

**An evaluation of the municipal solid waste management system within City of  
Tshwane Metropolitan Municipality, in Mamelodi East Township, Gauteng  
province South Africa.**

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## ABSTRACT

Municipal solid waste management systems (MSWMS) comprise of waste generation, segregation at the point of generation, collection, transportation and disposal at the landfill. The municipalities in South Africa were mandated by the constitution of the country to provide a number of basic services including solid waste management to their citizens. A rapid increase in municipal waste volumes is a problem in urban areas resulting in mushrooming illegal dumps.

The aims of this study were to evaluate the municipal solid waste management system implemented by City of Tshwane Metropolitan Municipality in Mamelodi East, identify the challenges within the system and explain the practice of illegal dumping by residents of Mamelodi East.

This was achieved through a descriptive cross sectional study which was conducted using qualitative data collection methods. The data was collected through interviews with key informants (two municipal officials and one waste removal contractor) and the waste removal process was observed and photographed. The illegal dumps were mapped and photographed and those of high public health concern were identified. A semi structured questionnaire was administered to the residents living closest to identified dump sites.

The analysis revealed that the system implemented by City of Tshwane Metropolitan Municipality included regular door to door and communal collection of waste from the residents, transportation of collected waste to Hetherley landfill and disposal. About 21 illegal dumps were identified, mapped and photographed, and nine of them were considered to pose health risk to the residents, especially those living closest to them. It was discovered that these residents were not happy with the illegal dump next to their yards and recommend that the sites be used for beneficial purpose.

Shortcomings included a lack of an updated waste management plan; lack of waste minimization strategy including the 3Rs (reduce, reuse and recycle); and lack of public awareness and involvement in waste management issues.

No measures are implemented for prevention of illegal dumping and the only control measure was to clean the dump sites periodically. There is a lack of law enforcement and systems overload.

The researcher concluded that the MSWMS implemented in the community of Mamelodi East was inadequate. It is recommended that the community should be involved at the planning phase and all mentioned shortcomings be addressed. The waste management legislation including policies and by-laws, need to be enforced.

## LIST OF ACRONYMS

CTMM	City of Tshwane Metropolitan Municipality
CSIR	Council of Scientific and Industrial Research
DALA	Department of Agriculture and Land Affairs
DEAT	Department of Environmental Affairs and Tourism
DWAF	Department of Water Affairs and Forestry
ECA	Environmental Conservation Act
EEA	European Environmental Agency
EST	Environmentally sound technologies
HCRW	Health Care Risk Waste
MDG	Millennium Development Goal
MSWM	Municipal solid waste management
MSWMS	Municipal Solid waste Management System
NEMA	National Environmental Management Act
NEMWA	National Environmental Management Waste Act
NGOs	Non-Government Organizations
PAH	Polycyclic Aromatic Hydrocarbon
PPE	Personal Protective Equipment
SHSPH	School of Health Systems and Public Health

SA	South Africa
SWM	Solid waste management
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environment Programme
USEPA	United States Environmental Protection Agency

## DECLARATION

I declare the dissertation, which I hereby submit for the degree of Master's in Public Health at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at another university.

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## PART 1: INTRODUCTION

### 1.1. Background

Population growth, urbanization and economic development have resulted in changing resource consumption patterns and led to a rapid increase in waste volumes and types of waste. As a result of these trends, existing waste management systems are often overburdened with increasing quantities and changing composition of the waste. This results in a need to periodically evaluate and improve the solid waste management systems.<sup>1</sup>

Effective municipal solid waste management systems (MSWM) can contribute to improving public health outcomes through reducing opportunities for disease spreading vermin to thrive, such as occurs at unregulated local dumpsites. It also contributes to enhancing environmental quality by protecting watercourses, ground water and preventing illegal dumping and littering. A well-designed MSWM system supports higher levels of economic activity and can contribute directly to poverty alleviation through job creation. Conversely, a failure to provide effective MSWM system is felt most severely by poor households.<sup>2</sup>

The City of Tshwane Metropolitan Municipality (CTMM) is one of the biggest metropolitan municipalities that form the local government in Gauteng province, South Africa. The CTMM was mandated by the Constitution of the Republic of South Africa to provide a number of basic services to its residents, including the management of municipal solid waste.<sup>3</sup> These services are provided to the residents at a particular cost that is payable on a monthly basis by citizens. The solid waste management services rendered by the municipality include the collection of domestic waste from the households, transportation and disposal to the landfill site. The collection of refuse from residential areas is done on weekly basis by service providers contracted by the municipality. All the residents are expected to put their refuse bins or bags outside their yards on the specific days for collection.<sup>4</sup>

Despite the provision of such services by the municipality and the fact that the residents are paying for those services, there are several illegal dumps within the residential areas at some street junctions, walk ways and open stands, generated by some residents and commercial facilities. This happens particularly in townships and squatter camp areas rather than in suburbs. Dumps contain all sorts of unwanted goods, including building rubble, garden waste, dead pets, bottles, papers, cans, etc.,.

It does not only become an aesthetic problem, but also poses a serious health risk to the residents, due to the fact that it can be toxic, corrosive, flammable, explosive,

reactive or pathological and therefore results in pollution of the environment, rodent infestation and flies. Some waste residues may be swept by the rain into the drainage system and to the nearby streams which will ultimately contaminate the natural resources and the underground water, while some gases are emitted to the atmosphere adding to the challenges faced by the nation due to global warming.<sup>5</sup>

Waste management is not solely the duty of the municipality but all citizens should also become the managers of waste. The use of an integrated municipal solid waste management system was found to be essential for improving the overall efficiency in municipal waste management in most developed nations globally.<sup>6</sup>

## **1.2. Research problem**

Regardless of the waste management services provided by the City of Tshwane regularly to the residents, the townships are still challenged by mushrooming illegal dumps at street junctions and open spaces. This leads to pollution of the environment (air, underground water and land), rodent infestation and other issues (unpleasant air, influx of flies, etc.) negatively affecting the residents. It was not known how effective the municipal waste removal system was and what the causes were that led to the illegal dumping.

## **1.3. Research question**

What are the challenges within the solid waste management system of the City of Tshwane Metropolitan Municipality in Mamelodi East and what is leading to dumping in the residential area?

## **1.4. The aim and objectives of the study**

The aim of the study was to evaluate the MSWM system and identify challenges within the system in Mamelodi East and explain the practice of illegal dumping by residents. The objectives of the study were to:

- a) To describe the solid waste management system in CTMM.
- b) To assess the effectiveness and identify the challenges of the current solid waste management systems implemented by CTMM in Mamelodi East, and explain the practise of illegal dumping by residents.
- c) To provide recommendations on the possible strategies that may be implemented to improve the management of solid waste and prevent dumping.

## 1.5. The role of the researcher

The researcher was the interviewer and coordinator of the study. The data collection was conducted in two local languages Sepedi and Zulu, as well as English, since they are the dominant languages used by Mamelodi East residents. She ensured that the necessary arrangements with the municipality were made in time, the interview questions were compiled and the interviews and observations were recorded, analysed and written up. The researcher has an honours degree in Environmental health and she is an Environmental Health Practitioner working for Mpumalanga Department of Health.

## **PART 2: LITERATURE REVIEW**

### **2.1. Introduction**

Municipal solid waste is commonly known as refuse or rubbish consisting of everyday items that are discarded by the public.<sup>1</sup>

One of the biggest problems facing South Africa's environment is pollution and the consumption of non-renewable natural resources. Ever-increasing population and industrial development mean that more and more natural resources are consumed each year with the result that more waste products are produced, such as plastics, tins, papers, and glass and greenhouse gases. In order to address the problem of increasing waste production, South Africa has formulated policies that will firstly ensure the protection of the environment, its biodiversity and people. Secondly, the policy aims to enable the structures that are mandated with waste disposal services such as municipalities and the communities to manage their waste appropriately.<sup>3</sup> The legislation such as the National Environmental Management Waste Act (NEMWA), and the Environmental Conservation Act (ECA) provide a framework within which the country can respond to this problem.<sup>2</sup>

South Africa generates 42 million m<sup>3</sup> of solid waste every year, which translates to 0.7 kg per person per day (State of the Environment report, 1999). The figures are said to be comparable to developed countries such as UK (0.73 kg and Singapore (0.8 kg)<sup>5</sup>. South Africa's capacity to treat, store and dispose of high volumes of waste are limited and this will lead to a shortage of land for landfill sites. Rapid urbanisation has created many informal and congested settlements on peripheries of towns and cities. This has provided authorities responsible for waste management in South Africa with new challenges. There is a need for a more systematic approach to managing waste in the rural and urban areas through integrated waste management practices.<sup>5</sup>

### **2.2. The Municipal solid waste management system**

The internationally accepted means of MSWM is the implementation of an integrated MSW management model, based on the MSWM hierarchy consisting of prevention, minimization (reduce, reuse, recycling) treatment and disposal.<sup>1</sup> MSWM involves activities associated with generation, storage, collection, transfer and transport, processing and disposal of solid waste. It requires proper infrastructure, and maintenance for all activities. The landfill disposal is regarded as the last resort in waste management (Fig 1). The typical municipal solid waste management system implemented in most municipalities in SA comprises of collection of waste from point of generation, transportation of waste to the treatment point or landfill site, treatment of waste including sorting and separation of waste at disposal site, disposal and recycling.<sup>2</sup>

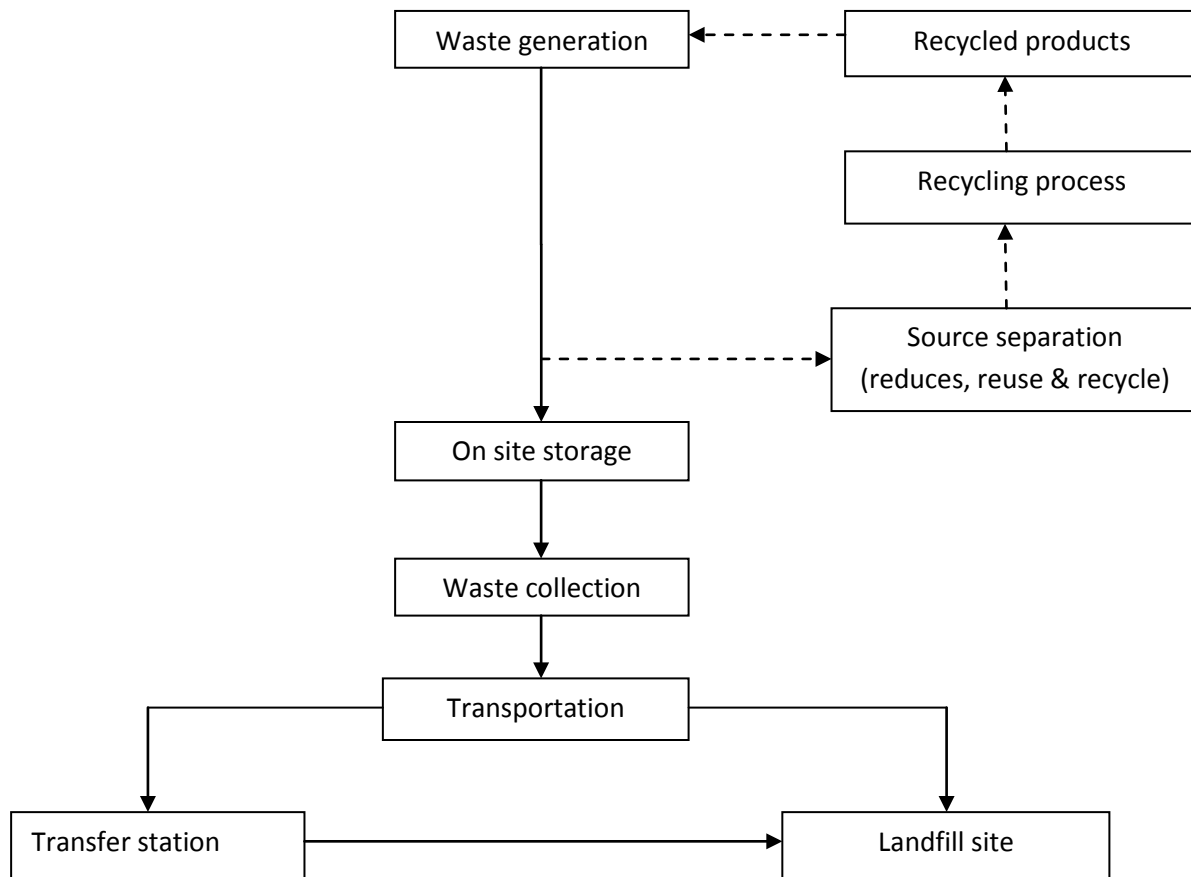


Figure 1: Municipal solid waste management system<sup>2</sup>

### 2.2.1. Waste generation and storage

Waste generation occurs at the source of waste where it encompasses activities in which materials are identified as no longer being of value and are either thrown away or gathered together for disposal. The 3 Rs (reduce, reuse and recycle) strategy should start at the point of generation to minimise the volume of waste that will be taken to the landfill site and to protect the environment.<sup>2</sup> The activities associated with the management of waste encompass handling, sorting, storage, and processing of waste at the source until they are placed in storage containers for collection. The best place to separate waste is at the source<sup>2</sup>.

The storage of MSW at the source is substantially lacking in most of the urban areas and it has a significant effect on the collection system. The bins are common for both decomposable and non-decomposable waste (no separation of waste is performed). It is important to plan and decide on the appropriate means of on-site storage in conjunction with transport options before implementing any system<sup>2</sup>. There are different

methods of on-site storage for domestic waste generated which include 85 litre black or clear plastic bags, 85 litre rubber/galvanised steel bins, 120/ 240 litre mobile bins and 11m<sup>3</sup> bulk containers (skip) for communal collections. The collected waste is then transported to the transfer station or the landfill site for treatment and final disposal.<sup>2</sup>

### **2.2.2. Waste collection**

The waste collection services were first implemented in the Cape Colony in 1786, and by the 1820s a regular waste collection service on specific days of the week, using animal-drawn carts was established.<sup>7</sup> The purpose of waste collection services is to separate the generated waste from the community for health reasons and for the protection of the environment.<sup>7</sup>

Currently the waste removal service can be done by the local authority, a conventional contractor or an emerging entrepreneur, although the responsibility lies with the local authority/ municipality<sup>7</sup>. There are two methods of household waste collection implemented in SA by most municipalities: firstly, the door to door collection system which is more prominently implemented in formal settlements, and secondly, communal collection which is generally implemented in poorly developed areas like informal settlements where the households are required to place their waste in the centrally provided containers for collection by large motorised refuse vehicles<sup>8</sup>.

