ZIBELINE INTERNATIONAL™ PUBLISHING
ISSN: 2637-0778 (Online)
CODEN: ECRNAE

Environmental Contaminants Reviews (ECR)

DOI: http://doi.org/10.26480/ecr.01.2021.29.32

CrossMark

RESEARCH ARTICLE

EFFECT OF WASTE DUMPSITE ON GROUNDWATER QUALITY OF A SHALLOW AQUIFER IN PORT HARCOURT, SOUTH-EASTERN NIGERIA

Esonanjor, E.E[a], Ohanuna, C.[b]*

[a] Department of Geology, Faculty of Science, Rivers State University, Port Harcourt.
[b] Department of Geography and Environmental Management, University of Port Harcourt, Choba
**Corresponding Author Email: ohanunachukwudi@yahoo.com*

ARTICLE DETAILS

Article History:

Received 27 May 2021
Accepted 30 June 2021
Available online 05 July 2021

ABSTRACT

The study assessed the effect of waste dumpsites on groundwater quality of upper aquifers in Port Harcourt. Water samples were retrieved from hand-dug wells from a dumpsite and a control site and analyzed for physico-chemical parameters and heavy metal content. Results show that electrical conductivity of the dumpsite water samples was 42.06µS/cm while the control site water samples recorded 31.27µS/cm. Turbidity of the water samples ranged from 0.62NTU-0.65NTU. Total Dissolved Solids of the dumpsite water sample was 26.8mg/l while the TDS of the control site water sample was 33.70mg/l. The pH of water samples from both sites ranged from 5.46 -7.34. The pH of water samples from the dumpsite was slightly acidic (5.46). The average temperature of the water samples was approximately 28^{o}C. Phosphate concentration of water samples ranged from 0.32 mg/l-0.54 mg/l while chloride levels ranged from 10.60mg/l-17.12 mg/l. All physico-chemical parameters and heavy metal content of the water samples all fell within the WHO and NSDWQ stipulated standards except for the lead concentration of the water sample retrieved from the dumpsite. The study also revealed that waste dumpsites did not alter the concentration of the measured physico-chemical properties and heavy metal concentration of water samples. However, the study recommended that periodic assessments of groundwater quality of waste dumpsites should be undertaken.

KEYWORDS

Groundwater Quality, Waste Dumpsites, Aquifers, Physico-chemical Parameters

1. INTRODUCTION

Groundwater serves many purposes. They are useful for drinking, domestic purposes, irrigation and industrial processes. However, in recent times, ground water resources have become threatened as a result of rapid population expansion, industrialization and various agricultural activities. On the other hand, natural geological processes such as weathering of rocks, evapotranspiration, depositions due to wind, leaching from soil, run-off due to hydrological factors, and biological processes in the aquatic environment have also contributed to the rapid deterioration of groundwater quality. Subsurface geological formations and depth of soil also impact on groundwater quality (Abimbola, et al., 2002). Groundwater in shallow aquifers is derived from leakage from streams and canals and infiltration of rain water and irrigation water. The groundwater in shallow aquifers is easily contaminated by open dumping of waste as the chemical components of toxic wastes infiltrates into the aquifers after precipitation. Contaminated surface water may also percolate through the soil particles into the groundwater and contaminating it (Ugwoha and Emete, 2015).

The rapid industrialization of Port Harcourt has had its attendant consequences on waste generation. More wastes have been generated on a daily basis. The current situation of employing the age-long system of land filling for disposing wastes within the city poses a major risk on groundwater pollution. Polluted water is hazardous and may likely cause several illnesses such as typhoid, dysentery and cholera (Eni et al., 2014). In consideration of the hazardous effects of ingesting polluted water, it has therefore become ideal to undertake a study of this nature to examine the physicochemical parameters and heavy metal concentration of water samples in a waste dump site in comparison to a control site in Port Harcourt, South-Eastern Nigeria. Port Harcourt is the capital of Rivers State and is situated approximately between latitude 04^{0} 43' and 04^{0} 57' North of the Equator and between longitude 06^{0} 53' and 07^{0} 08' East of the Greenwich Meridian as shown in figure 1 below.

