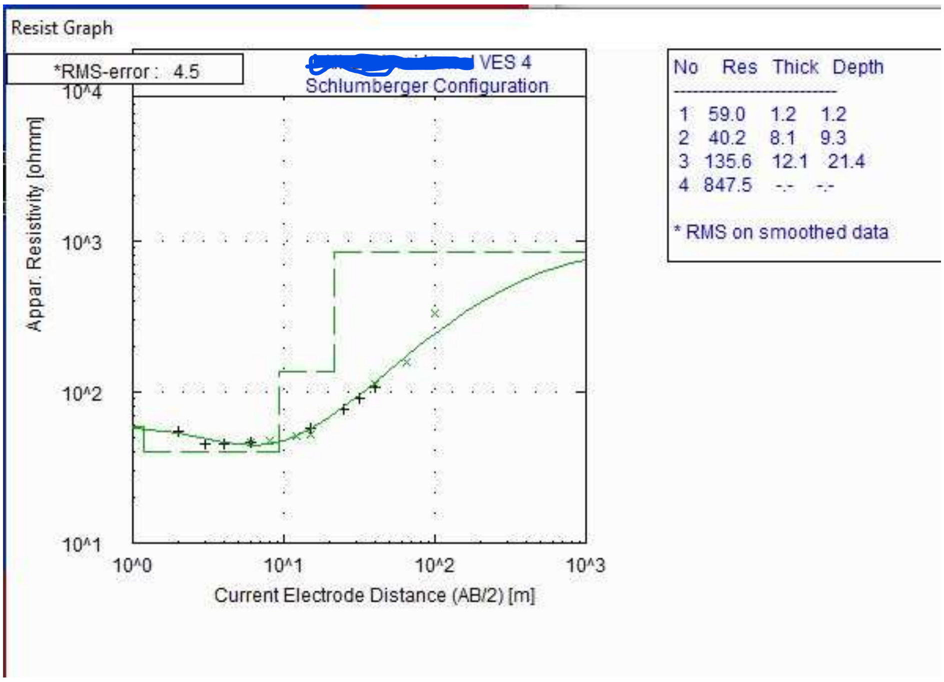

Fig. 4d: Depth sounding curve for VES 4

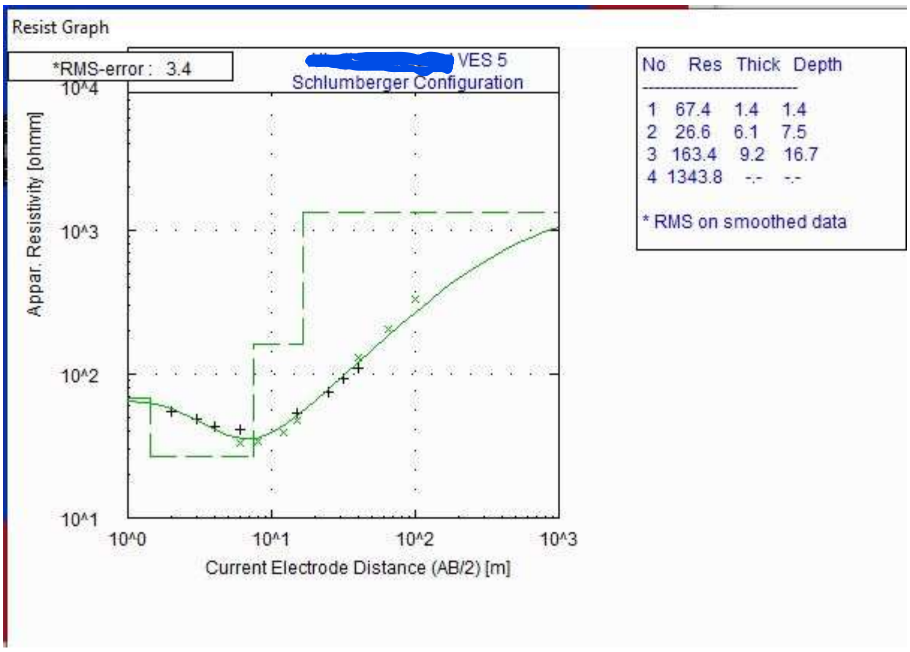

Fig. 4d: Depth sounding curve for VES 5

Table 3a: VES Interpreted Results (V1)