The most preferred frequency of collection services to households is once a week. Due to variations in community structures and geographical distribution, the same type of waste collection services is not appropriate and sustainable across all areas/ municipalities. Factors that can influence waste collection services include affordability, accessibility (particularly road infrastructure and condition), level of education of both community and authorities, availability and suitability of on-site storage containers, composition and volume of waste, appropriate vehicles and available expertise, distance to disposal site and collection systems like communal collection and door to door collection. The waste collection route map is critical as it provides a guide on the starting point and final point of collection and plays a role in minimising the travelling costs. The collection should also be at a regular time for the convenience of the residents.<sup>7</sup>

### **2.2.3. Transportation of waste**

It was only in the 1920s, that waste collection was done using motor vehicles in South Africa. There are several options for transportation of waste including the hand cart, animal-drawn cart, tractor and trailer, flat-bed truck, tip truck, rear-end loader, econo-loader, lugger/ skip loader, roll on- roll off truck, and rail. The type of transport selected will depend on the composition of waste, the type of storage container and funds available.<sup>2</sup>



#### **2.2.4. Transfer of waste**

A transfer station is a facility for transferring waste from the collection vehicle to a more appropriate vehicle where longer haul distances are necessary for final disposal. The purpose is to reduce the transport unit cost of collection vehicles and obtain more cost-effective payloads that also allow quicker turnaround times and therefore increased productivity. It is not necessary in areas where the distance to final disposal of waste is reasonable.<sup>2</sup>

#### **2.2.5. Waste disposal**

MSW generated by households in South Africa is collected and disposed off at a permitted municipal landfill sites. The MSW landfill sites are governed by section 20 of the Environmental Conservation Act 73 of 1989 and should meet the minimum requirements for waste disposal by landfill provided by DEAT South African Waste Information Centre, (2007) to ensure that the welfare of the public is protected against the harmful effects emanating from inadequate MSW disposal.<sup>9</sup> DWAF also has important guidelines for the governing bodies and the public to monitor and make sure that landfill sites are operating according to safety standards during the phases of MSW collection, transportation, treatment and disposal.<sup>9</sup>

Disposal of waste at the landfill involves burying the waste and this remains a common practice in most countries. The landfill site is structurally engineered and operated to compact and cover waste, so that pollution is minimised. A controlled landfill site has daily soil cover and perimeter drainage to minimize leachate generation. The private users are usually charged a disposal fee depending on the quantity or density of MSW determined by the weigh bridge at the respective facilities.<sup>9</sup>

There are alternative methods of waste disposal which include incineration of waste, and conversion of waste to energy and fuel. Incineration is common in countries like Japan where land is scarcer as it does not require much area as landfills.<sup>10</sup> Combustion in an incinerator is not always perfect and there have been concerns about pollutants in gaseous emissions such as dioxins, furans, and PAHs, from the incineration stacks.<sup>10,11</sup>

In SA, the incineration method is used for disposal of Hazardous waste like Health Care Risk Waste and the ash produced from the process is disposed off at the hazardous landfill site.<sup>9</sup>

### **2.3. Occupational and environmental health issues in solid waste management**

In most developing countries or cities MSW is collected manually which requires repeated heavy physical activities such as lifting, pulling, pushing, and carrying.<sup>12</sup> Globally, solid waste collectors are exposed to occupational health related problems

from waste material and physical effort they exert in waste handling.<sup>12</sup> Waste collectors in developing countries have significantly more direct contact with solid waste than their counterparts in high-income countries, who predominantly handle sealed plastic bags and covered dustbins. Because hazardous wastes are not separated at the source for separate collection and collection workers in most developing countries are more likely to encounter potentially toxic materials and gases and infectious microorganisms. Solid waste collectors should routinely wear gloves, safety boots, over-alls and respiratory mask when collecting or handling waste to prevent exposures and injuries.<sup>13</sup> Periodic health examination of waste collectors should be performed.<sup>13</sup>

Epidemiological studies have shown that dusts, smoke from open burning, and odour from decomposed waste materials at open dumps and landfills may be injurious to the respiratory system of solid waste workers and those exposed to the contaminants.<sup>13</sup> Studies in several countries have postulated a relationship between working at open dumps and increased respiratory illness as follows:<sup>13</sup>

- Epidemiological surveys conducted on 400 waste pickers in Calcutta, India, and compared with a control group of 50, indicated that waste pickers at open dumps were particularly vulnerable to experiencing increased incidence of respiratory diseases. The waste pickers experienced a 71% incidence of respiratory disease, compared to only 34% in the control group.<sup>13</sup>
- At Bombay's open dumpsites, 25% of the waste workers examined had coughs and 26% experienced dyspnoea. The majority (73%) complained of aggravated symptoms of cough and breathlessness during working hours.<sup>13</sup>
- Pulmonary function tests were conducted on dumpsite waste pickers and residents surrounding the dump in Bangkok, and 40% were below the normal range. Total suspended particulate levels at Bangkok's dump averaged  $490\mu\text{g}/\text{m}^3$ , exceeding average Bangkok residential levels of  $260\mu\text{g}/\text{m}^3$  and the USA 24-hour standard of  $150\mu\text{g}/\text{m}^3$ . Methane levels of  $20\text{mg}/\text{m}^3$  were measured.<sup>13</sup>
- Landfill gas has a number of volatile organic compounds due to high vapour pressures and low solubility, some of which are potentially toxic (dichloromethane), carcinogenic (benzene and vinyl chloride).<sup>13</sup>

The UNEP is working on the development of a global treaty to reduce and eliminate pollutants that can damage the ecosystem and human health.<sup>14</sup>

The environmental impacts caused by inadequate management of MSW are eminent and visible. This gives rise to global warming potential, acidification potential, eutrophication of surface water and resource consumption.<sup>12</sup>

## 2.4. Environmental legislation governing MSW

Environmentally sound technologies (EST) for MSWM were initiated at the Rio Declaration on the 14 June 1992 by UNEP and in the recommendations of Agenda 21, Chapters 21 & 34. These were initiated specifically to improve management of municipal solid wastes.<sup>14</sup>

In 2000, the United Nations Millennium Summit agreed on eight Millennium Development goals to be achieved by 2015. Goal 7 was to ensure environmental sustainability and had three targets, one of them was to integrate the principles of sustainable development into country policies and programs, and reverse the loss of environmental resources.<sup>15</sup>

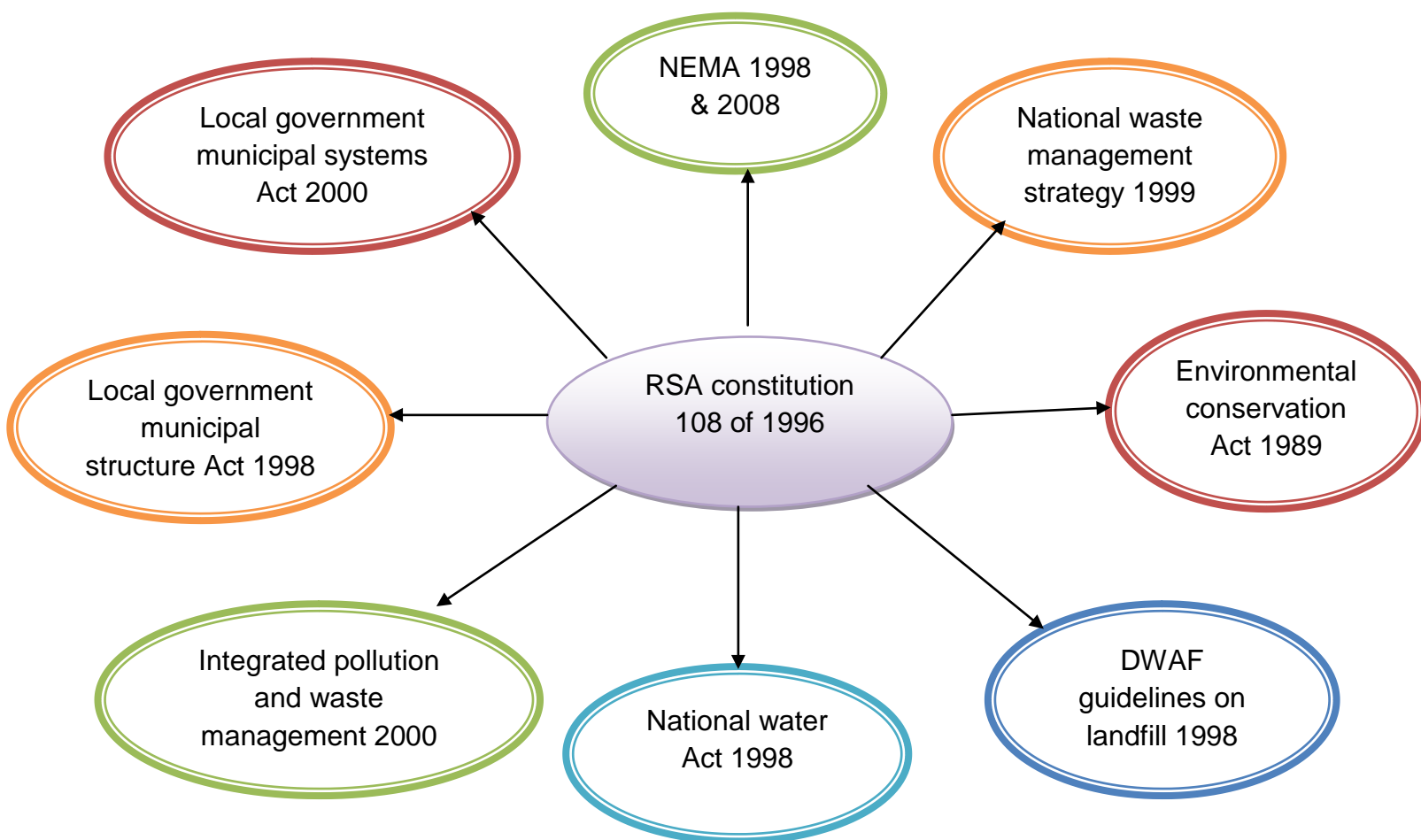


Figure 2: Legislation governing waste management in South Africa

South Africa has good legislation supporting the implementation of this MDG and ensuring effective and efficient solid waste management, starting with the Constitution of the Republic of SA, Act 108 of 1996, chapter 2, section 24, where it stipulates the rights of citizens to a healthy environment, and the rights to protect the environment.<sup>3</sup>

The Constitution is the umbrella law and all legislation needs to align with it as indicated on Figure 2 above. It further states that local government is tasked with ensuring the provision of services to communities in a sustainable manner and the promotion of a safe and healthy environment. Part B of schedule 5 of the Constitution designates solid waste collection and disposal as a local government function.<sup>3</sup>

The MSW legislations include NEMA, Act no 107 of 1998, ECA, Act no 73 of 1989, MSA, Act no 32 of 2000, etc. These are augmented by DWAF's guidelines for minimum requirements for waste disposal by landfill (1998), together with the white paper on integrated pollution and waste management for SA (2000), waste management policy (DEAT), waste management Bill 2007.<sup>2</sup>

The National Environmental Management Act (NEMA) contains the principles that inform the control of pollution, which includes “the polluters pay” principle emphasizing that actions be taken against those who pollute the environment.<sup>16</sup> The National Department of Environmental Affairs and Tourism (DEAT) require that the municipalities develop waste management plans for the management and minimization of waste in their areas. This includes public awareness; collection of data for the Waste Information System; provision of general waste collection services and management of waste disposal facilities; implementation and enforcement of appropriate waste minimization and recycling initiatives, and where possible, regional planning, establishment and management of landfill sites, especially for regionally based general waste landfills.<sup>2</sup>

The Waste Act (2008) provides a holistic approach to regulating waste management in South Africa.<sup>16</sup> It adopts the internationally recognised waste management hierarchy, which considers disposal of waste as the last resort and encourages a reduction of waste entering the system (Figure 3). It provides the legal mandate for the implementation of the waste management hierarchy derived from the National Waste Management strategy 1999, through the provision of additional measures for the remediation of contaminated land and to protect human health and secure wellbeing of the environment.<sup>16</sup>

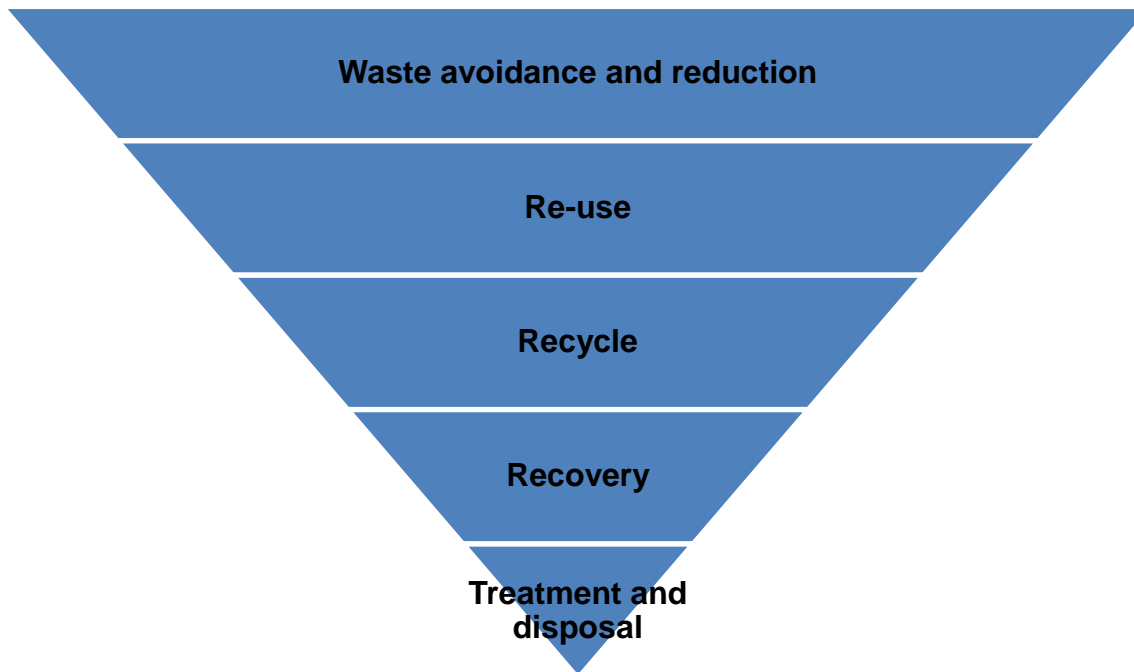


Figure 3: Waste management hierarchy<sup>16</sup>

The Waste Act established minimum requirements for handling and producing waste and improving the licensing of waste management activities. In terms of the Waste Act, it is the local government's role to ensure universal and sustainable delivery of services at an affordable price, subject to national and provincial legislation.<sup>16</sup> It puts emphasis on the development of an integrated waste planning system where local governments are expected to include waste management plans to their integrated development plans.<sup>2</sup>

Waste avoidance and reduction is the first important method of waste management as it prevents waste material from being created. It includes reuse of second-hand products, repairing broken items instead of buying new, designing products to be refillable or reusable (such as cotton instead of plastic shopping bags), encouraging consumers to avoid using disposable products (such as disposable cutlery, plate and cups, etc), and designing products that use less material to achieve the same purpose.<sup>17</sup>

The CTMM has comprehensive by-laws and strategies in place to control and prevent pollution and facilitate municipal solid waste handling within their jurisdiction. These include reduction, collection, transportation, separation and disposal of municipal solid waste to the landfill site.<sup>18</sup>

