PRE-FEASIBILITY STUDY FOR THE PROPOSED REGIONAL INTEGRATED WASTE FACILITY "ECOPARK" IN GAUTENG

EXECUTIVE SUMMARY

RFQ NO. WAS0023/22

GAUTENG PROVINCE
AGRICULTURE AND RURAL DEVELOPMENT
REPUBLIC OF SOUTH AFRICA

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LIST OF ABBREVIATIONS AND ACRONYMS

AGP – A	Ardagh Glass Packaging – Africa
App	Application
AWTT	Advanced Waste Treatment Technology
BPDM	Bojanala Platinum District Municipalit
^{o}C	Degrees Celsius
CBD	Central Business District
CCTV	Closed Circuit Television
C&D	Construction and Demolition
C&DW	Construction and Demolition Waste
CFCs	Chlorofluorocarbons
CO_2	Carbon dioxide
CoCT	City of Cape Town
CoE	City of Ekurhuleni Metropolitan Municipality
CoJ	City of Johannesburg Metropolitan Municipality
CoT	City of Tshwane Metropolitan Municipality
Consultants	Utho Capital (Pty) Ltd and DeltaBec
CRT	Cathode Ray Tube
CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs

DEAT	Department of Environmental Affairs and Tourism
DFFE	Department of Forestry, Fisheries and Environment
DSM	Demand Side Management
DTI	Department of Trade and Industry
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
ECA	Environmental Conservation Act, 1989 (Act 73 of 1989)
ED	Ennerdale landfill
EPR	Extended Producer Responsibility
ERWAT	East Rand Watercare
ESDA	East Service Delivery Area
EWASA	Electronic Waste Association of South Africa
E-waste	Waste from electric and electronic equipment (also see WEEE)
FML	Full Maintenance Lease
FS	Feasibility study
GCR	Gauteng City Region
GDACEL	Gauteng Department of Agriculture, Conservation, Environment and Land
GDARD	Gauteng Department of Agriculture and Rural Development
GDARDE	Gauteng Department of Agriculture, Rural Development and Environment
GDP	Gross Domestic Product

GDS	Growth Development Strategy
GIFA	Gauteng Infrastructure Funding Agency
GK	Goudkoppies Landfill
GNR	Government Notice: Regulation
GNR 634	Waste Classification and Management Regulation (2013)
GNR 635	National Norms and Standards for the Assessment of Waste for Landfill Disposal (2013)
GNR 636	National Norms and Standards for Disposal of Waste to Landfill (2013)
GPG	Gauteng Provincial Government
GVA	Gross Value Added
GVM	Gross vehicle mass
GWIS	Gauteng Waste Information System
GWMP	General Waste Management Plan
Ha	Hectare
HCGW	Health Care General Waste
HCRW	Health Care Risk Waste
HCW	Health Care Waste
HDPE	High Density Polyethylen
HL1	Heavy Letter One. Consists of white printed or unprinted sheets, shavings originating from printers or office records.
HOD	Head of Department
ICT	Information and Communications Technology

IDP	Integrated Development Plan
IMRFS	Integrated Material Recovery Facility Study
IWDMP	Integrated Waste Disposal Master Plan
IT	Information Technology
IWM	Integrated Waste Management
IWMP	Integrated Waste Management Plan
IWMSA	Institute of Waste Management of Southern Africa
K4	Regular Corrugated Cardboard
Kg	Kilogram
kg/m^3	kilogram per cubic metre
Km	Kilometre
km^2	Square kilometre
L	litre
LCD	Liquid Crystal Display
LDPE	Low Density Polyethylene
LDV	Light Delivery Vehicle
M	Metre
m^3	Cubic metre
Mm	Millimetre
MAYCO	Mayoral Committee
Mins	Minutes

Mℓ	Megalitre
ML	Marie Louise landfill
MoU	Memorandum of Understanding
MR	Minimum Requirements for Waste Disposal by Landfill (2nd Edition 1998)
MRD	Mean Rate of Deposition
MRF	Material Recovery Facility
Mt	Million tonne
MTSF	Medium-Term Strategic Framework
NWIBR	National Waste Information Baseline Report
NEMWA	National Environment Management: Waste Act, 2008 (Act 59 of 2008) (as amended)
NRF	National Recycling Forum
NSDA	North Service Delivery Area
NT	National Treasury
NWDACE	North West Department of Agriculture, Conservation and Environment
NWMS	National Waste Management Strategy
NWMSIP	National Waste Management Strategy Implementation Project
ORTIA	OR Tambo International Airport
p.a.	Per annum
PCBs	Polychlorinated Biphenyls
PE	Polyethylene

PET	Polyethylene terephthalate
PETCO	PET Recycling Company
PFS	Pre-Feasibility study
PPE	Personal Protective Equipment
PPGTT	Paper, Plastics, Glass, Tins and Tyres
PPP	Public Private Partnership
PVC	Polyvinyl Chloride
R	Rand
RCR	Round-collected—refuse
RD	Robinson Deep landfill
REDISA	Recycling and Economic Development Association of South Africa
R&D	Research and Development
REL	Rear-end-Loader
RFP	Request for Proposal
RFQ	Request for Quotation
RRLP	Resource Recovery and Logistics Plan
S@S	Separation at Source
SA	South Africa
SANS	South African National Standards
SDC	Spatial Development Concept
SDF	Spatial Development Framework

SDM	Sedibeng District Municipality
SMME	Small, Medium and Micro Enterprise
SMS	Short Message Service
SOC	State Owned Company
SOER	State of Environment Report
SPD	Spatial Development Plan
SSDA	South Service Delivery Area
StatsSA	Statistics South Africa
The Department	Gauteng Department of Agriculture, Rural Development and Environment
T	Tonne
TDF	Tyre Derived Fuel
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
ToR:	Terms of Reference
TV	Television
UNISA	University of South Africa
UPS	Uninterrupted Power Supply
VfM	Value for money
WCS	Waste Characterisation Study
WEEE	Waste from electric and electronic equipment (also see E-waste)
WIS	Waste Information System

WMB	Waste Management Bureau
WtE	Waste-to-energy
WTS	Waste transfer station
WWTPs	Waste Water Treatment Plant
ZAR	South African Rand

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The GDARDE also appreciates the support the Climate Group has given throughout the project as the study will assist in moving towards the next phase i.e. the conducting of the Feasibility Study for the Establishment of the Regional Integrated Waste Facility "Ecopark" in Gauteng Province. The findings and recommendations study will assist the Province to make prudent decisions towards implementing the establishment of the waste facility which will address the waste management challenges the Province is currently facing.

1. BACKGROUND

The Constitution of the Republic of South Africa (Act 108 of 1996) [1] *inter alia* stipulates that:

- Every person shall have the right to an environment which is not detrimental to his/her health or well-being. (Section 24)
- A local government shall, to the extent determined in any applicable law, make provision for access by all persons residing within its area of jurisdiction to water, sanitation, transportation facilities, electricity, primary health services, education, housing and security within a safe and healthy environment, provided that such services and amenities can be rendered in a sustainable manner and are financially and physically practicable. (Section 152)

Local governments are, amongst others, responsible for refuse removal, refuse dumps and solid waste disposal (Schedule 5, Part B).

The *National Environmental Management: Waste Act 59 of 2008* [2] (NEMWA), amongst others, sets the following waste service requirements (Section 9):

1. A municipality must exercise its executive authority to deliver waste management services, including waste removal, waste storage and waste disposal services, in a manner that does not conflict with the National Norms and Standards section (7) or Provincial Norms and Standards (8) of NEMWA.
2. Each municipality must exercise its executive authority and perform its duty in relation to waste services, including waste collection, waste storage and waste disposal services.
3. In exercising its executive authority contemplated in subsection (1), a municipality may furthermore, amongst other things, set:
   (a) local standards for the separation, compacting and storage of solid waste.
   (b) local standards for the management of solid waste.
   (c) local standards in respect of the directing of solid waste.

In terms of the National Environmental Management: Waste Act (Act 59 of 2008) (as amended), a municipality must exercise its executive authority to deliver waste management services, including waste removal, waste storage and waste disposal services, in a manner that does not conflict with the Act.

Each municipality must exercise its executive authority and perform its duty in relation to waste services, including waste collection, waste storage and waste disposal services, by:

- Adhering to all national and provincial norms and standards.
- Integrating its waste management plans with its integrated development plans.
- Ensuring access for all to such services.
- Providing such services at an affordable price, in line with its tariff policy in accordance with the *Municipal Systems Act.*
- Ensuring sustainable services through effective and efficient management.
- Keeping separate financial statements, including a balance sheet of the services provided.

- The waste hierarchy requires that a holder of waste must, within the holder's power, take all reasonable measures to:
- Avoid the generation of waste and where such generation cannot be avoided to minimise the toxicity and amounts of waste that are generated.
- Reduce, re-use, recycle and recover waste.
- Where waste must be disposed of, ensure that the waste is treated and disposed of in an environmentally sound manner.

Although the environment is unquestionably best served by meeting the waste hierarchy's higher-order objectives of waste minimisation, recycling and recovery, local and international experience demonstrate a continued need for landfills; a reality confirmed by the fact that waste disposal retains its place in the waste hierarchy. A head-in-the-sand approach of ignoring the need for continued environmentally sound waste disposal in South Africa may result in an environmental disaster.

Decisionmakers are, therefore, to take cognisance of reality regarding what is achievable in terms of waste minimisation; and ensure that infrastructure for integrated and sustainable service delivery is developed accordingly. In the absence thereof, another essential service delivery crisis is likely to arise within the next 5 years when some metropolitan municipalities in Gauteng will be without landfill airspace. Shortages in electricity supply did not have a significant impact on the demand for electricity; nor is less sewerage generated due to the unavailability of environmentally sound sewage treatment plants. Disruptions in the water supply are, at the same time, for various reasons, a common phenomenon. *The absence of appropriate and environmentally sound waste disposal facilities will not only have a significant impact on the environment, but also on human health – despite the opinion expressed that the absence of appropriate waste disposal facilities will result in less waste being generated and more being diverted from landfills.*

With Gauteng being the economic hub of South Africa, with high waste generation rates and limited sites suitable for new landfills, there is an urgent need for the development of legally compliant integrated waste management facilities - with proportional allowance for final disposal of waste. This should be done with a clear understanding that landfills are no longer developed for waste disposal only, but rather for the disposal of residues remaining from integrated waste minimisation processes that are to be implemented in various areas along the waste flow path. With the current waste recovery rate in South Africa reportedly in the order of 10% and waste disposal around 90%, it is evident that a significant effort will be required from all parties concerned to make a substantial difference in the amount of waste being disposed to landfill.

From an environmental point of view, it is also important to recognise the impact of municipal waste on per capita greenhouse gas emissions. Figure 1.1 below provides a comparison of South Africa's greenhouse gas emissions in kg CO2/capita/annum for each kg/capita/annum municipal waste generated to that of other large greenhouse gas existing countries. Although it is to be appreciated that the overall CO2 generated in each country is not only a result of waste (with fossil fuels being a large contributor towards greenhouse gas emissions), it does also illustrate the importance of having greenhouse gas emission levels reduced in South Africa.

