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GEOPHYSICAL INVESTIGATION ON THE FRACTURE DISTRIBUTION OF IWO-OLUPONA AREA SOUTH-WESTERN NIGERIA USING VLF-EM TECHNIQUES

L. A. Sunmonu, K. O. Suleman, I. T. Bello*, L. O. Tijani and A. O. Ogunbode

Department of Pure and Applied Physics, Faculty of Pure and Applied Sciences, Ladoke Akintola University of Technology, PMB 4000, Ogbomoso, Oyo state. Nigeria.

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ABSTRACT

This work uses Very Low Frequency Electromagnetic (VLF-EM) method to investigate the subsurface structure on a proposed Housing estate in Iwo, South-Western Nigeria with coordinates 7° 36’ 36.3” N and Longitude ≈ 4° 12’ 06.6” E. The average VLF frequency employed during the field work is 20.8 kHz with average signal strength of 17dBm and the measuring interval of 20m. The data obtained by the VLF-EM method were analysed by 2D-line Plotting. Raw real, R (In phase) and the imagining, I (quadrature) components were measured on the field. The Raw Real and filtered real data were plotted against stations on the same graph using excel, the graphs obtained are sinusoidal in shape with the peak indicating a conductive zones, resulting from weak geologic materials that may be due to fracture, joints, crack, and the trough indicates a non-conductive zones, associated with competent material which may be attributed to fresh basement material or resistive geological formation.

Key words: Fracture, conductive zone, weak zone, structural displacement, frequency

Author Correspondence, e-mail: itbello@student.lautech.edu.ng

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1. INTRODUCTION

In recent years, the use of integrated geophysical method of investigations have found useful and increasing applications in many geological studies which ranges from shallow engineering studies, groundwater and mineral deposits explorations as well as in a variety of geo-environmental studies that includes investigations of contaminated sites or waste disposal areas [1-4]. High urbanization rate and urgent need for natural resources on one hand and non-invasive character of the geophysical methods such as geo-electrics, electromagnetic methods, very low frequency (VLF), and induced polarization (IP), which can provide information over larger areas, are said to expedite this trend [5-9].

As reported by Coker *et al*., 2009, the search for ground water is faced with lots of uncertainties. The use of the right exploration techniques in the delineation of subsurface water- bearing formations will in no little measure, minimize or avoid altogether, this uncertainties [10].

Bernstone *et. al*., 2000; Karlık and Kaya 2001; Oskooi and Pedersen, 2005 while solving various problems, have all used geo-electric and electromagnetic methods in their investigations to a greater precision and accuracy [11-13]. Saydam, 1981; Ligas and Palmoba, 2006; Babu *et al*., 2007 have all identified the VLF-EM, in respect of mineral exploration and related geological structures, as a well-known method for quick mapping of near surface geologic structures [14-16]. The work of Wright, 1988; McNeill and Labson, 1991 as well as that of many other researchers have shown that, when compared with other electromagnetic methods, the VLF-EM method is one of the most used and is adequately described [17-18].

The method uses radio signals from worldwide network transmitter stations which operate in frequency ranges of between 5 kHz and 30 kHz. Chouteau *et al*., 1996; Gharibi and Pedersen, 1999 reported thatthe underlying principle of this method of survey is to exploit the fact that the ratio of the secondary vertical magnetic component to the horizontal primary magnetic field is a measure of conductivity/resistivity contrast since this tipper component is of internal origin of the anomalous body [19-20].

As a result of the above, VLF-EM technique have been employed in this study as the mapping tool with the overall objective of geophysical mapping for possible detection of buried subsurface structural features (such as fractures, quartz or pegmatite veins) in respect of fracture distribution prospects located at the outskirt of the study area (Iwo, Osun State) Nigeria. There is present evidence of fracture distribution within Iwo basement complex which is predominantly within a farmland grown with cassava at a coordinate of about 7° 36' 36.3" N and Longitude ≈ 4° 12' 06.6" E. The study area (iwo-olupona)is located at 7°30′–7°36′N latitude and 3°40′–4°12′E longitude. This region lies within the tropical rain forest of Nigeria that has two distinct seasons (wet, April–October; and dry, November– March). The annual mean rainfall is about 1,600 mm. The diurnal range in temperature is not significant, but the daily temperature can reach 29 °C and is seldom lower than 25 °C. The water table in the region is generally found at less than 12 m in depth from the ground surface. The study is also partly intended to possible structural features (fractures and fresh basement rocks). The VLF-EM techniques are expected to provide information on the subsurface structural features in respect of fracture distribution potential in the study area and possible further localized geophysical investigation. The quantity and deposition of ground water depends on the geological characteristics of the host rock formation.