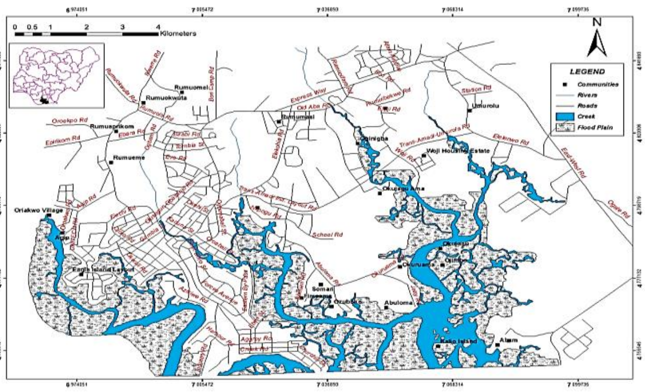

Figure 1: Map of Rivers State showing study area

As a result of its closeness to the equator, the area lies within the subequatorial region with mean annual temperature of 28^{0}C and heavy rainfall of over 2,000mm. The city possesses upper soil layer of soft mud and a high-water table. The soil is composed of silts, clays, sand and

Quick Response Code	Access this article online	
	Website: www.contaminantsreviews.com	**DOI:** 10.26480/ecr.01.2021.28.18

gravels. Geologically, the soil type can be categorized under the Benin formation (Oyegun, 1999). The relief of the area is generally low-lying while the drainage is poor, basically because of its low relief, high water table and heavy rainfall. The rapid population growth within the city accounts for increased waste generation which when not properly disposed contaminates ground water (Wizor, 2012).

2. Materials and Methods

The data used consist of primary data retrieved from the analysis of water samples recovered from the site. Further references were made from online journals and publications. Water samples were collected from hand dug wells within the proximity of the Aluu dumpsite and a control site. The static water levels in both sites ranged from 2.9-.6.5m. The overlying soils in both sites include clayey sand, clay and sand. The top soil of the control site is clay of about 8m thickness. The dumpsite water samples were collected at about 40 metres from the dumpsite while the control samples were retrieved at a distance of 10km from the dumpsite. The water samples from both locations were retrieved with the aid of the water sampler to about 30cm below the water surface and composited. The water samples retrieved for physicochemical analyses were put into a 2-litre plastic container that was already rinsed with the water sample collected and sealed.

The water samples retrieved for heavy metal analyses was stored in a 150ml plastic container and concentrated nitric acid was added. The water samples collected will be stored in ice-packed coolers, inscribed according to location and preserved for further analysis. Laboratory analyses were carried out on the samples in accordance with the American Public Health Association (APHA, 1995). Exchangeable cations and anions were measured with the aid of the flame photometer and UV/visible spectrometer while the Horiba Water Checker (Model U-10) was deployed to measure electrical conductivity, turbidity, dissolved solids, pH, temperature and salinity after calibrating the instrument with standard Horiba solution. Dissolved oxygen was determined by the Modified Azide or Winkler's method while the Argentometric method was used to evaluate the concentration of chloride in the presence of potassium chromate as indicator. Phosphate was measured with using the stannous chloride method while sulphate was determined by the turbidimetric method. Nitrate measurement was by the ultraviolet spectrophotometric screening method. Atomic absorption spectrophotometer was used to evaluate the concentration of heavy metals in the water samples.

3. Results

The analysis of electrical conductivity of water samples revealed that the electrical conductivity of water samples in the dumpsite was 42.06µS/cm while that of the control site water samples was 31.27µS/cm. However, the electrical conductivity of water samples from both dumpsite and control site were below the stipulated WHO and NDSWQ standards as shown in Figure 2 (WHO, 2011; NDSWQ, 2007; Ukpaka and Ukpaka, 2016).

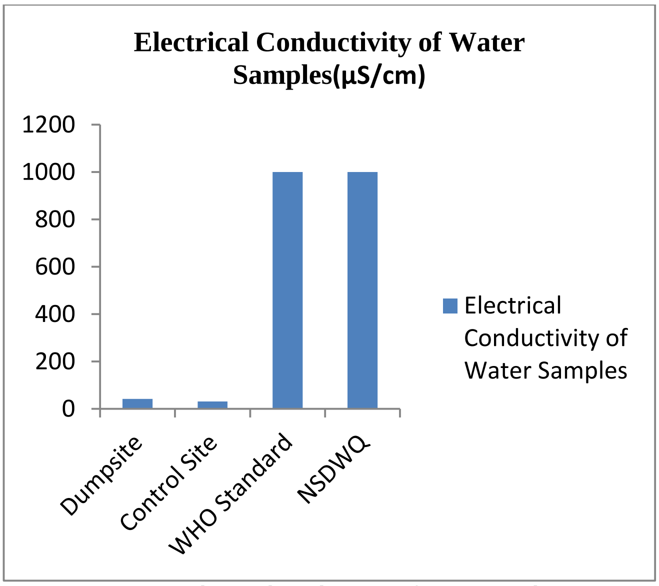

Figure 2: Electrical Conductivity of Water Samples.