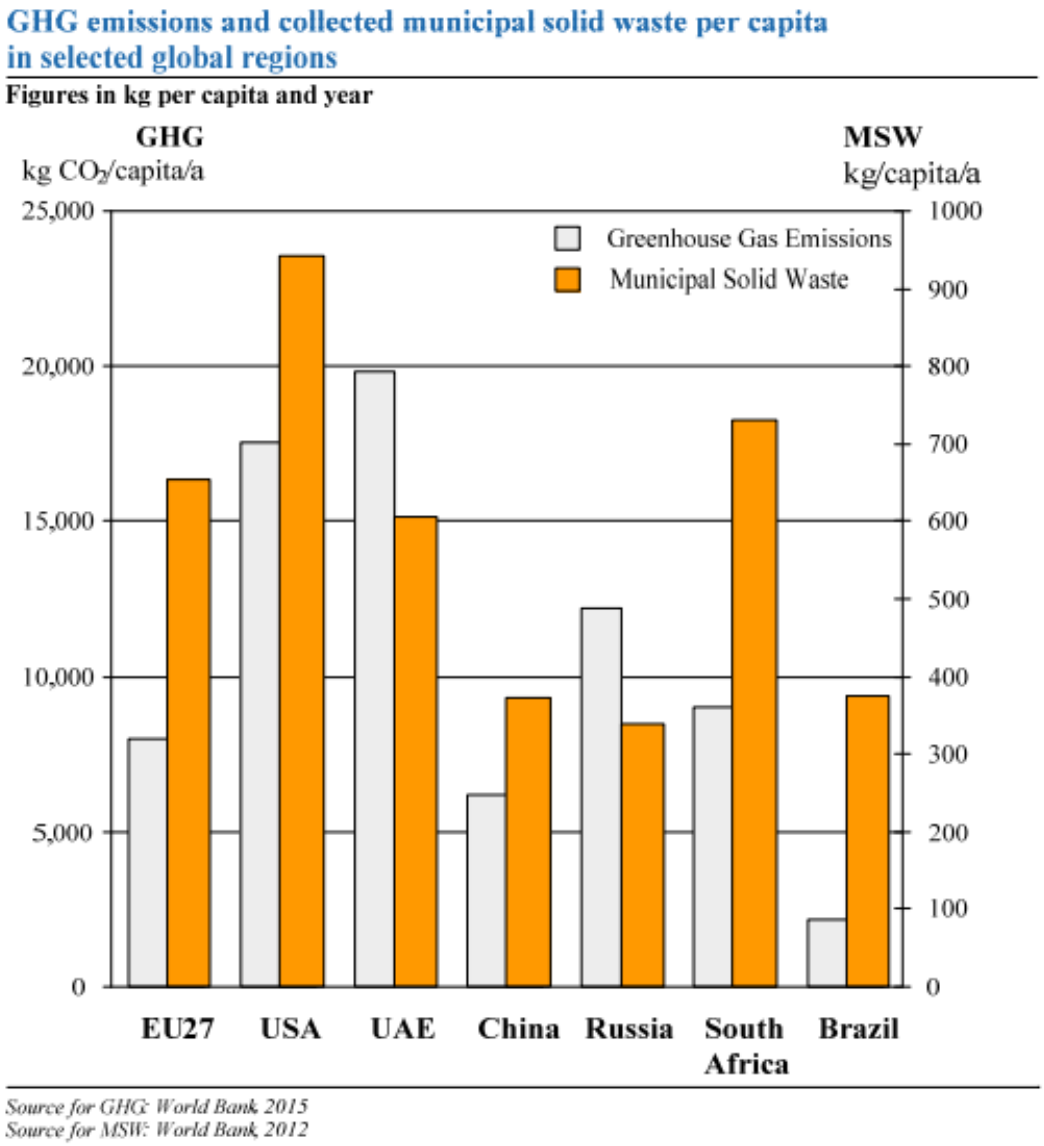


Figure 1-1: Comparison of South Africa's greenhouse gas emissions in kg CO_2/capita/annum for each kg/capita/annum municipal waste generated to that of other large greenhouse gas existing countries (Source: Whitebook Waste-to-Energy Austria).

The project is, therefore, not only aimed at evaluating and addressing the landfill airspace shortage in Gauteng in the short term, but also at identifying strategies through which airspace shortages can be addressed in the medium- to long term by identifying environmentally sound, viable and sustainable strategies to address the ever-increasing waste disposal needs in Gauteng's metropolitan municipalities.

2. THE PROJECT

The project is for the Service Provider to conduct a Pre-Feasibility Study to determine, at a high level, the feasibility of establishing a Regional Integrated Waste Management Facility in the Midrand/Centurion/Tembisa Node with participation from the three Metros: City of Johannesburg (CoJ), City of Tshwane (CoT), and the City of Ekurhuleni (CoE). Based on the outcome of this project, GDARDE will determine whether to conduct a full feasibility study.

3. OBJECTIVES OF THE PROJECT

The main objectives of the project include the following:

- To facilitate the development of an Integrated Regional Waste Management Facility that will service the three (3) Metropolitan Municipalities in the Centurion/Midrand/Tembisa Node where there is currently a deficiency in disposal facilities.
- To address the urgent airspace challenge facing the Metros, in particular for the City of Johannesburg and the City of Tshwane, who have less than 3 years of remaining life on most of their landfills. City of Ekurhuleni's landfill airspace shortage is mainly towards the north of the metro.
- To achieve the target of 25% diversion of waste from landfills by 2024 as per the Medium-Term Strategic Framework (MTSF) and the GGT2030. The proposed Regional Facility is aimed at ensuring that all the waste is diverted from the landfill by establishing various waste recovery and treatment solutions within the facility. The proposed landfill will only accept residual waste that cannot be recovered or treated on site.
- To establish the waste treatment facilities through a Public Private Partnership (PPP) arrangement that will require the municipalities to enter medium to long term partnerships with private partners.
- To change the status quo of waste disposal in the province in terms of planning, compliance as well as diversion of waste to save remaining landfill airspace.

4. METHODOLOGY AND APPROACH

The approach that was undertaken for the pre-feasibility study includes the following:

Table 4-1: Approach undertaken for the pre-feasibility study

Situational analysis	The situational analysis will be conducted by investigating all aspects related to the waste management systems in the three metropolitan municipalities (City of Johannesburg, City of Tshwane and City of Ekurhuleni) through documentation review, site visits, meetings with relevant officials and general observations.
Desired end state	The desired end state for the three metros will be developed based on the information collected on the historical and present waste management situations. For the purpose of this study, **the focus will be on crosscutting elements for the desired end state, i.e. matters that are related to the development of an integrated waste management facility that will serve the three metros in Gauteng.**
Gap and Needs Analysis	During this phase, the 'gaps' that exist between the situational analysis and the desired end state will be determined, and the 'needs' that, if fulfilled, will facilitate the achievement of the desired end state.
Options generation and selection	During this phase, various potentially viable options will be identified to address the needs identified. The preferred options for implementation aimed at addressing the cross-cutting needs of the three metros will then be selected.
Financial Analysis	For each of the technically feasible options identified to address the crosscutting needs of the three metros, a financial analysis will be undertaken to determine both the capital and the operational expenditure for each of the options. Findings from the financial analysis, together with the technical considerations identified during the option selection process, will then be used in a weighted decision-making matrix for the selection of the preferred options.
Implementation plan	The implementation plan will provide an overview of the proposed actions required to address the gaps and needs identified in the waste management system and also to provide timeframes for implementation of interventions.
Final Prefeasibility Study report and close-out	During this phase, the various reports submitted during consecutive phases of the project will be combined into one document that will serve as the final prefeasibility study report.

5. INTRODUCTION

The concept of bulk regional waste management service delivery was introduced to South Africa during the early 1990s. Although larger regional landfills were to replace existing smaller landfills developed by various local municipalities, several local municipal landfills remained in use and were permitted1 (licensed) after the publication of DWAF's2 Minimum Requirements for Waste Disposal by Landfill [5] (Minimum Requirements) during 1995. In 1998, DWAF published the second edition of Minimum Requirements – with standards adjusted based on experience gained since the publication of the first edition.

In the absence of landfill development standards prior to 1995, existing landfills were permitted conditional to new waste cells (within the boundary of the licensed landfill site) being constructed to the latest edition of Minimum Requirements once the operational cell in use was filled. This was, however, often not adhered to, resulting in several landfills being operated without the required lining systems to prevent pollutants from entering both surface- and groundwater.

Under the National Environmental Management: Waste Act 59 of 2008 – (NEMWA), the Waste Classification and Management Regulations (GNR 634) [7], the National Norms and Standards for the Assessment of Waste for Landfill Disposal (GNR 635) [8], as well as the National Norms and Standards for Disposal of Waste to Landfill (GNR 636) [9] were promulgated on 23 August 2013. All new landfills used for the disposal of municipal waste were to comply with the lining standards set for GLB+3 or Class B4 landfills, including the need for leachate collection and extraction systems. Leachate not extracted from landfills that is not trapped within waste bodies is assumed to be released into the environment polluting soil and water. Where non-compliant landfill cells were still in operation by the end of a 3-year window period after the promulgation of GNR 636, all non-compliant operational cells were to be capped and rehabilitated to the required standards to prevent water infiltration and subsequent generation of leachate. New waste disposal cells were then to be constructed in accordance with GNR 636.

In terms of the National Environmental Management: Waste Act (Act 59 of 2008), a municipality must exercise its executive authority to deliver waste management services, including waste removal, waste storage and waste disposal services, in a manner that does not conflict with the Act. Although the environment is unquestionably best served by meeting the waste hierarchy's higher-order objectives of waste minimisation, recycling and recovery, local and international experience demonstrates a continued need for landfills; a reality confirmed by the fact that waste disposal retains its place in the waste hierarchy.

At present, landfill airspace (capacity) in the Gauteng Province is being depleted at a rapid rate, and most municipal landfills in the province are left with ≤ 5 -10 years of remaining airspace [10] [11] based on current consumption rates. There is, at the same time, no

[1] Although landfills were 'permitted' in accordance with Minimum Requirements, the National Environment Management: Waste Act (NEMWA) in 2008 introduced 'licensing' of landfills.

[2] Department of Water Affairs and Forestry.

[3] In compliance with *Minimum Requirements (2nd Edition, 1998).*

[4] In compliance with *National Norms and Standards for Disposal of Waste to Landfill (GNR 636).*

significant diversion of waste from landfills [12] [13], and the current waste minimisation programmes (such as waste separation at source) are mostly in the pilot phase across Gauteng municipalities. The three metros experience pressure in the Midrand/Centurion/Tembisa nodes [14], where there are no municipal owned landfills, with most of their remaining operational landfills being more than 40 kilometres away from this node This is resulting in refuse removal trucks having to travel approximately 80 kilometres to complete one refuse collection service round – which comes at a great expense to the municipalities and affects efficiencies in providing waste services. The municipalities are forced to rely on contracting private landfills to dispose of waste at a high cost per tonne in view of the contract disposal fees charged by the private facilities. The dependence on private facilities also poses a potential risk to municipalities of not having full control of their disposal facilities.

