International Research Journal of Advanced Engineering and Science
ISSN: 2455-9024

# Assessment of Heavy Metal Concentrations in Borehole-Hole Water in Ozoro Town, Delta State

B. T. Sawere[1], C. K. Ojeba[2]
[1, 2]Department of Science Laboratory Technology, Delta State Polytechnic, Ozoro, Delta State
Email address: [1]saweretesi@yahoo.com

***Abstract*—** *The level of heavy metal contamination in borehole water in Ozoro town, were determined using AAS. Ten borehole were randomly collected from different sampling sites. The heavy metal analyzed includes PB, Cu, Fe Zn, Ni Cr, and Co. The result showed that the concentration of lead, (Pb), Copper (Cu), Fe (Fe), Zinc (Zn), Nickel (Ni), Chromium (Cr) and Cobalt (Co) were within WHO maximum permissible concentration with mean values of 0.01mg/L, 0.028mg/L, 0.06mg/L, 0.05mg/L, 0.046mg/L and 0.001mg/l. The level of the metal followed the order Pb>Cu>Fe>Zn>Ni>Cr>Co. The heavy metals are within the maximum contaminant level set by WHO, 2015.*

***Keywords*—** *Heavy metals, borehole, water samples, Ozoro town.*

## I. INTRODUCTION

Heavy metals are those with a density range from above 3.g/gm$^3$ to 7g/cm$^3$, atomic weight greater than Sodium (23), atomic number greater than 20, found in period four (4) and above (Baldwin et,al 1999). Heavy metals in water refers to the heavy, dense, metallic elements that occurs in trace level, but are toxic and tends to accumulate, hence are commonly referred to as trace metals. Heavy metals are one of the most persistent pollutants in water. Increase in urbanization and industrialization are to be balanced for an increased level of trace metals, especially heavy metals, in our water ways. Drinking water is exposed to different contaminants depending on the source. Surface water contamination occurs when water travels over a surface of land (Hauser, 2002). Many dangerous chemicals elements, if released into the environment, accumulate in the soil and sediments of water bodies. The three most pollutants of heavy metals are lead, cadmium and mercury. The poisoning could result for instance from drinking water contaminated by lead pipe of high ambient air contrition near erosion sources. They exist in water in colloidal particulate and dissolved phases (Adepoju, et al, 2009) with their accordance in water bodies being either of natural origin (e. eroded minerals within sediments) or of anthropogenic origin (soil wastes disposal industrial or domestic effluents) herb or channel dredging) according to Marcoovercchio, et al, (2007). The availability of portable water is an indispensable features of preventing disease and improve quality of life (Oluduro and Aderiye, 2007). The natural water contain some types of impurities whose nature and amount vary with sources of water.

Heavy metals are found naturally on earth and become concentrated as a result of human caused activities. Common sources are from mining and industries, vehicle emission, lead and batteries, fertilizers, paints and treated woods. Toxic metals are usually present in industrial and urban run-off, which can be harmful to human and biotic life. Motor vehicle emission are a major sources of air-born contaminants, including arsenic, cadmium etc. The major sources of heavy metals are natural, domestic, agricultural practices that sometimes, utilize some of the elements such as lead, cadmium, iron, zinc, Nickel, or chromium and discharge some quantities of these elements into the environment as waste. One of such sources of heavy metal discharge is the industries. Metals are introduced into water through weathering of rocks and leaching of soil, dissolution aerosol particles from the atmosphere and several particles from the atmosphere and several human activities including mining processing and use of metal based materials. They enter into our bodies via food, drinking water and air.

Heavy metals enter plants, animals and human tissues via inhalation and diet.