## 2.5. Effectiveness and efficiency in MSWMS

A previous study conducted in the City of Tshwane has shown that efficiency in the management of solid waste is adversely affected by a lack of adherence to municipal by-laws and regulations on adequate waste management, incorrect perceptions on the potential benefits of proper waste disposal, and a failure to provide customers with sufficient trash bins.<sup>19</sup> It was also reported that there is a significant accumulation of solid waste especially in townships such as Mamelodi and Marabastad produced by commercial businesses. Some recommendations indicated that health education on environmental sanitation and primary health care, socioeconomic incentives, as well as strict enforcement of municipal by-laws and other regulations are essential to ensure overall environmental cleanliness and the efficient management of waste in metropolitan municipalities.<sup>8</sup>

### 2.5.1. MSWM approaches

There are two MSWM approaches that the previous studies had proven being effective and efficient, and recommended that the municipality should consider them to ensure adequate management of MSW.<sup>8</sup> The first approach is called a community based waste management approach, where community participation was regarded as a crucial element in MSWMS. This approach is based on the principle of cooperation and partnership amongst community members, NGOs, community based organisation and the municipality. The main objective of this approach is to ensure segregation of waste at the source into biodegradable and reusable recyclable materials, where the biodegradable waste is processed locally and the reusable and recyclable materials are sold.<sup>8</sup>

The second approach is called the public private partnership. This is a case of cooperation between the private company and the municipality, where the private company renders waste collection, sorting and transportation to the landfill site.<sup>8</sup> The municipality in this instance monitor the services provided to ensure adequate management of MSW. The purpose of this approach is mainly to lower the cost of collection services and ensure cleanliness of the environment.<sup>19</sup>

A study conducted in Mekelle in Northern Ethiopia analysed the household waste disposal decisions.<sup>20</sup> The results revealed that demographic variables such as age, education, household size and the level of household income have an insignificant impact on the choice of waste disposal practices, whereas the supply of waste facilities significantly affects the waste disposal choices. Inadequate supply of waste containers and a longer distance to where the skip is located increases the probability of waste dumping in open spaces and by roadsides. Higher household income decreases the probability of using open areas and roadsides as waste destinations relative to communal containers.<sup>20</sup>

In order for the system to perform efficiently, all relevant stakeholders of the waste management chain including the residents must play a collaborative role in the handling, collection, disposal, processing and management of waste. It is also essential in reducing the cost of waste management and for the protection of the environment.<sup>21</sup>

Unequal provision of MSWM services remains an issue perpetrated by poor infrastructure, poverty, unemployment, lack of education, etc. Residents of core urban areas have relatively good access to waste management services while those in peri-urban and rural areas have limited access to formal services.<sup>22</sup> The services provided in suburb areas are driven by waste minimization rather than waste disposal in townships and rural areas. The backlog in waste services delivery was confirmed by the assessment of the status of waste services delivery and capacity at local government level.<sup>22</sup>

In this study, the focus was on the MSWM system implemented by the municipality to manage solid waste produced by the residents in Mamelodi East. It aimed to assess the effectiveness of the system, identify gaps and provide recommendations to correct identified shortcomings and explain the household decision on disposal of solid waste with a focus on illegal dumping in the area.

## PART 3: METHODOLOGY

### 3.1. Research setting

The study was conducted at CTMM in Mamelodi East area. CTMM is a category ‘A’ municipality located in the northern part of the province covering approximately 30% of the province’s surface. It comprises of seven regions, 105 wards and has 210 councillors and Mamelodi area falls within region 6.

Mamelodi is one of the biggest townships in CTMM located on the east of the city Pretoria, (see figure 3) with approximately 344, 500 people (Fig 1). In Mamelodi 98% of the population is black African and 42% of the population speaks Northern Sotho, followed by 18% Ndebele, Zulu, Tsonga, and others. It has been divided into two parts which are Mamelodi East and Mamelodi West. This study was done in Mamelodi East.<sup>18</sup>

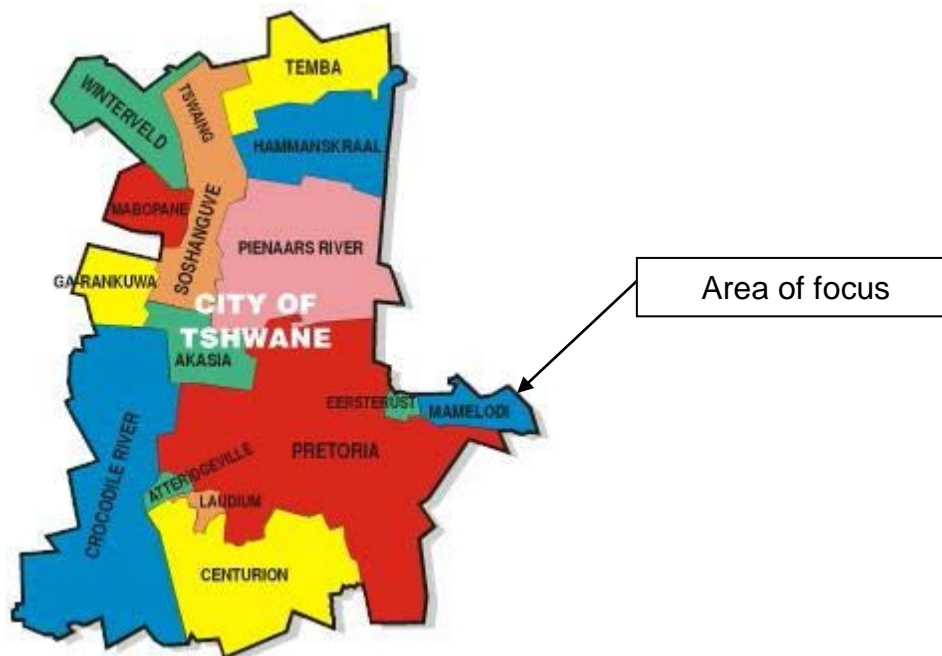


Figure 4: Areas constituting City of Tshwane Metropolitan Municipality<sup>18</sup>

### 3.2. Research study design

A descriptive, cross-sectional study was conducted using qualitative data collection methods. This enabled the researcher to collect information needed and to understand the MSWM being implemented in CTMM, and to identify the possible challenges within the system.



### **3.3. Data collection**

Firstly, a structured interview was conducted with the waste management component manager, the waste management officer and the waste collection contractor (key informants) within the respective component that deals directly with the subject matter in Mamelodi East area. This assisted the researcher to understand and describe the MSWM system and the operations within CTMM.

Secondly, observations of the system were made in Mamelodi East area from the point of generation where the contractor went into the streets collecting waste from households until the landfill site for final disposal. The illegal dumping spots were mapped, photographs were taken, and some notes were made to record the observations. This enabled the researcher to assess the effectiveness of the system, identify illegal dumping spots that pose a risk to the public health and identify other shortcomings within the implemented system.

Lastly, a semi-structured questionnaire was administered by the researcher to the residents living near the identified illegal dumping sites. The residents' perceptions and experiences regarding the issue of illegal dumping were obtained.

The report was compiled on all the findings from the data collected. Secondary data from waste management documents and literature was also included.

#### **3.3.1. Interviews with key informants**

##### **Sampling**

Purposive sampling was used to select three key informants. Purposive sampling is a non-random sampling technique that is used in exploratory research within which the researcher deliberately chooses the respondents in order to ensure that the sample covers the full range of possible characteristics of interest.<sup>23</sup>

The head of the waste management component in CTMM Mamelodi offices and waste management officer (who is responsible for the waste management services rendered in Mamelodi East area) working within the respective component and one of the waste removers employed by the appointed waste removal contractor (specifically the foreman of the waste removal process), were requested to participate in the study through structured interviews.

##### **Inclusion and exclusion criteria**

Two employees of CTMM who deal directly with the study subject at Mamelodi East were included within the study in order to obtain answers to the study question or problem, and a clear description of the MSWM system.

The employees of CTMM who were unable to be interviewed and those who were not working within the researched component were not included within the study.

### **Data collection tool**

The researcher prepared a list of questions that cover the MSWM system, the challenges within the system and the community involvement in waste management activities. The interview guide is included in Appendix A with the participant's information leaflet and informed consent form for the two officials of CTMM and Appendix B for the employee of the waste removal contractor.

### **Process**

An appointment was made by the researcher prior to the interviews. The researcher provided the written research information leaflet and consent form to the participant and ensured that they understand the undertakings. All participants signed the consent form before the commencement of interviews. A tape recorder was used to record all the interviews conducted. The interviews with two municipal officials were conducted together at one of their offices as it was convenient to them, and then the waste removal contractor was interviewed at his office. All interviews were directed by the researcher in a form of discussion and were recorded on the tape recorder with permission from the interviewees. Each interview took less than 1 hour.

### **3.3.2. Observations of the system**

#### **Refuse removal from point of generation**

The operation of the MSWM system was observed in Mamelodi East from the beginning of the process where the contractor does street collection of household refuse up to the landfill site for final disposal of waste. Refuse removal is done in each section within Mamelodi East on weekly basis by the appointed service provider, and each section has been allocated its collection day in a week.

#### **Sampling**

The researcher followed the pickup truck from the first point of collection, along the first two streets in the middle two streets and the last two streets of collection, on one day.

#### **Data collection tool**

The researcher used a diary to take notes of the process. A camera was used to take photos of the process from point of generation within the residential area up to the landfill site. Photos of the activities were taken throughout the process in order to record the typical range of activities involved in waste removal and dumping at landfill site.

## **Process**

The arrangement was made with the refuse removal contractor by the researcher prior to the observation process. The researcher observed the implementation of the system from the point of generation, where the waste collection was made and transported for treatment or final disposal at the landfill site by the appointed contractors. The researcher drove behind the pickup truck into the streets of Mamelodi East collecting waste from the household and transported it to the landfill site for disposal. The researcher took photos of the process, and wrote some notes of the findings in her diary. After observing the process in the first two streets, the researcher left the pickup truck collecting in other streets and drove to the middle streets waiting for the truck to arrive. The researcher compiled the noted findings of the first streets while waiting for the pickup truck to arrive at the middle streets and the same was done after observing the middle streets to the last streets. From the last point of collection the pickup truck was followed while transporting collected waste to the landfill site for disposal and the land filing process was also be observed. This gave the researcher insight into the overall MSWM system implemented in Mamelodi East and enabled her to comprehend the information given by the key informants. It also assisted the researcher to assess the effectiveness of the system and provide recommendations for the identified challenges. At the end of the process, the researcher compiled an observation report with findings and recommendations.

## **Location of illegal dumps**

After observation of the waste collection process, the researcher drove through all the streets identifying and mapping the illegal dumps within the residential area of Mamelodi East.

## **Sampling**

The entire area of Mamelodi East was covered to ensure that all the illegal dumping sites that pose a risk to public health are identified and mapped.

## **Inclusion and exclusion criteria**

Only household refuse dumping sites that had the potential to pose public health risk were considered. For example small litter and a little building rubble were not mapped. Industrial waste, hazardous waste, and Health Care Risk Waste were not covered in this study as the study had focused on general waste generated by households.

## **Data collection tools**

A street map indicating the stands and streets names was used to record the identified illegal dumping sites. This was scanned to create an electronic record of the dumping sites. A camera was also used to take photos of the identified illegal dumps.

## **Process**

The researcher drove street by street looking for the illegal dumps within residential area. The illegal dumps were identified and mapped. Photos were taken of every identified illegal dump as well as some street names to link the location of places where the photos were taken to the map. The mapping of the illegal dumping spots was used to select households for the residents' interviews.

### **3.3.3. Interviews with the residents**

A semi-structured questionnaire was administered by the researcher to the residents living near the recorded illegal dumping sites.

## **Sampling**

Mapped illegal dumping sites provided a guide to the researcher on which residents to select. The residents who live near the recorded illegal dumping sites formed the study population. A sample size of 30 households was intended to be used for data collection. One permanent adult resident per household was interviewed. It was planned that, approximately two residents living next to 15 dumping sites, spread across the area surveyed be interviewed.

## **Inclusion and exclusion criteria**

Only the permanent adult residents living closest to the recorded illegal dumping site had the opportunity to participate in the study. The residents living far away from the illegal dumping site were not considered in this study.

## **Data collection tool**

The questionnaire was administered by the researcher using some closed and some open ended questions covering the causes of illegal dumping and suggestions to prevent the occurrence of dumping sites. The questionnaire is in Appendix C together with the participant's information leaflet and informed consent form.

## **Process**

The researcher read out the written research information leaflet and consent to each participant and ensured that they understand the research undertakings and contents. The residents were required to sign a written consent before participating in the study. The questionnaire was administered by the researcher in English, Sepedi or Zulu based on the preference of the participant. The researcher wrote the response of the resident on the anonymous questionnaire form during the interview.

### **3.4. Data management and analysis**

The data from key informant' interviews were transcribed into a written word document including every single word that was said by both the interviewer and the interviewee. Content analysis was done by the research team comprising the researcher and the supervisor. The data was explored in detail for common themes and then categorized into units of meaning or codes.<sup>23</sup> The data was analysed as soon as it was collected. A flow diagram describing the system and the challenges from the point of waste generation to the final disposal was developed from the analysis of the interviews and the waste collection observations.

The residents' questionnaires were analysed using a simple frequency table for closed questions and a summary of the responses from open questions.

An observation report of the waste collection processes and the illegal dumps was compiled using the notes, map and the photos taken during the observations. The steps within the analysis process involved the organising of the data, reducing the volume of data by summarising data, categorising transcribed data from interviews and field notes into codes, interpreting the data, drawing up conclusions and compiling the final research report.

### **3.5. Trustworthiness of data**

More than two methods of collecting data were used for data to be trustworthy. In this case, data was collected through interviews from CTMM officials, waste removal contractor, and residents' questionnaires, and through observation of MSWM system. The data analysis was carried out by the researcher and supervisor, as it strengthened the truthfulness of the themes that were produced by the data.<sup>23</sup>

### **3.6. Ethical considerations**

The permission to conduct the study was obtained from the concerned municipality (see Appendix D). Ethical approval for this study was obtained on the 20/ 11/ 2013, Ethics reference No. 440/2013 from the Main Research Ethics committee of the Faculty of Health Sciences, University of Pretoria SHSPH (see Appendix E).

Permission to record the interviews was requested from the participants before recording and was granted by all participants. All participants completed the informed consent prior taking part in the study. A person's unwillingness to be interviewed or to participate within the study was respected and all participants agreed to have the interview taped.<sup>18</sup> Arrangements were made with the municipality prior to the interviews and the visits to observe the system.

Confidentiality was maintained during the interview process and the completion of questionnaires as no names or quotes that can be contributed to a specific person have been used. The permission to publish the research report will be obtained first from the CTMM.

## **PART 4: RESULTS**

### **4.1. Introduction**

The results of key informants' interviews, residents' semi-structured questionnaire, observations of the system and illegal dumps mapping are presented below in the form of narrative, photos and diagrams.

