EVALUATION OF WATER RESOURCES OF BIDA TOWN IN CENTRAL NIGERIA

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ABSTRACT

There are great concerns for quality of water supply all over the world most especially in developing countries. The concern in this research work is in the ancient town of Bida, which serves as one of the major stopover to the Federal Capital Territory and Minna the capital city of Niger State, where brass, glass and black smith work is a popular industry next to agriculture. The aforementioned activities have prompted the present study into the evaluation of water resources quality in the Bida sandstone around Bida town, Niger State, Nigeria. The sandstone occupies the central sector of Bida basin and it belongs to Bida sandstone series, which is characterised by siltstone, clay-stone and conglomerate. The aquifer types are unconfined, semi-confined and confined, with a member of the sandstone series serving as the principal aquifer. Various methods (physical, chemical and bacteriological) of evaluating surface and groundwater were employed to detect localities with good quality and area where water is loaded with chemical and bacteriological substances in undesirable amount. The study revealed that major elements analyzed have concentrations that are within the World Health Standard. However, in some localities especially around area where the major brass works are carried out, the surface water have the following trace elements: Fe, Cu, Mn, Zn, Pb and Cr in an amount higher than World Health Standard. Generally, the well and river water contains coliform and faecal coliform in an amount beyond the stipulated amount safe for human consumption, which is an indication of domestic contamination. The overall finding is that the groundwater obtained from the boreholes in the study area is safer than other sources of water.

Keywords: Groundwater, Bida, Bactrialogical, Hydrochemical, Coliform.

INTRODUCTION

There are great concerns for quality of water all over the world, most especially in developing countries. In recent time, attention of most researchers in the field of hydrology and hydrogeology have been shifted from assessing only the quantity of water available in any given environment to both quantity and quality of water (Adelana *et al,* 2001). Some advance areas/regions are favoured in term of numbers of research works carried out by various agencies. However, many areas/regions are still in dart of intense research on hydro-geochemical in which Bida is one of them (Olagoke, 2008). Detailed geological and hydrological research were carried out in Bida town (Fig.1) to evaluate the quality of her water resources so as to brings out

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the effects of human activities and its interaction with water resources, with view of bring out any pollutions and anomalies. Various methods were used to analyzes and measure physical, hydro-chemical and microbiological properties. Forty-eight (48) water samples were collected in total of twenty four locations (24) for both surface and underground water, which include hand-dug well, boreholes, tap-water and rivers (Figure. 2).