They get into products either naturally or as a result of human activities, during manufacturing, processing and storage or by diet addition (F.S.A, 2007). The rate at which human beings are exposed to heavy metals in our contemporary time is greatly on the high side. The toxic effect is through the skin contact, inhalation through breath and ingestion through eating and drinking (Asklund et al, 2005). Heavy metals can affect our body in multitude of negative ways. They have affinity for the central nervous system and nerve cells (Arain, 2011). However, lead, Cadmium, Mercury and Arsenic are main threats to human health when exposed to them. Mildvan, (1970) noted that heavy metals such as Cd, Ni, As, and Pb pose a number of hazard to human and are indeed co-factors as activator biochemical reactions and substrates metal complex. Many trace elements are necessary in small amount for the normal development of the biological cycles but most of them become toxic at high contractions. Lead is one of such heavy metals and most common of these elements. It is a metabolic poison and enzymes inhibitor. It can cause metal retardation and semi brain damage in young children. Cadmium is highly toxic even in low concentrations and will bio-accumulate in organism and ecosystem and has a large biological half life in the human body ranging from 10 to 33 years. Long time exposure to cadmium also induces renal damage (Celik et al, 2007). So, cadmium is considered as one of the priority pollutant form monitored in most countries by international organization. Heavy metals can build vital cellular components such as structural proteins enzymes and nucleic acids and interferes with their functioning (Landis et al, 2000). Symptoms and effect can very according to the



B. T. Sawere and C. K. Ojeba, "Assessment of heavy metal concentrations in borehole-hole water in Ozoro town, Delta State," *International Research Journal of Advanced Engineering and Science*, Volume 1, Issue 3, pp. 61-65, 2016.

International Research Journal of Advanced Engineering and Science
ISSN: 2455-9024

metal compound and the dose involved. Long term exposure to heavy metal can have Carcinogenic, Central and Peripheral nervous system and circulatory effects. Ingesting too much Iron through drinking is not associated with adverse health effects. However, while chemically consuming large amounts of iron, can lead to a condition known as iron over hand. Water is much more wholesome from earthenware pipe than from lead pipes. For, it seems to be made injurious by lead, because white lead is produced by it and this is said to be harmful to human body. In 2013 the World Health Organization (WHO) estimated that lead poisoning resulting in 143,000 deaths and contributed to 600,000 new cases in children with intellectual disabilities each year (WHO, 2013). It is necessary to know that heavy metals increases in concentration to a higher level, exert a toxic effect. Hence there is need to analyze the heavy metal contents at intervals in our boreholes. Lead is the most prevalent heavy metals contaminant. However, the maximum permitted level of heavy metal in the body is recommended by the World Health Organization (WHO) and National Agency for Food, Drugs Administration and Control (NAFDAC) hence there is great need to determine the contents of heavy metals in water (WHO, 2006).

## II. Material and Methods

The ten samples of borehole used for this analysis were collected randomly from ten different sites in Ozoro town; NDC road, Iyere, Owhrologbo road, Oviobor street, Ughelli-Ozoro extension, Odudu street, Umuefe street, Oviobio street, Ebuala street and Ughelli-Ozoro road. The samples were collected in a clean 1.5 litre plastic bottles. The bottles were thoroughly rinsed with the boreholes water. The borehole was allowed to run-off for 10 minutes before collection. The plastic bottles were partially filled with the collected samples borehole water, and tightly covered. The temperature of samples were measured and recorded. The samples were label from 1 to 10 and taken to the laboratory for the analysis of heavy metals. The borehole water samples were digested with nitric acid before further analysis for Pb, Ni, Cr, Fe, Co, Cu and Zn. The Atomic Absorption Spectrophotometer (Model Spectrum Lab ST-AAS-02, series AASW with Gravities finances, UK) instrument was used to detect the heavy metals.

## III. Statistical Analysis

SPSS (version 20) One-way ANOVA and Ducan multiple range test were used to evaluate the significant difference ($P<0.05$) in the concentration of different studied metals with respect to different sites. A probability at the level of 0.05 less was considered significant.

Mean $\pm$ STD was estimated.

Mean $\pm$ STD of heavy metals concentration (mg/l) in Borehole water

## IV. Result and Discussion

The samples of borehole water organoleptic assessment were carried out. All the sample were colourless, tasteless and odorless. The pH of the borehole water ranged between 6.0 and 6.5, within WHO permissible limit (6.5-9.5).

The conductivity (figure 2) ranged from 94 to 277 µu/cm, within the permissible limit of WHO (900 µs/cm).