In addition to some municipalities in Gauteng coming up with various interventions, including alternative waste treatment technology solutions to divert waste from the landfills, there have also been some new landfill applications received by GDARDE. In line with the National Environmental Management: Waste Act 59 of 2008 (NEMWA) development of new landfills is, however, only to be considered as a last option. The municipalities, all relevant sectors and waste producers must, therefore, prioritise waste minimisation, recovery, and recycling programmes prior to disposal of waste [15].

In the absence of significant (sustainable) waste minimisation programmes across Gauteng municipalities, the Extended Producer Responsibility (EPR) Regulations came into effect in February 2021. By extending the implementation of the scheme and measuring its impact on waste diversion during the first reporting cycle by the producers, the effectiveness of the system will be assessed. The recovery of recyclable materials continues to be largely due to an active and growing informal waste sector, small waste enterprises and cooperatives, resulting in an urgent need to upscale waste minimisation activities in the province through various programmes including separation of waste at source; processing and treatment of organic waste, including food waste (e.g., through composting, biogas), processing and beneficiation of construction and demolition waste [16].

GDARDE, with its mandate to coordinate integrated waste management planning within the province, is proposing a regional approach to address the challenges facing the three metros, namely, the City of Johannesburg (CoJ), the City of Tshwane (CoT), and the City of Ekurhuleni (CoE) in the Midrand/ Centurion/ Tembisa node.

This Report is the Executive Summary of the situational and needs analysis as well as the technical and financial options analysis that were undertaken in order to prepare the way for a full feasibility study to be undertaken.

6. SITUATIONAL ANALYSIS

Despite some differences regarding waste management conditions in the three metropolitan municipalities, the City of Johannesburg (CoJ), the City of Tshwane (CoT) and the City of Ekurhuleni (CoE), several matters are cross-cutting. Although aspects only related to a particular metro will be highlighted (e.g. regions where some metros may have a shortage in landfill airspace), most of the current problems are crosscutting, and will therefore be dealt with on a provincial level.

With the primary focus being on the potential development of a centrally located integrated waste management facility for Gauteng, the situational analysis will dealt with matters expected to have a direct impact on the proposed facility and not all matters related to the waste flow-path. Other than areas where separation at source is to form an integral part of the project, systems used for containerisation and collection of waste will, for instance, not be considered.

Due to the extent of the waste management services rendered by the three metros and the limited time for this study, it is not envisaged that investigations on all waste streams generated will be feasible. The focus of the study will be on areas where the bulk of the waste is generated, and where it will be most beneficial to the affected metros.

METROPOLITAN MUNICIPALITY OVERVIEW

The following is an overview of the current situations at each of the three metros based on information made available to the consultants. Although some metros provided substantial amounts of information, it may, in some instances, be outdated, with the studies on which the reports were based having been undertaken a decade ago. In the case of the CoJ, the consultant team participated in a recent study aimed at developing a Master Plan for the Pikitup (CoJ) landfills [18] during 2021/2022. The information presented for the CoJ is therefore considered to be relevant and may be used as guidance on the level of detail with which information will ultimately be required for all three metros.

Copies of recent, approved within the past 5 years, Integrated Waste Management Plans (IWMPs) for the various metros were not available at the time this report was drafted. Available copies of draft IWMPs were therefore used.

6.1 CITY OF JOHANNESBURG

Pikitup Johannesburg (SOC) Limited was established in 2001 [18] [19] as an independent municipal entity that is wholly owned by the City of Johannesburg (CoJ). Pikitup was mandated to serve and provide integrated waste management services across the entire 1 625 km^2 of Johannesburg - collecting around 6 000 tonnes of waste every day [20]. Pikitup has 12 waste management depots strategically located throughout the city, 44 garden refuse sites, 5 buyback centres, and 4 active landfill sites.

6.1.1 Waste Management Services Rendered

As the City of Johannesburg's waste management service provider, Pikitup provides a wide spectrum of general (non-hazardous) waste management services throughout the

metropolitan municipality's area of jurisdiction. As an introduction to the service review, the services rendered by Pikitup are considered.

Domestic and business Round Collection Refuse (RCR) services include the following:

(i) **Domestic waste collection**, which is a service provided once a week to all the citizens living in formal dwellings.
(ii) **Informal area RCR,** during which waste is collected from informal settlements. Since informal dwellings are not on the municipal town planning, residents do not qualify for wheelie bins, and waste is collected by means of 85-litre plastic liners issued to members of the communities.
(iii) **Business waste collection** from 85 l, 130 l, and 240 l bins.
(iv) **Collection of putrescible waste** (dailies), like food waste from restaurants.

The CoJ, through a service delivery agreement with Pikitup, which is monitored by the Infrastructure and Services Department of the City, regulates the service delivery in respect of the following:

- Financial services (annual operating and capital budgetary allocations and appropriate tariff levels).
- Levels of service delivery in the different market segments covered by Pikitup.

6.1.2 Waste Recovery and Recycling

Despite Pikitup's change in strategic focus to reduce the amount of waste generated in the CoJ by using a community-driven approach [21], there is an ever-increasing need for the disposal of large volumes of waste generated in CoJ's area of jurisdiction. In addition to that, the airspace remaining on the four municipal landfills owned by Pikitup is limited. Without the opportunity for further extension of Pikitup's landfills *within the previously licensed sites*, this creates an urgent need for sites to be identified and landfills to be extended and/or new landfills to be developed or acquired for the disposal of waste generated by the CoJ.

The shortage of landfill airspace available for use by the CoJ is of real concern – not only due to the financial implications associated with the licensing and development of new landfills, but also due to the timeframes required to establish such sites. Licensing of a new landfill can be expected to cost more than R5 million and can take anything between 5 and 7 years – should the licensing process be successful. Estimated landfill development costs will, in turn, depend on factors such as the size of the landfill and the associated economies of scale. It is further important to note that sufficient waste is not diverted from landfills. This may, to some extent, be due to a lack of facilities, but it may also be influenced by the costs associated with, for instance, composting or C&DW crushing, in relation to the market demand and value for the offtake. Diversion of such waste streams can, however, have a significant impact on the conservation of landfill airspace.

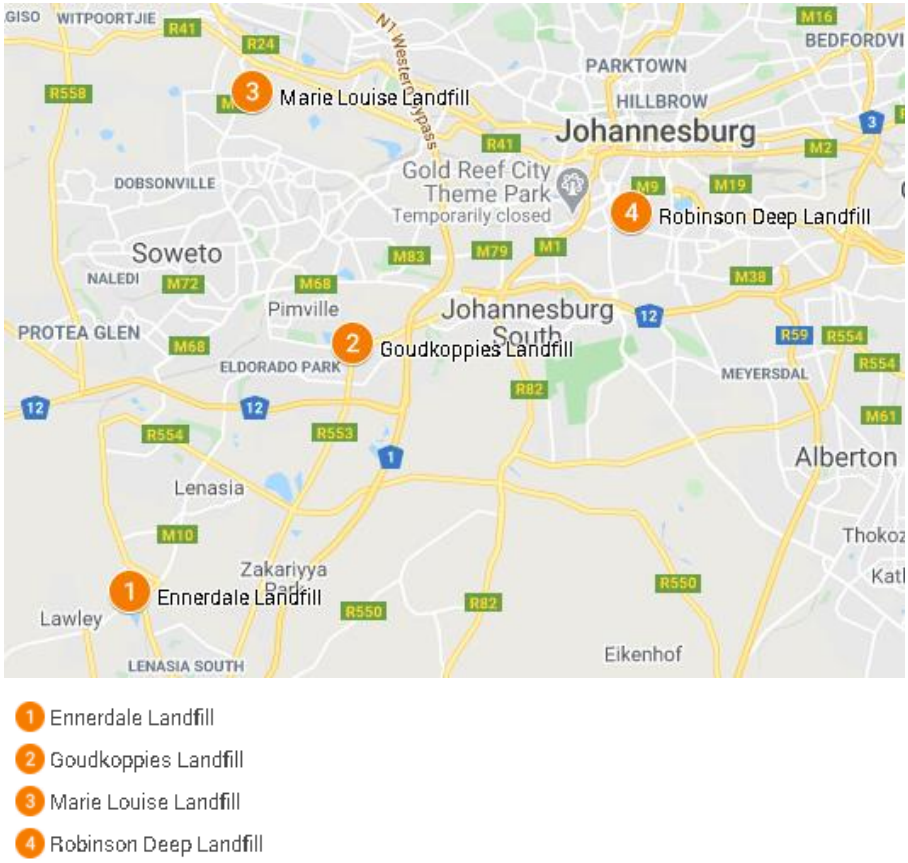
It is further recognised that the licensing, design, construction, and operation of landfills require specialised skills that may not be readily available. The likelihood of success in developing a new landfill is increased if human resources with the required skills and expertise are utilised during the project – with its existing landfills required to showcase Pikitup's ability

to develop and operate legally compliant landfills with limited impact on surrounding communities.

Despite previous attempts made to develop a new landfill at the Northern Sewage Works for waste generated in the northern parts of CoJ, such attempts were unsuccessful, with Pikitup still disposing of its waste at its four remaining landfills i.e. Goudkoppies, Marie Louise, Ennerdale and Robinson Deep. These landfills are not only situated towards the south of Johannesburg, but they are all close to capacity and will all have to be closed in less than 5 years.

In addition to its own landfills in the south, there are two privately owned landfills i.e. Chloorkop towards the east (with limited remaining airspace), and Mooiplaats towards the north. Where available, such private landfills are used to alleviate some of the airspace shortages. Limited competition in the market is, however, impacting negatively on landfill disposal fees charged at a cost per tonne basis by the private landfill owners – despite privately owned landfills used by Pikitup being appointed through an open tender process. Although the privately owned Genesis landfill is also located within the CoJ's area of jurisdiction, its proximity to Pikitup's Robinson Deep landfill does not warrant its use by Pikitup.

The locations of Pikitup's landfills are shown in the figure below.



1 Ennerdale Landfill
2 Goudkoppies Landfill
3 Marie Louise Landfill
4 Robinson Deep Landfill

Figure 6-1: Remaining Pikitup landfills that are still operational

6.1.3 Organic Waste Treatment

The contract for green waste diversion (chipping of green waste delivered to landfills) in CoJ lapsed, so there was, at the time, no diversion of green waste (December 2021) taking place. Pikitup operates 42 drop-off/garden sites in the CoJ. There are dedicated skips at the garden sites for garden refuse, recyclables and disposable general waste.

6.1.4 Construction and Demolition Waste Processing

Limited/occasional C&D waste crushing activities are undertaken at the Robinson Deep landfill site.

The consultant's inference is that there is no appetite in the market for the diversion of C&D waste arriving at Pikitup's landfills.

