Physico-Chemical Quality of Boreholes Waters at the Municipal Waste-Dumping Sites in Potchefstroom-South Africa

Elvis Fosso-Kankeu[1]* and Stenly Modupi Makuwa[2]

***Abstract*—**In this study, water samples were collected from a borehole upstream of the Sewage Purification Plant (SPP) and from three boreholes at the municipal dumping sites in Felophepa near Potchefstroom and analyzed with consideration of parameters such as pH, conductivity, temperature, turbidity, metal ions and chemical oxygen demand (COD). There was a concern with regard to the quality of water which contained toxic metals such as uranium and lead, relatively high values of turbidity, TDS and COD especially at the sampling point C located in the landfill site at Felophepa. The control sample which was the water from the borehole upstream of the SPP was less polluted, while the sample from point C was the more polluted. Such investigation is encouraged to predict ground water pollution and give feedback to the municipality for proper management of the solid waste disposal at the Felophepa waste dumping site.

***Keywords*—**Solid waste, municipal dumping sites, leachates, ground water, pollution.

I. Introduction

The nature of solid wastes at the municipal waste dumping sites varies significantly, as they originate from a number of sources including domestic, industry, hospital, agriculture etc. It is estimated that several tons of solid wastes are dumped at these sites every day around the world. In South Africa, following political change and national inclusion in the 90s, resulting into significant increase of municipal solid waste requiring collection; from 42 million cubic meters in 1997, general waste generation rose to 67 million cubic metres in 2008 [1]. The number of municipalities performing solid waste management functions therefore increased by 16% from 2005 to 2009; from 226 in 2005, the number of municipalities servicing around 8.4 million households rose to 239 [1]. It therefore ensues that the population and economy growth has resulted in large volume and complexity of waste, making the management of MSW more challenging. The complexity of the waste increases the chances for biochemical and chemical reactions that can result in the leaching of organic and inorganic pollutants into ground water [2].

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E. Fosso-Kankeu is with the School of Chemical and Minerals Engineering at the North-West University, Potchefstroom, South Africa.

S.M. Makuwa is with the Water Quality Section of the Tlokwe Municipality, Potchefstroom, South Africa

It has been previously reported from several countries that leachates from these municipal dumping sites (MDS) significantly contribute to the contamination of ground water [3]. Ground water which is stored in pores and fracture of rock strata constitutes an important part of available fresh water and should not be disregarded, especially in country such as South Africa where water scarcity is worsened by pollution [4-12]. The nature, concentration of pollutants in leachates from MDS and the degree of impact on ground water pollution will depend on the nature of solid wastes, the age of MDS as well as the stages of waste degradation at the dumping site [13]. Proper monitoring of the possible impact of MDS leachates on the ground water requires installation of wells and regular collection of samples for physical, chemical and biological analyses. The present study focuses on the evaluation of physicochemical contaminants in the wells from MDS in the city of Potchefstroom in South Africa.

II. Methodology

A. Sampling Area

Two different sampling sites were considered for this study. The borehole used as control was located upstream of the Sewage Purification Plant (SPP) within the premises of the Potch Animal Welfare Society (PAWS) where borehole water is used for domestic purposes and to run the business which consists of taking care of pets. The coordinates of this borehole is 26°44’84.1”S- 27°05’50.3”E. The landfill, which was previously the site of the Farm Hartbeeskop, is situated approximately 3.5 Km west of Promosa and approximately 10 Km west of Potchefstroom city centre in a remote location called Felophepa becomes operation between 2002 and 2003. The site lies near the watershed between tertiary catchments of the Vaal River Catchment and flanks the boundary between Water Management Areas ‘Upper Vaal’ and ‘Middle Vaal’. The site is approximately 20 Km north of the Vaal River and approximately 11 Km west of the Mooi River which are the main rivers around Potchefstroom.

B. Water Sampling

Water samples were collected in the Winter season or dry season from the main borehole upstream of the Sewage Purification Plant (control, sample A) and from three monitoring wells (samples B, C and D) at the landfill site in Felophepa near Potchefstroom. Samples in the 500 mL plastic bottles were analysed in situ to determine physicochemical parameters such as pH, Redox potential (mV), electrical conductivity (mS/cm) and temperature (°C). A portable pH meter with the appropriate probes (Hanna Instruments Inc., USA) was used for these analyses. The water in the 500 mL polyethylene bottles was then transported in the cooler box and stored between 4 and 8 °C in the main water laboratory at the School of Chemical and Minerals Engineering of the North-West University.

