

# Assessment of the Impacts of Solid Waste Dumpsites on Hand-dug Wells within Bauchi City Wall

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**Abstract:** *This study assessed the impacts of solid waste dumpsite on hand-dug wells within some parts of Bauchi metropolis. The results of the water samples collected and analyzed showed that there are high concentrations of physical (colour and Total Dissolved Solid) and some chemicals (zinc, cadmium, chromium, magnesium and calcium) parameters while some are low in concentration from hand-dug wells located near to solid waste at open dump sites. However, results of the water samples analyzed from hand-dug wells located very far away from open site shows that there are high concentrations of chemical (nitrate, nitrate-nitrogen, lead and pH) and high in bacteriologic content (faecal coliform). This finding therefore concludes that both water samples from hand-dug wells near and very far away from open waste dump sites are contaminated by solid waste, animal dung, latrine or geological formation.*

**Keywords:** Hand dug wells, Total Dissolved Solids, faecal coliform, dump sites, Solid waste

## 1. Introduction

Waste is an environmental problem that is faced at global, regional and local levels. Waste is an unwanted or unusable material or any substance which is discarded after primary use. Solid waste is defined as organic or inorganic waste materials produced by various activities of the society and which lose their values to the first user (Ramachandra, 2006).

Increase in solid waste generation globally has been attributed to rapid population growth, economic development and rising living standards, whilst industrial diversification and provision of expanded health care facilities have added substantial quantities of industrial hazardous waste and biomedical waste into the waste stream with potential environmental and human health consequences.

Nigeria with a population growth rate about 2.8% per annum and an urban growth rate about 5.5% per annum generates about 0.58kg of solid waste person per day. (Sridhar and Adeoye, 2003 in Babyemi and Dauda, 2009).

In Nigeria, open dump is a common method of waste management because disposal dump sites are never chosen based on environmental safety but rather for convenience. As such, it poses serious environmental pollution problems (air, water, food and soil), threatens human and animal health. Obviously, the north eastern part of Nigeria is not excluded from such problems of waste generation, collection and management. In its simplest form, increase population density leads to intensified human activities that if not managed contribute to environmental damaged and resource depletion. Bauchi state metropolis is not left out with the risk of exposing man and animals to the municipal solid waste collection centers. Based on findings, waste is an inevitable by-product and managing it more effectively is a challenge that needs to be addressed (Sasikumar, 2009).

At present, improper disposal and evacuation of municipal solid waste generated in local districts are creating serious environmental problems such as heaps at roadsides, stream channels, river banks and open space, resulting to pollution of such localities (Vincent, 2012).

According to Ogwueleka, (2009), open dumping of waste cannot be considered as a long term method of disposal. The dangers of open dumping are many; health hazard to scavengers at the dump sites, pollution of ground water sources, blockage of drainages and channels that causes flood which leads to spreads of infectious diseases, highly toxic smoke from continuously smouldering fires and foul odour from decomposing refuse (Aliyu, 2014).

In Nigeria, slums and squatter areas appear in the poor neighborhood of most cities with narrow, hilly, bad unpaved streets. This makes it impossible for environmental agencies to service the areas. Compaction trucks used in solid waste collection are either, uncommon, expensive or difficult to repair. Hence, this leads to non-collection of disposed municipal solid waste at the dumped sites which causes a lot of problems to the environment such include the leachate of soil (Akachukwu, 2009). Also the pollutants seep into the underground water there by contaminating it.

## 2. Statement of Problem

Over the years, Bauchi metropolis, the capital of Bauchi state, north-east Nigeria, has witnessed various approaches to solid wastes management, (Ogwueche, 2013; Bogoro, 2013), but the problems has been one; inefficient solid waste management system. Recent population explosion and uneven urbanization patterns in Bauchi compounded the problems.

