The International Journal Of Engineering And Science (IJES)
||Volume||2 ||Issue|| 8 ||Pages|| 95-101||2013||
ISSN(e): 2319 – 1813 ISSN(p): 2319 – 1805

Comparative Analysis of Water Quality in Hand Dug Well and Borehole in Calabar South Local Government Area in Nigeria

Ukpong, E. C., [1] Ogarekpe, N. M.[2] And Bejor, E. S. [3]
[1]Department of Civil Engineering, Faculty of Engineering, University of Uyo, Uyo, AkwaIbomState, Nigeria
[2&3] Department of Civil Engineering, Cross River University of Technology, Calabar, Cross River State, Nigeria

ABSTRACT
The unreliable water supply in Calabar South by the Water Company has forced private individuals to drill boreholes and hand dug wells for private and commercial purposes. Some individuals, whose financial status is low, resort to constructing hand dug wells which serves as a source of water supply to them, hence the need to ascertain the wholesomeness status of this source of water supply. Two boreholes and two hand dug wells within the study area were randomly selected for the study. Samples were taken from the hand dug wells and boreholes. The samples were analyzed based on the standard methods of analysis. The research revealed that the total coliform count of the boreholes satisfied the World Health Organization (WHO) recommended standard, while the total coliform count of hand dug wells did not satisfy the WHO standard. The turbidity, dissolved oxygen, biochemical oxygen demand, total dissolved solids and nitrate satisfied the WHO standard for both boreholes and hand dug wells respectively. However, the results for pH, ranging from 4.95 to 5.30 for both hand dug wells and boreholes indicated a measure of acidity, therefore requiring treatment in order to be potable.

KEYWORDS: Boreholes, hand dug wells, water quality, analysis

Date of Submission: 19,June, 2013 ⟺ Date of Acceptance: 20,August,2013

1. INTRODUCTION

Water is a very essential substance for human existence. Adequate supply of water is important to life and civilization.The provision of water in the past was solely a governmentaffair;however, the inability of the government to meet the daily demands of water for the people has forced some private individuals and communities to seek alternatives and self-help measuresof providing water. Private individuals drill their own deep wells (boreholes). In some localities, they dig wells due to its affordability. These hand dug wells are constructed to serve as a source of water supply water. Water meant for food preparation and drinking must be free from contamination (organism) capable of causing diseases and from minerals and organic substances producing adverse physiological effects. In some communities, water from deep wells is sold to the public without reference and conformance to requisite quality standards such as set by the World Health Organization (WHO).

With the high level of atmospheric pollution due to increase in industrialization and sharp practices, rain water in its natural state is not guaranteed safe. Surface water is exposed to human and animal activities and is easily contaminated and polluted. The source of water supply must be potable and wholesome or else people may decide to turn down the general supply of water and supply water for themselves from other sources which are appealing but may not be safe for consumption.

Water is one of the abundantly available substances in nature. It is regarded as a very vital necessity of life and is a part of every living cell. Water is vital for living processes.Animals and plants need it for survival. Villages and towns can only be constructed if there is enough water for their use.Apart from cooking and drinking, water is used for cleansing. Drinking water must be pure and not polluted. Water is such a widespread material that its presence is accepted without question and its importance is really appreciated when there is a shortage. The Federal Government policy on water supply guarantees the provision of water as one of the primary needs of man.Water is used for different purposes includingdomestic and municipal supply, industrial water supply, food and beverage industries, aquatic life,boiler and water pharmaceutical and antibiotic requirement, transportation and process, and recreation, agricultural water supply.