### **4.2. Key informants interviews**

The municipality appointed a large waste management company to render waste collection services, transportation and disposal to the land fill site. The appointed contractor had 8 sub-contracts rendering the services within the entire Mamelodi area.

#### **4.2.1. A description of the MSWMS**

The typical solid waste management system implemented by the municipality from the point of generation includes waste collection services, transportation and disposal of waste at Hatherley landfill site as indicated on figure 10 of the formal activities.

The entire area of Mamelodi east receives the waste management services. Each household in the formal settlement was provided with an 85 litre bin while in the informal settlements each household was given 1 plastic bag once a week for disposing their waste and a skip was provided at a communal point for waste storage. In the formal settlement the area has been divided into blocks where collection is done once a week on a specific day (within 24hrs). The appointed service provider removes waste from the households and also cleans up the illegal dumping sites within the residential area. The services are paid for by the residents on monthly basis in the formal area as part of their municipal taxes and rates. The residents have to make special arrangement with the municipality for the collection of garden waste and building rubble, for a fee.

#### **4.2.2. Community participation**

The municipality appointed 700 local citizens to assist cleaning up the litter from the streets, recreational facilities, and pavements including the illegal dumping sites. This initiative is called "Operation Vat Ales". It is an ongoing program managed by municipality aimed at keeping the surrounding clean and creating jobs for the citizens of Mamelodi. The waste management activities that were emphasised by the municipality at the point of generation (to the residents) was only storage of waste in a provided 85 litre bin and taking out the container in the mornings of the given day of collection. Although, there were pockets of individuals (waste entrepreneurs) sorting waste into

reusable and recyclable materials to generate income for their families, other than any environmental protection purpose. It is an individual initiative rather than the “operation vat ales” which was the project owned by the municipality.

The municipality indicated that there was a greening program conducted in collaboration with DALA encouraging the community to adopt the illegal dumping sites and convert it into a park or vegetable garden. They further mentioned that most people request those sites for business purposes hence they were not given. Community waste management help desk was established although there are some logistics that need to be finalised before the operation starts “We have appointed five interns to operate the consumer help desk that will be working hand in hand with the community on waste management issues” said the waste management director.

Previously there was a forum composed of community members trained and delegated to educate the community during the ward councillors’ meetings. However, the operation was ceased as the councillors were no longer inviting them in their meetings.

#### **4.2.3. Highlighted challenges in implementation of MSWMS**

The municipality indicated that there were sufficient resources to effectively and efficiently render household solid waste management services within the area although they were challenged by the backlog in removing dumped building rubble caused by the recent hail storm which struck Mamelodi east area in December 2013. The waste removal contractor appointed mentioned that they do not have the waste collection route map as they start collecting waste wherever convenient for them at a given place and day of collection, “We start anywhere but we have to finish the section for the day” said the waste removal contractor.

There were several factors that were mentioned by the key informants as informing the waste disposal decisions by the households. The socio-economic status, rapid urbanisation, and the level of education exacerbate the illegal dumping in the area, and were highlighted as some of the factors that burden the provision of waste management services. Some of these factors are indicated on figure 5 such as the factors influencing illegal dumping. In most households there are back rooms generating income to the owners resulting in an increase in the volume of waste generated by each household. The backroom occupants do not pay waste management services provided to them by the municipality as they only pay rent to the land lord. Some residents do not always take out their waste at the specified day of collection and instead dispose their waste at the nearest illegal dump site.



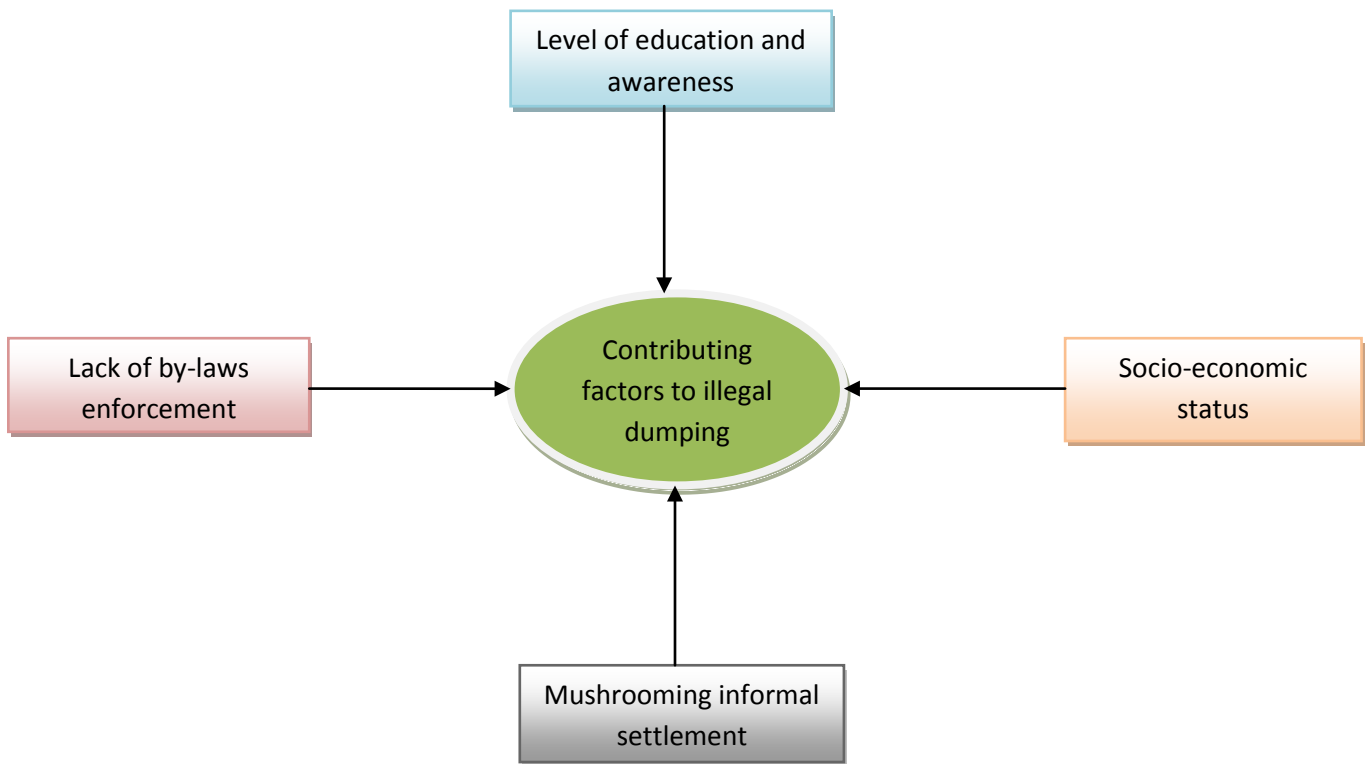


Figure 5: Factors influencing illegal dumping within residential areas

#### 4.2.4. The strategies for prevention and control of illegal dumping.

According to the key informants, there were no measures in place to prevent illegal dumping of solid waste within the residential area and community involvement/ participation in waste management activities was very minimal. The municipality reported that they previously used to put the no dumping signs at the illegal dump sites but the community removed them. “There was no use of putting up the signs because the next day it won’t be there” said the waste management director. This refers back to the issue of community awareness, education and involvement in waste management issues. It was obviously indicating that the municipal by-laws were not enforced.

Even the adopt a spot program was the initiative from DALA to promote greening of the environment. DALA ensured that the interested groups receive the necessary starting tools and the progress on those sites was monitored. The municipality only assisted by locating and clearing the site.

They reported that the solid waste management plan in use was outdated as the reviewed plan was awaiting approval by the council “We are currently guided by the National strategy although for us to be more focus we need to have our own plan which

talks to our consumer”. They mentioned that they also use the NEMA and other waste management guidelines.

### 4.3. Observation of waste removal service

The pictures of the process were taken from the point of generation where waste was gathered or placed outside the yards for collection until the landfill site for final disposal.

#### 4.3.1. Waste generation and storage

The 85 litre waste bins were used by residents to store waste and some waste was placed in the black refuse bags and shopping plastic bags next to the waste bins because the bins were overflowing.



Figure 6: Household waste bins gathered for collection

The residents placed their waste bins outside for collection as shown on figure 6 above. Some waste bins were gathered by residents at one place while some were found placed in front of each yard gate for collection. Each bin was labelled with the house number. The observed bins were not lined with the black/ clear refuse bags, did not have lids and were overflowing with waste. Some waste entrepreneurs or beggars sorted through the bins looking for valuables and recyclables before the truck arrives.

This act caused a mess on the streets, however it reduces the volume of waste collected to the landfill site.

#### 4.3.2. Waste collection process

The waste removal system observed was door to door system using the Econo-truck waste loader. There were five males working for the appointed waste removal contractor collecting waste.



Figure 7: Waste collectors removing household waste

Figure 7 illustrate the method of waste removal by waste collectors. One of the collectors was the driver, two were on the truck tipping the containers and plastic bags into the truck and the other two were collecting the bins from the street lifting them to those on the truck. Some residents were taking out their waste as the truck pass by their yards, and some ran after the truck carrying the waste with plastic bags to the truck. Waste collectors were wearing their own clothes rather than adequate personal protective clothing, except that they all had gloves. There was a terrible odour coming from the waste. Only the manual waste collection process was used including carrying and lifting the plastic bags and bins to the truck. This activity was observed to be very strenuous on the waste collectors as they had to lift up heavy filled bins and tip them into the truck.

#### 4.3.3. Transportation of waste to the landfill site

The collected waste was then transported (see figure 8) to Hatherley land fill site which is situated 5 km from Mamelodi east, for final disposal.



Figure 8: Transportation of waste to Hatherley landfill site



Figure 9: Off-loading of waste at Hatherley landfill site.

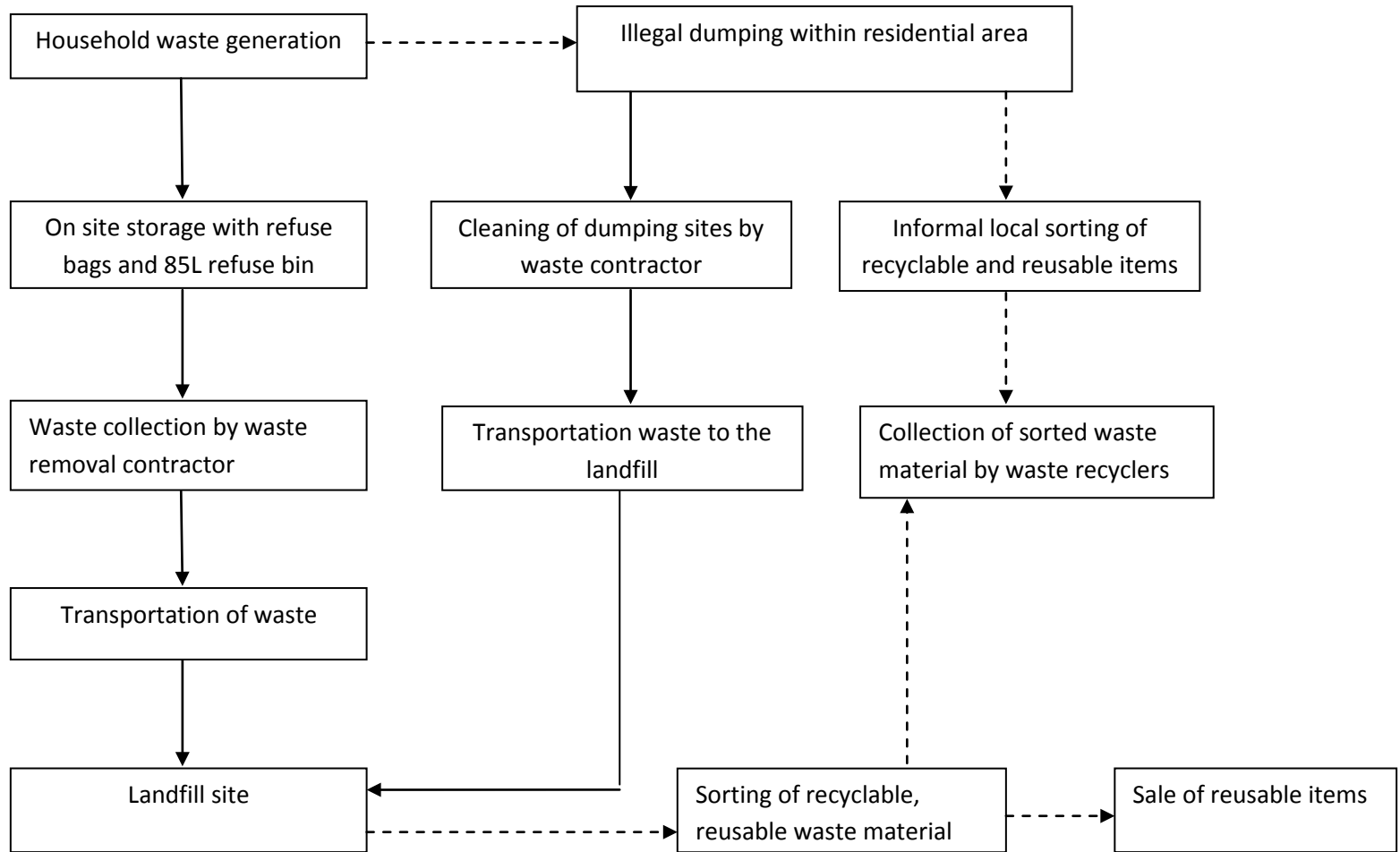
When the truck arrived at the entrance, it was weighed to determine the volume of waste to be disposed and the mass of waste was recorded before disposal. All private disposals are paid for according to the volume of waste. Immediately after the truck entered the landfill, a group of scavengers (waste entrepreneurs) ran to the truck climbing onto the waste as the truck offloaded, opening the plastics searching for any valuable/ recyclable items (see figure 9).

The separated items will be sold to the recycling company or back to the community. This activity poses health and safety risks to the scavengers as some waste may contain toxic materials, bottles with chemical residues, sharps, metal containers with pesticides and solvents, exposure to methane gas emanating from decomposed waste and other hazardous substances. They did not have any kind of personal protective clothing which is the mask, gloves, safety boots, or over-alls and they were not even anxious that they may get ill or injured.



Figure 10: Processing of waste at the landfill site

The compactor machine was found at the landfill site spreading and compacting the disposed waste (see figure 10). The area was terribly smelly with lots of flies. There were some papers and plastics scattered all over the place and beyond the landfill boundaries giving a very bad picture of what was happening within site. The person who was driving the compactor machine did not have a respiratory mask on.



—————> Formal activities

- - - - -> Informal activities

Figure 11: MSWM system flow diagram in Mamelodi East.