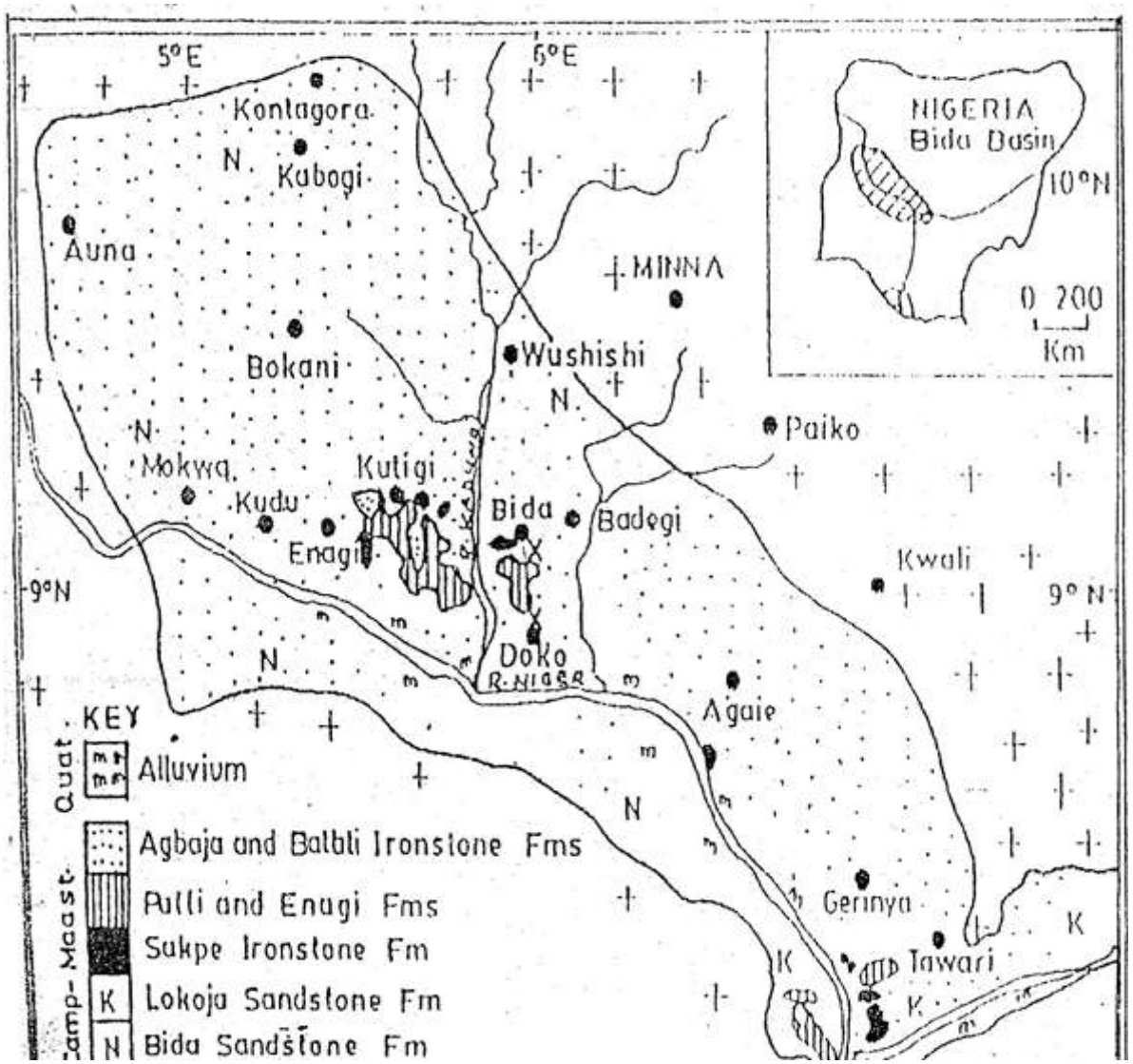


Figure 1: Simplified Geological Map of the Study Area

LOCATION AND GEOGRAPHICAL INFORMATION

The study area, Bida is an ancient Nupe town, the headquarters of Nupe ethnic group in central Nigeria. It is located in middle Niger Basin that can also be referred to as Bida basin. The town lies within latitude 09^0 03″8N/ and 09^0 06″40N/ and longitude 06^0 0″0E/ and 06^0 02″42E/. It is about 35km away from tributary of River Kaduna called River Wuya along Mokwa-Bida road and 84km south –east of Minna, Niger state capital (Adebunmi, 2002). According to Ayoade (1975), there are two

climatic regimes in the area; the distinct dry season, which occurs from November to March and wet season which occurs from April to October. The dry season usually get to its peak in the month of March which is also the period for highest evapotranspiration, while the wet season usually get to its peak between the months of July and September which also records highest precipitation.

The area belong to guinea savannah vegetation with short grasses that grows rapidly during rainy season and dry up during dry season because of the intense heat associated with high evapotranspiration. The prolonged drought makes most of the hand-dug wells to dry during dry season, while the surviving ones are characterised with lower static water level or intermittently recharged. The major rivers in the studied area are Rivers Chicken and Tukwagi, they take their source from River Wuya. River Chicken cut across the center of the town at Dokodza and Post-office area and is refer to as Lanzun. River Tukwagi flow through Sima area and Banyagi area. The two rivers converge at Cirico area. Logically, it can be deduced that Bida town was drain mainly by River Kaduna. The rivers flow in N – S direction having many drainage joining in dendritic and rectangular pattern (Figure 2). Bida is mainly lowland, it has a characteristics of general lowland within the town with some hills at the outskirt of the town. The highest elevation recorded with the aid of GPS within the study area is 177 m above sea level (absl) while the lowest elevation is 127 m absl.

GEOLOGY

Bida is located within Bida basin. The name of basin was derived from the name of this town, or Niger basin which was derived from river Niger. The basin extended from Kontagora and Auna area in Niger State to Dekena in Benue State where it merges with Anambra basin. The basin is a down-warped structure filled with upper Cretaceous (Maastrichtian) rock (Adeleye and Dessauvagie, 1972). It is an elongated NW – SE trending block situated at the center of west central part of Nigeria. The three physiographical units which are recognized in the area are the river Niger with its floods and tributaries, a belt of mesas and the plains (Adeleye, 1976). Other distributary is Gurara, which drain the northern Nigeria Basement Complex. The distributaries including similar ones that are marked by fairly wide flood plains (the fadama rice lands), the belt of mesas is discontinuous. It runs from an area about 16 kilometers east of Mokwa, through an area south of Bida to Baro, Lokoja and southwest Dekina (Fig.1), the mesas cover about 10% of the basin (Adebunmi, 2002; Shekwolo and Shoeneich 1994). In Bida basin, the buried Precambrian to probably Paleozoic Basement Complex is directly overlain by rounded to sub-rounded coarse conglomerates, clay-sand pebble admixtures, and cross stratified sandstones locally with scattered pebbles, cobbles and boulders. These basal sediments may be of alluvial fan origin. They are conformably overlain by certain lithology comprising mainly sandstones and subsidiary clay-sands, fine conglomerates and siltstones. Both these beds and the underlying ones are probably about 300 meter thick. They are known by various local names; Bida sandstone around Bida and Lokoja Basal sandstones around Niger/Benue confluence they underlie the Mokwa and Kontagora Plains. The sandstones are generally angular to sub-angular, well to poorly sorted and very fine to very coarse and pebbly. Arkose and feldspathic sandstones are common in lower areas, quartzose sandstone dominate the upper

