Hazardous Waste Management in the West Rand District Municipality, Gauteng, South Africa: A Review

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***Abstract*—**Hazardous and medical waste types are often generated in the West Rand District Municipality (WRDM). The WRDM is made up of four Local Municipalities (LMs) which are Randfontein, Mogale City, Westonaria and Merafong City. Hazardous waste can cause significant health and environmental impacts when managed inadequately. It contains organic and in-organic elements with inherent physical, chemical and biological or toxicological characteristics. All the WRDM landfill sites (Luipaarsdvlei, Rooiport, Lebanon and Uitvaalfontien) do not cater for hazardous waste as all wastes are classified and permitted as generally the same. Hazardous waste requires special handling, treatment and disposal and thus spotters and gate controllers on the landfill site screen for hazardous waste. There is no hazardous or medical waste disposal site in the WRDM therefore, hazardous waste generated by WRDM is disposed off at an incinerating plant near Roodepoort in Johannesburg.

***Keywords*—**Hazardous waste, Incinerator, Inorganic, Medical waste, Organic, Spotters, Toxicological.

I. INTRODUCTION

HAZARDOUS WASTE is any waste that contains organic or in-organic elements or compounds with inherent physical, chemical or toxicological characteristics and having detrimental effects on human and environment health. In terms of the minimum requirements of the Department of Water Affairs and Forestry (DWAF), hazardous wastes are grouped into four hazard ratings. High hazardous waste requires the strictest control and urgent attention. Its contents are said to be significantly toxic and persist in the environment and accumulate in biological tissues. Moderate hazardous waste possesses highly dangerous characteristics and contains significant concentration of high/moderate toxic constituents. Low hazardous waste has dangerous characteristics or with significant concentrations of available toxic constituents. Potential hazardous waste have characteristic toxicity, which are either in a form that will remain insoluble or are of significant concentrations [2]. Hazard ratings are summarised in Table 1.

TABLE I
HAZARDOUS WASTE RATINGS

HAZARDOUS WASTE RATINGS	
HAZARD RATING 1	High Hazard
HAZARD RATING 2	Moderate Hazard
HAZARD RATING 3	Low Hazard
HAZARD RATING 4	Potential Hazard

Health care risk waste (HCRW) or medical waste presents a great hazard to the environment and to those who come into contact with the waste. It is waste generated in health care facilities i.e., hospitals, clinics including pathogenic or biological infectious waste, sharps objects and hazardous waste mainly originating from laboratories containing toxic substances [3].

II. HAZARDOUS WASTE MANAGEMENT

The disposal of medical and hazardous waste in WRDM's four local municipalities (Mogale City, Merafong City, Westonaria and Randfontein) is done by accredited service providers. These include among others Phambili Waste, Buhle Medical Waste, Sanumed, Envirocil (also disposes animal carcasses), Waste-tech and Lancet Laboratories. There is no hazardous or medical waste disposal site in the WRDM thus, medical wastes generated by the local public and private medical facilities are is disposed off at the incinerating plant in Roodepoort, Johannesburg as shown in Fig. 1. Sanumed Waste has three incinerating facilities in the Gauteng Province. Majority of medical practitioners, clinics and hospitals do separate their medical waste from the general waste. Medical waste includes sharp objects, ampules, soiled dressings, syringes, needles, etc. However, a few places where the practice of separating medical waste from general waste was not done were identified. The waste is disposed in 240L bins which are collected by the respective service providers. Companies such as Sanumed also provide medical waste containers. In instances where the municipality collects the waste, this is taken to the central clinic where an accredited service provider collects them for disposal outside the WRDM. The frequency of waste collection depends on the amount of waste generated as they range from daily

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collection in hospitals to weekly collection for other medical practitioners.

Fig. 1: Hazardous waste incinerator in Rodepoort, Johannesburg [2]

Hazardous and general waste is collected by service providers in skip containers and other mass storage containers provided by the WRDM. Service providers include among others Mogale City LM, Multi-waste, Skip Waste, Waste-tech, Reclaim Metals, Chamdor Waste, Rainbow Waste and Oil Kol. No information was provided for other hazardous and toxic waste generators, such as hair and beauty salons. WRDM landfill spotters currently do not identify and separate all hazardous and toxic waste coming into the landfill due to highly mixed waste streams. Thus, it is highly possible that other hazardous material such as aerosol cans, batteries, paint, household chemicals also end up in landfills. WRDM landfills (Luipaardsvlei, Roipoort, Lebanon and Uitvaalfontein) cater for general waste excluding hazardous, medical/pharmaceutical and toxic waste [2].

III. HAZARDOUS WASTE STREAM ANALYSIS

Hazardous waste stream include house hold waste, oil based paints, paint thinners, paraffin, wood preservatives, pesticides, household cleaners, used motor oil as shown in Fig. 2 as well as antifreezes, batteries, discarded tyres, used oil, electronic waste, wet batteries, construction and demolition waste, municipal waste water treatment sludge and slaughterhouse waste. Industrial hazardous waste include metal cutting from processing or cannery waste [3].