The turbidity of the water samples in the dumpsite was 0. 65NTU while the control site sample recorded a turbidity of 0.62NTU with all values within the stipulated standard for WHO and NDSWQ standards as shown in Figure 3 (Oboh and Egun, 2017; WHO, 2011; NDSWQ, 2007).

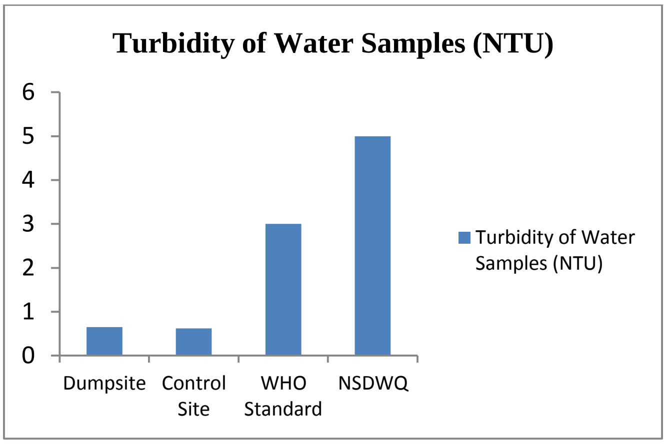

Figure 3: Turbidity of Water Samples.

In the analysis of total dissolved solids (TDS), the research findings revealed that the TDS of the dumpsite sample was 26.8mg/l while the TDS of the control site sample was 33.70mg/l with both values falling within the stipulated WHO and NSDWQvalues of 500mg/l as shown in figure 4 (WHO, 2011; NSDWQ, 2007; Amadi, 2011).

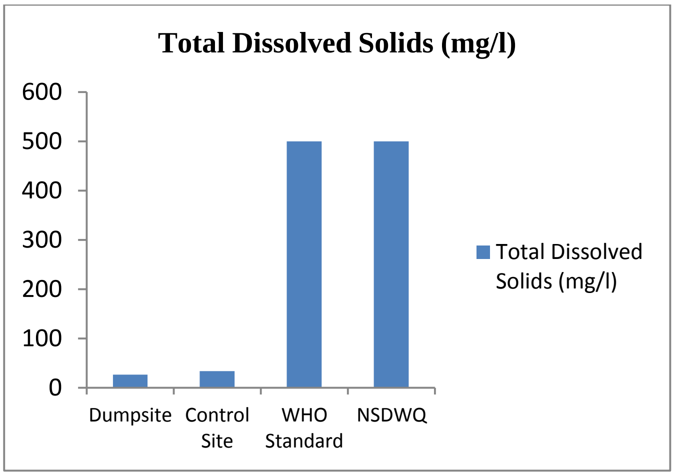

Figure 4: Total Dissolved Solids of Water Samples.

The analysis of pH of water samples revealed that the pH of dumpsite samples was 5.46. The pH of the control site was 7.34. This implies that the pH of the dumpsite was slightly acidic. This could be attributed to the percolation of organic waste to the aquifers and contaminating the water. The finding of this research is in agreement to the findings of who in their study revealed that the pH of water samples within the proximity of dumpsite were slightly acidic (Nwankwola and Offor, 2018). The analysis of pH is shown on Figure 5.

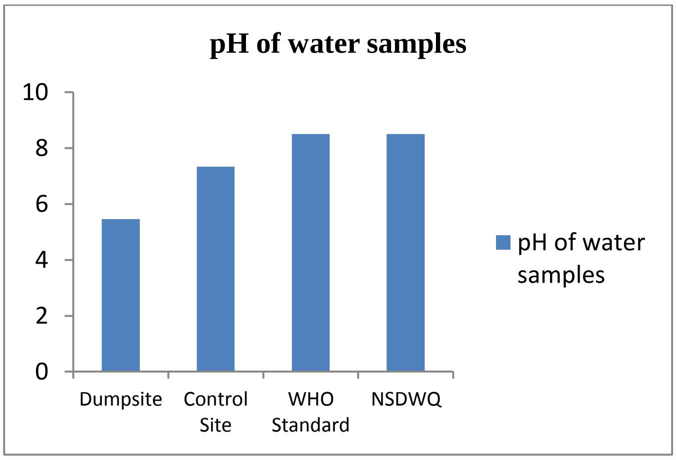

Figure 5: pH of Water Samples.