area (Braide, 1992). Massive appearance and flat beds are most common in the basal areas of sandstones in Bida Area while the upper parts show widely developed large scale cross-stratification.

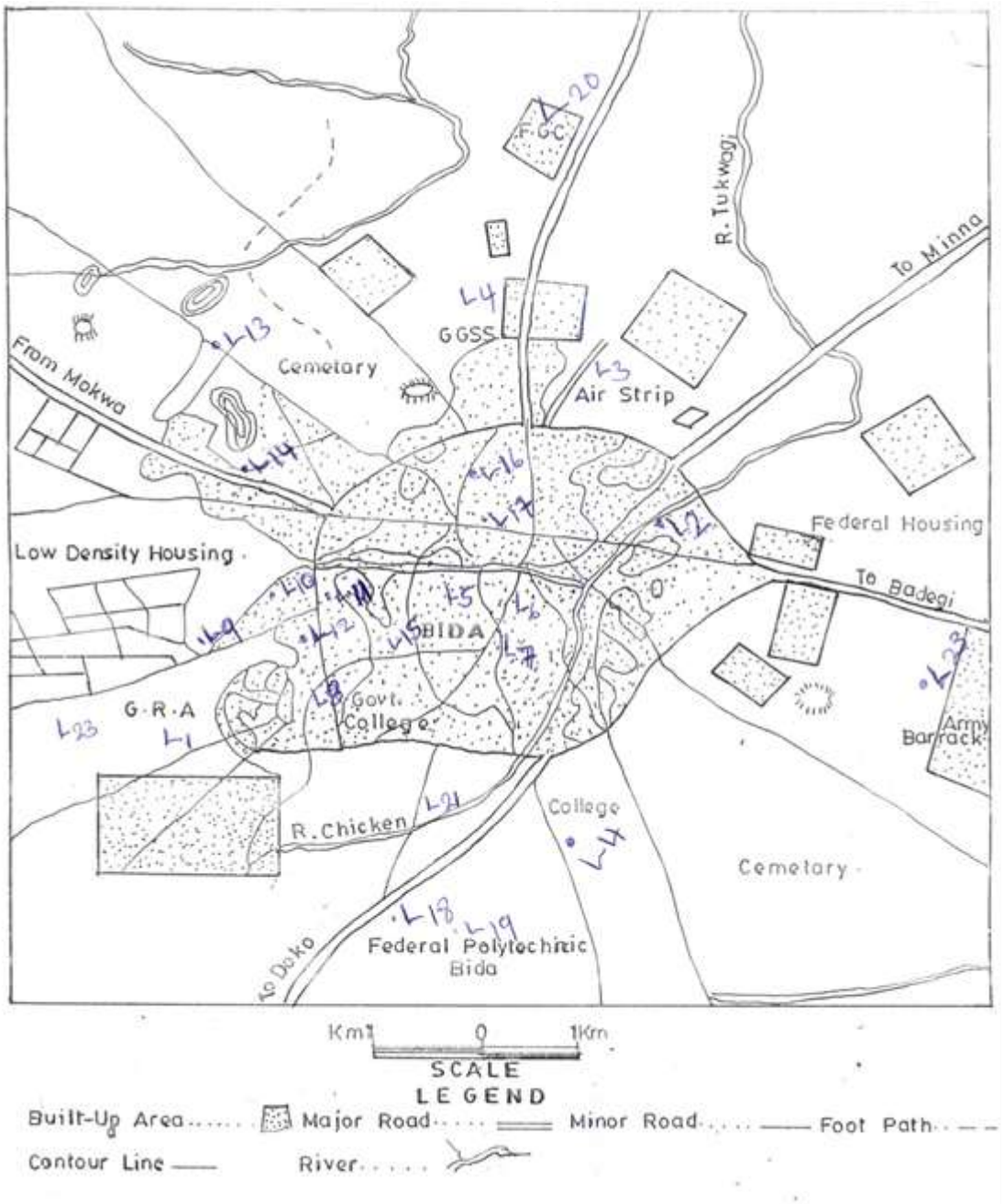


Figure 2: Location Map of Water Samples

HYDROGEOLOGY

The water resources of the area are of two types; the surface and underground sources. Bida is well drained by River Wuya, which is a tributary of River Kaduna. There are several drainages having dendritic and rectangular patterns of drainage,