2. RESULTS AND DISCUSSION

In this research, the geophysical investigation on the fracture distribution of Iwo-Olupona Area South-western Nigeria Using VLF-EM Techniques is presented. The raw real (blue) in the graphs below indicate that the raw results observed from the field work which has been affected by some anomallies such as interference , noise, temperature inversion, near resitivity and so on while, the filtered real (pink) in the graphs below indicate that the anomallies that affected the raw data has been filtered. Also in the graphs below the positive peaks indicate conducting areas which may be due to faults zones, fractures zones and shears zonesWhile, the negative peaks indicate non – conducting which may be due to fresh basement. Peaks of the pinks are well defined because they are filtered, so the peaks of the pink graphs will be consider most in this discussion.

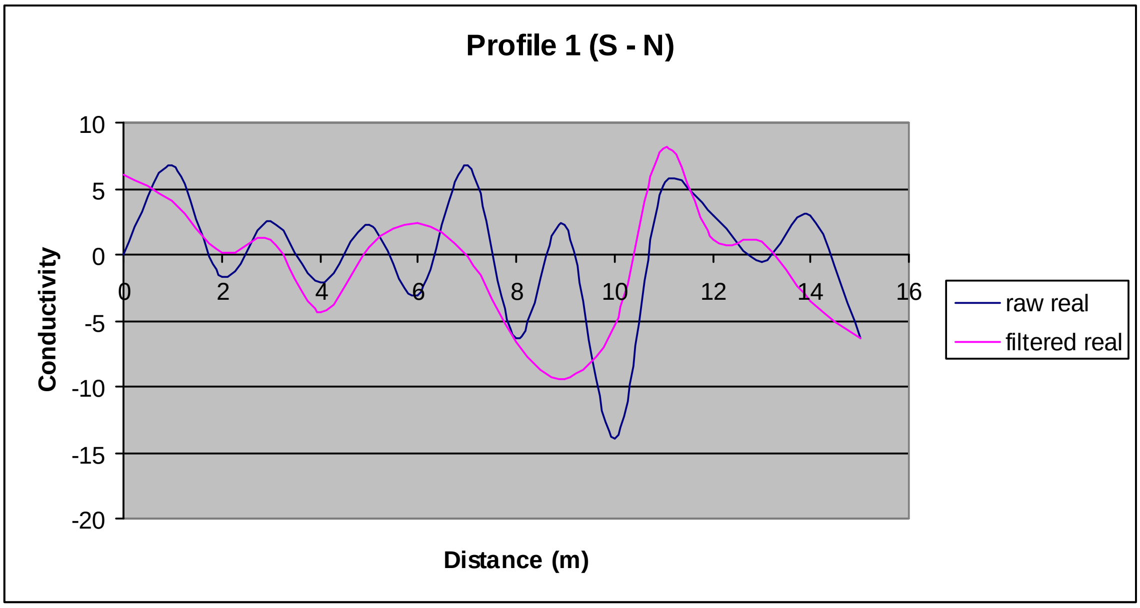

Fig.1. Profile 1(S - N); from the Southern part to the Northern part of the study Area

Figure (1),shown the profile 1 (S - N), the negative peak from 32m to 50m indicate non – conducting area due to small fresh basement while, the broad positive peak from 50m to 70m indicate conducting area due to fractures of a large extension. Also the negative from 70m to 102m shows that the areas are non – conducting of a large fresh basement, while the positive peak from 102m to 120m indicate conducting area due to fracture of a sharp or shallow void and the areas are not suitable for any construction rather than ground water development.