Due to this increase in population growth, technology and rate of consumption, the rate at which solid wastes are generated and disposed is high. Methods adopted in disposal of solid waste in Bauchi metropolis is open dumping which has a potential impact to the environment (water, air and

soil). Some of these wastes are biodegradable or non-biodegradable, toxic or non-toxic and so on. More than 50 percent of the inhabitants of the study area remain unserved with potable water supply, hence they resort to other supply sources commonly the use of hand dug wells.

The solid waste dumpsites within Bauchi city wall serve as a point where these solid wastes are dumped usually open dumping method. However, the collection center for municipal solid waste have many impacts to the environment such as land degradation, aesthetic pollution and underground water pollution.



Plate 1: Jahun waste dumpsite



Plate 2: Bakaro waste dumpsite



Plate 3: Goje waste dumpsite



Plate 4: Gwallaga waste dumpsite

## 2.1 Aim

The aim of the research is to assess the impacts of solid waste dumpsite on hand-dug wells within some parts of Bauchi city wall.

## 2.2 Objectives

- 1) To identify the open dump sites in some parts of Bauchi city wall
- 2) To determine the chemical characteristics of water from hand-dug wells near and very far away from solid waste dumpsites within some parts Bauchi city wall.
- 3) To determine the physical characteristics of water from hand-dug wells near and very far away from solid waste dumpsites within some parts Bauchi city wall.

- 4) To determine the biological characteristics of water from hand-dug wells near and very far away from solid waste dumpsites within some parts Bauchi city wall.

## 2.3 The study area

The study area is some parts within Bauchi city wall. It has a coordinates of 10°15'N, 9°45'E and 10°22'N, 9°55'E. It has a total land mass of 3687 km<sup>2</sup>. Population of the area is projected to be 264,809 persons as of 2020. It consist of fifty five (55) different tribal groups which include Hausa, Fulani, Gerawa, Sayawa, Jarawa, Kirfawa, Tafawa Balewa, Karekare, Kanuri, Fa'awa, Butawa, Warjawa, Zulawa, and Badawa. In terms social economic status the people, 90% of the people are crop and livestock producers. The remaining 10% are traders and civil servants and artisans.



Figure 1: Map of Bauchi Metropolis showing the study area

### 3. Materials and Method

The Bauchi city wall was divided into four (4) strata/zones using stratified sampling technique, in order to have a representative of the total samples within the town. These are Zone A, B, C and D. The boundaries of the zones were done using the major roads with Kobi Street round about as the center point to the zones. These zones were;

ZONE A: from kobi street round about to Ajyia road and Wase road.

ZONE B: from Kobi street round about to Wase road and Jahun road.

ZONE C: from Kobi street round about to Jahun road and Kobi road.

ZONE D: from Kobi street round about to kobi road and Ajyia road.

#### 3.1 Method of Data Collection

Various scholars have established safe (30m and above) and unsafe (less than 30m) distances between waste dump sites, pit latrines and septic tanks from groundwater based water wells (Sirajul Islam et al, 2016; Eno Eyak James, Aniedi Udo Essien and Eyo Effiong Etim, 2019; Fubara-Manuel, I. and Jumbo, R. B, 2014.), therefore, their methods were adopted for this research. The ground water samples were taken from hand dug wells with proximities to solid waste dumpsites in each of the zones mentioned above to a distance between 27m to 134m. The S1 Jahun has a distance of 57m, S2 Jahun is 68m, and S1 Gwallaga is 67m, S2 Gwallaga is 80m, S1 Bakaro is 47m, S2 Bakaro 88m, S1 Goje is 65m, S2 Goje 134m, S1 Blind workshop is 27m, and S2 Blind workshop is 109m all measured from the dumpsite

to the hand-dug wells where the water samples were collected.

Sterilized 50cl bottles made of polyethylene were used for the collection of the ground water samples. The sample bottles were air tight to avoid contamination and they were identified and labeled as (S1 Jahu, S2 Jahu) for Zone A, (S1 Gwa, S2 Gwa) for Zone B, (S1 Bak, S2 Bak) for Zone C, (S1 Goj, S2 Goj, S1 Bli, and S2 Bli) for Zone D. The collected samples were taken to the laboratory for analyses.