The bacterial qualities ofgroundwater, pipe borne water and other naturalwater supplies in Nigeria, have been reported to beunsatisfactory, with coliform counts far exceedingthe level recommendation by W.H.O (Dada et al., 1999a, 1999b, Edema et al., 2001). Chemically, water contains metallic chlorides, bicarbonates of calcium, magnesium, iron, silicates compounds, sulphate and clay particles and carbonic acids as dissolved gases in varying levels and degrees. At high concentrations, the constituents of water becomepollutants either singly or collectivelythereby rendering water unsafe for drinking. These pollutants resultin odour, obstruction of light, impair recreational and domestic uses.Human activities on the environment often times results to pollution and degradation of water qualitytherefore the need for periodic assessment. To this end, the specific objectives of the study are as follows:

a To determine the physical, biological and chemical characteristics of the available source of water within the proposed area of study.
b To access the quality of water obtained within the proposed study area.
c To recommend to government and the private individuals ways of improving the present situation.

II. MATERIALS AND METHODS

2.1 Description of Area of Study

Nelson Mandela, Palm Street, EdemEdet and Afokang communities constitute the study area and is situated in Calabar, the capital of Cross River State.Calabar Metropolis lies between latitudes 04° 45’ 30” North and 05° 08’30” North of the Equator and longitudes 8° 11’ 21” and 8°30’00” East of the Meridian**.** The town is flanked on its eastern and western borders by two large perennial streams viz: the Great Kwa River and the Calabar River respectively.The Calabar River is about 7.58 metres deep at its two major bands (Tesko-Kutz, 1983). The city lies in a peninsular between the two rivers, 56km up the Calabar River away from the sea. Calabar has been described as an inter-fluvial settlement (Ugbong, 1998).The location of the University within these communities impacts positively on the population of these areas. Calabar South has a total population of 191,515 as at the 2006 census. The habitants of these areas are mainly students, civil servants and traders etc. The research design for this study is experimental in nature. It involved the scientific collection of water samples from the boreholes and hand dug wells water supply sources in the study area. The analytical design involved the examination of physicochemical and bacteriological parameters of the water samples. The results of the analyses were compared with the World Health Organization (WHO, 2004) standards for drinking water.
The main materials used for this study were water samples collected from different sources and places, and the usual apparatus in a sanitary engineering laboratory in accordance with American Public Health Association (1998).

2.2 Collection of Water Samples

Water samples were collected from boreholes and hand dug wells for physicochemical and bacteriological analysis using standard analytical techniques.Water samples were collected using clean containers, labeled and transported immediately to the laboratory for physicochemical analysis.For bacteriological analysis, five drops of aqueous sodiumthiosulphate solution were added to the sample bottles and sterilized in a hot box oven at $160^{o}C$ for one hour. The addition of the solution was to neutralize any available chlorine in the samples. The samples were labeled and transported to the laboratory in properly labeled containers. Table 1 shows randomly selected sample locations, sources and sample identification code.

Table 1: Randomly selected sample locations, sources and sample identification code

Sample Location	Source of Supply	Sample Identification Code
Nelson Mandela	Borehole 1	B_1
Palm Street	Borehole 2	B_2
EdemEdet	Hand Dug Well 1	W_1
Afokang	Hand Dug Well 2	W_2

The instruments used include portable pH meter (HACH Sension 3) to measure pH, an automatic absorption spectrometer (UNICAM 969 AA) to measure the concentration of trace metals and dissolved oxygen meter to measure the dissolved oxygen. In addition,temperatures, turbidity, total dissolved solids, biochemical oxygen demand, total coliform count (TCC) were determined using the appropriate instruments. All analyses werecarried out using standard methods (APHA, 1998).

III. RESULT

The World Health Organization WHO (2004) standard was used as the criteria for comparing the water standard from each location under investigation. The results obtained are presented in Table 2 below.

3.1 Temperature

Table 2 shows the results of the temperature of water samples from the different locations. Temperature values of 25°C, 24°C, 25°C, 25°C were recorded for boreholes and hand dug wells for locations B_1, B_2, W_1, and W_2 respectively. There was no significant variation in the temperature. The boreholes samples and samples from the hand dug wells met the recommended standard.