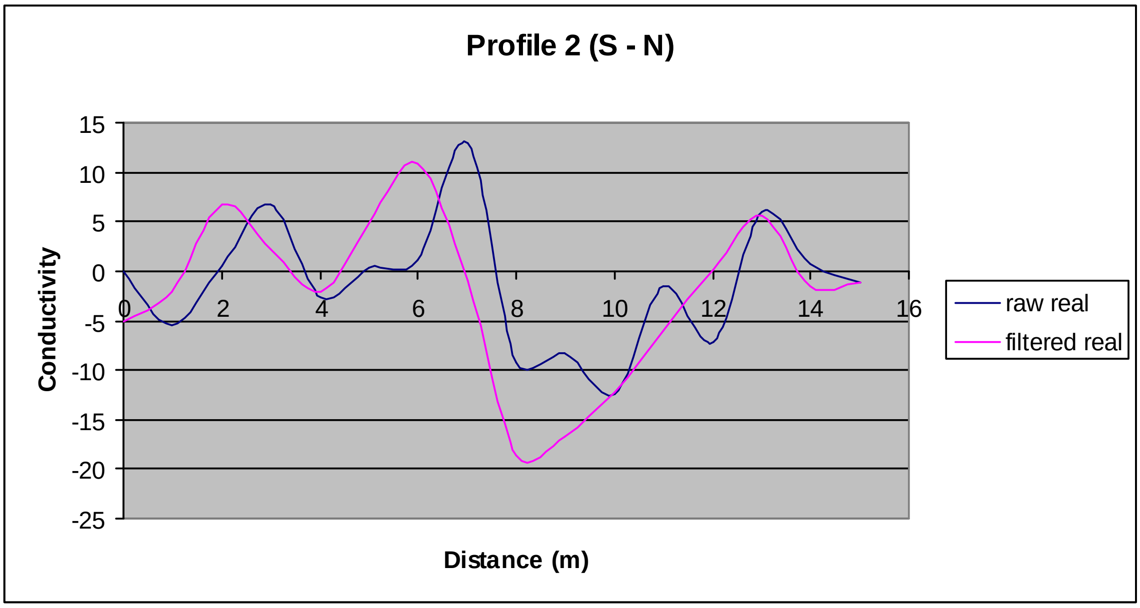

Fig.2. Profile 2(S - N); from the Southern part to the Northern part of the study Area

In Figure (2), which shown the profile 2 (S - N), the positive peak from 16m to 37m indicate conducting or weak area due fault/ fracture zone while, the sharp positive peak from 42m to 70m indicate conducting area due to fractures and the areas are suitable for ground water development. Also the negative from 70m to 120m shows that the areas are non – conducting or non – weak zones of a large fresh basement, hard rock or near surface material while, the positive peak from 120m to 139m indicate conducting area due to fracture of a very narrow hole.

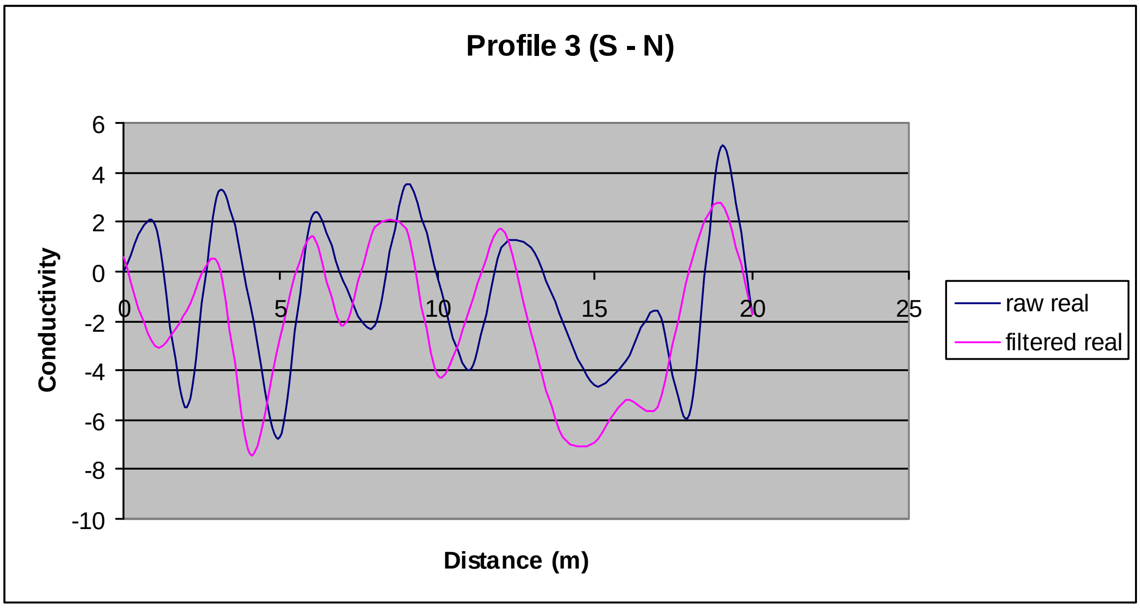

Fig.3. Profile 3(S - N); from the Southern part to the Northern part of the study Area