The physical parameters analyzed included Total Dissolved Solid (TDS) (mg/l), colour (Pt.co), pH, Conductivity (uS/cm), Turbidity (NTU), and Temperature (°C);

Chemical parameters included Lead (mg/L), Zinc(mg/L), Copper (mg/L), Nitrate (mg/L), Nitrogen in Nitrate (mg/L), Chemical Oxygen Demand (COD) (mg/L), Cadmium (mg/L), Magnesium (mg/L) and Calcium (mg/L) while biological parameter analyzed included faecal count (CFU/100ml) analysis.

### 4. Results and Discussions

Table 1: Average parameters of water samples from near and very far away hand-dug wells from solid waste dump sites in Bakaro in comparison with the permissible limits of (WHO and SON)

Parameters	WHO	SON	S1 Bak	S2 Bak
pH	6.5-9.5	6.5-8.5	8.22	8.71
E.C uS/cm	1000	1000	14416	12430
TDS mg/L	500	500	9270	81106
Color Pt.co	15	15	0	29
Magnesium mg/L	-	0.20	50.36	49

Chromium mg/L	0.05	0.05	0	0.01
Cadmium mg/L	0.003	0.003	0.020	0.016
Lead mg/L	0.01	0.01	0	0.01
Nitrate mg/L	50	50	100.40	113.50
Faecal coliform CFU	0	0	0	100

Source: Author field work, 2020.

#### 4.1 Discussion

The table above shows the various parameters tested from a near hand dug well of a distance 47m and very far hand dug well had a distance of 88m in Bakaro. Some of the parameters tested indicate a significant increase or decrease levels of concentrations compared to WHO/SON standards. The comparison between near and very far away hand-dug wells include, the TDS result obtained shows that near well had 9270 mg/L while very far away well had 8106 mg/L which were above 500 mg/L permissible limit of WHO/SON. This may be due to presence of inorganic salt and organic substance such as faeces, paper, leather, etc. at the dumpsite that seeps into the soil. Magnesium permissible limit is 0.20 mg/L of WHO/SON but the level of concentration shows that near well have 50.36 mg/L in whereas very far well have 49 mg/L. However, this could be as a result of distance between the dumpsites and the geological formation of the earth. The permissible limit of Cadmium is 0.003 mg/L whereas near well have 0.02mg/L and very far have 0.016 mg/L. Nitrate concentration was showing 100.40 mg/L in near well and very far shows 113.5 mg/L indicating a high concentration to compare with 50 mg/L of WHO/SON. Finally, faecal coliform is 0 CFU whereas 100 CFU in very away well to compare to 0 CFU of WHO/SON. This may be due presence of latrine closes to very far well.

**Table 2:** Average parameters of water samples from near and very far away hand-dug wells from solid waste dump sites in Blind workshop in comparison with the permissible limits of (WHO and SON)

Parameters	WHO	SON	S1 Bli	S2 Bli
pH	6.5-9.5	6.5-8.5	11.48	10.40
E.C uS/cm	1000	1000	8536	24286
TDS mg/L	500	500	5513	16233
Color Pt.co	15	15	0	0
Magnesium mg/L	-	0.20	48.96	53.36
Chromium mg/L	0.05	0.05	0.01	0.01
Cadmium mg/L	0.003	0.003	0.043	0.026
Lead mg/L	0.01	0.01	0	0
Nitrate mg/L	50	50	28.50	184.80
Faecal coliform CFU	0	0	0	140

Source: Author field work, 2020.