link with the described tributaries. These drainages are seasonal and mainly contribute to the tributaries only in the rainy season and essentially during the rain and for short hour(s) after the rain stops through a process called overland flow. The rate of infiltration is higher during the early period of rain (April – May), and reduces as the precipitation increase from July to September when high precipitation is usually recorded (Olagoke, 2008). Therefore the mobility of bacteriological and chemical pollutant increases from July to September. Hardly can impound water or dam be seen within Bida town, but in some villages outside the town there are a lot of impounded water that are mainly used for agricultural purposes. The estimated flow of River Niger is put at $8.5x10^{10}$ m^3/year above Lokoja which is $2.0x10^{11}$ m^3/year, the former value may be true for River Wuya or somehow less than that (Ayoade, 1975).

Three type of aquifer are identified (unconfined, semi-confined and confined), out of which two are the most accesses that is the unconfined and semi-confined. The unconfined are those between 7 – 12 m which are mainly found in hand-dug well. This aquifer is seasonal mostly productive in rainy season. The semi-confined is the most accessed; they are found in more than 90% of the bore-holes which are usually between 40 – 50 meters. The confined aquifer, which is from around 80 m – 120 m are rarely access, they are typical of hilly areas.

MATERIALS AND METHODS

A total of twenty (24) pairs of water samples were collected from various sources (hand-dug well, boreholes, rivers and tap waters) in different part of the town in a 1.5 litres Eva bottle for analyses. Twenty four (24) samples were used for chemical analyses that are Cations, Anions and trace elements. The other twenty four (24) samples were used for bacteriological analyses that is determination of *coliform* and *E-coli*. Absorption Atomic Spectroscopy (AAS) (Zenith England model cm 35) was used for the Cations and Ethyl-diamine-tetra acetate Disodium (EDTA) titration for the Anions and the pH. Conductivity and temperature measurement were obtained with an instrument called Haliff T-28. Presumptive coliform count was used to estimate the *coliform* organism present and differential *coliform* count to determine whether the *coliform* organism detected in the presumptive test are *E-coli*. The presence of the latter is an indication of faecal pollution of the water (Brock, 1974).