Figure (3), shown profile 3 (S - N), the negative peaks from 0 to 200m are well distributed, this shows that the area non – conducting zones which may due to fresh rock basement While, the positive peaks from 0 to 200m are conducting areas due to small fracture zones.

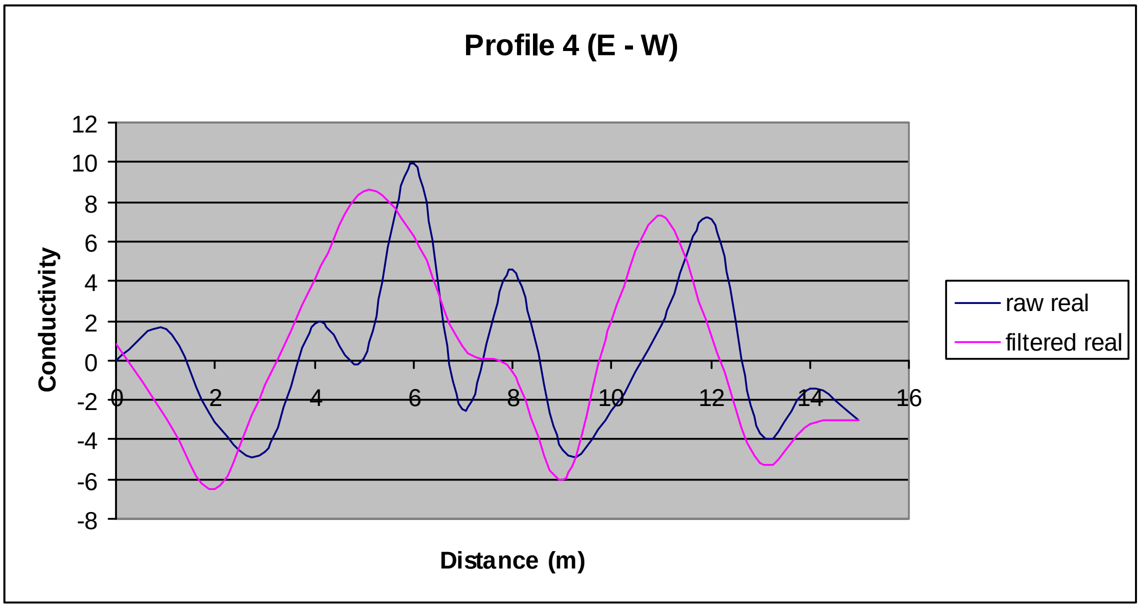

Fig.4. Profile 4(S - N); from the Eastern part to the Western part of the study Area

In Figure (4), that shown the profile 4 (E - W), the negative peak of sharp curves from 5m to 31m and from 80m to 90m indicate the non – conducting area due to large fresh rocks basement While, the positive peaks of sharp curves from 31m to 80m and from 90m to120m indicate conducting area which may be due to fracture, fault and shears zones of large or shallow void, so these areas is good for groundwater development.