C. *Water Analysis*

Stored water samples were then sent to accredited laboratories for analysis of physicochemical parameters such metal ions, total dissolved solids, total organic carbons (TOC) and chemical oxygen demand (COD). Suspected organic pollutants such as semi volatile organic compounds and organochlorine pesticides were also analyzed.

III. RESULTS AND DISCUSSION

A. *Physico-Chemical Quality of Boreholes Water*

The results in Table 1 show that as expected water quality of sample A was relatively acceptable, while samples B, C and D collected from the wells at the landfill site exhibited poorer quality; although the pH was quite acceptable, the turbidity was high especially in sample C, which also had the highest value of total dissolved solid (1142 mg/L).

TABLE 1 PHYSICO CHEMICAL PARAMETERS VALUES OF WATER

Sampling points	pH	ORP (mV)	EC (mS/cm)	Temperature (°C)	Turbidity (NTU)	TDS (mg/L)
A	7.24	-3.1	1.802	23.6	0.7	527
B	6.64	20	1.03	26.8	81.5	234
C	6.68	17	3.632	29.3	116	1142
D	7.72	-38	0.228	26.6	15	116

Table 2 shows the concentrations of selected metals in the various samples; it can be observed that sample C contained the highest concentrations of metals, but does not contain lead. The presence of uranium at all the sampling points is of concern, although the concentration did not exceed the recommended value of 0.03 mg/L for drinking water by the World Health Organization [14], while relatively high concentrations of Ca and Mg in samples may contribute to water hardness, affecting the suitability of water for various purposes.

TABLE 2 SELECTED METALS VALUES OF WATER

Sampling points	Ca (mg/L)	Mg (mg/L)	Pb (mg/L)	U (mg/L)
A	75	62	0.002	0.02
B	48	25	nd	0.011
C	130	98	nd	0.013
D	11	nd	0.002	0.008

B. *Organic Contaminants in Water*

Water samples were tested for the presence of a wide range of organic pollutants belonging mainly to the groups of semi volatile organic compounds and organochlorine pesticides; however, none of these compounds was detected in the water samples. As shown in Table 3, no detectable values of COD and TOC were recorded in samples A and D, while the highest values were found in sample C.

TABLE 3: INDICATORS OF ORGANIC POLLUTANTS

Sampling points	COD (mg/L)	TOC (mg/L C)
A	nd	nd
B	38	5
C	101	20
D	nd	nd

C. *Discussion*

Sample A collected upstream of the Sewage Purification Plant did not have any influence of waste disposal and was therefore considered as a control in this study; the results therefore confirm little to no inorganic or organic contamination in that water. While samples B, C and D which were collected at the landfill side show a varied level of contamination by inorganic and organic pollutants. The difference of pollutants concentration may be due to the different spatial characteristic of waste, the difference of stages of biodegradation of waste as well as the possible difference of the level of water table at each collection point [13]. Among these three sampling sites, the pH was found to be relatively low at sampling points B and C, implying that more acetogenic activities are likely to take place at these points compared to point D [3]. According to the literature the volume of waste water that infiltrates the landfill significantly influences the composition of the leachate as well as the quantity of pollutant released from the waste [2]; in this study the water samples were collected toward the end of the Winter season which is a dry season; that will probably explain why relatively low values of COD were recorded. Furthermore, previous authors [15, 16](Chang, 1989; Chen, 1996) have reported that higher values (more than 10000 mg/L) of COD must be recorded from leachates of young landfills, while for landfills older than 10 years, lower values (below 3000 mg/L) of COD are expected. Concerns with high uranium values and hardness have been previously reported in the area of Potchefstroom where the Mooi River is loaded with calcium and magnesium originating from the dolomite rocks upstream [17, 18].

IV. CONCLUSION

Wastes dumped at the landfill contain a host of pollutants of different nature that can considerably affect the quality of our underground water. This preliminary study has shown that there is a reason of concern when considering inorganic pollutants such as metals and the possible presence of organic pollutants not yet identified in the leachates from dumped wastes at the Felophepa landfill near Potchefstroom; further investigations are therefore required to identify the exact organic pollutants in the leachates.

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The corresponding author is currently an Associate Professor in the School of Chemical and Minerals Engineering at the North-West University (Potchefstroom). He is an NRF rated researcher who has published journal articles, book chapters and book.

Prof Elvis Fosso-Kankeu has been the recipient of several merit awards.