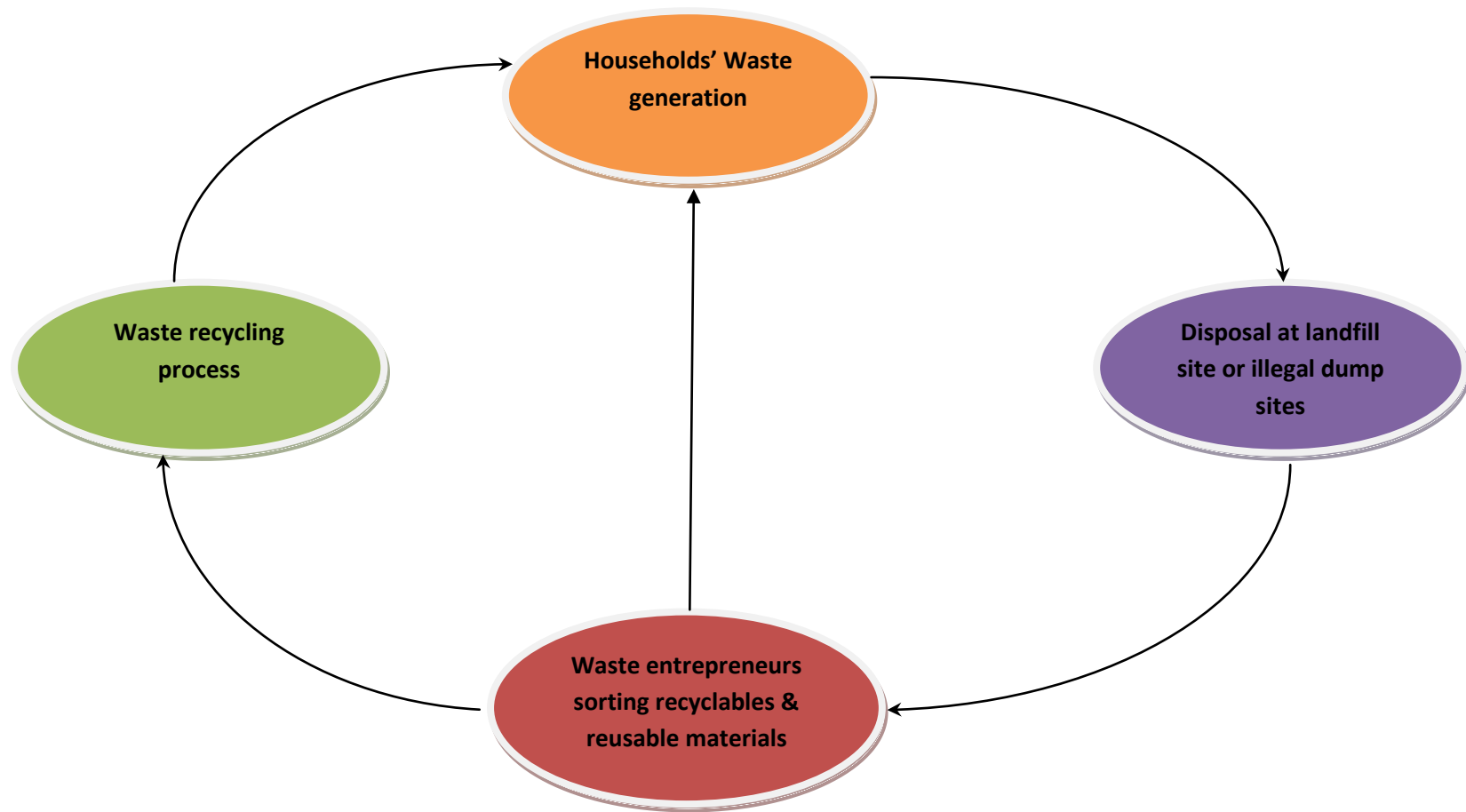


Figure 12: The waste minimization cycle implemented by local waste entrepreneurs in Mamelodi East.



Figure 12 indicate how the activities performed by the waste entrepreneurs contribute to waste minimization. The waste cycle starts from the point of generation where items are thrown away by the household. These items end up at the land fill site or at the illegal dump site. Then the waste entrepreneurs sort them from those sites, categorising them according to their classes, for example bottles, papers, plastics, cans, papers, clothes, furniture, clothes, and electric appliances, etc. The sorted waste materials will then be collected by recycling companies for recycling and some reusable materials will be cleaned and sold back to the community at the train stations, shopping complex pavements, street corners and pension pay points. The recycled material will then be bought back by the households and the cycle start again. These projects were not supported in any way by the responsible municipality whereas they contribute a lot in saving the landfill space.

There was a clear indication that the waste entrepreneurs were not informed about the health and safety hazards they were exposed to, and do not have knowledge on waste management issues. There was one old lady found at the landfill site sorting the clothes and she explained that she will wash them and sell them at the station and give some to her children. They were driven by poverty within their families as their main focus was to obtain income to sustain their lives.

### **4.3. Identification of illegal dumps**

The researcher was able to identify 21 illegal dumps within Mamelodi East area using the street map to record them, indicated on Appendix F. They were found at the vacant stands, some next to the fence of a resident, on open land, behind the school fence, at the street corners and on pavements. Most of them contained general household waste like papers, plastics, bottles, boxes, cardboards, cans, electric appliances, old clothes, kitchen residues, garden waste and building rubbles. Most of the items found on the sites were recyclable/ reusable materials that could be separated for recycling. Burning waste after disposing it at the illegal dumping was observed as depicted on figure 13.

About four dump sites had skips provided by the municipality for the community to dispose their waste. Of the 21 dumps, nine dumps were considered as having high potential of public health risk / creating nuisance. Figure 14 shows some number of household refuse bags (black/ yellow) containing waste disposed at the illegal dump.

There were some skips at a few dump sites provided for the residents to dispose into but some opt to dump outside the provided skips, while some dump into and burn the waste.



Figure 13: Burning waste at illegal dumping site



Figure 14: Illegal dump site indicating mostly household waste

## 4.4. Residents questionnaire

The researcher went house to house administering the questionnaires to the residents residing close to the identified illegal dumps. Nine residents participated in the interviews and all of them signed the consent forms allowing the researcher to continue with the interviews.

### 4.4.1. The demographics of the respondents

Table 1 indicates the demographics of the respondents and table 2 summarises the closed responses.

Table 1: Demographics of the respondents

Age groups	18-25	26-33	34-41	42-49	50-57	58-65	65+	Total
Male	0	1	1	0	0	1	0	3
Female	0	1	1	1	3	0	0	6
Total	0	2	2	1	3	1	0	9

Table 2: Summary of closed responses (n=9):

Questions	Yes	No	Don't know
1. Availability of 85 litre waste bin	8	1	0
2. Sorting of waste before disposal	0	9	0
3. Placing the waste bin outside in morning on the day of collection	9	0	0
4. The sufficiency of collection frequency	2	6	1
5. Do you also dump your waste on the illegal dumping site next to you?	2	7	0
6. Do you know who dumps next to you?	8	1	0
7. Do you know why do they waste next to you?	6	2	1

### 4.4.2. Summary of perceptions on illegal dumping:

All the participants gave their views and explained their feelings on illegal dumping in their areas. Most participants highlighted the need to implement measures to prevent illegal dumping and that illegal dumping is bad for their health and the environment. All of them indicated that illegal dumps should be cleared up and recreational facilities like parks, tennis courts, soccer field, etc be developed on those open spaces. Some indicated that the municipality should fine or arrest people disposing waste on an

unauthorised site. A few indicated that the municipality should conduct awareness campaigns to inform the public on the impact of dumping and the importance of proper waste management. One of the respondents reported that he was considering relocating to the suburb area as they are more taken care of than townships. Some of their family members don't want to visit them during summer and they send away their children to the relatives during summer holidays. "I send my kids to their grandmother during December school holidays because the dumping site becomes worse around that time and they do not enjoy their holidays as they always complain about the smell and flies from the dumping site" explained one of the respondents.

It was mentioned that most of the people who dump at the illegal dumps are known and they come at any time of the day carrying their waste in refuse bags, wheelbarrows, vehicles and their bins or any kind of container. They dump all sorts of unwanted goods like their old furniture and clothes, kitchen waste, plastics, boxes, papers, bottles, cans, building rubbles, pets, electronic waste, and everything that might be perceived as useless. It was very shocking to hear that even foetus/ unwanted babies were dumped. One of the respondents reported that she once approached young man carrying waste in a black waste bag dumping it on the site next to her. She tried to discourage him not to dump the waste at the site but the young man scolded her and told her that he is not her son and she must not tell him what not to do.

These practices were more prominent when regular waste collection was not made, when the bins are full before collection day or during waste collectors/ municipal industrial actions.

The residents complained about the rodents, influx of flies including mosquitoes, bad odour and smoke, untidy environment emanating from the illegal dumping spots next to them. They mentioned that the situation worsens during summer when most of these pollutants are evident, forcing them not open their windows and doors. They reported that they don't enjoy their homes, they can't sit outside under their trees because of the terrible odour and even inside the house becomes too hot. They rely on the electric fans (artificial ventilation) for provision of ventilation inside their houses as the openings on the house can't be used. Two of the interviewed residents explained that their children suffer respiratory conditions due to the smell/ smoke from the illegal dumps next to them "My 2 years girl was sick last year and I took her to the doctor they told me that she had a respiratory infection due to inhalation of polluted air" explained one of the participants.

The interviewees recommended that the municipality should assist them to stop illegal dumping. They mentioned that the municipality should develop recreation facilities like parks and tennis courts on the open spaces and all vacant stands should be fenced.

## PART 5: DISCUSSION

### 5.1. Municipal Solid Waste Management System

The system implemented in Mamelodi East area by CTMM, includes door to door waste collection for formal settlement and communal point collection in informal settlements, transportation of collected waste to Hetherley landfill site for final disposal. The waste minimization activities which include the 3Rs strategies were not included within the implemented system, as most households generate more than one 85 litre bin per week and all collected waste was transported to the landfill site for final disposal. Some community members (waste entrepreneur / scavengers) were sorting waste materials although their main aim was not to minimize generated waste but to make an income to feed their family. The non- implementation of waste minimization strategies by the municipality has a huge impact on the environment as it exacerbates illegal dumping problems, and reduces the landfill lifespan <sup>2</sup>.

- Waste generation

Most houses in Mamelodi East generate more than the provided 85litre bin of waste per week. This challenge compels some community members to dispose off their waste to the nearby dump site as their containers get filled before the collection day and they do not have sufficient storage containers. The municipality mentioned that they have planned to roll out the 240 litre mobile bins to the residents in May 2014 to accommodate the volume of waste generated.

The only routine waste management activities that the residents carry out at the point of generation is storing of waste in 85 litre bin, and taking the bin out on the day of collection. Classification of MSW disposed off or generated by the residents include papers, bottles, plastics, appliances, old clothes, kitchen residues, cardboard, garden waste, building rubbles, metals, batteries, tyres, old furniture, etc.

There were no waste minimisation/ reduction activities implemented at the point of generation, although the municipality had planned to revive the previous strategies where the community had environmental forums working closely with the residents on waste management issues and engage the councillors to emphasize waste management activities (awareness and clean-up campaigns) during their ward meetings.

The Minister of Environmental Affairs and Tourism has issued regulations, guidelines and standards guiding and supporting effective solid waste management system.<sup>2</sup> The national domestic waste collection standards was one of them, which came into effect

on the 1 February 2011 seeking to ensure uniformity in relation to the frequency of collections, transportation, receptacles and storage. It promote the separation of waste at the source, meaning that domestic waste should be sorted into recyclable and non-recyclable materials at that point to reduce the volume of waste for disposal and safe our environment.<sup>24</sup> The municipalities should provide clear guidelines on waste separation at source to households regarding types of waste, the sorting of waste, appropriate containers, and removal schedule. Where the municipality does not provide for collection of source separated waste, it must provide facilities where source separated waste can be dropped-off for collection. This encourages community involvement in recycling of waste.<sup>16, 24</sup>

The implementation of 3 Rs strategies is of utmost important as we can save the huge amount of landfill space because less waste will be disposed.<sup>2</sup> The raw materials will be saved as the sorted recyclables will be remanufactured or reused. The emission of the greenhouse gases emanating from the disposed or burned waste will also be minimised and overall environment will be protected for the future generations.<sup>25</sup>

A previous study indicated that a community based waste management approach, where community participation was regarded as a crucial element in MSWMS was shown to be successful.<sup>8</sup>

- Waste collection and transportation

The waste collection services in the area are rendered to all residents by the contractor appointed by the municipality as guided by part B of schedule 5 of the Constitution. The volume of waste generated and the method of storage inform the collection method and the kind of collection vehicle used. The collection methods used include door to door and communal points collection. The door to door collection method is suitable for formal dwellings where the streets and roads are well structured and communal points collections are used mostly in squatter camp/ informal settlement where the area is congested and the road infrastructures are poor.<sup>7</sup> The communal disposal points are normally located on the peripherals to enable the truck to pick up the skip for disposal, whereas those staying far from the point may be reluctant to dispose their waste at the located site and they alternatively dispose it at the junctions and yard fence corners. The municipality also highlighted this as the challenge that burdens their system as in most cases the area was not included in their plan.

The collection route map is critical as it provides a guide on the starting point and final point of collection and plays a role in minimising the travelling costs.<sup>19</sup> It also assists the community to maintain the collection time for their convenience. There were some difficulties in determining the collection starting point, middle point and the final point as the collection route map was neither available nor utilized. There was no specific time of

collection and the process commenced at any point or street convenient to the collector at the given day and section. Some residents do not adhere to their given collection days as they mentioned that some households do not take out their waste bins on the set day for collection. This is of great concern as those residents might not tolerate having a bin full of waste rotting and smelling in their yards. The options are that they will have to wait for the next collection, or alternatively disposed it at the illegal dump site, since ferrying it to the landfill site by themselves will cost them.

The National domestic waste collection standards stipulates that the frequency of waste collection shall not encourage illegal dumping or cause a nuisance in terms of odours and volumes of waste being stored.<sup>24</sup>

- Waste disposal

The waste generated by the households in Mamelodi was taken to Hatherley landfill site for final disposal as the standard practice not as a last resort in waste management system implemented by the municipality. The DEAT guidelines indicate that disposal of waste at the land fill site should be last resort within the system as most of the waste items from the households are generally recyclables.<sup>2</sup>

The waste management activities at the land fill site involve spreading, compacting and covering of the waste material. There was no evidence of daily waste covering at Hatherley landfill site as required by the DEAT. The DWAF landfill guidelines of 1998 also require the municipality to comply with the safety standards provided and ensure that the human health and the environment are protected. It also has important guidelines for the governing bodies and the public to monitor and make sure that landfill sites are operating according to safety standards during the phases of MSW collection, transportation, treatment and disposal.<sup>2</sup>

The alternative methods of waste disposal include incineration of waste, and conversion of waste to energy and fuel.<sup>10</sup> Incineration is common in countries like Japan where land is scarcer as it does not require much area as landfills.<sup>10</sup> MSW in S.A is disposed through landfill. Other methods like incineration are prohibited by DEAT as combustion in an incinerator is not always perfect and there have been concerns about pollutants emission to the atmosphere. Incineration method is considered for the disposal of hazardous waste like HCRW.<sup>11</sup>

## **5.2. The challenges discovered in MSWM system**

There were several challenges that the key informants highlighted and others were discovered during observation of waste removal process:

- Lack of updated waste management plan
- Lack of community awareness and involvement (community participation).
- Nonexistence of measures to prevent and control illegal dumping
- Lack of law enforcement
- Non-payment of MSWM services by residents.
- The 3 Rs strategies were not implemented anywhere within the system.
- Nonexistence of waste collection route map by contractor
- Straining waste collection mechanism
- Lack of support for local waste entrepreneurs
- Inadequate monitoring of access to landfill site including the control of scavengers at the landfill site
- Lack of training of Waste collector
- Waste collectors were not wearing adequate personal protective clothing

### **5.3. Health and safety risk associated with handling of MSW**

The process of waste collection was observed to be very strenuous as the collectors had to carry the bins on their shoulders lifting and tipping them into the truck. The waste entrepreneurs are more at risk than the waste collectors because of the activities they perform. Their work activities exposed them to several health and safety risks stated below:<sup>13</sup>

- Waste collectors may develop back and shoulder muscle pains from carrying, lifting and tipping of heavy filled bins.
- The previous studies reported that exposure to MSW may cause injuries and illness which include the respiratory diseases, allergies and irritations caused by inhalation, ingestion or absorption of some hazardous substances, gases emanating from the waste, smoke from burning open dumps, dust and terrible odour.<sup>13</sup>
- Injuries may be caused by sharps (broken glasses and bottles, metal nails, etc).