6.1.5 Health Care Waste Treatment & Disposal

A feasibility study conducted for a new Health Care Risk Waste (HCRW) treatment facility for Pikitup SOC limited (Springfield depot) in October 2015 provides an overview of the HCRW situation in Gauteng and, more specifically, the CoJ. It should be noted that there has been a general trend over the years for the mass of HCRW generated to increase at a rate faster than could be inferred from, for instance, the increase in population. This increase is mostly due to an increasing use of disposable items and higher levels of service (i.e. more disposable items used more often per patient). Furthermore, the COVID-19 Pandemic has caused a major increase in HCRW generation over the period 2020/21.

The Health Care Waste (HCW) stream generated at healthcare facilities consists of:

- Health Care General Waste (HCGW)
- HCRW (including radioactive waste)
- Health Care General and Health Care Risk Liquid Waste.

- **Health Care General Waste**

HCGW is the non-hazardous component of HCW that includes many substances similar to domestic waste but could also include certain non-infectious and non-hazardous liquids. HCGW is generated, *inter alia,* during the administrative and housekeeping functions of healthcare facilities and by patients and visitors. HCGW primarily consists of:

- Packaging materials: e.g. cardboard boxes, plastic bags, etc.
- Kitchen waste: e.g. organic waste and packaging materials.
- Office wastes: mostly paper, etc.
- Other solid wastes generated from patient wards: similar to household waste.
- Non-infectious animal bedding: e.g. from veterinary facilities.
- Garden and park waste: e.g. organic waste from gardening activities.
- Construction and demolition waste: e.g. from construction and renovation activities.

- **Health Care Risk Waste**

HCRW represents the hazardous component of HCW generated at both large and small healthcare facilities. HCRW has the potential for creating several environmental, health and safety risks, depending on the particular type of HCRW that is handled and how exposure takes place.

The 2015 HCRW Feasibility Study undertaken on behalf of Pikitup [22] estimated that the annual HCRW mass generated in Gauteng was approximately 11 850 tonnes. The consultant's estimated range for the CoJ itself, based on relative population size and relative economic activity within the province, is between 4 800 to 6 000 tonnes per annum. (Note that these tonnages could be expected in 'normal' circumstances; it is likely that HCRW generation can be considerably higher due to the COVID-19 pandemic.)

HCRW collection and treatment is a very competitive activity. Therefore, it is mostly managed by the private sector within the metro.

6.1.6 Hazardous Waste and E-waste Management

Hazardous waste entering a landfill site typically includes the following:

- Fire extinguishers
- Gas cylinders
- Ink and toner cartridges
- Paint
- Pesticides, varnish, inks and other chemicals
- WEEE (fluorescent tubes, low energy light bulbs and other light bulbs)
- Mineral oil (motor/machine oil)
- Automotive batteries (i.e. car batteries)
- Non-automotive batteries (i.e. torch batteries, renewable energy batteries, etc.)

E-waste refers to all electric and electronic waste, such as kitchen appliances, electric tools, computers, TVs, computer monitors, printers, scanners, keyboards, mice, cables, circuit boards, lamps, clocks, flashlights, calculators, phones, etc.

Formalised recycling of E-waste is (i) providing access to various precious and semi-precious metals used during the manufacturing of electric and electronic goods and (ii) creating a vast number of formal job opportunities. Informal recycling is, however, to be discouraged due to the informal sector being known for it not disassembling E-waste but rather burning it for the remaining metals to become easily accessible.

6.1.7 Other waste types

Other prominent waste types generated in the CoJ that may not have large volumes generated, but that require special attention due to the problematic nature of such waste streams are:

- **Waste Tyres**
- **Abattoir waste**
- **Sewage sludge**

6.1.8 General Waste Disposal

Landfill Locations

Despite previous attempts made to develop a new landfill at the Northern Sewage Works for waste generated in the northern parts of CoJ, such attempts were unsuccessful, with Pikitup still disposing of its waste at its four remaining landfills i.e. Goudkoppies, Marie Louise, Ennerdale and Robinson Deep. These landfills are not only all situated towards the south of Johannesburg, but they are all close to capacity and will have to be closed in less than 5 years.

In addition to its own landfills in the south, there are two privately owned landfills, i.e. Chloorkop towards the east (with limited remaining airspace), and Mooiplaats towards the north. Where available, such private landfills are used to alleviate some of the airspace shortages. Limited competition in the market is, however, negatively impacting landfill disposal fees charged at a cost per tonne basis by the private landfill owners – despite privately owned landfills used by Pikitup being appointed through an open tender process. Although the privately owned Genesis landfill is also located within the CoJ's area of jurisdiction, its proximity to Pikitup's Robinson Deep landfill does not warrant its use by Pikitup.

The locations of Pikitup's landfills are shown in the figure below.

Figure 6-2: Remaining Pikitup landfills are mostly situated towards the south of the CBD.

1 Ennerdale Landfill
2 Goudkoppies Landfill
3 Marie Louise Landfill
4 Robinson Deep Landfill

- **Weighbridge Tonnages**

  Monthly tonnages for the 2020/21 financial year, as recorded at the Pikitup landfill weighbridges, are shown in the table below [18].

Table 6-1: Waste disposal tonnages at Pikitup landfill sites

Waste disposal tonnages at Pikitup landfills 2020/21					
Month	Ennerdale	Goud-koppies	Marie Louise	Robinson Deep	**All Sites**
Jul-20	14,934 t	61,593 t	29,766 t	41,520 t	**147,813 t**
Aug-20	14,247 t	37,666 t	27,636 t	35,030 t	**114,579 t**
Sep-20	13,011 t	35,552 t	37,089 t	51,333 t	**136,985 t**
Oct-20	17,758 t	33,922 t	28,252 t	48,349 t	**128,281 t**
Nov-20	15,249 t	41,954 t	26,345 t	33,459 t	**117,007 t**
Dec-20	13,389 t	44,432 t	35,988 t	43,841 t	**137,650 t**
Jan-21	11,195 t	47,295 t	29,592 t	37,731 t	**125,813 t**
Feb-21	14,339 t	38,158 t	32,753 t	32,928 t	**118,178 t**
Mar-21	14,175 t	32,795 t	46,802 t	42,441 t	**136,213 t**
Apr-21	8,805 t	30,918 t	24,320 t	41,294 t	**105,337 t**
Total- 9 months	128,297 t		294,223 t		
Total- 10 months		404,285 t		407,926 t	
Monthly averages 2020/21	**14,300 t**	**40,400 t**	**32,700 t**	**40,800 t**	**128,200 t**
Projected totals 2020/21	**172,000 t**	**485,000 t**	**392,000 t**	**490,000 t**	**1,539,000 t**

Note that weighbridge data for April 2021 was incomplete for two landfill sites; data for May and June 2021 were either unreliable or sites were closed (Goudkoppies and Marie Louise).

Historical waste disposal tonnages for the Pikitup landfill sites from 2015/16 have further been collated from various sources, including Pikitup Annual Reports/Integrated Annual Reports and previous work undertaken by Delta BEC on behalf of Pikitup. Historical waste disposal data is presented in Figure 6-9 below.

Note that the 2018/19 data (sourced from the Pikitup Integrated Annual Report 2018/19, p. 62) is most likely to be anomalous, chiefly due to the very low tonnages reported for Marie Louise and Robinson Deep landfills.

Notwithstanding the COVID-19 pandemic, which essentially had the effect of reducing economic activity and, therefore, waste disposal tonnages, the overall trend from 2015/16 to 2020/21 is upward.

The picture is quite different when looking at waste hauled and disposed of by Pikitup itself when compared based on the relevant disposal tonnages. The chart below reflects Pikitup's disposal tonnages at Pikitup landfill sites (individual and overall), its own landfills and private landfill sites.

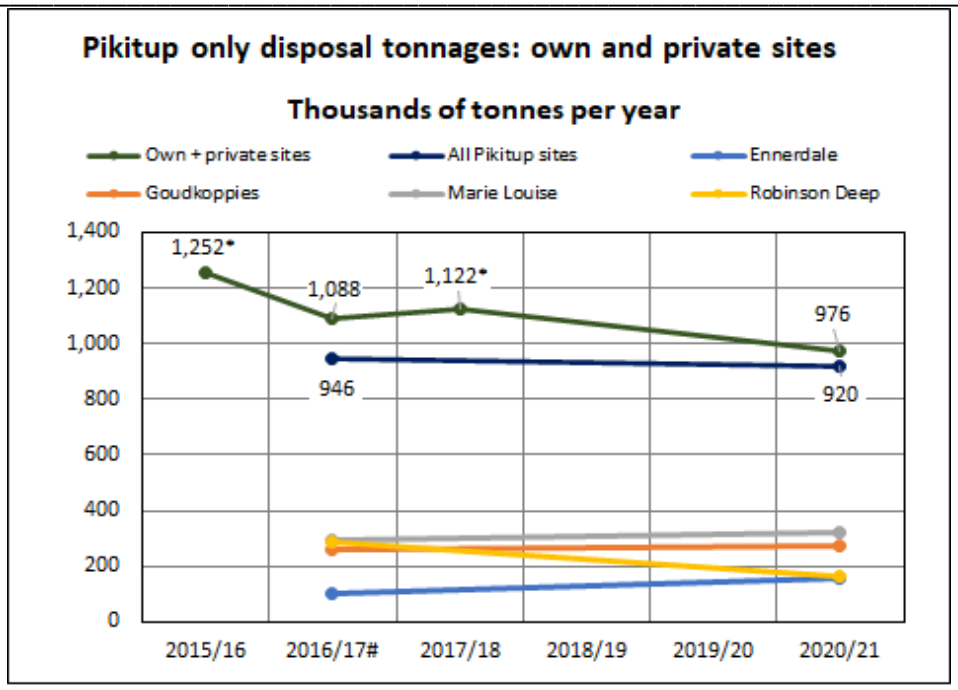


Figure 6-3: Only Pikitup's disposal tonnages

Unfortunately, relevant data for the 2018/19 and 2019/20 financial years could not be sourced from the available data; this may well indicate an (overall) steady or even rising trend from 2017/18 through 2019/20 and then a pandemic-related drop between 2019/20 and 2020/21.

- **Waste generation rates based on population**

The last comprehensive population census for which results were available at the time of the study was conducted by Statistics South Africa (StatsSA) in 2011. In that year, the population of Johannesburg was estimated to be 4.07 million. The 2016 Community Survey gave an estimate of 4.9 million for that year. Assuming a similar growth rate to the 2011-2016 period (3.8% p.a.), the 2020 population was estimated to be approximately 5.7 million.

Using the 2011 StatsSA survey on annual household income, it was possible to determine the approximate number of individuals in each income band. Having reference to various previous studies on annual per-capita domestic waste generation rates, it was then possible to hypothesise a reasonable domestic waste generation vs. household income relationship and, from this, to produce estimates for the theoretical total annual domestic waste generation rate in the CoJ.

Based on the above, the theoretical domestic waste generation tonnages for 2011 and 2020 were 700 000 tonnes and 970 000 tonnes, respectively.

- **Waste mass balance for the City of Johannesburg**

The number of variables involved renders it extremely difficult to undertake an overall waste mass balance for the CoJ. It is, however, possible to attempt a mass balance for domestic waste only since a theoretical domestic waste generation tonnage can be determined, as indicated above.