3.2 Total Coliform Count

The results of the total coliform test are presented in Table 2.No total coliform counts per 100ml were recordedfor boreholes B_1, B_2.The values recorded for boreholes B_1, B_2 met the WHO (2004)standard. However, the results for the hand dug wells (W_1 and W_2), was above the guideline value implying that the water was polluted.The total coliform count for W_1 and W_2 are 2 per 100ml and 2 per 100ml respectively.

3.3 pH

Table 2 shows the results for the potential hydrogen ions concentration of the samples. Borehole B_1had a pH of 5.30 while borehole B_2 was 5.29. The pH values for the hand dug wells W_1 and $W_2$where 4.97 and 4.96 respectively.

None of the samples met the recommended standard of 6.5 indicating acidity. Thus both boreholes and hand dug wellswere not suitable for drinking and therefore require treatment using lime.

3.4 Biochemical Oxygen Demand (BOD_5)

The results of the Biochemical Oxygen Demandare presented in Table 2. Both boreholes B_1 and B_2recorded average values of 0.1mg/l while the results for the hand dug wells $W_1$and W_2were 0.3mg/l and 0.4mg/l respectively. The BOD_5 values do not actually indicate water quality but potential for removing dissolved oxygen from the water and strength of sewage and industrial wastes. A high BOD_5 signifies or indicates the presence of a large amount of organic pollution.

3.5 Turbidity

The results of the turbidity are shown in Table 2. The boreholes B_1 and B_2 have the same turbidity of 0NTU. Also, the hand dug wells W_1 and W_2,have the same turbidity of 0NTU. This is probably because there were no washing or bathing activities in the water. The boreholes and hand dug wells have relatively zero values throughout, therefore, satisfying the WHO standard.

3.6 Total Dissolved Solid (TDS)

The results of the total dissolved solids are presented in Table 2.The results revealed that both the boreholes and hand dug wells all examined met the WHO recommended standard.

3.7 Nitrate

Nitrate was another parameter analyzed. The resultsare shown in Table 2. Both the boreholes and hand dug wells met the WHO recommended standard. The absence of nitrate maybe as a result of the absence of a waste dump, abattoir around that water source.

3.8 Dissolved Oxygen (DO)

The resultsof the dissolved oxygen are shown in Table 2.The dissolved oxygen was low for boreholes $B_1$and B2with values of 2.9 and 3.0mg/l and3.1 and 3.0mg/lfor hand dug wells W_1 and W_2respectively. These were all lower than the WHO standard of 5 to 14mg/l. The low values of the DO in the boreholes and the hand dug wells maybe due to the chemical reaction as the water is in contact with the subterranean minerals.

Table 2: Comparison of boreholes and hand dug wells water quality

Parameters	**Unit**	**Nelson Mandela (B_1)**	**Palm Street (B_2)**	**EdemEdet(W_1)**	**Afokang(W_2)**	**WHO Standard (2004)**	**Boreholes (B_1) and (B_2)**	**Hand dug Wells(W_1) and (W_2)**
pH	-	5.30	5.29	4.97	4.95	6.5 – 8.5	Borehole B_1 and B_2 have values of 5.30 and 5.29 respectively which are below the WHO standard for drinking water of 6.5 – 8.5. None of the boreholes met the recommended standard.	The pH values of hand dug wells W_1 and W_2 are 4.97 and 4.95 respectively. Judging by the WHO standard, the water is unsafe for drinking.
DO	mg/l	2.9	3.0	3.1	3.0	5 – 14	The dissolved oxygen was low for boreholes B_1 and $B_2$with values 2.9mg/l and 3.0mg/l respectively. Boreholes B_1 and B_2 did not meet the WHO standard of 5 - 14mg/l.	The dissolved oxygen was low for hand dug wellsW_1 and $W_2$with values 3.1mg/l and 3.0mg/l respectively. Hand dug wellsW_1 and W_2did not meet the WHO standard of 5 - 14mg/l.
BOD_5	mg/l	0.1	0.1	0.3	0.4	2 – 4	Both boreholes B_1 and B_2recorded	Hand dug wells $W_1$and W_2 were 0.3mg/l and