TABLE I. Physico-chemical parameter of borehole water samples.

| Sample | Appearance | Taste | Odour | pH | Conductivity |
|---|---|---|---|---|---|
| NDC | Colourless | Tasteless | Odourless | 6.5 | 113 |
| Iyeriri | Colourless | Tasteless | Odourless | 6.5 | 116 |
| Owhelogbo road | Colourless | Tasteless | Odourless | 6.0 | 277 |
| Ovibor Street | Colourless | Tasteless | Odourless | 6.5 | 108 |
| Ughelli /Ozoro Exp | Colourless | Tasteless | Odourless | 6.5 | 107 |
| Odudu Street | Colourless | Tasteless | Odourless | 6.0 | 164 |
| Unuafe Street | Colourless | Tasteless | Odourless | 6.0 | 122 |
| Oviobio Street | Colourless | Tasteless | Odourless | 6.5 | 100 |
| Ebuale Street | Colourless | Tasteless | Odourless | 6.5 | 146 |
| Ughelli /Ozoro road | Colourless | Tasteless | Odourless | 6.0 | 94 |
| Pl(WHO) | Colourless | Tasteless | Odourless | 6.5-9.5 | 900µs/cm |

Table II. Mean concentration of heavy metal (mg/l) in borehole.

| | Samples | Pb | Cu | Fe | Zn | Ni | Cr | Co |
|---|---|---|---|---|---|---|---|---|
| 1 | NDC | 0.02±0.02 | 0.015±0.10 | 0.07±0.01 | 0.02±0.01 | 0.01±0.00 | 0.08±0.02 | BDL |
| 2 | Iyeriri | 0.01± 0.01 | 0.030±0.10 | 0.07±0.01 | 0.02±0.04 | 0.01±0.00 | 0.07± 0.01 | BDL |
| 3 | Owhelogbo road | 0.02±0.03 | 0.014±0.00 | 0.06±0.02 | 0.04±0.01 | 0.01±0.00 | 0.04±0.00 | 0.004 ±0.00 |
| 4 | Ovibor Street | 0.01±0.02 | 0.045±0.02 | 0.05±0.02 | 0.02±0.01 | 0.005±0.01 | 0.02±0.01 | BDL |
| 5 | Ughelli/Ozoro Exp | 0.007±0.01 | 0.045±0.02 | 0.09±0.01 | 0.02±0.02 | 0.005±0.01 | 0.03±0.00 | BDL |
| 6 | Odudu Street | 0.009±0.02 | 0.040±0.01 | 0.03±0.01 | 0.03±0.01 | 0.004±0.00 | 0.03±0.00 | BDL |
| 7 | Unuafe Street | 0.001±0.00 | 0.009±0.03 | 0.06±0.00 | 0.07±0.01 | 0.009±0.00 | 0.04±0.00 | 0.003± 0.00 |
| 8 | Oviobio Street | 0.01±0.01 | 0.025±0.00 | 0.04±0.01 | 0.04±0.03 | 0.009±0.01 | 0.06±0.02 | BDL |
| 9 | Ebuale Street | 0.008±0.00 | 0.025±0.001 | 0.05±0.00 | 0.08±0.02 | 0.01±0.00 | 0.04±0.00 | 0.003±0.00 |
| 10 | Ughelli/Ozoro road | 0.009±0.002 | 0.032±0.10 | 0.06±0.01 | 0.03±0.01 | 0.02±0.00 | 0.05±0.01 | BDL |
| | **Pl(WHO)** | **0.01** | **2.00** | **3.00** | **3.00** | **0.02** | **0.05** | **0.005** |

Ten samples of borehole water were analyzed for Pb, Cu, Fe, Zn, Ni, Cr and Co with AAS in this research work. The Pb, Cu, Fe, Zn, Ni, Cr, and Co have maximum acceptable concentration of 0.01mg/L, 2.0mg/L, 3.00mg/L, 3.00mg/L, 0.02mg/L, 0.05mg/L respectively for borehole and 0.005mg/L maximum acceptable concentration M.A.C in borehole drinking water. For the protection of the human health guidelines for the presence of heavy metals in drinking water have been set by different international organizations such as WHO, EPA, USEPA and the European Union Commission



B. T. Sawere and C. K. Ojeba, "Assessment of heavy metal concentrations in borehole-hole water in Ozoro town, Delta State," *International Research Journal of Advanced Engineering and Science*, Volume 1, Issue 3, pp. 61-65, 2016.