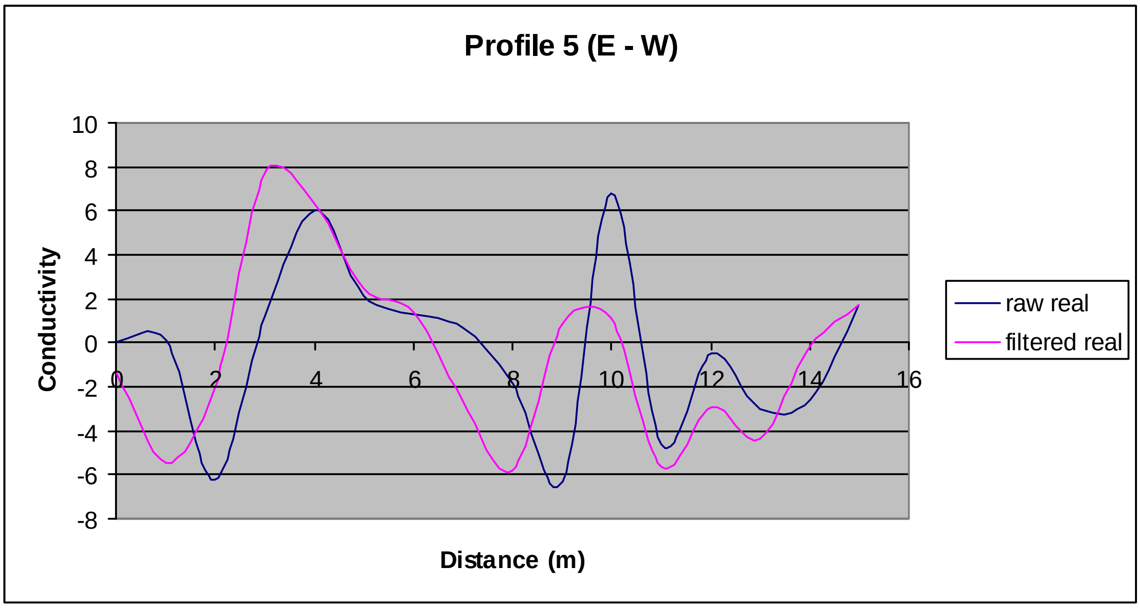

Fig.5. Profile 5(S - N); from the Eastern part to the Western part of the study Area

Figure (5), shown the profile 5 (E - W), the sharp positive peak from 21m to 61m are conducting or weak areas which may be due to fault or fractures zone of deep void and these areas remain the best area for groundwater exploration While, the negative peaks from 0 to 120m shows the non – conducting area of fresh rock basement which may be good for engineering purpose such as construction of bridges, building e.t.c.

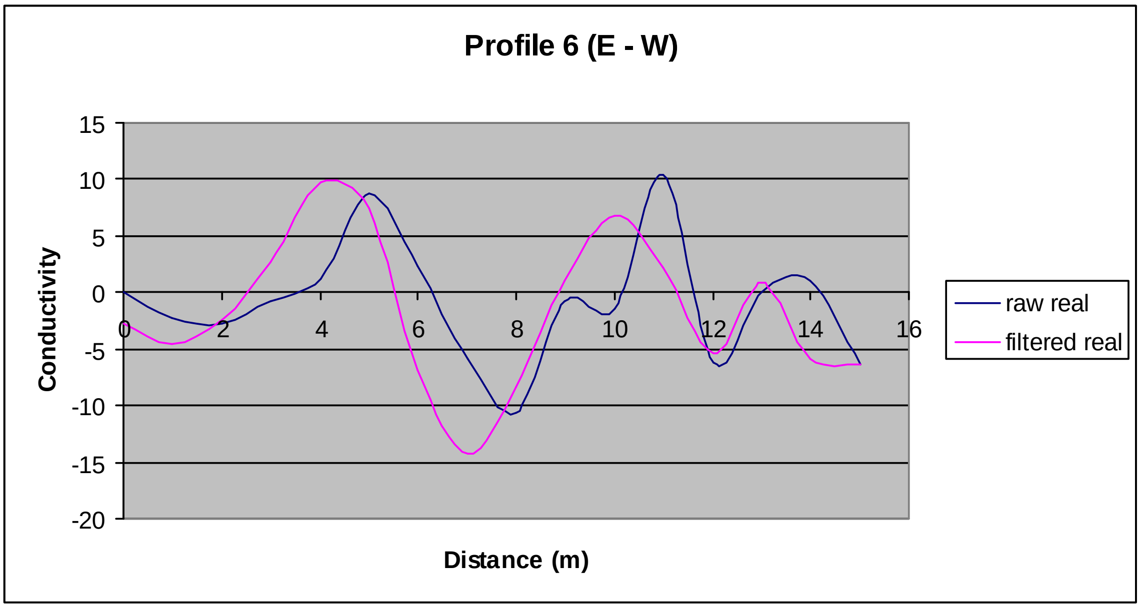

Fig.6. Profile 6(S - N); from the Eastern part to the Western part of the study Area

Figure (6), shown the profile 6 (E - W), the positive peaks from 22m to 58m and from 84m to 116m indicates conducting or weak area due to fracture distribution which may be good ground water development While, negative from o to 22m and sharp curves peaks from 58m to 84m indicate non conducting areas which may be due to fresh rock basement, hard rock or near surface material.