The above stated risks are not limited to waste collectors and waste entrepreneurs only, even the community members residing close to the illegal dumps are at risk of acquiring some of the conditions especially the respiratory problems.

It has been observed that in other areas of CTMM automated bin loading trucks are used, reducing the health and safety risks for the waste collectors. There seems therefore to be some inequity between the standards adhered to within the CTMM. According to Occupational Health and Safety Act 85 of 1993 section 7, any employer is obliged to prepare a written policy concerning the protection of the health and safety of his employees at work including a description of his organization and the arrangements



for carrying out and reviewing that policy.<sup>26</sup> The waste collectors are expected to wear PPE to prevent exposure to occupational injuries and illness.

The National Domestic Waste collection standards were developed in accordance with section 7 of NEMWA to address challenges with waste services provision in S.A and ensure a service to all while complying with health and safety regulations.<sup>24</sup> NEMWA stipulates that the standards are required to give effect to the right to an environment that is not harmful to health and well-being and this right have to be applied uniformly throughout the Republic.<sup>16</sup>

In addressing the general health of the waste collectors, it is advised that they should receive (i) regular medical check-ups to ensure their health and well-being, (ii) appropriate personal protective equipments, e.g. gloves, masks, overalls, raincoats and gumboots, (iii) ongoing training on health and safety issues.<sup>24</sup> This provision does not outline specifically the type of PPEs required, e.g. specific types of masks, gloves, boots, overalls, etc.

#### **5.4. Illegal dumping within the residential area of Mamelodi East**

A high number of illegal dumps were identified across Mamelodi East area. Illegal dumping is the most visible aspect of poor waste management within the area and it becomes a major contributor to rodent infestations, blocked storm water drainage and sewers, and many other environmental concerns that the residents mentioned.

It was observed that the dumped waste was generally recyclable and reusable waste which could have been sorted at the point of generation and placed aside for recycling.

There were some residents (waste entrepreneur) found at some illegal dumps and the landfill site collecting recyclables by sorting and categorising them according to classes, and selling them to the recycling businesses and the community members. This activity has a very positive impact on the environment as it reduces the volume of waste to be disposed on the landfill. Previous studies have shown that S.A has limited capacity to store and dispose high volumes of waste leading to a shortage of landfill space.<sup>25</sup> The recycling is done on an individual basis to make an income for living without any kind of support by municipality, or any knowledge of waste management issues.

Other sites were provided with skips while most sites do not have such provision, although some residents still throw their waste outside next to the skip not inside. The provision of skips at the dump spot does not really assist or alleviate illegal dumping hence it is perceived as promoting dumping.<sup>16</sup> Burning of waste contaminates our atmosphere and it is illegal in South Africa as stipulated in the NEMWA and other

environmental legislations<sup>16-17</sup>. Therefore the polluters' pay principles and other environmental justice principles need to be enforced to protect the environment.

The cleaning of illegal dumps is necessary but it is unfortunately not sustainable and may be viewed as promoting illegal dumping. The municipality reported that they clean the dump sites on regular basis using the tipper truck and the TLB machine. The process is very detrimental to the environment as the topsoil was generally been removed by the process and later the area become a dam of stagnant water creating another nuisance.

The illegal dumping indicated that there was poor community awareness and involvement in waste management issues and the lack of enforcement by the municipality. NEMWA encourages the municipalities to establish a system for waste communication, awareness creation and complaints. They should designate a waste information officer for such activities.<sup>16</sup>

## **5.5. Residents' perceptions and behaviours on illegal dumping**

More than 60% of the residents indicated that the frequency of collection is insufficient although the municipality explained that they will roll out the 240 litre mobile bins to accommodate a large volume of waste. Therefore the need for increasing collection frequency will not be necessary. The residents are unhappy with the dumps in their surroundings and they need them to be removed and the public be made aware of waste management issues including its consequences. The community usually acquire knowledge through general education from schools, media, friends and family or through political meetings.<sup>21</sup>

All participated residents reported that they do not sort their waste before disposal, and these simply showed that the 3Rs strategies were not recognized at the point of generation by residents. An awareness and education on MSWM will assist the community to understand the importance of the 3Rs strategies and how they should implement them.

The former Environmental Affairs' Minister Vali Moosa began the process of the plastic bag legislation in 2001. This was effected on the 9 May 2003 in order to reduce the amount of plastic bag produced and disposed including promoting the use of thicker and recyclable plastic shopping bags.<sup>19</sup> Only 18% of the participants mentioned that they also dump their waste on the nearby illegal dump whenever the collection was not made, when their bins are full before the day of collection and during the waste removers' strikes, although all of them stated that they do take out their waste to the street on the day of collection. About 90% of the participants indicated that they know

the people who dispose their waste at the dump site next to them as they frequently saw them disposing.

There are several factors influencing the illegal dumping within the residential areas as indicated by figure 5. The fact that people dump waste freely at any time of the day especially during the day, raise a great concern of awareness and education as educated or informed people would not do it. Even if they may attempt to dump their waste there, they will perhaps do it at night or when they are not seen. It is perceived as a norm that whenever the bin gets filled before collection it will be emptied at the nearby dump site. The lack of enforcement on waste management by-laws gives freedom to the public to do as they wish. If the by-laws were enforced, then the public will refrain from dumping illegally as they know that they will be charged.

It is of utmost important to educate and assist the public to understand the fundamental principles of waste management. Consultation and involvement of the community within the system is imperative as it will result in improved effective solid waste management system.<sup>25,27</sup>

The three factors shown on figure 5, i.e. awareness/education, socio-economic, mushrooming informal settlements, interlink as people who are uneducated or uninformed are usually unemployed and more likely to settle in informal settlements (urbanisation) as they cannot afford to pay rents or buy houses.

## **5.6. Public private partnership in job creation through recycling**

The waste management sector plays an important role in terms of job creation, in particular for semi-skilled and unskilled workers. The use of community based collection of domestic waste and recyclables is becoming more prevalent and encouraged by the National Waste Management strategy 1999.<sup>24</sup> These schemes have potential to create employment, reduce cost and extending waste services to previously un-serviced areas especially in areas where municipal waste collection is difficult and unemployment rates are high.<sup>22</sup>

The recycling industry has the potential to contribute towards job creation through materials collection and the sorting of waste. Indirect job opportunities are created for informal collectors (waste entrepreneur) who sell their produce to buy-back centres and recycling industries. These opportunities could stimulate small business development and entrepreneurial activities.<sup>22</sup> There is however a need for further research to assess the understanding of waste entrepreneurs on the impact of waste recycling issues.

## 5.7. Limitations of the study

- The study was limited to municipal solid waste generated by the households, therefore emissions to air and water pollution was not investigated.
- The study was conducted only in Mamelodi East within the jurisdiction of CTMM, and the focus was on municipal solid waste management system implemented within residential areas.
- Waste water, agricultural waste, Health Care risk waste (Medical waste), industrial waste, sewage sludge and other gaseous/ hazardous waste including any kind of waste that is not part of domestic waste were not falling within the scope of the study, therefore there were not covered in the study.
- Observations of waste removal process were limited since the study was once off due to cost and time constraints.
- A limited number of residents were interviewed making the results non-representative of the population, but sufficient to gain some insight into the perceptions and practices of the residents regarding illegal dumping.

## PART 6: CONCLUSION AND RECOMMENDATIONS

The outcome of the study indicated that the municipality lack capacity in terms of ensuring adequate and sustainable waste management service provision to the residents, although they reported that they do have sufficient resources to render the municipal solid waste management services. There were several challenges identified during the study indicating that the municipality needs to be capacitated in terms of effective, efficient and sustainable municipal solid waste management.

South Africa has relevant legislations for adequate waste management and for the protection of the environment starting with the Constitution of the Republic of South Africa, Act 108 of 1996 which is a comprehensive law and requiring all other Acts and regulations to be in line with it.<sup>3</sup>

An effective solid waste management system contributes critically to public health, environmental sustainability, economic development and poverty reduction. Ineffective solid waste management system affects the planet negatively and is felt most severely by poor households since most people who are rich will not tolerate residing near polluted areas. The rights of the poor to a healthy environment have not been fulfilled and the right for protection of the environment has been disregarded while the constitution of RSA, Chapter 2, section 24 clearly stipulates that every citizen of RSA has the right to an environment that is not detrimental to his/her health and wellbeing and the right to protect the environment.<sup>3</sup>

The following recommendations were informed by the challenges identified within the system including the recommendation given by the residents. They should be considered and applied to improve the MSWM system implemented by CTMM in Mamelodi East area:

- The municipality should fast track the provision of the 240 litre mobile refuse receptacles to the residents and ensure that the collection vehicles be fitted with the mechanisms of lifting the bins from the ground and tip them into the truck to alleviate physical strains on the workers. The collection route map should be developed and be implemented as this can reduce the transport cost, time and create consistency in collection for the convenience of the residents.
- The waste collectors should be provided with adequate personal protective clothing composed of the respiratory mask, gloves, safety shoes, and over-alls. They should be regularly trained on work practices which include the importance of wearing proper PPE during waste collection to limit exposure to hazardous substances and injuries. Waste collectors should undergo periodical medical examination to ensure their well-being.

- Effective SWM can be achieved through community participation in waste management activities, meaning that the community should be involved in decision making processes together with other stakeholders (DEAT, National and local government).<sup>17</sup>
- Informal waste entrepreneurs found within the residential area and at the landfill site need to be supported in terms of training on waste management issues, be designated suitable area for their operations, and be provided with the necessary resources. The municipality should promote and participate in safe and healthy waste recovery methods.<sup>28</sup>
- Community awareness and education on waste management needs to be conducted regularly and all schools within the area need to be involved on MSWM issues. It is believed that the level of education and socio-economic status amongst citizens of Mamelodi East play a vital role in influencing the MSW management practices and behaviours.
- The 3Rs strategies on the waste management hierarchy (figure 3) should be implemented and emphasised at the point generation.
- Integrated SWM plan should be reviewed regularly and be implemented as required by the NEMWA.
- Access to the landfill site needs to be strictly controlled and monitored to reduce the unauthorized movements of scavengers as the landfill is considered as a formal organised premise. There should be designated space/ area for waste entrepreneur preparing recyclable or reusable items.
- The municipality should develop and implement measures that are sustainable and environmentally sound to prevent illegal dumping within residential area. The “No dumping” notices should be placed on all open spaces, vacant stands, street corners, junctions, pavement and where dumping is prevalent. The community environmental forums should be revived to monitor illegal dumping and any infringement relevant to waste management matters. The MSWM community help desk should be established to enhance adequate communication between the municipality and the community and adequate dissemination of information on waste management. These should further ensure that waste management issues reported by the community are attended to and also encourage community to report illegal dumping.
- The municipality needs to enforce all their MSW by-laws and other relevant legislations to combat illegal dump issues and ensure compliance with all legislations specified on figure 2.
- The CTMM should undertake initiatives that will promote appropriate and efficient use of natural resources, and to protect the people of Mamelodi East and the environment.<sup>28</sup>The national government should monitor and evaluate municipalities to ensure that the MSW is managed in an adequate, sustainable

and environmentally sound manner and that the health and safety of all the citizens and the environment are protected.

The municipal solid waste does not pose a significant threat to public health or the environment if properly managed. Therefore, the above recommendations are essential to improve MSWM in CTMM.

## REFERENCES

1. UNEP [internet]. Global Partnership on Waste Management. Integrated solid waste management. United States: International Environmental Technology Centre; [updated 2010 Nov 10; cited 2013 Jun 15]. Available from: <http://www.unep.org/gpwm/sponsoredareasofwork/integratedsolidwastemanagement>
2. Department of Environmental Affairs and Tourism [internet]. Solid waste management systems Vol. 22 no 12. Pretoria: DEAT; [updated 2003 Jul; cited 2013 Jun 12]. Available from: <http://www.environment.gov.za/governmentDigest>
3. The Constitution of the Republic of SA Act 108 of 1996, Pub. L. S. 24 - 52. RSA; SA Government printers
4. City of Tshwane Metropolitan Municipality [internet]. CTMM resolution dated 26 May 2005 and resolution dated 31 May 2006. Pretoria. [updated 2006 May 31; cited 2013 Jul 18]. Available from: <http://www.tshwane.gov.za/documents/tariffs/SanitationTariffs2007.pdf>
5. United States Environmental Protection Agency. Solid Waste and Emergency Response. United States: EPA 530-F-02-026a; [updated 2002 May; cited 2013 Jun 15]. Available from: <http://www.epa.gov/globalwarming>
6. Tchobanoglous G, Theissen H, Vigil S. Integrated solid waste management Engineering principles and management issues. New York: McGraw-Hill; 1993.
7. CSIR [internet]. Guidelines for human settlement planning and design, solid waste management. Pretoria [updated 2009; cited 23 Oct 2014]. Available from [http://www.csir.co.za/Built\\_environment/Redbook/vol\\_II/chapter\\_011\\_vol\\_II.pdf](http://www.csir.co.za/Built_environment/Redbook/vol_II/chapter_011_vol_II.pdf).
8. Rathi S. Alternative approaches for better municipal solid waste management in Mumbai, India. Waste Management. 2005 Sep 27; 26 (2005): 1192- 1200.
9. Naidoo K. An analysis of Municipal solid waste management in South Africa using Msunduzi Municipality as a case study [dissertation]. School of Geography, Faculty of Science and Agriculture: University of Natal; 2009.
10. Adkin A [internet]. Sustainability Law- An Alternative to Landfills for Waste Disposal. [updated 2011 March 18; cited 2014 Oct 24]. Available from: <http://sustainabilityandlaw.com/2011/03/18/an-alternative-to-landfills-for-waste-disposal-plasma-gasification>.
11. Department of water Affairs and Forestry [internet]. Waste management series. Minimum requirements for Waste Disposal by Landfill. Pretoria: DWAF; [updated 2005; cited 2014 Nov 11]. Available from: <http://www.dwaf.gov.za/documents/Other/WQM/RequirementsWasteDisposalLandfillSep05Part1.pdf>.
12. Bogale D, Kumie A, Tefera W. Assessment of occupational injuries among Addis Ababa City municipal solid waste collectors. BMC Public Health. 2014;14:169