The table above shows the various parameters tested from a near hand dug well of a distance 27m and very far hand dug well had a distance of 109m in Blind workshop. Some of the parameters tested indicate a significant increase or decrease levels of concentration compared to WHO/SON standards. The comparison between near and very far away hand-dug wells include the pH results obtained from water samples shows that the two wells were above 6.5-9.5 permissible limit of WHO/SON standard. S1 Blind workshop had 11.48 whereas S2 Blind workshop had 10.40; the TDS result obtained shows that near well had 5513 mg/L while very far away well had 16233 mg/L which were above 500 mg/L

permissible limit of WHO/SON; Magnesium permissible limit is 0.20 mg/L of WHO/SON but the level of concentration shows that near well have 48.96 mg/L in whereas very far well have 53.56 mg/L. However, this could be as a result of distance between the dumpsites and the geological formation of the earth. The permissible limit of Cadmium is 0.003 mg/L whereas near well have 0.043mg/L and very far have 0.026 mg/L.

**Table 3:** Average parameters of water samples from near and very far away hand-dug wells from solid waste dump sites in Goje in comparison with the permissible limits of (WHO and SON)

Parameters	WHO	SON	S1 Goje	S2 Goje
pH	6.5-9.5	6.5-8.5	6.26	8.01
E.C uS/cm	1000	1000	36933	28500
TDS mg/L	500	500	23965	18533
Color Pt.co	15	15	148	0
Magnesium mg/L	-	0.20	56.56	53.33
Chromium mg/L	0.05	0.05	0.043	0.016
Cadmium mg/L	0.003	0.003	0.026	0.030
Lead mg/L	0.01	0.01	0.08	0.01
Nitrate mg/L	50	50	3.50	156.80
Faecal coliform CFU	0	0	80	120

Source: Author field work, 2020.

The above table shows the various parameters tested from a near hand dug well of a distance 65m and very far hand dug well had a distance of 134m in Goje. Some of the parameters tested indicate a significant increase or decrease levels of concentration compared to WHO/SON standards. From near well, the table indicates the presence of Total Dissolve Solid in high content which is about 23965 mg/L whereas very far away well having 18533 mg/L which were above 500 mg/L permissible limit; Magnesium permissible limit is 0.20 mg/L of WHO/SON but the level of concentration shows that near well have 56.56 mg/L in whereas very far well have 53.33 mg/L. However, this could be as a result of distance between the dumpsites and the geological formation of the earth. The permissible limit of Cadmium is 0.003 mg/L whereas near well have 0.026mg/L and very far have 0.030 mg/L. Also, the permissible limit of Lead is 0.01 of WHO/SON whereas near well had 0.08 while very far had 0.01. The permissible limit of faecal coliform is 0 CFU whereas near well had 80 CFU while very away well had 120 CFU. This maybe as a result of vegetables, animal dugs, metals, etc. that were dumped at the dumpsites.

**Table 4:** Average parameters of water samples from near and very far away hand-dug wells from solid waste dump sites in Gwallaga in comparison with the permissible limits of (WHO and SON)

Parameters	WHO	SON	S1 Gwa	S2 Gwa
pH	6.5-9.5	6.5-8.5	11.04	9.49
E.C uS/cm	1000	1000	14103	12176
TDS mg/L	500	500	19170	7916
Color Pt.co	15	15	5	0
Magnesium mg/L	-	0.20	50.36	47.33
Chromium mg/L	0.05	0.05	0.13	0.063
Cadmium mg/L	0.003	0.003	0.053	0.043
Lead mg/L	0.01	0.01	0	0
Nitrate mg/L	50	50	8.30	62.50
Faecal coliform CFU	0	0	1000	40

Source: Author field work, 2020.

The above table shows the various parameters tested from a near hand dug well of a distance 67m and very far hand dug well had a distance of 80m in Gwallaga. Some of the parameters tested indicate a significant increase or decrease levels of concentration compared to WHO/SON standards. From near well, the table indicates the presence of Total Dissolve Solid in high content which is about 14103 mg/L whereas very far away well having 12176mg/L which were above 500 mg/L permissible limit; Magnesium permissible limit is 0.20 mg/L of WHO/SON but the level of concentration shows that near well have 56.56 mg/L in whereas very far well have 53.33 mg/L. also near well had 0.13 mg/L whereas very far well had 0.063 mg/L which were above 0.05 mg/L permissible limit of WHO/SON. This maybe as a result of waste at the dump sites close to residential building or the geological formation of the earth.