International Research Journal of Advanced Engineering and Science
ISSN: 2455-9024

(Marcovecchio et al, 2007). From the result (Table II), it can be seen that all the samples analyzed were within the safe limit recommended by (WHO 1999). The mean± STD values of the measured metals (Pb, Cu, Fe, Ni, Cr, Co and Zn) as recorded. The result obtained from the analysis of lead, (figure 3) ranged from 0.009 to 0.02mg/L. The samples collected at NDC and Owhelogbo road both showed concentration values of 0.02mg/L and were higher than the maximum acceptance concentration (0.01mg/L). Lead is a poisonous metals that can damage nervous connection (especially in young children) and cause blood and brain disorder. It is also a potent neurotoxin that accumulates in soft tissues and bones and a possible human carcinogen (Ehi-Eromosele et al, 2012). From the result obtained from the analysis of copper, (figure 4) it ranged from 0.009 to 0.045mg/L and all the water samples concentration of copper were below the specified maximum acceptable concentration (2.00mg/L).

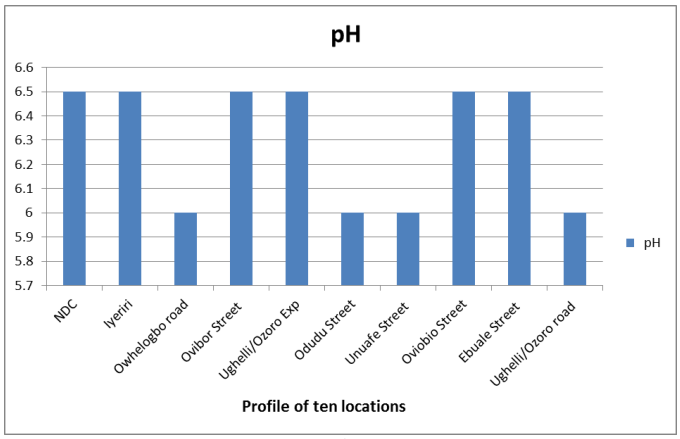


Fig. 1. Bar chart showing the pH of selected borehole water in Ozoro.

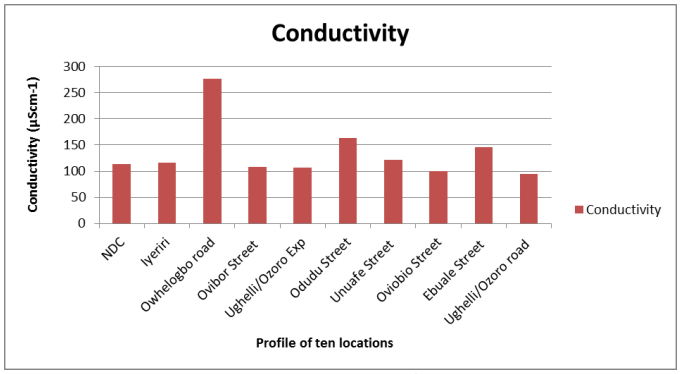


Fig. 2. Bar chart showing the conductivity of selected borehole water in Ozoro.

Contamination of drinking water with high level of copper may lead to chronic anemia, vomiting diarrhea, nausea and abdominal pain (Toxic Metal Research Programm, 2001). Copper occurs in drinking water from copper pipe, as well as from additive designed to control algal growth (Njar et al, 2012). Iron (figure 5) contents in borehole water samples ranged from 0.03 to 0.09Mg/L and were all within the maximum acceptable concentration (3.00mgl). The presence of iron may be due to clay deposit in the area and is responsible for brownish-red colour of water when allowed to stay for some minutes (Itodo et al, 2010). From the result obtained for the analysis of zinc, (figure 6) the values ranged from 0.02mg/L to 0.08mg/L and all the samples have concentration below the maximum acceptable concentration for drinking water (3.00mg/L). The low concentration of zinc is an indication that borehole is free from caustic taste and good for drinking. Nickel (figure 7) content in the borehole water sample range from 0.004 to 0.02mg/L within the maximum acceptable concentration (0.02mg/L). The highest level of Nickel recorded was 0.02mgt/l at Ebuale street and Ughelli-Ozoro road while the least was 0.009mg/L at Unuafe street. The high level of Nickel, could be that the area is associated with igneous rocks.