RESULTS AND DISCUSSION

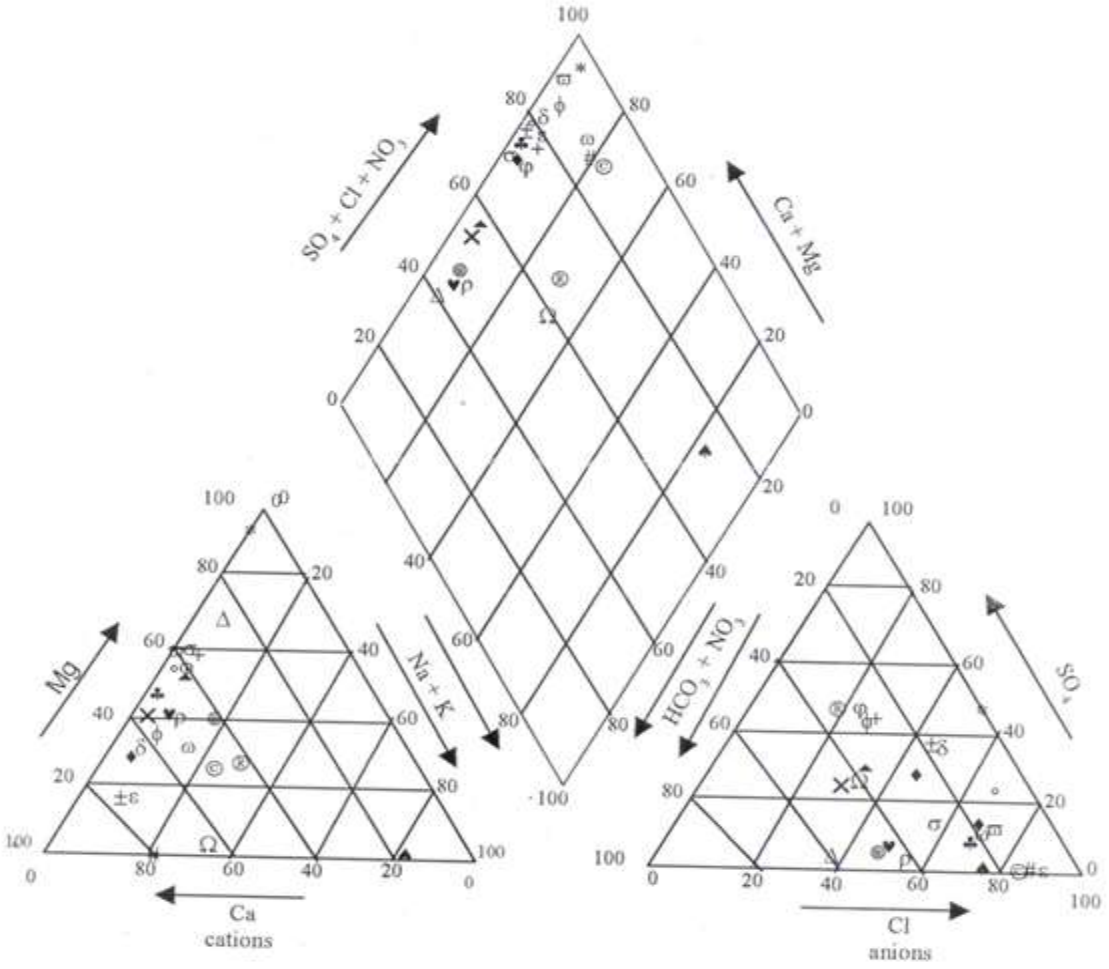
The raw results obtained from the field and those obtained from physical, chemical and biological analyses were presented in Table 1, 2 and 3 and also presented as Piper diagram, Stiff diagram. Table 1 contains the locations, type of water and chemical characteristics of the water samples, while Table 2 contains the results of physico-chemical characteristics; Table 3 contains the bacteriological characteristic.

The major Cations and Anions for both surface and groundwater are within stipulated standard of World Health Orgnization (WHO). However, the following trace element Cu, Zn, Fe, Mn and Cr are detected in greater concentrations in the surface water samples at sample 2; Fe – 2.36mg/l, Zn – 2.1 mg/l, sample 3; Zn – 2.1 mg/l, Cr – 0.4 mg/l, sample 4; Fe – 1.03 mg/l, Zn 1.7, Cr – 0.32 mg/l, Sample 5; Cu – 1.03, Zn – 1.64, Cr – 0.36, Sample 6; Cu – 1.25, Zn – 1.2, Cr – 0.38, sample 7; Cu –

2.12, Zn – 1.82, Cr – 0.38. Samples given above indicate water from the environment where brass and blacksmith works are done (Figure 2).

Chloride has the highest concentration amongst all the anions analysed, its having a range of 1.16 – 120 mg/l, bicarbonate 2.35 – 60.3 mg/l, nitrate 0.1 – 18.2 mg/l, phosphate 0.13 – 3.18 mg/l. Generally, the groundwater (BH) recorded lower anions values, except in sample 1 where the value of bicarbonate is relatively higher. However, they are lower than the prescribed threshold level recommended by WHO (1996). Lead was detected only in six locations (1, 3, 4,5,17 and 19), which are mostly from environment where brass work are done and from hand-dug well.

Hydrochemical facies of the water samples as shown in Figure 3 reveals that the water type is of CaMg-Cl type, especially for the hand-dug wells and rivers. The stiff diagram (Figure 4) clearly indicates higher proportion of chloride over other Anions, and calcium and magnesium higher respectively for Cations.



Symbol:	*	Δ	®	©	#	+	φ	ϕ	δ	♣	♦	♥	♠	•	±	°	ϖ	ω	ε	σ	ρ	Ω	▲	×
Sample No:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

Figure 3: Piper Trilinear Diagram of the Chemical Analyses of Water Samples (Meq/L).