The difficulty is then to isolate domestic waste tonnages being disposed of at the various Pikitup landfills and domestic waste tonnages hauled by Pikitup to private landfills for disposal.

The assumptions that have been made in the computation below are:

- All waste categorised as 'RCR' and 'Compacted waste' at Pikitup landfills is assumed to be domestic waste
- All waste categorised as 'uncompacted waste' is assumed to be domestic waste.
- 33% of all 'After-hours' waste arriving at Pikitup landfills is assumed to be domestic waste (the other 67% is assumed to be garden waste hauled from Pikitup garden sites, especially over weekends, and other wastes).
- All 'Street cleaning' waste arriving at Pikitup landfills is assumed to be domestic waste.
- 10% of all 'Illegal dumping waste' arriving at Pikitup landfills is by mass assumed to be domestic waste (the balance of 90% is predominantly C&D waste and soil).
- All waste hauled by Pikitup to private landfills for disposal is assumed to be domestic waste.

The table below gives the associated tonnages:

Table 6-2: Estimated overall domestic waste disposal tonnages

Estimated overall domestic waste disposal tonnage 2020/21		
Waste category	**Annual tonnage**	*Notes*
RCR + Compacted waste	599,000t	*Annualised on basis of first nine months of 2020/21*
Uncompacted waste	477,000t	
Street Cleaning	19,000t	
Illegal dumping waste x 10%	18,000t	
Private landfills	42,500t	*Data provided by Pikitup*
Total 'domestic' waste	**1,155,500t**	

Although the total estimated annual tonnage of 1 155 500 is approximately 19% higher than the theoretical domestic waste generation tonnage of around 970 000 for the CoJ, this margin of difference is considered acceptable.

- **Remaining Airspace and Remaining Life of Pikitup Landfills**

The remaining life of landfills is determined by the remaining airspace (disposal capacity) available on each landfill, which is, in turn, determined by the current shape and size of the waste body as compared to the final landform that is to be achieved at the time the landfills reach full capacity. The latter is, in turn, amongst others, determined by the final height of the landfill, as well as the shape (including steepness of side slopes) of the waste body.

The compaction density of the waste is also a primary consideration in determining the mass of the waste that can be disposed of within the remaining airspace, in turn, determining the expected remaining life of the landfill.

For each of the four Pikitup landfills under investigation, two options were considered during the development of the final landforms for determination of the remaining airspace and, subsequently, the remaining life of each of the landfills:

Option 1: Landfill closure license applications submitted to the regulating authorities (GDARDE/DWS) for all Pikitup landfills, with a view to (after licensing) commence with operation-to-closure[5] of the respective landfills.

Option 2: Landfill operations at all Pikitup's landfills continue until the respective landfills reach their licensed heights based on 1:3 side slopes or until the upper surface of the landfill becomes too small for safe landfill operations (whatever occurs first).

The following assumptions were made to calculate the remaining airspace and expected life of the landfill sites:

- Compacted density of waste is assumed to be 800 kg/m^3 (i.e., 0.8 tonnes/m^3) on average.
- Imported additional cover material required for final rehabilitation and capping of the landfills is assumed to consume 10% of the available remaining airspace.
- The above allowances, taken together, result in an airspace consumption value of 1 / (0.9 x 0.8) = 1.39 m^3 airspace/tonne of waste
- Monthly waste disposal tonnages are based on reliable data for the past 7 years.

Table 6-8 below shows the overall remaining available airspace and estimated life for each of the landfills, and overall, over a range of possible annual waste disposal tonnages.

[5] With Pikitup's landfills not complying with *GNR 636 National Norms and Standards for Disposal of Waste to Landfill* and based on formal communication with representatives from the DWS, Option 1 is the only legally compliant option.

Table 6-3: Overall remaining available airspace

Pikitup landfills: remaining life estimates as at 22 July 2022							
Site	**Airspace July 2022**	**At average waste disposal rate 2015/16 to 2021/22***		**At 75% of average waste disposal rate 2015/16 to 2021/22***		**At 50% of average waste disposal rate 2015/16 to 2021/22***	
		Annual tonnage	**Expected life**	**Annual tonnage**	**Expected life**	**Annual tonnage**	**Expected life**
ED option 2 (ii)	72,000t	130,000t	0.4 yrs	97,500t	0.5 yrs	65,000t	0.8 yrs
GK option 1	18,800t	350,000t	0.0 yrs	262,500t	0.1 yrs	175,000t	0.1 yrs
GK option 2	3,891,200t	350,000t	8.0 yrs	262,500t	10.7 yrs	175,000t	16.0 yrs
ML option 1	22,000t	370,000t	0.0 yrs	277,500t	0.1 yrs	185,000t	0.1 yrs
ML option 2	1,053,900t	370,000t	2.0 yrs	277,500t	2.7 yrs	185,000t	4.1 yrs
RD option 1	70,900t	530,000t	0.1 yrs	397,500t	0.1 yrs	265,000t	0.2 yrs
RD option 2	2,920,200t	530,000t	4.0 yrs	397,500t	5.3 yrs	265,000t	7.9 yrs
Overall option 1	**111,800t**	**1,380,000t**	**0.1 yrs**	**1,035,000t**	**0.1 yrs**	**690,000t**	**0.1 yrs**
Overall option 2	**7,937,300t**	**1,380,000t**	**4.1 yrs**	**1,035,000t**	**5.5 yrs**	**690,000t**	**8.3 yrs**

Note: Airspace consumption rate assumed to be 1.39 x waste tonnage disposal rate
* Excluding years with unreliable / incomplete data
Option 1 = 'Operate to closure'
Option 2 = 'Operate to licensed height'

As far as the remaining airspace and life of Pikitup landfills are concerned, the following is, therefore, to be noted:

It can thus be concluded that the closure of all Pikitup landfills will be within the five-year time horizons as presented in Figure 6.11 below:

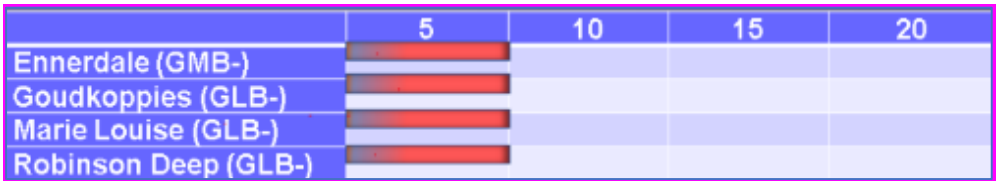


Figure 6-4: City of Johannesburg landfills projected to have an estimated remaining life of less than the maximum 5-year time horizon presented, depending on the waste diversion and disposal strategy selected.

6.1.9 Impact of Waste Transport Distances

As reported in the latest published versions of the CoJ's Integrated Waste Management Plan (IWMP), the closure of Pikitup's landfills inevitably result in longer transport distances to remaining landfills. To address this problem, Pikitup, at the time when the IWMP was compiled, entered into an agreement with the owners of the Chloorkop landfill to make use of their private landfill.

With fleet operation costs having made up around 28% of total operational costs in 2011, it is evident that transport costs are making a substantial contribution towards the overall cost of waste management in the CoJ.

Increased transport distances not only have a significant impact on transport costs but will also have a detrimental effect on waste collection efficiencies. **A sensitivity analysis[6] undertaken in 2020 on transport distance versus transport costs** [18] indicated that transport costs can be expected to double over the first 35 km (from R200/tonne for round collection only to R450/tonne for collection and transport over a distance of 40 km). The analysis further demonstrated that waste collection and transport costs increased drastically for transport distances in excess of approximately 40 km. Impact of Waste Diversion from Landfill

Pikitup's own projections for waste flows/tonnages from 2015 through 2040 are set out under 'Household Waste Generation' in the document *"RRLP (Resource Recovery and Logistics Plan) 2016".* These projections consider **expected growth** in waste generation, and also **expected diversion** of waste from landfill through (i) **recycling and recovery** and (ii) **waste-to-energy** (WtE) initiatives. The projections are depicted graphically in the chart presented in Figure 6-13 below.

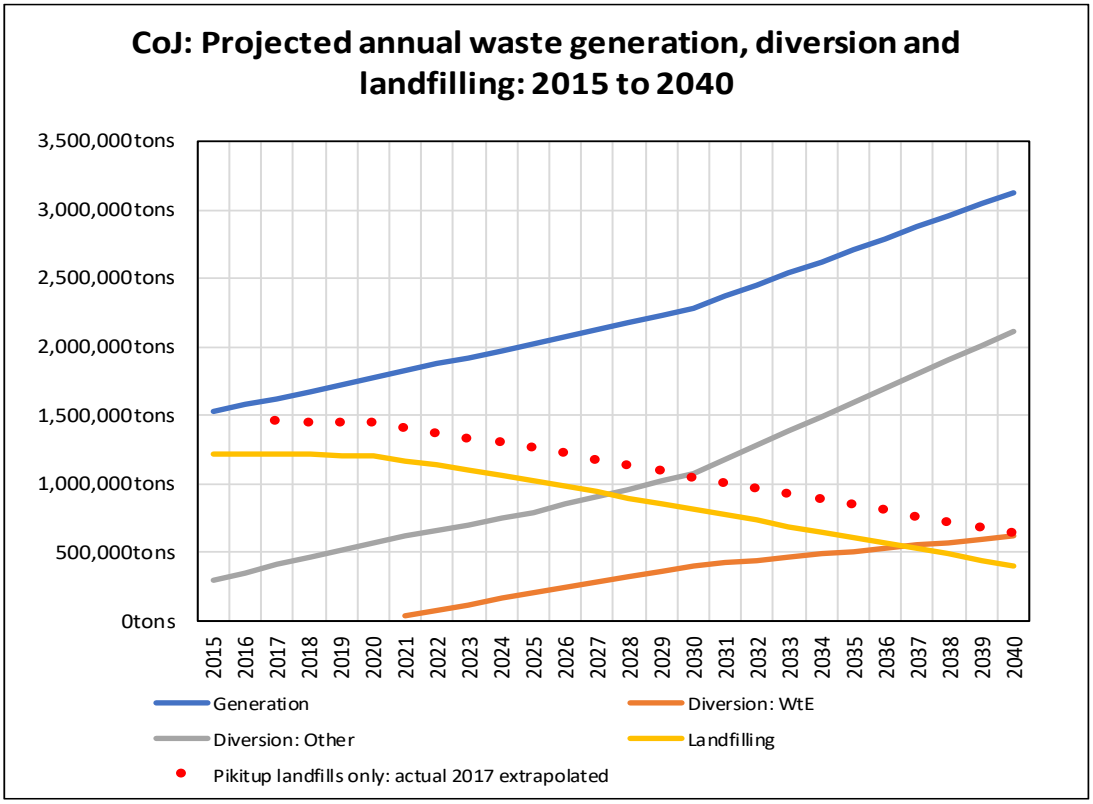


Figure 6-5: Pikitup's projections for waste flows/tonnages from 2015 through 2040

The above chart, based on Pikitup's information, indicates that after diversion through recycling and WtE, the total waste disposal to landfill of approximately 1 200 000 tonnes in 2016/17, which is slightly above the 1 090 000 tonnes actually hauled and disposed of by Pikitup in the same year, but well below the 1 900 000 tonnes estimated above for total waste

[6] It is to be appreciated that the analysis is not exact and will be influenced by a number of local conditions. The results are, however, presenting certain trends.

from the CoJ area that is landfilled. The tonnage of waste disposed at Pikitup landfills was then used as a 'reference value' in determining the required landfill capacity.