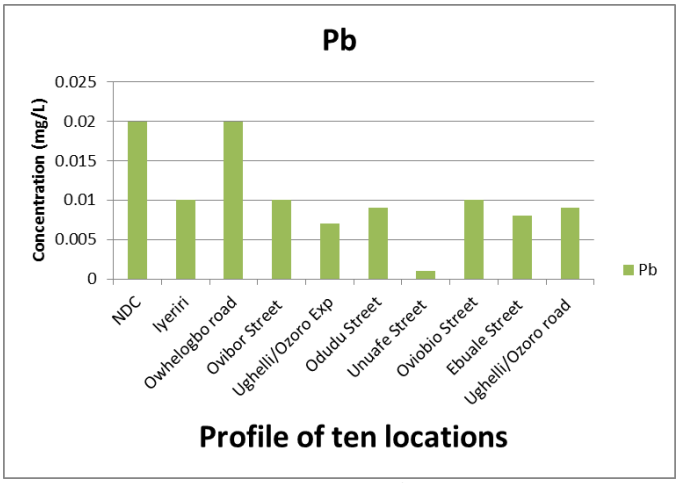


Fig. 3. Bar chart showing the concentration of Pb in selected borehole waters in Ozoro.

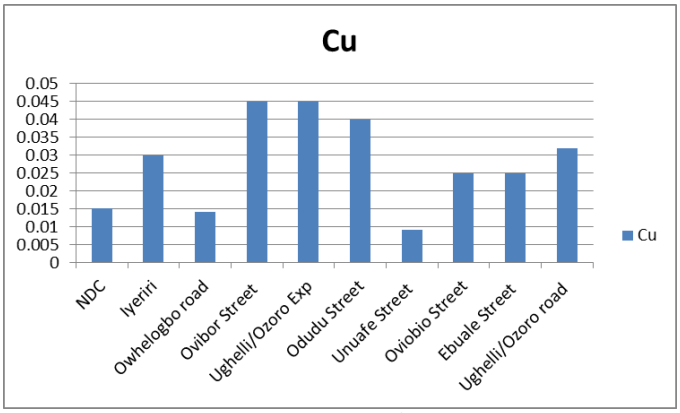


Fig. 4. Bar chart showing the concentration of Cu in selected borehole waters in Ozoro.

Chromium (figure 8) contents in the boreholes water analyzed ranged from 0.02 to 0.08mg/L. The high concentration of chromium recorded were 0.06 mg/l at Oviobio street and 0.08 mg/l at NDC and were higher than the maximum acceptable concentration (0.05mg/l). This could pose a health threat to those who live in these quarters. Long term exposure to chromium can cause damage to the kidney, liver, circulatory and nervous tissue. (Njar et al, 2012). However, the remaining eight samples were within the maximum acceptable concentration (0.05mg/L). Cobalt (figure



B. T. Sawere and C. K. Ojeba, "Assessment of heavy metal concentrations in borehole-hole water in Ozoro town, Delta State," *International Research Journal of Advanced Engineering and Science*, Volume 1, Issue 3, pp. 61-65, 2016.

International Research Journal of Advanced Engineering and Science
ISSN: 2455-9024

9) content in the borehole water analyzed ranged between 0.003 to 0.004 mg/L. and were below the maximum acceptable concentration. (0.005) Cobalt was recorded for Owhelogbo road (0.004mg/L) Onuefe street (0.003mg/L) and Ebuale street (0.003mg/L) borehole water, but shows no detectable level (BDL) for other seven samples.