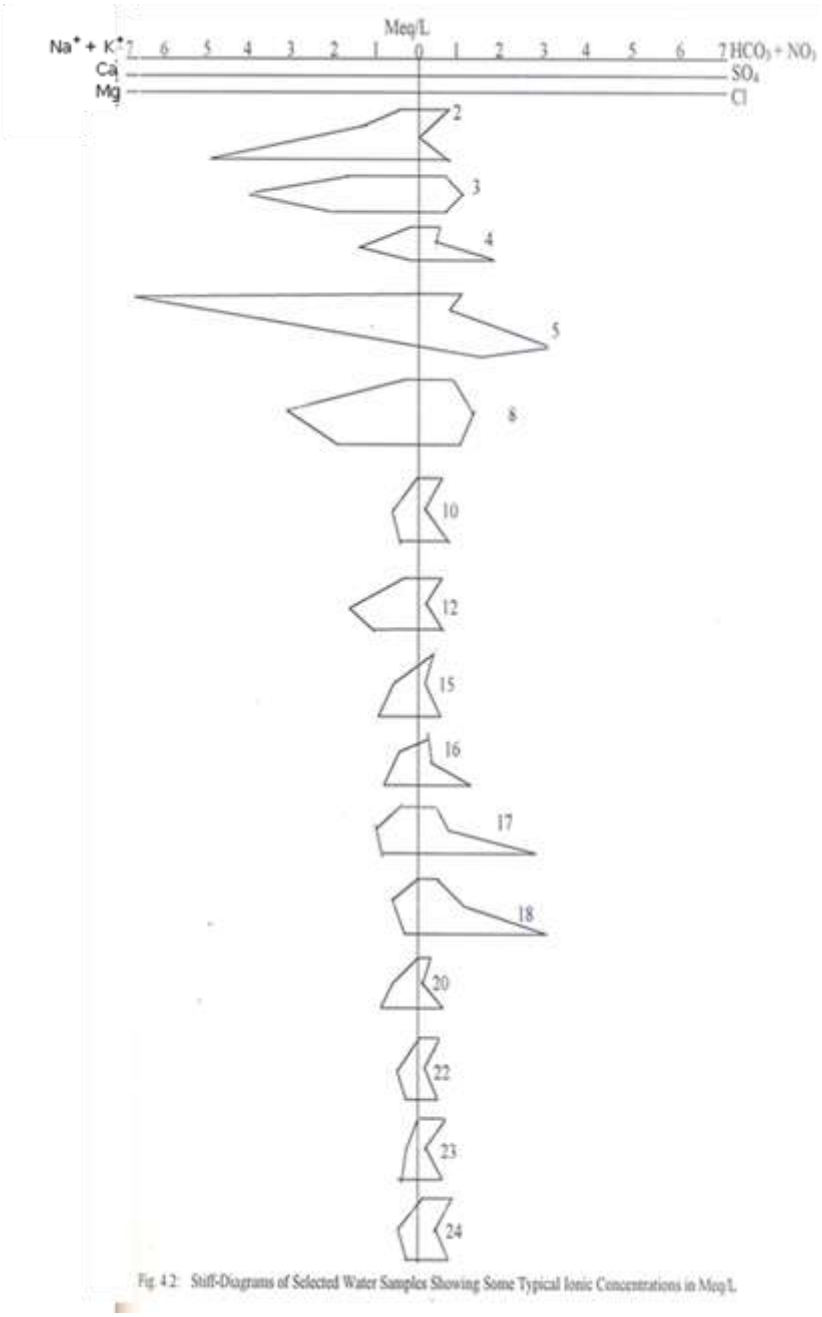


Figure 4: Stiff Diagram of the Selected Water with Some Typical Ionic Concentration in Meq/L.