Fig. 2: Hazardous motor oils and paint cans collected for recovery [4]

There is a tyre cutter at the Luipaardsvlei landfill site in Mogale City LM where waste tyres are cut as shown in Fig. 3 before they are landfilled in order to reduce their size and save landfill space. Some re-claimers on site burn the tyres thereby recovering metals from this exercise. This is a hazardous act due to the presence of flammable and explosive gases at the landfill site.

Fig. 3: Tyre cutting @ Luipaardsvlei landfill site

IV. E-WASTE RECYCLING

Hazardous components in electronic waste (e-waste) complicate the recycling/dismantling and disposal processes in the waste management sector. It requires a full understanding of the components of the materials dealt with. Strict measures should always be put in place in dismantling e-waste equipments to avoid further environmental impacts due to improper waste management and lack of education and training on waste management [5]. E-waste is often found in general landfill site as they are also disposed in waste bags. There are currently no e-waste drop off centers and separation at source initiatives, awareness and education for household electronic appliance users in the WRDM. Fig. 4 shows e-wastes such as computers, microwaves, TV's, cell phones for recycling [6].

Fig. 4: Electronic waste mixed with hazardous waste [4]

Some electronic waste pose high levels of risk to human health and the environment such as arsenic and mercury from waste lamps i.e., fluorescent lamp, thermometers, and dental amalgam as shown in Fig. 5. These types of waste cannot be destroyed and therefore must be immobilized and permanently encapsulated. These are costly processes, which illustrate the importance of changing product composition, industrial processes or the source of raw material [7].

Fig. 5: E-waste spent lamps [7]

V. MEDICAL WASTE SITUATION ANALYSES

WRDM is currently not able to properly treat much of the medical waste, especially when not separated, it enters municipal waste stream where it is mixed with general waste. It is often found in waste bags, disposed by some medical practitioners thereby decreasing the likelihood of spotters to identify the medical waste from the waste stream. This can lead to injury and infection for waste pickers, contamination of other waste fractions, recovery and re-sale of sharps objects without sterilization and pollution of water including drinking water. Medical waste presents a risk to the health of people and can cause infectious diseases and pollution if not handled properly. Medical waste or health care waste consist of infectious waste at 25% of the total health care waste among which are sharp object and body part wastes which constitutes 1% each, chemical or pharmaceutical waste at 3%, radioactive waste and broken thermometers containing mercury at 1% of the total health care risk waste. Infectious waste, especially sharp objects such as discarded syringes poses risk to anyone who comes into contact with it especially in cases where they are re-used.

VI. HAZADOUS WASTE LEGISLATIVE

WRDM municipality has a mandate to adhere to the hazardous waste legislative framework, which are the Hazardous substance Act, Health Act and the National Environmental Management Act. These acts are associated with addressing the gap of hazardous waste management that provide and promote the health status of people as well as prevent prevailing conditions detrimental to health. It also provides for legal disposal of empty containers with flammable containers being disposed separately [8].

VII. AIR POLLUTION

Poorly managed landfill sites contribute to air pollution through hazardous substances such as benzene, methane, naphthalene, tetrachloroethylene and trichloroethylene. These gases decompose and create volatile gases and if they become concentrated in pockets, they can be explosive. Bad odours are common during wet summer months when landfill sites are kept moist. High temperatures facilitate decomposition of waste and production of odours. Communities located close to landfill sites can be impacted on by air pollution and landfill gases. These substances cause burning of the eyes, sore throats and headaches. It also attracts rats, snakes, flies and other insects which spread to surrounding communities. Other potential consequences for poorly managed hazardous waste include air pollution by dust release particularly from mine deposits as well as health care risk from waste incinerators [9].

VIII. CONCLUSION

This paper has identified gap analysis that needs assessment in the hazardous waste management and treatment for the West Rand District Municipality. The paper has also shown that there are serious detrimental consequences on the environment and to the health of people if hazardous waste is improperly managed.

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REFERENCES

[1] KwaZulu Natal – Hazardous Waste Management Plan, Final Status Quo Report, 2013.

[2] IWMP Integrated Waste management Plan Report, West Rand District Municipality, 2010.

[3] National Waste Management Strategy. Department of environmental affairs, 2011.

[4] Waste and Chemicals Management, Guidelines or the hospitality industry, 2012.

[5] Municipal waste management - good practices, 2011.

[6] Development of a General Waste Minimisation Plan for Gauteng, Status Quo and Waste Minimisation Options Report, 2008.

[7] Guidelines for Waste Management Strategies. Moving from Challenges to Opportunities, 2013.

[8] Integrated Waste Management Plan. Westonaria Local Municipality, 2005.

[9] Gauteng State of Environmental Report. Using indicators to track environmental change, 2004.

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