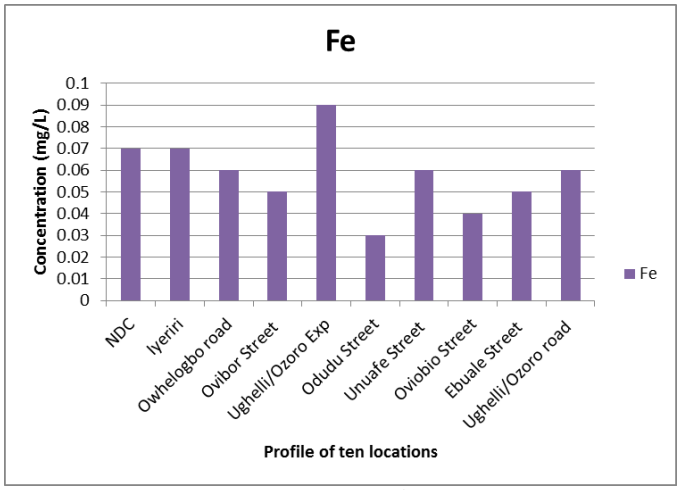


Fig. 5. Bar chart showing the concentration of Fe in selected borehole waters in Ozoro.

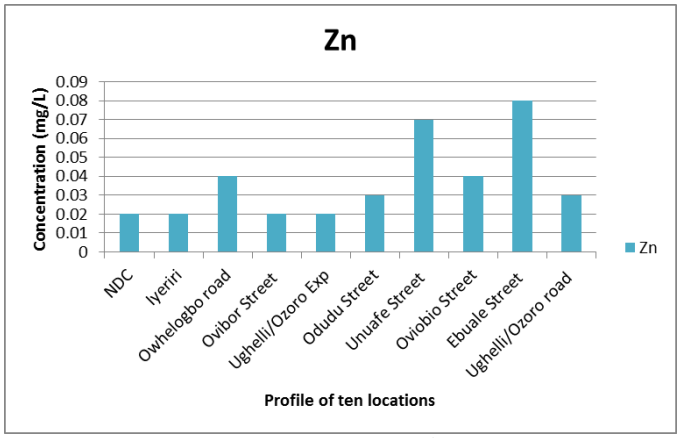


Fig. 6. Bar chart showing the concentration of Zn in selected borehole watersin Ozoro.

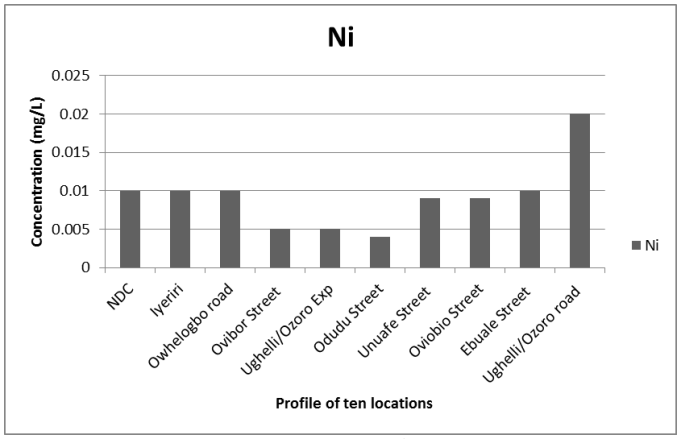


Fig. 7. Bar chart showing the concentration of Ni in selected borehole waters in Ozoro.

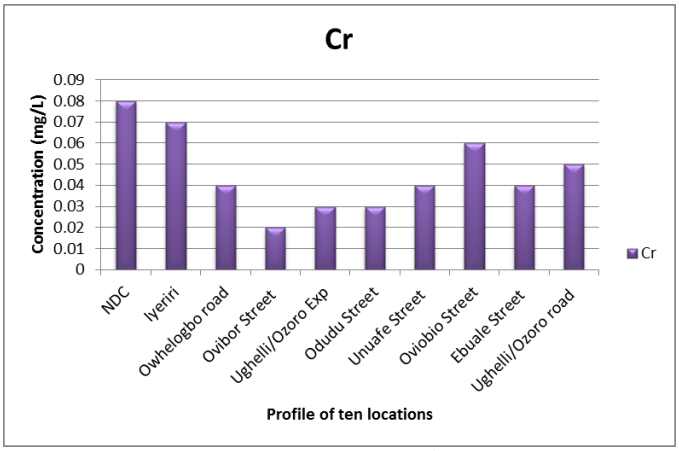


Fig. 8. Bar chart showing the concentration of Cr in selected borehole watersin Ozoro.