Assuming that CoJ's envisaged waste diversion program is successful (through recycling and incineration), the tonnage will decline on a similar trajectory to that indicated on the chart above (see series indicated by red dots on the chart), **it suggests that disposal tonnage at Pikitup landfills could drop to ~630 000 tonnes per annum in 2040**. The **average deposition rate over the 2017 through 2040 period would in that instance be in the order of 1 090 000 tonnes per annum**. Assuming further that this waste is **landfilled at three Pikitup sites,** it implies that each site will need to accept ~363 000 tonnes per annum or ~30 000 tonnes per month on average over the period 2017 through 2040. **This, in turn, equates to 9 million tonnes over a 25-year landfill life.**

By assuming an average compaction density of 1 000 kg/m^3 and allowing for a 1:6 cover-to-waste ratio as required by Minimum Requirements, the 'reference' landfill airspace required over the next 25 years is, therefore, 10.5 million m^3 (gross). It goes without saying that a landfill of double the capacity (say 21 million m^3) will either have an expected life of 50 years or will allow for the disposal of 50% of the waste disposed at Pikitup's landfills.

6.1.10 Impact of Waste Pickers and the Informal Waste Sector

For waste picker integration models to be sustainable, they should form part of the integrated waste value chain. The most important stakeholders in an integration process are individual waste pickers, as well as representatives from waste picker organisations. Other stakeholders involved in the value chain *inter alia* include national, provincial, and local government, waste management service providers, as well as stakeholders at various levels within the packaging and recycling industries.

- **Infrastructure**

The extent and condition of recycling infrastructure, e.g. buyback centres and material recovery facilities (MRFs), vary throughout the CoJ. This is mostly influenced by ownership, as well as available sources of funding/income streams.

Buyback centres are often operated by Small, Medium and Micro Enterprises (SMMEs) – with or without access to external funding like grants. The level of sophistication and standards to which facilities are equipped to vary from the essential items (some form of a scale and temporary storage facility) to permanent structures equipped with sophisticated scales, bulking facilities (like balers) and covered waste storage facilities. The volume of material accumulated and stored on-site, the form in which it is stored, and the frequency/how it is transported from the buyback centre will, in turn, be dependent on the throughput of the facility, the size of land available and the funds available for investment in infrastructure.

Like buyback centres, the level of sophistication and infrastructure required for MRFs also varies significantly – depending on the types and volumes of material sorted, as well as the sorting system used (manual or mechanical).

Experience with previous state-of-the-art MRFs erected and operated in Gauteng demonstrated that such facilities will only be financially viable if source-separated material is processed (clean MRF). Dirty MRFs, where mixed waste is sorted, tend to remain in business only where external financial support in the form of subsidies is available. The income generated from the sale of sorted recyclable materials is not sufficient for such facilities to be financially viable.

It is evident that recycling infrastructure requirements will not only depend on the waste throughput, or the available funding, but will also depend on the state of the feedstock supplied to the facility. Subsequent to sorting, various options are available for bulking (e.g., baling) and storage facilities. This will, in turn, impact the size and the type of vehicles required to transport bulked recyclable materials between the MRFs and the recyclable material processing industries.

- **Recyclable Waste Sources**

The objective in addressing the key principles underpinning waste picker integration should ultimately be aimed at capturing as much recyclable material as possible in a safe, healthy, cost-effective, and environmentally sound manner – forming part of an integrated recycling system. Evaluating the four primary sources of recyclable materials showing potential for intervention, as identified for the CoJ, will provide clear guidance on where the focus areas should be during the development of a long-term strategy.

The four main sources of recyclable material identified for future intervention by waste pickers in Johannesburg are:

- **Recyclable materials collected from landfills by waste pickers.**
- **Recyclable materials from <u>unsecured</u> residential, commercial, and industrial areas**
- **Recyclable materials from <u>secured</u> residential, commercial, and industrial areas**
- **Recyclable materials sold to generate an income**

The current situation is as follows:

- Households/businesses/industries generating waste would separate recyclable material into various categories as a means of adding more value before it is sold to buyback centres.
- Waste pickers would also sort their landfill/street collected recyclable materials into various categories before selling them to buyback centres.
- The uneven spread of buyback centres, together with differences in prices paid by different buyback centres, is resulting in sorted recyclable materials having to be transported over long distances.
- Waste pickers sorting mixed recyclable materials into various categories are often causing nuisances like windblown litter, soil-, water- and air pollution, particularly where non-recyclable/low value recyclable waste is dumped or burnt illegally.
- Buyback centres pay waste generators/waste pickers cash for sorted recyclable materials delivered to them before the material is bulked and sold to MRFs, or in the

case of large buyback centres, sufficient volumes are collected to allow for bulking and direct selling to recycling industries.

6.1.11 Impact of Illegal Waste Dumping

Illegal dumping of waste is not only a problem for the CoJ, but for most municipalities throughout South Africa [18]. Although there are different underlying reasons for illegal dumping in different parts of the city, with different impact levels, the implications are, in broad terms, the same – pollution of the environment with significant additional resources required for the collection, transport and disposal of waste illegally dumped.

What is important to note is that unless the underlying reason for the illegal dumping is addressed in any area, the problem cannot be resolved through legal means only. Some of the reasons why there is illegal dumping includes:

- **Unavailability or inaccessibility of municipal waste transfer/disposal facilities**

Due to the limitation on the volume or type of waste to be collected as part of RCR, residents sometimes find themselves in situations where they need to discard of excess waste or waste is not suitable for collection and transport by means of waste compactor trucks. With the cost of having such small volumes of waste collected by third parties being high, this inevitably results in residents having to make their own arrangements for the disposal of such waste.

In many instances, waste disposal facilities provided by the municipality do, however, not meet the need. Not all residents have access to vehicles suitable to transport waste over long distances, resulting in the 'distance over which a wheelbarrow can be pushed' becoming the yardstick in determining the accessibility of bulk waste containers/disposal facilities. Added to this is the incorrect assumption that people transporting waste by wheelbarrow, or children carrying waste to the bulk containers, will make a significant effort to dispose of the waste into containers with sides as high as 1.5-m above ground level. Despite the availability of bulk containers (skips), waste is, in such instances, often disposed of adjacent to the empty skips. Where skips are not regularly serviced and subsequently overfilled, it will inevitably result in waste being disposed of adjacent to the full skips.

Residents from medium to high income areas may, in turn, have access to transport, but may find the disposal facilities to be at excessively long travelling distances, or to be inaccessible from a logistical or safety perspective

For the reasons provided above, it can be expected that the volumes of waste disposed of illegally will be relatively large. Illegal dumping is, however, not only resulting in pollution to the environment, but it can also have health impacts, for instance, where the waste disposed of may attract/result in the breeding of flies and rodents.

- **Closure of local landfills disrupting access to recyclable materials**

With thousands of waste pickers earning a living from the waste reclaimed on operational landfills, there is a tendency for the closure of landfills not only to result in limited ad hoc or arranged illegal dumping in the area as described earlier but also tends to lead to the establishment of informal landfills. Although informal landfills are initially established to

provide waste pickers (no longer working on landfills) with a source of recyclable materials, it ultimately leads to disposal charges being asked for commercial waste transporters to dispose of their waste. With the disposal fees at informal landfills being lower than that of formal, legally compliant landfills, it tends to attract waste from the public and some small commercial waste transporting companies.

Considering the significant impact that illegal landfills have on the surrounding communities, it is important that proactive steps be taken to prevent the development of such landfills where existing landfills are due to close - rather than trying to address the matter after the informal landfill was established.

6.2 CITY OF TSHWANE

6.2.1 Overview

The City of Tshwane Metropolitan Municipality was established on 5 December 2000, and when it was founded, it was made up of 13 former city and town councils and managed by means of an executive mayoral system [24]. The incorporation of the Metsweding District Municipality in 2011 added a significant amount of rural and semi-urban areas to Tshwane’s eastern boundary, which consequently also increased the waste management services required. The City of Tshwane Metropolitan Municipality's land area increased from 2 198 km^2 in 2010 to 6 368 km^2. The city, therefore, also includes the former towns of Bronkhorstspruit, Cullinan and Rayton (Figure 6-6). The addition of these urban centres also meant that a range of waste management services was required, and the extent and area of waste services increased significantly.

A regional service delivery model has been adopted by the City of Tshwane, and the seven regions include (Figure 6-6):

- Region 1: Mabopane and Akasia,
- Region 2: Hammanskraal and Temba
- Region 3: Atteridgeville, Moot and CBD
- Region 4: Centurion and Olievenhoutbosch
- Region 5: Cullinan and Rayton
- Region 6: Menlyn, Pretoria East and Mamelodi
- Region 7: Bronkhorstspruit.

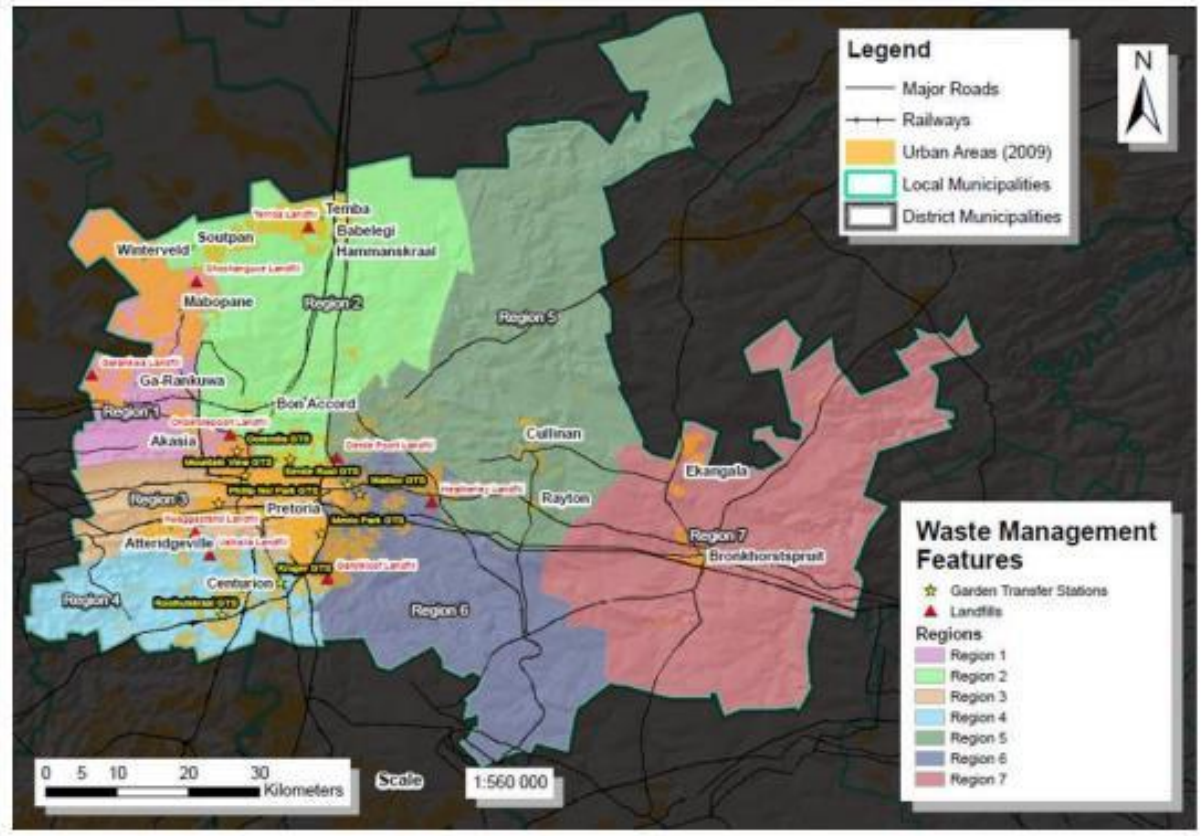


Figure 6-6: Administrative Regions of the City of Tshwane.