As shown in fig 6 below, the temperature of water sample in the dumpsite was slightly higher than that of the control site sample. The temperature of water sample in the dumpsite was 28.6^{0}C as against the control site which was 28.2^{0}C in agreement to the findings of who noted that the average temperature of the groundwater samples in the study area was approximately 29^{0}C (Nwankwoala and Udom, 2011).

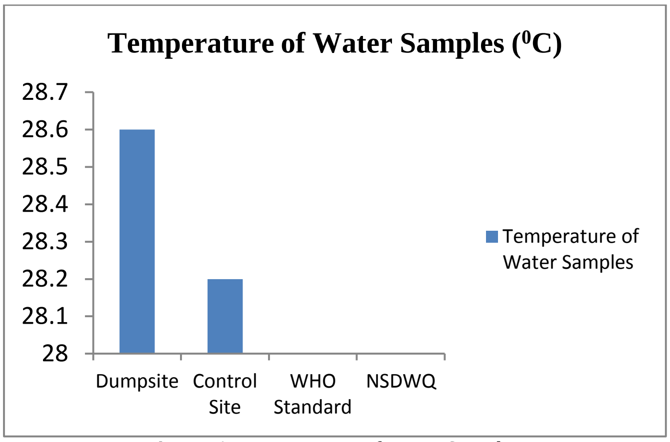

Figure 6: Temperature of Water Samples.

In the analysis of dissolved oxygen in the water samples, the dumpsite sample recorded a value of 6.30 mg/l as against the control site sample which recorded a value of 5.60mg/l as shown in fig 7. These values were above the WHO recommended value of 5.0mg/l but fell within the NSDWQ recommended value of 7.5mg/l (WHO, 2011; NSDWQ 2007). However, this finding is in sharp contrast to the findings of who discovered in a separate study that dissolved oxygen level in groundwater samples in the study area fell within the recommended WHO Standard (Sokpuwu, 2017; WHO, 2011).

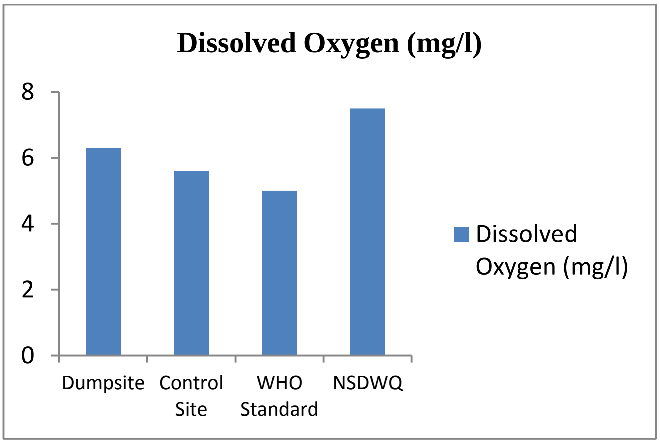

Figure 7: Dissolved Oxygen of Water Samples.

In the analysis of chloride in the water samples, the chloride concentration in the water sample in the dumpsite was 17.12 mg/l as against the water sample in the control site recorded a chloride value of 10.60mg/l as shown in figure 8. These values fell below the WHO and NSDWQ stipulated value of 250 mg/l (WHO, 2011; NSDWQ, 2007; Akpoveta et al., 2011; Eni et al., 2014).

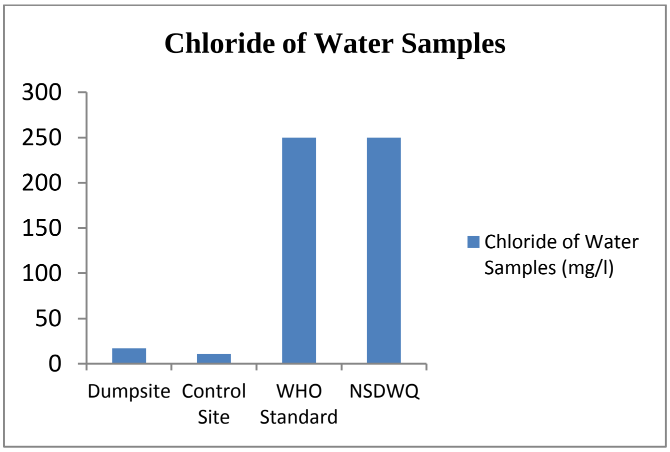

Figure 8: Chloride of Water Samples.