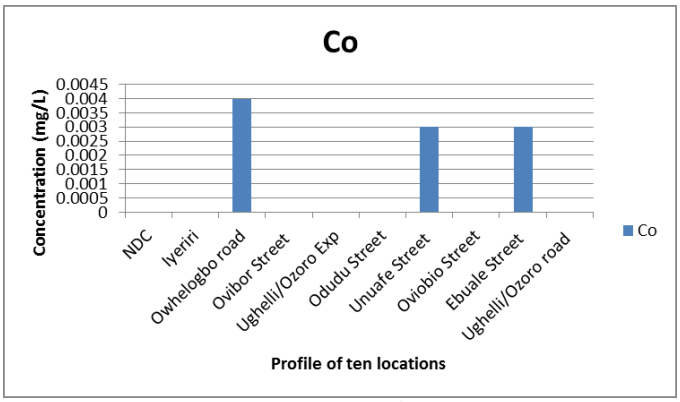


Fig. 9. Bar chart showing the concentration of Co in selected borehole waters in Ozoro.

## V. CONCLUSION/RECOMMENDATION

The source of water (boreholes) studied is the commonest sources of drinking water within Ozoro town. The low levels of heavy metals contents recorded for the sample boreholes within the WHO maximum acceptable concentration shows that they were not polluted and suitable for human consumption. The presence of chromium level reported could be avoided if boreholes are sited far from septic tanks since chromium could be introduced through soap and detergents used for washing and bathing (Ali et al, 2005); that could be what was responsible for the high chromium level in NDC and Oviobio street. In order to maintain the present state of good quality borehole, sanitary inspection officer should carryout routine monitoring of boreholes that are sunk within the locality. There should be proper information and advice on the position further to sink new bore-hole.

## REFERENCES

[1] R. Asklund and B. Eldvall, "Contamination of water resources," Department of Engineering Geology, Lund University, KFS, AB, Lund Sweden, 2005.

[2] A. A. Adepoju-Bello, O. O. Ojomolade, G. A. Ayoola, and H. A. B. Coker, "Qualitative analyses of some toxic metals in domestic water obtained from Lagos Metropolis," *The Nig. J. Pharm*, vol. 42, issue 1, pp. 57-60, 2009.

[3] M. A. Arain, *International Journal of Chem. Tech Research*, CODEN (USA), 2011.

[4] D. R. Baldwin and W. J. Marshall, "Heavy metal poisoning and its laboratory investigation," *Annuals of Clinical Biochemistry*, vol. 36, no 3, pp. 267-300, 1999.
[5] U. Celik and J. Ochlenschager, "Food control in biological and health implication of toxic heavy metal and essential trace element interaction," *Progress in Food and Nutrition Science*, vol. 11, issue 1, pp. 55-113, 2007.
[6] Ehi-Eromosele, C.O M.Sc Thesis, University of Lagos Nigeria, 2010.
[7] B. A. Hauser, *Drinking water chemistry, of a laboratory manual*, USA, CRC press, 2002.
[8] W. G. Landis, R. M. Sofield, and M. H. Yu, *Introduction to Environmental Toxicology Molecular Structures*, 4th edition, CRC press, Boka Raton, Florida, 2000.
[9] A. S. Mildvan, *Metals in Enzymes Catalyst*, in D. D. Boyer (ed), The Enzymes Academic Press, London, pp. 445-536, 1970.
[10] J. E. Marcovecchio, S. E. Botte, and R. H. Freije, *Heavy metals, major-Metals, Trace Elements*, Handbook of water Analysis 2nd edn, edited by L.M Nollet, CRC press, London, pp. 275-311, 2007.
[11] World health Organization (2013), "Stop lead poisoning in children" Retrieved 10th, June, 2015.
[12] World Health Organization, *Guidelines for Drinking Water Quality: Recommendation*, 3rd Edition, WHO Geneva pp. 345-465, 2006.
[13] World Health Organization, *Guidelines for Drinking Water Quality*, vol. 1, 3rd ed. WHO press, Switzerland, 2006.



B. T. Sawere and C. K. Ojeba, "Assessment of heavy metal concentrations in borehole-hole water in Ozoro town, Delta State," *International Research Journal of Advanced Engineering and Science*, Volume 1, Issue 3, pp. 61-65, 2016.