Finally, the WHO/SON permissible limit of faecal coliform is 0 CFU whereas the by well had 1000 CFU while very far away well had 40 CFU. This is maybe due to hand-dug wells close to dumpsite or another source of contamination such as latrine, etc.

**Table 5:** Average parameters of water samples from near and very far away hand-dug wells from solid waste dump sites in Jahun in comparison with the permissible limits of (WHO and SON).

Parameters	WHO	SON	S1 Jahu	S2 Jahu
pH	6.5-9.5	6.5-8.5	5.65	6.12
E.C uS/cm	1000	1000	10173	28500
TDS mg/L	500	500	6613	13400
Color Pt.co	15	15	50	128
Magnesium mg/L	-	0.20	51.43	50.66
Chromium mg/L	0.05	0.05	0.043	0.016
Cadmium mg/L	0.003	0.003	0.016	0.046
Lead mg/L	0.01	0.01	0.016	0.01
Nitrate mg/L	50	50	56.2	259.8
Faecal coliform CFU	0	0	1360	3400

Source: Author field work, 2020.

The above table shows the various parameters tested from a near hand dug well of a distance 57m and very far hand dug well had a distance of 68m in Jahun. Some of the parameters tested indicate a significant increase or decrease levels of concentration compared to WHO/SON standards. From near well, the table indicates the presence of Total Dissolve Solid in high content which is about 6613 mg/L whereas very far away well having 13400 mg/L which were above 500 mg/L permissible limit; Magnesium permissible limit is 0.20 mg/L of WHO/SON but the level of concentration shows that near well have 51.43 mg/L in whereas very far well have 50.66 mg/L. Also near well had 0.13 mg/L of Chromium whereas very far well had 0.063 mg/L of Chromium which were above 0.05 mg/L permissible limit of WHO/SON. Finally, near well and very far away well were highly contaminated by faecal coliform. That is near well had 1360 CFU while very far away well had 3400 CFU which were above 0 CFU of the permissible limit of WHO/SON standard. This may be presence of human faeces, animal dugs at the dumpsites or well closed to latrine.

The physical analysis shows that there were slight contaminations of near hand-dug wells due to locations of open dump waste sites compare to very far away hand-dug wells. For instance, the Total Dissolve Solid has 23965 mg/L and Colour 148 Pt.co in S1 Goje; pH is 5.6 in S1 Jahun and S1 Blind workshop is 11.48 and Electric conductivity is 36933 uS/cm in S1 Goje. The chemical analyses were found to be highest in Calcium 60.30 mg/L and Magnesium 56.56 mg/L of S1 Goje. While Chromium is 0.13 mg/L and Cadmium is 0.053 in S1 Gwallaga. This also indicates the contamination of near hand-dug wells due location of open dump waste sites compare to very far away hand-dug wells. However, Lead is 0.1 mg/L, Nitrate is 259.80 mg/L, Nitrate-nitrogen is 58.60 mg/L and Faecal coliform of bacteriological analysis has 3400 CFU in S2 Jahun. From the results, it shows that some the hand-dug wells were contaminated by another sources of pollution such as latrine, etc.

**Average parameters of water sample from different study locations in comparison with the permissible limits of (WHO and SON)**