The analysis of phosphate in water samples revealed that the dumpsite recorded a concentration of 0.54 mg/l while the control site had a concentration of 0.32 mg/l which were all within the WHO and NSDWQ stipulated standard of 10 mg/l and 5 mg/l respectively as shown in figure 9 (WHO, 2011; NSDWQ, 2007; Nwankwoala and Udom, 2011; Oboh and Egun, 2017).

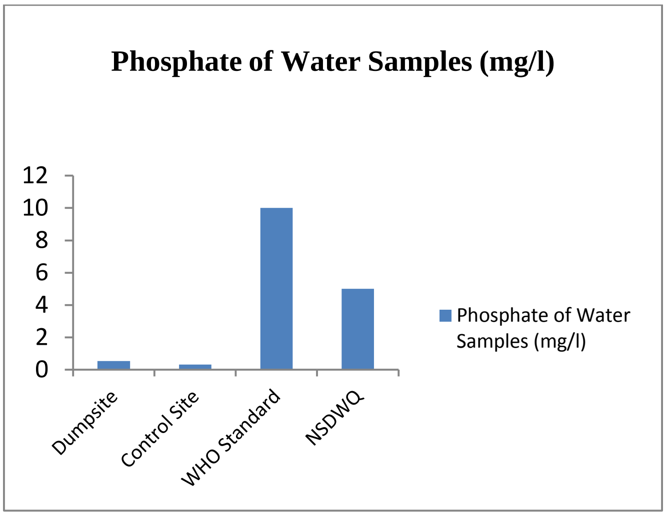

Figure 8: Phosphate of Water Samples.

The nitrate concentration of the water sample in the dumpsite was slightly higher than the water sample retrieved from the control site. The concentration of nitrate in the water sample at the dumpsite was 0.31 mg/l. However, the concentration of the control site was 0.18 mg/l as shown in figure 9. These values all fell within the WHO and NSDWQ stipulated value of 50 mg/l (WHO, 2011; NSDWQ, 2007; Ukpaka and Ukpaka, 2016).

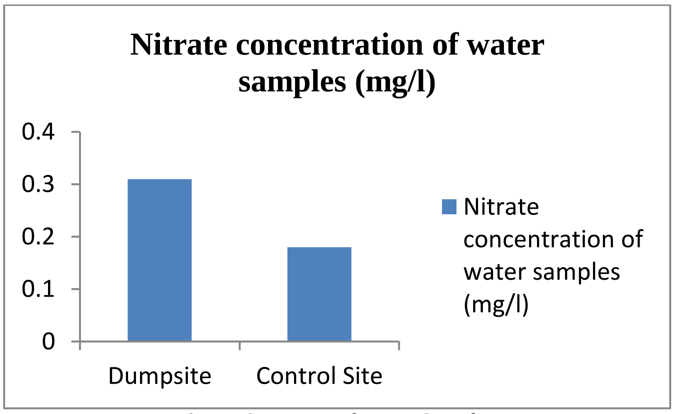

Figure 9: Nitrate of Water Samples.

The detailed analysis of heavy metal concentration of the water samples is represented in Table 1. The result revealed that cadmium concentration in both the dumpsite sample and control sample were below detection limits. The analysis of iron revealed that the dumpsite sample had a concentration of 0.295mg/l as against the control site sample with a concentration of 0.168 mg/l. However, the concentration of both dumpsite and control site samples were below the WHO and NSDWQ guidelines (WHO, 2011; NSDWQ, 2007). The analysis of zinc also revealed that the concentration of dumpsite water sample was 0.028 mg/l while that of the control site sample was 0.05 mg/l. However, these values all fell within the stipulated WHO and NSDWQ guidelines (WHO, 2011; NSDWQ, 2007). In the analysis of copper, the dumpsite water sample had a concentration of 0.067 mg/l while the control water sample had a concentration of 0.062 mg/l which were all within the stipulated WHO and NSDWQ guidelines (WHO, 2011; NSDWQ, 2007). However, the analysis of lead showed slightly elevated levels of lead in the dumpsite (0.020 mg/l) while the control site sample recorded a lead concentration 0.006 mg/l which fell within the stipulated WHO and NSDWQ guidelines (WHO, 2011; NSDWQ, 2007).