6.2.2 Waste Categories Generated

The waste generated in the CoT can be divided into the following categories:

- Domestic waste (household waste)
- Industrial and commercial waste (business waste)
- Construction and demolition waste (building rubble)
- Hazardous waste (including oxides, oils, fluorescent tubes, paints)
- Garden waste
- Agricultural waste
- E-Waste
- Grit, Screenings & Wastewater Sludge
- Abattoir Waste
- Health Care Risk Waste (HCRW)

6.2.3 Waste Management Services

The functional responsibility for solid waste management lies within the Waste Management Services Division of the Environment and Agriculture Management Services Department. Municipal waste management includes the following key areas of performance:

- Collection and transportation to disposal sites
    a. Daily (business); and
    b. Weekly (households)

    c. Bulk collection and transportation of waste to disposal facilities for a skip for medium volume generators (ad hoc and regular services)
- Waste disposal sites (landfill) management
- Waste minimisation and recycling
- Public cleansing
    a. litter picking
    b. clearing of illegal dumping
- Regulation and by-law enforcement, community liaison, education and awareness
- Corporate (planning and strategic) management, including information management.

From the information presented in the CoT Integrated Waste Management Plan (IWMP 2019), the extent of poor capacity in the City's waste management function is reflected in its poor performance as compared to the National Domestic Waste Collection Standards.

The City of Tshwane has, developed into a very large and dispersed metropolis featuring numerous challenging characteristics that include low-density sprawl, fragmentation, and separation of functions and land uses. These all have a direct bearing on waste management services due to the vastness of the metropolitan area, which, in turn, has an impact on the time needed to deliver services and on travelling time/costs. Land use is fragmented, which means that the consumer distribution is spread across CoT with a continuous demand for services due to population growth and urbanisation - placing pressure on waste services, including budget, staff and waste collection fleet.

Waste is generally collected several days a week, from Monday to Friday and, in some areas, Monday to Saturday. As shown in **Error! Reference source not found.**, majority of households in the CoT have their waste removed by the local authority or private contractor at least once a week (80.66%), all of which goes to one of the four operational municipal landfills in CoT, *i.e. no household waste goes to any private waste disposal facility in CoT*.

Removal of waste by local or private companies has increased from 1996 to 2011 as per the 2019 IWMP. Refuse removal to communal or municipal landfills has increased throughout the years and is higher than in the rest of Gauteng. There has also been an increase in households that do not have access to refuse removal.

A current problem is the lack of information on the number of service points (customers) being serviced. This creates a need to verify the number of households currently receiving waste management services, including the number of bins each household uses. Such verification should also include the details (such as land use and typology) of households or areas that currently receive services from private service providers who are not contracted to the City of Tshwane. The aforesaid data will make it possible for the City to (i) improve its billing, (ii) plan for future capacity, and (iii) enable the CoT to provide more accurate information on the scope of work where waste collection services are to be outsourced.

Nevertheless, the Census 2011 data indicates that the CoT is servicing 911 536 points, which are spread across all wards with various land uses and residential types. The majority of service points, at 711 940, are considered to be formal residential.

6.3 Diversion of Waste from Landfill

In its IDP, the CoT sets itself an ambitious target of diverting 50% of the waste it was dumping at landfill sites through avoidance, recycling and reuse. The diminishing capacity of landfills and the depletion of natural resources, together with the environmental impact of waste, have prompted the need to reduce the amount of waste disposed of at landfill sites. Waste reduction, reuse and recycling are firmly entrenched in South African legislation such as the NEM:WA. Municipalities are to align their integrated waste management plans with the goals and objectives of the Act, meeting new national waste regulatory requirements, reducing waste transportation costs, providing meaningful employment, effectively diverting waste from landfill sites, and enhancing the beneficiation of waste.

With waste recycling initiatives taking place in the CoT, it is important to design recycling activities around regional, social, economic and environmental issues to foster ownership of the integrated planning and objectives of the municipality among residents. Regional objectives based on the issues identified will facilitate the identification of options and the development of strategies. Awareness and education programmes are further essential to the success of recycling efforts and require buy-ins from all sectors of the economy, community and age groups. Materials recovery facilities must become key waste management facilities that will support the diversion of waste from landfill sites.

In 2014, the CoT passed a resolution for the alienation of a site on the buffer zone of the Kwaggasrand landfill site in Atteridgeville, where a multipurpose recycling facility was subsequently developed. The facility was to service Regions 3 and 4, approximately 300 000 households, and was made up of the following three components:

- An MRF where sorted at source recyclable waste from a two-receptacle system was to be processed (with recyclables going into a plastic bag distributed free of charge by the CoT and non-recyclables going into the bin).
- A composting facility where green waste was to be shredded, chipped and turned into organic compost.
- A building rubble recycling facility where building rubble was to be crushed and turned into aggregate.

The above three waste streams make up approximately 65% of the waste that is disposed of in the City of Tshwane's landfill sites (GDARD).

The facility was to be supported by the CoT through the following measures:

- Implementing sorting of waste at source through a two-bag system.
- Conducting education and awareness directly to residents and to schools around the benefits of and the need to reuse, reduce and recycle waste.
- Changing the waste management by-laws to introduce mandatory sorting of waste at source for residents and businesses.
- Implementing a waste collection process that collects recyclable and non-recyclable waste separately.

- Ensuring that all recyclable waste is diverted to these facilities and that the proof of disposal of recyclable waste at these facilities is a requirement for a municipal contractor's invoice to be paid.
- Fast-tracking the development of additional multipurpose recycling facilities in partnership with the private sector.

Construction of the various components of the Kwaggasrand multipurpose recycling facility was completed in 2014/2015. When fully operational, it was expected that the facility was to create approximately 261 direct, new green jobs.

Due to various operational problems encountered, the facility is, however, no longer in operation.

The City was also working towards introducing a paper recycling programme in 100 government buildings and City properties in the 2014/15 financial year. Waste separation at source was also to be promoted in regions 3 and 4, targeting to get 200 000 households participating in the same financial year.

Furthermore, a memorandum of agreement was signed with the National Department of Environmental Affairs in April 2014 to facilitate the process of refurbishing the buy-back centres in Hammanskraal, Atteridgeville and Stinkwater and the construction of buy-back centres in Mamelodi and Ga-Rankuwa. The buy-back centres were to provide a local market for informal recyclers operating in the township areas and reduce the proportion of the recyclers' transport costs, making such activities economically viable. These centres were to accept and process recyclables to alleviate poverty through job creation, preserving natural resources by implementing the three R's – Reduce, Reuse and Recycle – and ensuring that communities live in a healthy and sustainable environment. Clear plastic bags were to be distributed to participating households for the implementation of the separation-at-source programme.

With the Kwaggasrand facility no longer in operation, the CoT's primary waste recovery is through informal picking from waste receptacles in residential, commercial, and industrial areas, as well as at the municipality's operational landfills. One of the concerns around informal waste picking taking place on waste disposal sites is that it not only poses a health and safety threat to the individuals working (and living) on and around the waste disposal sites, but it also has a negative impact on the environment due to the constraints subsequently placed on the landfill's operations. Where uncoordinated informal waste picking is taking place in residential, commercial and industrial areas, it also results in harsh working conditions, health impacts on waste pickers and environmental degradation through waste spillage and littering.

To create sustainable jobs, recover natural resources, limit the risk of pollution and save landfill airspace, there is a dire need for the CoT to formalise recycling and support private initiatives.

6.3.1 Organic Waste Treatment (Composting)

Garden waste streams were processed with industrial chippers and shredders at some CoT garden waste facilities (e.g. Kruger Ave) to generate compostable material for use on CoT

landfills that are closed and due to be rehabilitated. Composting operations can, however, also be established in *closed* landfills, with the product then used for land rehabilitation. Care should, however, be taken when establishing a composting operation on a *rehabilitated* landfill site, as it can damage the landfill capping and expose the waste beneath. Also, the watering of windrows on top of landfills will increase the generation of leachate inside the waste body.

The option further exists for CoT to enter into agreements with external partners to collect the compostable material. Several municipalities are encouraging the production of compost from organic waste streams at home. This will entail establishment of compost heaps in gardens for organic waste like grass, clippings, and leaf trimmings. This can effectively reduce the volume of waste to be collected by the municipality – subsequently also saving landfill airspace.

In the absence of operating weighbridges at the CoT garden waste facilities and landfills, it is not possible to obtain accurate information on the organic waste tonnages generated in the CoT.

6.3.2 Construction and Demolition Waste Processing

There are currently no construction and demolition waste (C&DW) processing facilities operated at any of the CoT landfill sites. Where C&DW is disposed of at landfills, such material is mainly used as daily cover material and for the construction of site roads.

The management of C&DW in Tshwane is controlled in terms of Chapter 5 of the Solid Waste By-law. Provisions include the following matters:

- Management of builder's rubble at the point of generation (household or business).
- Disposal at the Municipality's waste disposal sites is subject to the applicable tariff.
- Material from civil engineering construction and remediation sites requires special permission from the Municipality to dispose of the material at sites other than designated landfill sites.
- The Derdepoort landfill site was exclusively used for the disposal of building rubble and garden waste but is now closed. Building rubble was also accepted at Garstkloof landfill site, which is also closed.

The closure of the two landfill sites that received builders' rubble and garden waste resulted in such materials being diverted to operational general waste landfill sites, which unnecessarily diminishes landfill airspace. The by-law needs to be amended to require that C&DW be diverted from landfill sites to a crushing and recycling plant at the nearest multipurpose recycling facility.

The absence of functional weighbridges is once again not making it possible to obtain information on the C&DW tonnages generated and disposed of at the CoT landfills.

6.3.3 Health Care Waste Treatment & Disposal

Health care risk waste (HCRW) represents the hazardous component of health care waste (HCW) which has the potential to create several environmental, health and safety risks - depending on how it is managed, as well as the exposure that takes place. HCRW includes infectious wastes, sharps, pathological waste, chemical waste and radioactive waste. It is estimated that only 15% of all medical waste is HCRW, while the remaining 85% is Health Care Waste (HCW), which can typically be disposed of at a landfill site.

