GROUNDWATER POTENTIAL MAP OF MINNA: A PRACTICAL GUIDE

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INTRODUCTION

Groundwater is the source of water for wells, boreholes and springs. It occurs below the surface within cracks in bedrock or filling the spaces between particles of soil and rocks (Offodile, 2002). Approximately over half the population of Minna (>350,000, NPC 1991) rely on groundwater for drinking water and over 90% of those living in the environs obtain their water from groundwater through wells and boreholes. In its natural state, ground water is usually of excellent quality and can be used with no costly treatment or purification.

Minna is the capital of Niger State, and lies between latitudes 9°32'N and 9°41'N and longitudes 6°28'E and 6°37'E, covering an approximate surface total area of 105km^2. The area is easily accessible through Abuja-Dikko-Lambata-Tegina, Lagos-Mokwa-Bida and Kaduna- Sarkin Pawa roads. It has an annual rainfall of about 2500mm with a distinct rainy and dry seasons experienced between April to October and between November to March respectively. It has a mean temperature of 27°C in the rainy season and 35°C at the peak of the dry season with a relative humidity of 87% in the rainy season and 35% in the dry season. The vegetation is typically that of the savannah grassland, comprising mainly of mangos, gmelinas, neem, cashew and mahogany, most of which have given way to urbanisation. The area is drained mainly by River Chanchaga, which is a tributary of River Kaduna, as well as other minor seasonal streams. In recent years Minna has witnessed a high increase in population as a result of influx of people into the town from neighbouring states in the country. The rapid expansion of the town coupled with the inability of the state water corporation to meet up with the demand for water has led to a large number of people resorting to the use of groundwater through the drilling of boreholes and hand dug wells.

In order to address acute shortage of water experienced by residents of Minna and environs the state government as part of its short and intermediate intervention plans decided to: (1) drill 100 water boreholes in Minna metropolis; (2) buy a number of water tankers to augment water supply to especially areas with doubtful ground water potential. Sequel to this, the senior special assistant to the governor on borehole monitoring together with senior special assistant to the governor on water intervention, assessment and evaluation were charged with the responsibility of producing a ground water potential map of Minna and environs to aid planning and execution of the borehole project.

GEOLOGY

Minna is underlain by rocks belonging to the Pre Cambrian basement complex system of Nigeria. These are a group of crystalline (hard) rocks generally represented by Granites, Schist, Migmatite, Gneiss, Quartzite and a host of others. These rocks have undergone various stages of metamorphism, tectonism and weathering to produce secondary structures like jointing, fracturing, foliations and weathered zones that tend to modify their original form and structure.

The specific rock type that underlies most part of Minna is Granite and schist belonging to the Kushaka Schist Formation. The northern part of the town is however underlain by Schist belonging to the BirninGwari Formation which has a very poor groundwater potential.

HYDROGEOLOGY

The capability of a rock to hold and transmit water in sufficient quantity to be considered economical determines the hydrogeological potential of such a rock. The properties of the rock that determines such a potential include porosity, permeability and degree of jointing in crystalline rock. These in turn determine the Transmissivity, storativity and specific yield of the aquifer.

In crystalline (hard) rocks these properties are represented by fracturing within the rock and the degree of weathering of the overburden. Surface geophysical surveys, such as the one conducted here, is targeted at determining the level and total depth of weathering as well as the presence of fracturing within the rock, depth of the fracture and the extent of fracturing. A combination of these will generally give an indication of the groundwater potential of the area been surveyed. Areas that are deeply but not intensely weathered and also deeply fractured will tend to give higher indication of groundwater potential than areas that are only moderately weathered. Lower groundwater yields are obtained were only one of the zones serves as the aquifer.

GEOPHYSICS

Geophysical survey was conducted using the electrical resistivity method. The method involves sending of electrical currents of known voltage through two point electrodes (AB), and then measuring the potential drop between the two electrodes through two inner electrodes (MN). Geological materials have different responses to this electrical current passing through them. Their response depends on the chemical composition of the material, degree of compactness, presence of conductive zones or fluids (e.g. water), presence of surfaces of discontinuity (such as fractured zones) as well as other geological phenomena that may be considered to be anomalies.

It should be noted that no single geophysical method can give a conclusive indication of the presence of water in any particular geological material, rather what is indicated is the presence of structures that may be capable of storing and transmitting water to wells placed in them. It therefore follows that the structure may be there but may not hold any water.