Table 1: Heavy Metal Concentration of Water Samples

S/No	Parameters	Aluu Dumpsite (mg/l)	Control Site (mg/l)	W.H.O Standard (mg/l)	NSDWQ Standard (mg/l)
1	Cadmium	Bdl	Bdl	0.003	0.003
2	Iron	0.295	0.168	0.1	0.3
3	Zinc	0.028	0.05	1.5	3.0
4	Copper	0.067	0.062	2.0	1.0
5	Lead	0.020	0.006	0.01	0.01

*Bdl – Below detection limit

4. Conclusion

The study elaborated the effect o waste dumpsite on groundwater quality. The findings of this study revealed that the physicochemical parameters and heavy metal content of the groundwater samples measured during the period of study were still within the stipulated standard set by WHO and NSDWQ except for the pH and lead content of water sample within the dumpsite. The slightly elevated level of lead in the water sample of the dumpsite could be attributed to the contamination of groundwater by lead containing waste disposed at the dumpsite. The slight acidity of the dumpsite water sample could be as a result of the acidic release from decomposing waste materials. It is revealed from this study that waste dumpsites have little or no effect on the concentration of physico-chemical properties and heavy metal content of groundwater. In line with this finding, the study recommended that periodic assessment of groundwater quality of dumpsites should be undertaken.

References

Abimbola, A.F., Odukoya, A.M., Olatunji, A.S., 2002. Influence of Bedrock on the Hydrogeochemical Characteristics of Groundwater in Northern part of Ibadan Metropolis, South-West Nigeria. Water Resources Journal, 9, Pp.1-6.

Akpoveta, O.V., Okoh, B.E., Osakwe, S.A., 2011. Quality Assessment of Borehole Water used in the Vicinities of Benin, Edo State and Agbor, Delta State of Nigeria. Cur. Res. Chem., 3, Pp. 62 -69.

Amadi, A.N., 2011. Assessing the Effects of Aladimma Dumpsite on Soil and Groundwater Using Water Quality Index and Factor Analysis. Australian Journal of Basic and Applied Sciences, 5 (11), Pp. 763-770.

APHA. 1995. Standard Methods for the Examination of Water and Wastewater, 18th ed. APHA-AWWA-WPCF, Washington DC.

Eni, D.I., Ubi, A.E., Digha, N., 2014. Vulnerability Assessment of Boreholes located close to Lemna landfill in Calabar metropolis, Nigeria. Int. J. Phys. Human Geo., 2 (2), Pp. 6 – 15.

NSDQW. 2007. Nigerian Standard for Drinking Water Quality. Nigerian Industrial Standard NIS 554. Standard Organization of Nigeria: Lagos, Nigeria, Pp. 30.

Nwankwoala, H.O., Offor, S.C., 2018. Contamination Assessment of Soil and Groundwater within and around Semi-controlled Solid Waste Dumpsites in Port Harcourt, Nigeria. J Waste Recycl., 3 (2), Pp. 8.

Nwankwoala, H.O., Udom, G.J., 2011. Hydrogeochemical Evaluation of Groundwater in Parts of Eastern Niger Delta, Nigeria. Journal of Academic and Applied Studies, 1 (2), Pp. 33 - 58.

Oboh, I.P., Egun, N.K., 2017. Assessment of the Water Quality of Selected Boreholes Close to a Dumpsite in Agbor Metropolis, Delta State, Nigeria. African Scientist, 18 (1), Pp. 43-53.

Oyegun, C.U., 1999. Soil" In Oyegun C. U. and Adeyemo A. (Eds.) Port Harcourt Region. Port Harcourt: Paragraphic

Sokpuwu, I.A., 2017. Groundwater Quality Assessment in Ebubu Community, Eleme, Rivers State, Nigeria. J Environ Anal Chem., 4, Pp. 228.

Ugwoha, E., Emete, K.C., 2015. Effects of Open Dumpsite Leachate on Groundwater Quality: A Case Study of Alakahia Dumpsite in Port Harcourt, Nigeria. J Environ Stud., 1 (1), Pp. 8.

Ukpaka, C.P., Ukpaka, C., 2016. Characteristics of Groundwater in Port-Harcourt Local Government Area. Chemistry International, 2 (3), Pp. 136-144.

WHO. 2011. World Health Organization. Guidelines for Drinking Water Quality. 4th edition

Wizor, C.H., 2012. Analysis of the Developmental Trends of Single Family Housing Estates in Port Harcourt Metropolitan Fringe Areas. Ph.D Dissertation, Department of Geography dand Environmental Management, University of Port Harcourt, Choba, Rivers State.