13. Cointreau S [internet]. Occupational and environmental health issues of solid waste management- special emphasis on middle and lower income countries. Washington D.C: The World Bank; [updated 2006 Jul 02; cited 2014 Oct 23] Available from <http://www.worldbank.org/urban/>.
14. UNEP. Developing Integrated Solid Waste Management Plan, Training manual, vol. 2: assessment of current Waste Management system and Gaps therein. Japan: International Environmental Technology Centre; 2009.
15. WHO [internet]. MDG7. UN Millennium projects; [updated 2000; cited 2013 Jun 15] Available from: <http://www.unmillenniumproject.org/goals/gti.htm#goal7>
16. National Environmental Management Waste Act 59 of 2008, Pub. L. RSA, SA Government printers
17. DEAT [internet]. The Polokwane Declaration on Waste Management. First national Waste Summit, Polokwane: DEAT; [updated 2011 Sep 26-28; cited 2014 Nov 11]. Available from: [http://soer.deat.gov.za/dm\\_documents/polokwane\\_nmZiT.pdf](http://soer.deat.gov.za/dm_documents/polokwane_nmZiT.pdf).
18. City of Tshwane Metropolitan Municipality. State of the environment report for the City of Tshwane 2001 – 2002. Department of Housing, City Planning and Environmental management section: Environmental Resource Management. Tshwane. 2002.
19. Worku Y, Muchie M. An attempt at quantifying factors that affect efficiency in the management of solid waste produced by commercial business in the City of Tshwane, South Africa. Environmental and Public Health. 2012 Oct 11; 2012(16):2.
20. Tadesse T, Ruijs A, Hagos F. Household waste disposal in Mekelle city, Northern Ethiopia, Waste Management 28; [updated 2007 Oct; cited 2014 Oct 16]. Available from: <http://www.sciencedirect.com>. Accessed on 16/10/2014
21. Wilson DC, Scheinberg A. What is good practice in solid waste management? Waste Management Research. 2010 Dec 17; 28 (12):1055-1056.
22. DEAT [internet]. Assessment of the status of waste services delivery and capacity at local government level. Pretoria: General Waste Management Directorate; [updated 2007 Aug; cited 2014 Nov 11]. Available from [http://www.gov.za/files/waste-assessment\\_0.pdf](http://www.gov.za/files/waste-assessment_0.pdf).
23. Joubert G, Ehrlich R, editors. Epidemiology: A research manual for South Africa. 2<sup>nd</sup> ed. Cape Town: Oxford University press Southern Africa; 2007.
24. DEAT [internet]. National Domestic Waste Collection Standards, February 2011. RSA: DEAT; [updated 2011 Feb; cited 2014 Nov 10]. Available from: <http://sawic.environment.gov.za/documents/696.pdf>.
25. CSIR [internet]. Municipal Solid waste- good practice guide. Pretoria: CSIR; [2011 Mar; cited 2014 Oct 23]. Available from: [http://www.csir.co.za/nre/docs/waste\\_management\\_toolkit](http://www.csir.co.za/nre/docs/waste_management_toolkit).
26. Occupational Health and Safety Act 85 of 1993, Pub. L. Section 7. RSA, S.A Government printers.

27. European Environment Agency. Managing Municipal Solid Waste. A review of achievements in 32 European countries. EEA Report. No 2/2013. DOI: 10.2800/71424.pub2.
28. De Haan M, Dennill K, Vasuthevan S. The health of Southern Africa. 9<sup>th</sup> ed. Cape Town: Juta & Co. Ltd; 2008.

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**PARTICIPANT'S INFORMATION LEAFLET  
AND INFORMED CONSENT FORM FOR CTMM OFFICIALS**

**TITLE OF THE STUDY**

An evaluation of municipal solid waste management system within City of Tshwane Metropolitan municipality, in Mamelodi East Township, Gauteng province, South Africa.

**INTRODUCTION**

You are invited to participate in a study to evaluate the municipal solid waste management system in City of Tshwane metropolitan municipality in Mamelodi East. You are the relevant candidate to provide a clear description on how is MSWM system in Mamelodi East and outline the challenges within the system.

This information leaflet provides you with the information that will assist you to understand what the study is all about and make an informed decision on whether you will take part in the study or not. Any questions or enquiries that are not covered within this leaflet can be directed without any hesitation to the researcher for further clarification and you are at liberty to withdraw from this study at any point during the study.

**THE PURPOSE OF THIS STUDY**

The aim of this study is to evaluate the municipal solid waste management system implemented by the City of Tshwane Metropolitan municipality to the residents of Mamelodi East in order to identify gaps, assess its effectiveness and determine the possible interventions in alleviating the illegal dumping problems. The focus of this study will be on waste generated by the households.

**PROCEDURES TO BE FOLLOWED**

The researcher will be conducting the interviews with the key informants that are the municipal officials to obtain a clear description of the municipal solid waste management system and an understanding of how the system is implemented. The implementation of the system will be observed in Mamelodi East area to assess the effectiveness of the system. The interviews will be audio-recorded and the notes will be made during the discussions. The observation findings and all data collected will be presented to the municipality and the university on conclusion of the study.

### **PROCESS INVOLVED**

The interviews with the key informants will take about an hour and you are free not to answer any question.

### **POSSIBLE BENEFITS OF THIS STUDY**

This study is striving for a clean and healthy environment for the citizen of Mamelodi East and for the protection of the environment for the future generation. However, you will not personally benefit from the interview.

### **RISKS**

There are no risks to your participation in the interview.

### **RIGHTS AS PARTICIPANT**

- Your participation is voluntary; and
- You may at any time withdraw from the study

### **ETHICAL APPROVAL**

The permission to conduct the study WAS obtained from the City of Tshwane Metropolitan Municipality. This proposal received written approval from the Faculty of Health sciences Research Committee, University of Pretoria. A copy of the approval letter is available for reference.

### **INFORMATION AND CONTACT PERSON**

The contact person for the study is Ledile Francina Nkosi,  
cell number 083 308 1266.

### **COMPENSATION**

No compensation will be given for your participation.

### **CONFIDENTIALITY**

All information collected will be kept strictly confidential. No names will be included in the research report.

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**CONSENT TO PARTICIPATE IN THIS STUDY**

- I confirm that the person asking my consent to participate in this study has explain to me the purpose, procedure, discomforts and benefits of this study.
- I have also received, read and understood the above written information about this study.
- I am aware that the findings of this study, including personal details, will be processed anonymously into research report.
- I am participating voluntarily, and agree that the interview can be audio-recorded.
- I have had time to ask any questions and have no objection to participate in the study.
- I understood that there is no penalty if I wish to withdraw from the study and my withdrawal will not affect me in any way.
- I will receive a signed copy of this informed consent agreement should I wish to have one.

**Participant's name** \_\_\_\_\_

**(Please print)**

**Participant's signature** \_\_\_\_\_ **Date** \_\_\_\_\_

**Researcher's name** \_\_\_\_\_

**(Please print)**

**Researcher's signature** \_\_\_\_\_ **Date** \_\_\_\_\_

**Witness's name** \_\_\_\_\_

**(Please print)**

**Witness's signature** \_\_\_\_\_ **Date** \_\_\_\_\_

**STRUCTURED INTERVIEW QUESTIONS FOR CTMM OFFICIALS**

**CONTACT DETAILS OF INTERVIEWER:**

Name and surname: Mrs Ledile Francina Nkosi

Institution: University of Pretoria  
Faculty of Health Sciences  
School of Health Systems and Public Health

Physical Address: 31 Marishane Street  
22966 Ext 4  
Mamelodi East  
0122

Contact numbers: 083 308 1266; 084 456 9888

E-mail address: [ledilenkosi@gmail.com](mailto:ledilenkosi@gmail.com)

**CONTACT DETAILS OF INTERVIEWEE:**

Name and surname: \_\_\_\_\_

Organisation: \_\_\_\_\_  
\_\_\_\_\_

Physical Address: \_\_\_\_\_  
\_\_\_\_\_

Contact numbers: \_\_\_\_\_

E-mail address: \_\_\_\_\_

**DETAILS OF INTERVIEW:**

Venue: \_\_\_\_\_

Date: \_\_\_\_\_

Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

### QUESTIONS:

1. How is household solid waste in Mamelodi East currently managed?
2. How many contractors or service providers render waste collection services in Mamelodi East?
3. Are there sufficient resources to render the municipal solid waste management services?
4. How many permitted landfill sites are in use for disposing solid waste from Mamelodi East?
5. Which waste management activities are emphasised at point of generation?
6. Do the residents of Mamelodi East participate in the management of household solid waste? And how do they get involved?
7. What are the measures in place to prevent illegal dumping of solid waste within residential area?
8. How do you control the existing illegal dumping spots?
9. What strategies could be put in place to reduce the problem of illegal dumping on streets and open spaces?
10. Do you know any factors that affect the household waste disposal decisions?
11. Is there any area in Mamelodi East that is not receiving waste management services?
12. Are there any challenges experienced in implementing the MSWM system in Mamelodi East?
13. Is there any plan in place to evaluation the current MSWM system? How often do you evaluation the MSWM system?

INTERVIEWEE'S REMARKS: \_\_\_\_\_

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INTERVIEWER'S REMARKS: \_\_\_\_\_

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**PARTICIPANT'S INFORMATION LEAFLET  
AND INFORMED CONSENT FORM FOR WASTE REMOVAL CONTRACTOR**

**TITLE OF THE STUDY**

An evaluation of municipal solid waste management system within City of Tshwane Metropolitan municipality, in Mamelodi East Township, Gauteng province, South Africa.

**INTRODUCTION**

You are invited to participate in a study to evaluate the municipal solid waste management system in City of Tshwane metropolitan municipality in Mamelodi East. You are therefore requested to provide a description on how the MSWM system in Mamelodi East is implemented and the challenges encountered in providing the waste removal services.

This information leaflet provides you with the information that will assist you to understand what the study is all about and make an informed decision on whether you will take part in the study or not. Any questions or enquiries that are not covered within this leaflet can be directed without any hesitation to the researcher for further clarification and you are at liberty to withdraw from this study at any point during the study.

**THE PURPOSE OF THIS STUDY**

The aim of this study is to evaluate the municipal solid waste management system implemented by the City of Tshwane Metropolitan municipality to the residents of Mamelodi East in order to identify gaps, assess its effectiveness and determine the possible interventions in alleviating the illegal dumping problems. The focus of this study will be on waste generated by the households.

**PROCEDURES TO BE FOLLOWED**

The researcher will be conducting the interviews with the key informants, including the contractor who does the waste collection to obtain a clear description of the municipal solid waste management system and an understanding of how the system is implemented. The implementation of the system will be observed in Mamelodi East area to assess the effectiveness of the system. The interviews will be audio-recorded and the notes will be made during the discussions. The observation findings and all data collected will be presented to the municipality and the university on conclusion of the study.

**PROCESS INVOLVED**

The interviews with the key informants will take about an hour and you are free not to answer any question.

**POSSIBLE BENEFITS OF THIS STUDY**

This study is striving for a clean and healthy environment for the citizen of Mamelodi East and for the protection of the environment for the future generation. However, you will not personally benefit from the interview.

**RISKS**

There are no risks to your participation in the interview.

**RIGHTS AS PARTICIPANT**

- Your participation is voluntary; and
- You may at any time withdraw from the study

**ETHICAL APPROVAL**

The permission to conduct the study was obtained from the City of Tshwane Metropolitan Municipality. This proposal received written approval from the Faculty of Health sciences Research Committee, University of Pretoria. A copy of the approval letter is attached for reference.

**INFORMATION AND CONTACT PERSON**

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cell number 083 308 1266.

**COMPENSATION**

No compensation will be given for your participation.

**CONFIDENTIALITY**

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- I am participating voluntarily, and agree that the interview can be audio-recorded.
- I have had time to ask any questions and have no objection to participate in the study.
- I understood that there is no penalty if I wish to withdraw from the study and my withdrawal will not affect me in any way.
- I will receive a signed copy of this informed consent agreement should I wish to have one.

**Participant's name** \_\_\_\_\_

**(Please print)**

**Participant's signature** \_\_\_\_\_ **Date** \_\_\_\_\_

**Researcher's name** \_\_\_\_\_

**(Please print)**

**Researcher's signature** \_\_\_\_\_ **Date** \_\_\_\_\_

**Witness's name** \_\_\_\_\_

**(Please print)**

**Witness's signature** \_\_\_\_\_ **Date** \_\_\_\_\_

**STRUCTURED INTERVIEW QUESTIONS FOR WASTE REMOVAL  
CONTRACTOR**

**CONTACT DETAILS OF INTERVIEWER:**

Name and surname: Mrs Ledile Francina Nkosi

Institution: University of Pretoria  
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School of Health Systems and Public Health

Physical Address: 31 Marishane Street  
22966 Ext 4  
Mamelodi East  
0122

Contact numbers: 083 308 1266; 084 456 9888

E-mail address: [ledilenkosi@gmail.com](mailto:ledilenkosi@gmail.com)

**CONTACT DETAILS OF INTERVIEWEE:**

Name and surname: \_\_\_\_\_

Name of employer: \_\_\_\_\_  
\_\_\_\_\_

Physical Address: \_\_\_\_\_  
\_\_\_\_\_

Contact numbers: \_\_\_\_\_

E-mail address: \_\_\_\_\_

**DETAILS OF INTERVIEW:**

Venue: \_\_\_\_\_

Date: \_\_\_\_\_

Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

### QUESTIONS:

Question	Respond
1. How long have you being working as a waste collector at Mamelodi East?	<hr/> <hr/>
2. Do you collect household waste from the entire Mamelodi East area?  If no, which areas in Mamelodi East do you cover?	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 2px 10px;">Yes</div> <div style="border: 1px solid black; padding: 2px 10px;">No</div> <div style="border: 1px solid black; padding: 2px 10px;">Sometimes</div> </div> <hr/> <hr/> <hr/>
3. How do you collect waste bins from households and where do you start?	<hr/> <hr/>
4. How often do you collect waste from household in Mamelodi East?	<hr/> <hr/>
5. Do you also pick up waste from illegal dump sites?	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 2px 10px;">Yes</div> <div style="border: 1px solid black; padding: 2px 10px;">No</div> <div style="border: 1px solid black; padding: 2px 10px;">Sometimes</div> </div>
6. Do you get the refuse bins readily placed outside for collection?	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 2px 10px;">Yes</div> <div style="border: 1px solid black; padding: 2px 10px;">No</div> <div style="border: 1px solid black; padding: 2px 10px;">Sometimes</div> </div>
7. Do you have specific time for collection of waste in Mamelodi East?	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 2px 10px;">Yes</div> <div style="border: 1px solid black; padding: 2px 10px;">No</div> <div style="border: 1px solid black; padding: 2px 10px;">Don't know</div> </div>
8. Where do you take the waste after collection?	<hr/> <hr/>
9. What challenges do you experience during collection of household waste in Mamelodi East?	<hr/> <hr/> <hr/>
10. What items do you not take that households place outside for collection?	<hr/> <hr/> <hr/>

11. What strategies could be put in place to reduce the problem of illegal dumping on streets and open places?

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INTERVIEWEE'S REMARKS: \_\_\_\_\_

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INTERVIEWER'S REMARKS: \_\_\_\_\_

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**PARTICIPANT'S INFORMATION LEAFLET AND INFORMED CONSENT FOR ANONYMOUS RESIDENT QUESTIONNAIRES**

**Researcher's Name: Ledile Francina Nkosi**

**Student Number: 10527321**

**Department of School Health Systems and Public Health**

**University of Pretoria**

Dear Participant

**AN EVALUATION OF MUNICIPAL SOLID WASTE MANAGEMENT SYSTEM WITHIN CITY OF TSHWANE METROPOLITAN MUNICIPALITY IN MAMELODI EAST TOWNSHIP, GAUTENG PROVINCE SOUTH AFRICA.**

I am a third year student enrolled for Master of Public Health in the School Health Systems and Public Health at University of Pretoria. You are invited to volunteer to participate in my research project on an evaluation of municipal solid waste management system within City of Tshwane Metropolitan Municipality in Mamelodi East Township, Gauteng province South Africa. The information that will be obtained from you will assist the researcher to determine the sources and causes of illegal dump in your area and the interventions needed to prevent the occurrence of illegal dumping, and you are the relevant participant to provide such information since you are staying closest to the dumping area.