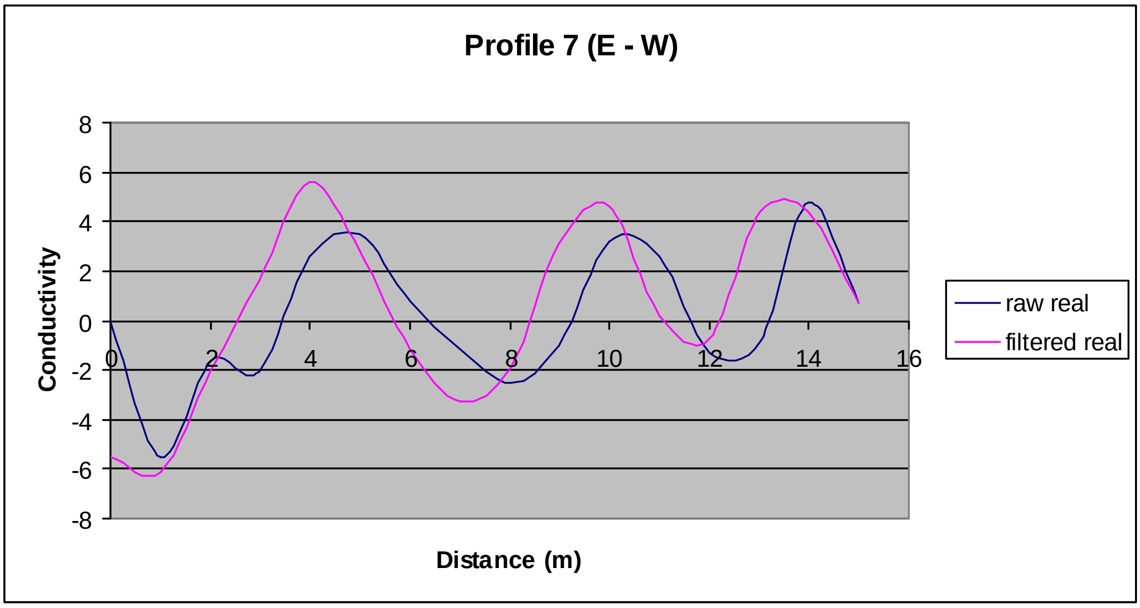

Fig.7. Profile 7(S - N); from the Eastern part to the Western part of the study Area

Figure (7), also shown the profile 7 (E - W), the positive peaks from 22m to 59m, from 82m to 115m and from 120m to 145m of relatively the same peaks indicate conducting areas which shows that the deep fracture are evenly distributed While, the negative peaks from 0 to 120m indicate non – conducting areas due to fresh basement of rocks, hard rock or near surface material like magnetic intrusive.

3. MATERIALS AND METHODS

The research carried out in this work was performed using ABEM WADI equipment (plate1). The raw real VLF were converted with the aid of an in-built filtering program provided in the ABEM WADI equipment as well as a software package (KHF filt version 1.0, pirttijarvi 2004), into filtered real data in which an anomaly infection appear as peak positive anomalies and false VLF anomaly infection as negative anomalies of the profiles. The average VLF frequency in the field work was 20.8kHz with the average signal strength of 17dBm and the measuring interval of 20m. The Raw Real and filtered real against stations where plotted on the same graph using excel, the graph are inform of sinusoidal graph, its peak is conductive or weak zone and the through of the graph is non-conductive or non-weak zone.

Plate 1: ABEM WADI INSTRUMENT AND GADGET

4. CONCLUSION

This research revealed an even distribution of deeper fracture in the east western part of the study area which remain the best area for groundwater development while the remaining part are suited for good structural construction such as bridges constructions, buildings and so on. This shows that the initial designated of the study area as a residential site remain the best which shall enable the residence to construct buildings and drilling of borehole for domestic purpose.

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