Field methods employed for the survey were the electrical resistivity profiling (ERP), which was used for determining the lateral variations in resistivity, and the vertical electrical sounding (VES), which was used to determine the vertical variations in resistivity.

WATER LEVEL MEASUREMENTS

Water level measurements were carried out across the town and environs using an electronic water level dipper. The electronic dipper consists of a length of twin – core cable, which is graduated in meters, wound around a drum and has an electrode attached to the end. When the electrode touches the water surface, a circuit is completed which activates a light and a buzzer. Wells and boreholes were studied using the gridding system which involved gridding of the base map of the town (Minna street guide map) and systematically picking sample points in the grid system. A total of seven hundred and fifty wells and fifty boreholes were sampled for the study.

METHODOLOGY

The following steps were taken to achieve results:

1. Geologic map of Minna using routine field mapping techniques
2. Mapping of ground water levels in existing hand dug wells and boreholes
3. Geophysical surveys using electrical resistivity method. At least fifty (50) of such surveys covering all parts of Minna were made
4. Superposition of results on Minna street guide map obtained from Niger state ministry of lands and housing

RESULTS

Integration of field mapping with geophysical survey data revealed that the area covered by the Minna Street Guide Map can be characterized into three broad hydro-geological zones. These zones have been delineated and colour coded in the map for easy identification. They are:

1. **Green areas** :- the areas covered by colour are characterized by good to excellent ground water potential. This is made possible by a combination of fairly thick weathered zone and good fracture density at the subsurface. Three out of five boreholes are expected to yield good quantity of water. The areas include: IBB specialized hospital; college of education, Federal Government College, Minna; Government Technical College; Shango area; House of Assembly Quarters; Hilltop Model School; Radio Niger FM station along Minna-Kuta road. This area covers the bulk of the eastern half of the city. Within the western part, however, there is a small portion with

good ground water potential. The areas are: Kpakungu; White Heart area; Soje; Bida Motor Park; High Court area.

2. **Orange areas** :- these are areas with fair to good groundwater potential. Five out of ten boreholes are expected to yield good quantity of water. The areas include: Mobil area (city center); Vocational School; Emirs palace; Intermediate Quarters (airport quarters); IBB sport complex (the new Minna Central Market); Type "A" and Type "B" Quarters; Dutsen Kura area; Federal Secretariat Complex; Federal University of Technology, Minna.

3. **Red areas** :- these areas can best be said to be high risk areas because the ground water potential is low and analysis show that one out of five boreholes is likely to be good. The areas are so because the overburden and weathered zones are either thin or absent and the fracture network is sparse at the subsurface. The areas include: Bosso town; Angwan Biri; Ahmadu Bahago Secondary School; Bosso Estate; Tudun Fulani in the extreme north of the city. These areas comprise the northern part of city. It is however noted that areas with similar ground water potential exist within the central, mid to southern part of the city. These areas include Minna Industrial Layout (now Dadinkowa Layout), Shiroro Hotel area, Barikin Sale to Police Barrack areas.

CONCLUSIONS

1. A ground water potential map of Minna city has been constructed using geological field mapping combined with hydrogeological and electrical resistivity geophysical surveys.

2. Three types of ground water potential zones were indicated by the results. They are:
   a. High ground water potential areas coloured green;
   b. Fair groundwater potential areas coloured orange and
   c. Low ground water potential areas coloured red

3. This map will serve as a guide for groundwater development of the proposed 100 borehole project of Minna metropolis.

RECOMMENDATIONS

1. It is advised that areas shaded red be avoided when designating boreholes to the various political sections of the town.

2. It is recommended that at least nine 10,000 litres capacity water tankers be provided for effective distribution of water in Minna to especially those areas painted red in the map to reduce wastage due to borehole failures

3. It is also recommended that at least 10,000 litres surface tanks be provided in such areas to enhance storage and avoid water wastage during

distribution. Fetching the water from the storage tanks through taps reduces wastage.

4. It is advised that high yielding boreholes be connected to overhead reservoirs for distribution to the pubic while low yielding ones be installed with hand pumps
5. Chemical analysis of the water ought to be done in approved laboratories to monitor the quality of the water

Thank you for the opportunity.

Groundwater Potential Map of Minna