This letter gives information to help you to decide if you want to take part in this study. Before you agree you should fully understand what is involved. If you do not understand the information or have any other questions, do not hesitate to ask me. You should not agree to take part unless you are completely happy about what I expect of you.

The purpose of the study is to evaluate the Municipal solid waste management system and identify challenges within the system and explain the practice of illegal dumping by residents in Mamelodi East.

I would like you to respond to a questionnaire that will be presented to you. This may take about 20 minutes. I will ask you some questions and I will fill in the answers you will be giving. The filled questionnaire will be kept in a safe place to ensure confidentiality. I will not write your name on the questionnaire. This will ensure confidentiality. I will help you with the questionnaire and fill it in on your behalf.

You need not to answer questions that are of a sensitive nature to you.

The Research Ethics Committee of the University of Pretoria, Faculty of Health Sciences, telephone numbers 012 3541677 / 012 3541330 granted written approval for this study.

Your participation in this study is voluntary. You can refuse to participate or stop at any time without giving any reason. As your name is not written on the questionnaire, you give me the information anonymously. Once you have given the questionnaire back to me, you cannot recall your consent. We will not be able to trace your information. Therefore, you will also not be identified as a participant in any publication that comes from this study.

In the event of questions asked, which will cause emotional distress, then the researcher is able to refer you to a competent counselling.

**Note: The implication of completing the questionnaire is that informed consent has been obtained from you. Thus any information derived from your form (which will be totally anonymous) may be used for e.g. publication, by the researchers.**

I sincerely appreciate your help.

Yours truly,

Ledile Francina Nkosi

Contact numbers: 083 308 1266; 084 456 9888

E-mail address: [ledilenkosi@gmail.com](mailto:ledilenkosi@gmail.com)

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### CONSENT TO PARTICIPATE IN THIS STUDY

- I confirm that the person asking my consent to participate in this study has explain to me the purpose, procedure, discomforts and benefits of this study.
- I have also received, read and understood the above written information about this study.
- I am aware that the findings of this study, including personal details, will be processed anonymously into research report.
- I am participating voluntarily, and agree that the researcher fill in the questionnaire on my behalf.
- I have had time to ask any questions and have no objection to participate in the study.
- I understood that there is no penalty if I wish to withdraw from the study and my withdrawal will not affect me in any way.
- I will receive a signed copy of this informed consent agreement should I wish to have one.

**Participant's signature** \_\_\_\_\_ **Date** \_\_\_\_\_

**Researcher's signature** \_\_\_\_\_ **Date** \_\_\_\_\_

**Witness's signature** \_\_\_\_\_ **Date** \_\_\_\_\_

**SEMI STRUCTURED QUESTIONNAIRES FOR THE RESIDENTS**

**DETAILS OF THE RESIDENT:**

Physical Address: \_\_\_\_\_  
\_\_\_\_\_

**FOR OFFICE USE ONLY**

Unique ID No.: \_\_\_\_\_

Age group: 18 – 25  ; 26 – 33  ; 34 – 41  ; 42 – 49   
50 – 57  ; 58 – 65  ; 66 +

Gender:  F  M

**DETAILS OF QUESTIONNAIRE:**

Date: \_\_\_\_\_

Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_

**QUESTIONS:**

Question	Respond
1. Do you have a 40 litre waste bin? If not, where do you dispose your waste?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know _____ _____
2. Do you sort waste before placing it in a waste bin? If yes, what do you do with the sorted waste?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know _____ _____ _____
3. Do you take out the waste bin to the street every morning on the day of collection?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know

<p>If not or sometimes, what do you do with the filled waste container?</p> <p>Is the frequency of collection of waste sufficient?</p>	<hr/> <hr/> <div style="display: flex; justify-content: space-around; border: 1px solid black; padding: 5px;"> <span>Yes</span> <span>No</span> <span>Don't know</span> </div>
<p>4. What do you do with extra waste when your waste bin is full before the day of collection?</p>	<hr/> <hr/>
<p>5. What do you think about the dumping site next to you?</p> <p>How does it affect you?</p> <p>Do you also dispose your waste on it?</p> <p>So, what do you suggest should be done to stop it?</p>	<div style="display: flex; justify-content: space-around; border: 1px solid black; padding: 5px;"> <span>Good</span> <span>Bad</span> <span>Don't know</span> </div> <hr/> <div style="display: flex; justify-content: space-around; border: 1px solid black; padding: 5px;"> <span>Yes</span> <span>No</span> <span>Don't know</span> </div> <hr/> <hr/>
<p>6. Do you know who dumps their waste on the dumping site next to you?</p> <p>How and when do they dump their waste?</p> <p>Do you know why do they dump there?</p> <p>If yes, can you explain why?</p>	<div style="display: flex; justify-content: space-around; border: 1px solid black; padding: 5px;"> <span>Yes</span> <span>No</span> <span>Don't know</span> </div> <hr/> <div style="display: flex; justify-content: space-around; border: 1px solid black; padding: 5px;"> <span>Yes</span> <span>No</span> <span>Don't know</span> </div> <hr/>
<p>7. What could the municipality do to reduce the illegal dumping here?</p>	<hr/> <hr/> <hr/>

RESEARCHER'S REMARKS: \_\_\_\_\_

\_\_\_\_\_

RESIDENT'S REMARKS: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

PERMISSION TO DO RESEARCH STUDY AND ACCESS RECORDS/ FILES/  
DATA BASE AT CITY OF TSHWANE METROPOLITAN MUNICIPALITY.

**To: The Manager**  
**City of Tshwane Metropolitan Municipality**  
**Waste Management Department**

**From: The Researcher**  
**Mrs Ledile Francina Nkosi**

**Date: 17 October 2013**

**Re: Permission to do the following research study at City of Tshwane Metropolitan Municipality.**

I am a student at University of Pretoria studying Master of Public Health. I hereby request permission to conduct a study on solid waste management within your organisation.

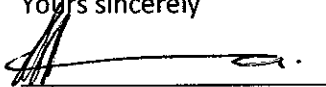
The title of the study is: A review of municipal solid waste management system within City of Tshwane Metropolitan Municipality at Mamelodi East, Gauteng province, South Africa.

I intend to publish the findings of the study in a professional journal and or at professional meeting like symposia, congress, or other meeting of such a nature.

I furthermore request in terms of the requirements of the Promotion of Access to Information Act No. 2 of 2000 that I be granted access to your solid waste management documents.

I undertake not to proceed with the study until I have received approval from the Faculty of Health Sciences Research Ethics Committee, University of Pretoria.

Yours sincerely

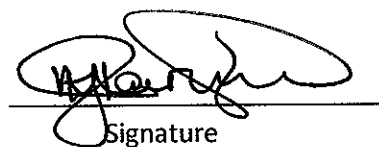


Permission to do research study and access records/ files/ data base at City of Tshwane Metropolitan Municipality as requested, is hereby approved.

The Manager  
City of Tshwane Metropolitan Municipality

JOEL MARUMO.

Name of the Manager



Signature



The Research Ethics Committee, Faculty Health Sciences, University of Pretoria complies with ICH-GCP guidelines and has US Federal wide Assurance.

- FWA 00002567, Approved dd 22 May 2002 and Expires 20 Oct 2016.
- IRB 0000 2235 IORG0001762 Approved dd 13/04/2011 and Expires 13/04/2014.



UNIVERSITEIT VAN PRETORIA  
UNIVERSITY OF PRETORIA  
YUNIBESITHI YA PRETORIA

Faculty of Health Sciences Research Ethics Committee

21/11/2013

**Approval Certificate  
New Application**

**Ethics Reference No.: 440/2013**

**Title** A review of Municipal Solid Waste Management system within City of Tshwane Metropolitan Municipality in Mamelodi East township, Gauteng Province South Africa.

Dear Mrs. Ledile Francina Nkosi

The **New Application** as supported by documents specified in your cover letter for your research received on the 13/11/2013, was approved by the Faculty of Health Sciences Research Ethics Committee on the 20/11/2013.

Please note the following about your ethics approval:

- Ethics Approval is valid for 1 year
- Please remember to use your protocol number (**440/2013**) on any documents or correspondence with the Research Ethics Committee regarding your research.
- Please note that the Research Ethics Committee may ask further questions, seek additional information, require further modification, or monitor the conduct of your research.

**Ethics approval is subject to the following:**

- The ethics approval is conditional on the receipt of 6 monthly written Progress Reports, and
- The ethics approval is conditional on the research being conducted as stipulated by the details of all documents submitted to the Committee. In the event that a further need arises to change who the investigators are, the methods or any other aspect, such changes must be submitted as an Amendment for approval by the Committee.

The Faculty of Health Sciences Research Ethics Committee complies with the SA National Act 61 of 2003 as it pertains to health research and the United States Code of Federal Regulations Title 45 and 46. This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki, the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles Structures and Processes 2004 (Department of Health).

We wish you the best with your research.

**Yours sincerely**

**Dr R Sommers; MBChB; MMed (Int); MPharMed.**

**Deputy Chairperson** of the Faculty of Health Sciences Research Ethics Committee, University of Pretoria

◆ [Tel:012-3541330](tel:012-3541330)

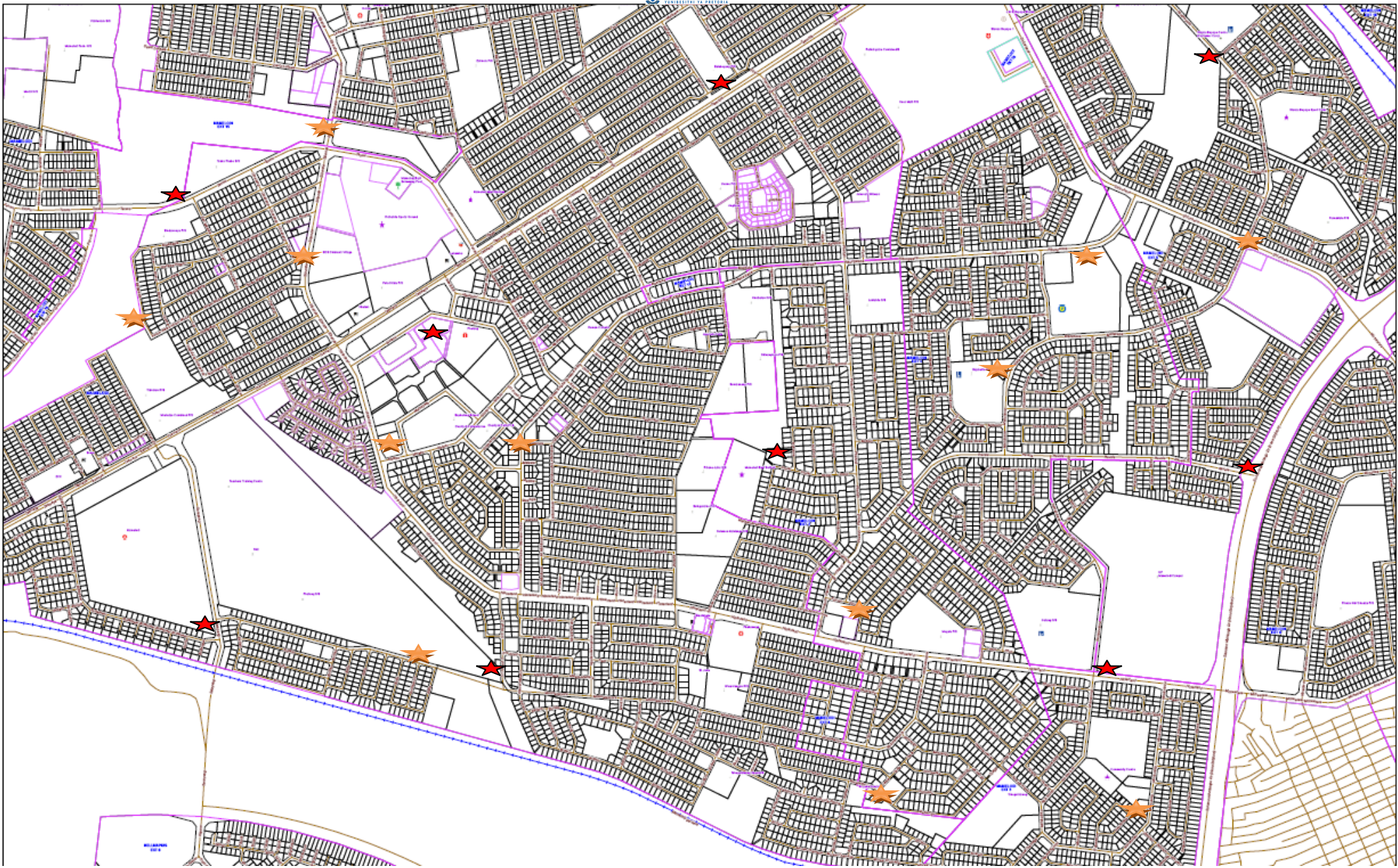
◆ [Web: //www.healthethics-up.co.za](http://www.healthethics-up.co.za)

◆ Fax:012-3541367 Fax2Email: 0866515924

◆ H W Snyman Bld (South) Level 2-34

◆ E-Mail: [manda@med.up.ac.za](mailto:manda@med.up.ac.za)

◆ Private Bag x 323, Arcadia, Pta, S.A., 0007



## Appendix F: Illegal dumps in Mamelodi East

- ★ - Illegal dumps considered for residents' questionnaires
- ★ - Illegal dumps not considered for residents' questionnaires