Table 1: Locations and Results of Hydrochemical Analysis

S/N	Sample Location	Source	Ca	Na	K	Mg	Fe	Cu	Mn	Zn	Pb	Cr	Cl	SO_4	NO_3	HCO_3	PO_4	SiO_2	THW	Turbidity		
						Mg/														FTU		
1	Kure Crescent GRA	BH	15.70	0.60	0.20	24.00	0.12	0.10		0.01	0.23	0.01	0.25	20.00	0.18	0.10	56.00	2.14	0.07	14.20	0.13
2	Banrwa,Circo	RW	36.00	7.86	0.01	6.40	2.36	0.70		0.03	2.10	-	-17.00	0.20	0.18	0.10	56.00	2.14	0.07	14.20	0.13
3	Airstrip gate, Esso	DW	75.40	45.61	0.07	28.00	0.16	0.33		0.01	2.10	0.02	0.40	1.16	41.00	7.50	32.00	0.38	0.01	24.10	5.00
4	Opp. G.G.S.S	DW	44.00	20.41	0.09	12.00	1.03	0.75		0.04	1.70	0.01	0.32	52.00	27.68	8.00	18.00	0.40	0.12	17.30	5.72
5	Emi Tswapa, Tswatamako	DW	26.12	4.62	0.06	12.60	0.10	1.03		0.02	1.64	-	0.36	40.00	44.00	14.50	20.00	0.44	0.01	26.10	7.20
6	Mosq.Area at Tswatamako	DW	30.44	7.53	0.03	32.00	0.15	1.25		0.03	1.20	-	0.38	18.00	40.00	8.26	24.00	0.41	0.03	20.00	6.52
7	50m away from Msq (6)	DW	32.00	7.20	0.03	30.00	0.02	2.12		0.01	1.82	-	0.38	12.60	36.40	17.00	15.00	0.45	0.06	27.60	8.01
8	Opp. F.M.C Bida	DW	70.00	6.20	0.07	26.30	0.12	1.00		0.02	-	-	0.37	30.00	50.00	14.00	18.00	0.04	0.10	19.00	7.60
9	Pichi Road	DW	78.00	6.00	0.10	28.20	0.11	1.40		0.02	-	-	0.30	40.28	48.60	15.02	10.00	0.48	0.11	30.10	7.50
10	Dokodza Junction	BH	16.29	0.88	0.10	16.20	0.09	0.08		-	2.10	-	-	16.00	6.01	0.92	18.00	0.26	0.10	0.92	0.26
11	Dokodza Area	DW	68.00	6.50	0.11	24.30	0.13	1.09		0.04	-	-	0.28	50.00	42.80	16.30	25.00	0.42	0.04	56.20	6.90
12	Dokodza Area	BH	38.72	6.90	0.01	20.00	0.18	0.63		0.03	20.00	-	-	28.02	4.21	0.32	50.78	2.17	0.10	58.20	8.80
13	Wadata behind NPF barrack	DW	16.29	0.50	0.02	17.30	0.07	0.06		-	1.86	-	-	19.20	7.86	0.70	6.20	0.12	-	11.80	0.13
14	Wadata behind NPF barrack	RW	76.80	5.40	0.02	10.40	0.09	1.00		0.01	1.34	-	0.20	48.60	57.40	18.20	13.0	0.38	0.10	25.30	7.10
15	Sauki water Adj, F.M.C	BH	16.83	0.43	0.01	12.90	0.07	-		-	2.01	-	-	18.00	8.10	0.70	6.20	0.12	-	11.80	0.13
16	Chuks, Water, Bangbara	DW	17.00	-	-	15.30	0.04	-		0.01	1.73	-	-	26.20	7.96	0.50	8.23	0.30	-	11.00	0.12
17	Behind chuks (16)	BH	22.60	6.40	0.07	6.30	0.10	0.80		0.01	0.30	0.03	0.40	120.30	38.10	17.20	18.10	0.16	0.07	26.10	7.83
18	Polytechnic Bida	BH	15.84	0.43	0.02	11.90	0.02	0.02		-	1.71	-	-	8.40	7.10	0.80	2.35	0.40	0.058	12.20	0.15
19	Opp. Poly Bida	DW	28.30	3.80	0.02	3.80	0.10	0.93		0.02	0.80	0.01	0.36	118.40	38.60	15.90	16.00	0.29	0.02	20.22	9.93
20	F. G.G. C	BH	16.00	0.40	0.01	15.00	0.10	0.01		-	1.20	-	-	22.10	8.03	1.20	17.00	1.80	0.12	6.40	0.13
21	Lanzun down F.M.C	RW	35.40	8.50	0.02	17.2	1.65	0.68		0.04	2.10	-	-	26.40	3.76	0.42	60.30	2.20	-	51.20	8.78
22	Army Barack	TW	11.31	0.12	0.01	4.14	0.07	0.61		-	1.00	-	-	16.40	14.30	1.11	29.00	0.20	-	25.30	3.40
23	Nurses Qtrs. G.R.A	TW	10.50	0.20	0.01	4.60	0.02	0.56		0.01	1.63	-	-	15.43	19.50	1.00	36.00	0.13	-	27.20	3.10
24	Hajia Lolo Area	TW	11.10	0.18	-	4.63	0.07	0.62		0.01	1.40	-	-	18.21	18.10	1.41	43.00	0.19	-	25.91	3.6
	Min		10.50	0.00	3.80	0.02	0.00	0.00		0.00	0.00	0.00	0.00	0.00	1.16	0.81	0.10	2.35	0.04	0.00	0.92
	Max		78.00	45.61	0.20	32.00	2.36	0.93		0.04	2.10	0.03	0.40	120.30	57.4	18.20	60.3	3.20	0.12	58.20	9.93
	Average		33.69	6.38	0.05	15.98	0.29	0.72		0.02	1.52	0.02	0.33	32.61	23.75	6.72	25.00	0.72	0.07	25.35	4.88
	WHO standard		200	200	20	150	0.3	1.0		1.0	0.01	0.05	200	400	44	500	0.1				
	KEYS		BH= Boreholes			DW = Hand-dig well				RW= River water			TW= Tap water				THW = Total Hardness				