S/N	Resistivity (Ωm)	Thickness (m)	Depth (m)	Lithologic Equivalence
1	37	2.3	2.3	Topsoil
2	43	5.9	8.2	Weathered layer
3	191	10	18.1	Partially Weathered Layer
4	661	-	-	Basement

Table 3b: VES Interpreted Results (V2)

S/N	Resistivity (Ωm)	Thickness (m)	Depth (m)	Lithologic Equivalence
1	70	1.6	1.6	Topsoil
2	66	4.3	5.9	Weathered Layer
3	173	11.3	17.2	Partially Weathered Layer

4	650	-	-	Basement

Table 3c: VES Interpreted Results (V3)

S/N	Resistivity (Ωm)	Thickness (m)	Depth (m)	Lithologic Equivalence
1	59	2.4	2.4	Topsoil
2	58	4.5	6.9	Weathered Layer
3	148	12.8	19.7	Partially Weathered Layer
4	840	-	-	Basement

Table 3d: VES Interpreted Results (V4)

S/N	Resistivity (Ωm)	Thickness (m)	Depth (m)	Lithologic Equivalence
1	59	1.2	1.2	Topsoil
2	46	8.1	9.3	Weathered Layer
3	136	12.1	21.4	Partially Weathered Layer
4	848	-	-	Fresh Basement

Table 3e: VES Interpreted Results (V5)

S/N	Resistivity (Ωm)	Thickness (m)	Depth (m)	Lithologic Equivalence
1	67	1.4	1.4	Topsoil
2	27	6.1	7.5	Weathered Layer
3	163	9.2	16.7	Partially Weathered Layer
4	1344	-	-	Fresh Basement

From Tables 3a, b, c and d, the geo-electric parameters obtained from depth sounding at the five VES locations V1, V2, V3, V4 and V5 classified the area into four geo-electric layers. Further interpretation revealed that the area is underlain by Top Soil, Weathered Layer, Partially Weathered

Layer, and Basement at the five locations. In addition, at the VES locations, the top soil has a resistivity value range (37 – 70 ohm-m) with thickness (1.2 – 2.4 m), the weathered layer has a resistivity value range (27 – 66 ohm-m) with thickness (4.3 – 8.1 m). Also, the partially weathered layer has a resistivity value range of (136 – 191 ohm-m) with thickness (9.2 – 12.8m) and the basement has a resistivity value range (650 – 1344 ohm-m) with infinite thickness. **The weathered layer in the locations do not offer groundwater prominence since judging from the resistivity values, it will be clayish nature indicating less permeability which offers threat for efficient groundwater potential. Furthermore, the fairly thin overburden of the partially weathered layer which is the target layer offers negative effect on the groundwater abstraction through borehole drilling. However, due to the relatively higher thickness of this partially weathered layer at VES 3, it offers suitability for groundwater abstraction through hand dug well to a reasonable depth.**

GROUNDWATER POTENTIAL EVALUATION

In a typical basement terrain, the groundwater prospect is hinged on a fairly thick overburden and weathered layer with resistivity parameters compatible with groundwater saturation. The weathered layer in the study area is clayish in nature and due to the relatively lower permeability nature of clay, it is unsuitable for groundwater abstraction. Nevertheless, the partially weathered layer offers sufficient prospect for groundwater exploitation through hand dug well. **In view of this, the four VES locations 1, 2, 4 and 5 are therefore unsuitable for groundwater exploitation through either borehole development or hand dug well whereas VES location 3 support exploitation through hand dug well**

CONCLUSION

The most promising lithologic unit for groundwater occurrence within the study area would have been the weathered layer supposed it is not clayish in nature which forfeited it to be suitable for groundwater abstraction. However, the partially weathered layer offers prominence judging from its resistivity value being compatible with groundwater saturation. Therefore, such locations can be harnessed for groundwater development leveraging appropriate means.

RECOMMENDATION

It is therefore recommended that groundwater abstraction through borehole development is not feasible at the five VES locations 1, 2, 3, 4 and 5. However, a shallow hand dug well to a depth of about 10m – 15m (33 – 50ft) is proposed at VES 3.