							average values of 0.1mg/l.The BOD_5 values do not actually indicate water quality but potential for removing dissolved oxygen from the water and strength of sewage and industrial wastes.	0.4mg/l respectively. These values are less than the recommended WHO standard of 2 – 4mg/l.
Turbidity	NTU	0	0	0	0	5.0	The turbidity value for B_1 and B_2 are 0 NTU implying that there is no contamination in the water and as such okay for consumption when compared with the WHO guidelines.	However, the values for the hand dug wells;W_1 and W_2 were observed to be 0NTU respectively. This implying that there is no contamination in the water and as such okay for consumption when compared with the WHO guidelines
TDS	mg/l	129.4	129.4	326.0	323.0	600 - 1000	The results revealed that both boreholes examined met the WHO recommended standard.	The results revealed that both hand dug wells examined met the WHO recommended standard.

NO_3	mg/l	4.982	4.980	5.516	5.519	50	The results revealed that both boreholes examined met the WHO recommended standard.	The results revealed that both hand dug wells examined met the WHO recommended standard.
TCC	Counts/ 100ml	0	0	2	2	0	Values of the total coliform count of boreholes B_1 and B_2 samples were recorded as 0 and 0 respectively. The boreholes B_1 and B_2satisfied the WHO standard value of0 per 100ml.	The results for the hand dug wells (W_1 and W_2), were above the acceptable limit implying that the water was polluted.The total coliform count for W_1 and W_2 are 1 per 100ml and 2 per 100ml respectively
Temperature	°C	25	24	25	25	27 - 29	The temperature values recorded for boreholes B_1 and B_2 were 25°C and 24°C. These values were below the WHO range of values 27 – 29°C.	Hand dug wells W_1 and W_2 recorded the same temperature of 25°C below the WHO range of values 27 – 29.

IV. CONCLUSION

Experimental investigations were carried out on two boreholes and two hand dug wells randomly selected within the study area.The samples were analyzed based on the standard methods of analysis. The research revealed that the total coliform count of the boreholes satisfied the World Health Organization(WHO) recommended standard, while the total coliform count of hand dug wells did not satisfy the WHO standard. The turbidity, nitrate, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, total dissolved solids and nitrate satisfiedthe WHO standard for both boreholes and hand dug wells respectively. However, the results for pH, ranging from 4.95 to 5.30 for both hand dug wells and boreholes indicated a measure of acidity, therefore requiring treatment in order to be potable.

REFERENCES

[1] APHA (1998).Standard methods for the Examination of water and wastewater, 20th Edition, Washington, D. C., American Public Health Association.

[2] Dada, O.O.; Okuofu, C.A. and Obele, E. (1990a): Fecal pollution of well water in Zaria City , Nigeria, *Savannah* 10: 1-5

[3] Dada, O.O.; Okuofu, C.A. and Yusuf, Z. (1990b).The relationship between residual chlorine and bacteriological quality of tap water in the water distribution system of Zaria Nigeria. *Savannah 10* (2):95-101.

[4] Edema, M. O., Omemu, A. M. and Fapetu, O. M. (2001).Microbiology and Physicochemical analysis of different source of drinking water in Abeokuta. Nigeria Journal of Microbiology, 15(1): 57-61.

[5] Tesko-kotz (1973), A Survey & Development Plan for Calabar*:* The Government of South-Eastern State of Nigeria, Calabar.

[6] Ugbong, I.A. (2000), An Analysis of Runoff flow, Channel Characteristics & Flood & Erosion Menace in the Calabar Drainage Basin.An MsC Research, Dept. of Geography and Regional Planning, University of Calabar.

[7] WHO(2004), Guidelines for Drinking-water Quality. Third Edition Volume 1: Recommendations. World Health Organization, Geneva