Table 2: Result of Physiochemical Analyses of water Samples

S/N	Locations	Sample Type	Temp (^{0}C)	CND (ucm)	pH
1.		BH	34.4	22.0	7.6
2.		RH	32.8	158.7	6.5
3.		DW	33.2	378.0	7.9
4.		DW	32.7	446.0	7.6
5.		DW	36.0	880.0	8.9
6.		DW	36.6	274.0	7.5
7.		DW	32.4	276.0	7.0
8.		DW	32.0	17.3	7.2
9.		DW	35.8	41.7	7.2
10.		BH	36.4	34.5	7.0
11.		DW	39.9	45.0	8.1
12.		DW	35.7	28.2	8.2
13.		BH	39.9	112.0	7.2
14.		DW	36.3	76.0	7.6
15.		BH	36.5	49.0	6.9
16.		BH	36.2	35.0	7.1
17.		DW	35.7	24.0	7.1
18.		BH	36.2	28.0	7.3
19.		DW	36.5	31.0	7.6
20.		BH	36.8	450.0	7.1
21.		RW	33.6	29.0	7.7
22.		TW	30.3	90.0	6.8
23.		TW	32.0	120.0	7.8
24.		TW	29.6	116.0	7.6
		Min	30.0	17.3	6.5
		Max	39.9	880.0	8.9
		Avg	34.9	156.73	7.44
	WHO STD			2700	

BACTERIOLOGICAL RESULT

Bacteriological results of the entire water sample contains coliform in an amount ranges from 50 – 312, as shown in Table 1.3 below. Only four of them contained faecal coliform (samples 3,8,14 and 19), incidentally they are locations with shallow water level and open water body (river). At location of sample 8 there is highest count of faecal coliform which may be as a result of location of source of sample and the improper way of handling domestic waste water. None of the groundwater contains *E-coli*.

Table 2: Result of Bacteriological Analyses

S/N	Locations	Example Type	Coliform MPN/100m/	*E. coli* MPN /100m/
1.		BH	76.33	0.00
2.		RH	312.00	0.00
3.		DW	213.00	0.00
4.		DW	128.00	0.00
5.		DW	203.00	0.00
6.		DW	206.00	0.00
7.		DW	147.00	0.00
8.		DW	189.00	0.00
9.		DW	202.00	0.00
10.		BH	180.30	0.00
11.		DW	110.00	0.00
12.		DW	226.00	0.00
13.		BH	78.00	0.00
14.		DW	177.03	0.00
15.		BH	71.30	0.01
16.		BH	69.00	0.00
17.		DW	168.00	0.00
18.		BH	76.15	7.50
19.		DW	190.00	0.00
20.		BH	78.22	0.00
21.		RW	0.00	0.00
22.		TW	59.00	0.00
23.		TW	58.78	0.00
24.		TW	0.00	0.00
		Min	312.00	0.00
		Max	136.60	7.50
		Avg		0.07
		WHO STD		**2700**

CONCLUSION

Geological materials that make up the aquifers in the area are consolidated to unconsolidated sandstones, gravel and the conglomeratic beds which overlie the basement in some places. The aquifer descriptions are between 7 – 10 m unconfined, predominantly served hand-dug well and rivers environment. The semi-confined are between 40 – 50 m, is the most access in more than 90% of the functional borehole within and around Bida. The confined aquifer, which are between 80 – 120 m are rarely access. The Bida sandstone has an average yield of 48 to 159 lit/min with a specific capacity of 17 to 26 m^3/day/m. The alluvium is the most prolific aquifer with a yield of 450 to 2,200 lit/min, and has a thickness which range from few meter to 30 m. it can be asserted that all the aquifer are recharged by River Niger, River Kaduna and by direct precipitation. The hydrochemical facies revealed a $CaMgCl_2$ type which is influenced by geologic materials. The water is neutral in character not hard and fresh, a clear indication of non-marine environment and less agricultural activities that may result in any pollution. All the major Cations and Anions are within threshold of WHO standard. However, the following trace elements Fe, Cu, Mn, Zn, Pb and Cr are above acceptable standard for safe drinking water. Ironically, they came from Massaba and Dokodza area where headquarters of brass and blacksmith craft are situated. The value of Total Hardness

in Table 4.1 revealed that water from unconfined aquifer (dug-well) is higher than the semi-confined aquifer (boreholes). The turbidity is generally high for rivers and hand-dug well but low for the boreholes. All the water samples contain coliform out of which shows the presence of *E. coli* which are found in shallow water of dug well and not in deeper water of borehole.

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