S/N	Parameters	(WHO)	(SON)	S1 Bak	S2 Bak	S1 Bli	S2 Bli	S1 Goj	S2 Goj	S1 Gwa	S2 Gwa	S1 Jah	S2 Jah
1.	Temperature	Ambient	Ambient	23.30	23.26	23.06	23.56	23.16	22.73	22.73	23.23	22.96	22.73
2.	Ph	6.5-9.5	6.5-8.5	8.22	8.71	11.48	10.40	6.26	8.01	11.04	9.49	5.65	6.12
3.	Turbidity (NTU)	5	5	0	1	0	0	3	0	0	0	1	3
4.	E.C (u/cm)	1000	1000	14416	12430	8536	24286	36933	28500	14103	12176	10173	20300
5.	TDS (mg/L)	500	500	9270	8106	5513	16233	23965	18533	19170	7916	6613	13400
6.	Colour (Pt.co)	15	15	0	29	-0	0	148	-0	5	-0	50	128
7.	Calcium (mg/L)	50	50	44.43	48.20	54.86	40.43	60.63	17.33	29.30	29.0	16.40	15.56
8.	Magnesium (mg/L)	-	0.20	50.36	49.30	48.96	53.56	56.56	53.33	50.36	47.80	51.43	50.66
9.	Chromium (mg/L)	0.05	0.05	0	0.01	0.01	0.01	0.043	0.016	0.13	0.063	0.016	0.046
10.	Copper (mg/L)	2	1	0	0.013	0	0.02	0	0.01	0	0.046	0	0.026
11.	Cadmium (mg/L)	0.003	0.003	0.020	0.016	0.040	0.043	0.026	0.030	0.053	0.043	0.016	0.010
12.	Zinc (mg/L)	3	3	1.64	2.31	2.08	0.98	0.03	1.23	2.64	0.52	1.07	0.28
13.	Lead (mg/L)	0.01	0.01	0	0.01	0	0	0.08	0.01	0	0	0.03	0.10
14.	COD (mg/L)	60	60	8.16	0	0	0	20.98	0	0	0	0	36.92
15.	NO <sub>3</sub> <sup>-</sup> (mg/L)	50	50	100.40	113.50	28.50	184.80	3.50	156	80.3	62.5	56.2	259.8
16.	NO <sub>3</sub> <sup>-</sup> -N (mg/L)	11	11	22.70	25.60	6.40	41.80	0.80	35.20	18.10	14.10	12.70	58.60
17.	Faecal coli (CFU)	0	0	0	100	0	140	80	120	1000	40	1360	3400

## 5. Summary

Water quality is an important element that needs to be considered before consumption. Hence, management of municipal solid waste using open dumping method of disposal must be evaluated to avoid environmental degradation (water contamination). However, five areas where surveyed out of seventeen dumpsites within some part of Bauchi city wall. Water samples from Hand-dug wells were analyzed and the results indicated high concentration levels of some of the physical, chemical (significant different in nitrate content) and bacteriological (high significant count of faecal content) parameters. This high concentration levels of maybe caused either due to solid waste disposal, rearing of animals, latrines located close to the hand-dug wells or geological formation of the earth. Based on the findings, hand-dug wells near solid waste dumpsites are of highly contaminated by physical and some chemical parameters to compare to very far away hand-dug wells that are of low concentration. The findings also indicated that some hand-dug wells very far away from solid waste dumpsites are highly contaminated by some chemical and bacteriological parameters (faecal coli) compared to near hand-dug wells. Findings from the respondents show that the people are ignorant of the impacts associated with disposal of waste close to the wells.

## 6. Conclusion

The results of the data analyzed showed that there are high concentrations of physical (colour and Total Dissolved Solid) and some chemicals (zinc, cadmium, chromium, magnesium and calcium) parameters while some are low in concentration from hand-dug wells located near to solid waste at open dump sites. However, result of the water samples analyzed from hand-dug wells located very far away from open site shows that there are high concentrations of chemical (nitrate, nitrate-nitrogen, lead, electric conductivity and pH) and high in bacteriologic content (faecal coliform). This finding therefore concludes that both water samples from hand-dug wells near and very far away from open waste dump sites are contaminated by solid waste, animal dung, latrine or geological formation.

## 7. Recommendation

From the results discussed, it is important for the government to map out suitable locations for disposal or adopt other options for municipal solid waste management practice in order to protect the public from health hazards such as cholera typhoid, diarrhea, etc. There should be proper education and enlightenment to the public on the danger of waste due to its toxicity and the need to treat water before consumption. Finally, there should be further research to enhance, suggest and contribute to the protection of environment.

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