6.3.4 Hazardous Waste and E-waste Management

- **Electronic waste (e-waste)**

The status of e-waste in the CoT will need to be determined for integration into future versions of the IWMP. E-waste *inter alia* consists of computers, monitors, keyboards, radios, appliances, cell phones, etc.

In terms of the Waste Act, Waste Amendment Act, 2014, hazardous waste means "…organic or inorganic elements or compounds that may, owing to the inherent physical, chemical or toxicological characteristics of that waste, have a detrimental impact on health and the environment …". For the purpose of assigning waste quantities to the correct waste categories, it is therefore paramount that waste definitions contained in the revised IWMP are consistent with the meaning assigned to it in Schedule 3 of the Waste Act as amended.

6.3.5 Other waste types

These include the following:

- Waste Tyres
- Abattoir waste
- Sewage sludge

6.3.6 General Waste Disposal

According to the waste management hierarchy, landfilling of waste is the least desirable option because of the demands made on spatial resources, the need for aftercare in perpetuity, the loss of material resources involved, and the pollution caused by landfill sites. It is widely acknowledged that landfills are potential sources of contamination of soil and groundwater, even after the termination of landfilling activities.

National Environmental Management: Waste Act, 2008 (Act 59 of 2008) (NEM:WA) is therefore promoting waste minimisation, reuse and recycling, and reducing the amount of biodegradable waste to landfill (which causes methane emissions).

General Waste Minimisation Plan for Gauteng, (July 2009). The diversion from the landfill will assist to –

- Extend the life of the operating landfill sites
- Create formalised, green jobs
- Attract private sector investment of approximately R80 million to R100 million per facility into previously marginalised township areas

- Reduce pollution and environmental degradation
- Reduce the city's carbon footprint.

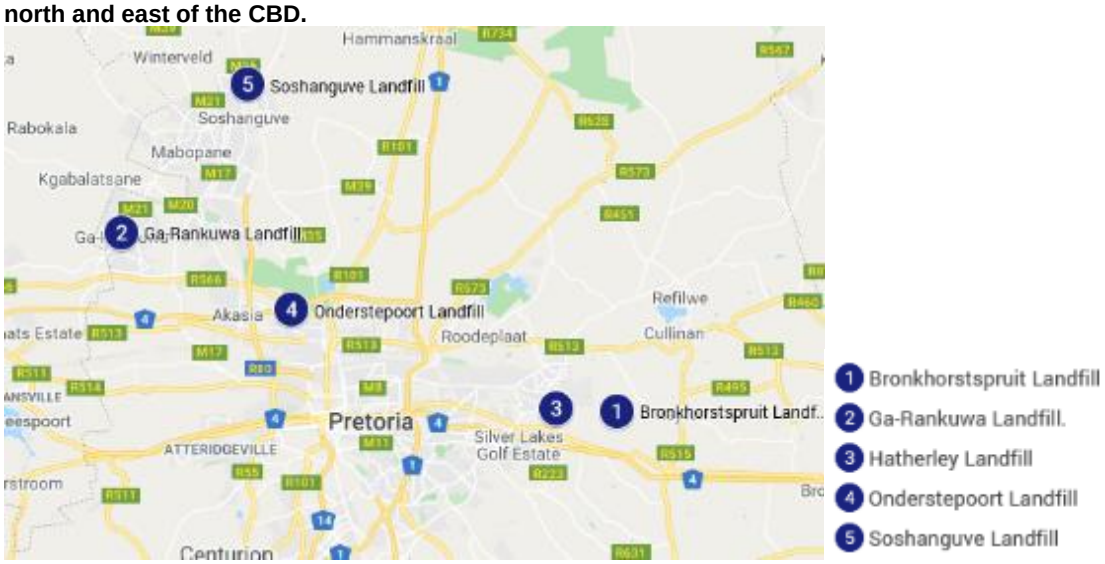
In the absence of effective waste diversion from landfills - with several existing landfills in CoT having reached capacity over the past decade and with no new landfills licensed and developed in CoT since 1998 - there is an urgent need for additional landfill airspace in the CoT. Details on the state of the CoT landfills, as presented during 2020, are indicated in the Table below.

Table 6-4: state of the CoT landfills

Name of landfill site	Location	Active/inactive	Remaining lifespan
Ga-rankuwa	Ga-Rankuwa	Active	8 - 9 years
Hatherley	Hatherley	Active	15 - 20 years
Bronkhorstspruit	Bronkhorstspruit	Active	9– 10 years
Soshanguve	Soshanguve	Active	7 - 8 years
Onderstepoort	Onderstepoort	Inactive	0 years
Kwaggasrand	Kwaggasrand	Inactive	0 years
Temba	Temba	Inactive	0 years
Garskloof	Garskloof	Inactive	0 year
Valhalla	Valhalla	Inactive	• 0 years • Under care and maintenance • Sinkhole management
Derdepoort	Derdepoort	Inactive	• 0 years • Under care and maintenance
Pretoria North (converted to Golf course)	Pretoria North (converted to Golf course)	Inactive	• 0 years • Under care and maintenance
Eersterust	Eersterust	Inactive	• 0 years • Under care and maintenance

The locations of CoT's remaining landfills are shown in Figure 6.11 below. Although the Onderstepoort landfill was in the recent past closed, its position is indicated on the map, illustrating the distortion on the geographical distribution of landfill locations in CoT that resulted from the closure of Onderstepoort.

Table 6-5: Existing CoT landfills available for use. The Onderstepoort landfill indicated on the map was, however, also closed in the recent past, resulting in the remaining landfills being positioned towards the north and east of the CBD.



The technical assessment report compiled by the Business Enterprises, University of Pretoria, in 2016, highlights that the remaining life in the City of Tshwane landfills is centred in the Hatherley landfill situated towards the east of the CBD. According to the findings of this report, transporting waste from the remainder of the city over long distances will not only result in significantly increased transport costs but will also result in significantly reduced production during waste collection – all resulting in the City of Tshwane's waste collection service becoming more expensive.

Despite limited data on waste generation rates in CoT in the absence of operational weighbridges, the information presented in the Alternative Waste Treatment Technology (AWTT) study report [25] in 2016 indicated a constant rise in the waste generation rates. The landfill that was at the time accepting the bulk of the CoT's waste, i.e. Onderstepoort, was subsequently also closed. With no private landfills being used by CoT for disposal of its municipal waste, closure of the Onderstepoort landfill resulted in all waste previously disposed of on the landfill having to be diverted to the remaining municipal landfills. This is not only resulting in increased transport distances, resulting in increased costs and reduced production, but it is also resulting in a 'domino effect', as the remaining landfills can be expected to reach capacity sooner than initially anticipated.

Landfill Overview

The sections that follow attempt to provide the status quo of the landfills that exist within the City of Tshwane municipality boundaries.

- **Onderstepoort landfill site**

The landfill site was established in 1997 and closed in May 2019. The site was classified as G:M:B- (general waste, 150< MRD (mean rate of deposition) <500 tonnes per day and, at the time of permitting, assumed to be non-leachate generating). None of the landfill cells complied: National Norms and Standards for disposal of waste to landfill, and the continued

operation of the landfill since 2016, when the 3-year window period for compliance came to an end, was therefore not authorised.

The total airspace volume of the site was 4 848 768 m^3. The estimated throughput at the site, according to Hill & Associates, was 1 487 tonnes per day in 2011, which exceeded the permitted MRD. Since the closure of the Kwaggasrand landfill site, the waste collection trucks operating in the south and west of CoT used to be diverted to the Onderstepoort landfill site, which aggravated the situation at the Onderstepoort landfill, which is approximately 25 km from the Kwaggasrand landfill site. The longer distance to had impacted negatively on the efficiency and cost of operations, resulting in service delivery disruptions.

The weighbridge was not functioning, and disposal types and rates were guesstimated at the office building on site. The Onderstepoort landfill is now subject to all the standard monitoring controls for closed landfills.

Initiatives to divert recyclable waste from Onderstepoort were to be implemented at an early stage to reduce the high consumption of landfill airspace. The next closest municipal-owned landfill sites to Onderstepoort are Soshanguve and Ga-Rankuwa. Both the Soshanguve and Ga-Rankuwa landfill sites are in residential areas, have minimal airspace, and are both not compliant with GNR 636.

- **Soshanguve landfill site**

This landfill site is classified as G:S:B– and accepts general waste with a rate of deposition of 25 < MRD < 150 tonnes per day. The landfill site is not fenced and started operations in 1990. It has remaining airspace of 14 years based on its current disposal rate and is currently still in operation.

There is no operational weighbridge on site, and the current throughput at the landfill site is estimated to be in the order of 7 454 m^3 per month (287 m^3 per day). The type of waste is registered according to a referencing system instituted by the City and based on historical loads.

The volumes of waste received at the Soshanguve landfill site in June 2009 were already exceeding the permit conditions. This contravention has been exacerbated by the closure of the Temba landfill site in December 2013 and the diversion of the waste disposed of there to the Soshanguve landfill site.

- **Ga-Rankuwa landfill site**

The landfill site was opened in 1995 and has a footprint of approximately 41.9 ha. The remaining site life is, according to the CoT, in the order of 8-9 years based on current waste disposal rates. The site is classified G:M:B-, which means that it accepts general waste with a rate of deposition of 150 < MDR < 500 tonnes per day, and it does not generate any leachate (based on assumptions made at the time of permitting).

The site has a total airspace volume of 2 786 400 m^3. There is a weighbridge that is not operational.

Salvaging of waste for recycling takes place on site and is not controlled. Waste is not covered daily, which poses an operational and environmental risk. Grey water is being used for dust suppression.

- **Temba landfill site**

The Temba landfill site was established in 1995 and has a footprint area of 3.7 ha with airspace volume of 121 033 $m^{3,}$ according to the 2011 study (Hill & Associates, 2011). The permit indicates that it was classified as G:S:B- (general waste, 25 < MRD <150 tonnes per day and, at the time of licensing, assumed to be non-leachate generating).

The Temba landfill site reached its capacity and was closed in December 2013.

- **Hatherley landfill site**

This site accepts garden refuse, builders' rubble and general waste. It was established in 1998 and has a footprint area of 96 ha. The site is classified as G:L:B- (general waste, MRD >500 tonnes per day and the assumption was made that it is not leachate generating). The disposal rate before the closure of Garstkloof landfill site was 793 tonnes per day, with the total airspace volume of the site at 20 834 369 m^3. There are currently two cells in operation, i.e. cells 1 and 2, which results in a vast part of the waste body being exposed to environmental elements. The landfill is further not in compliance with GNR 636 and is therefore not authorised to be used for waste disposal since the end of the window period for existing landfills to become compliant, which expired in 2016.

The Hatherley landfill site, licensed in 1998, is the CoT's 'newest' and largest landfill site. The landfill airspace is depleted at a high rate due to the closure of the Garstkloof landfill site and the Onderstepoort landfill site. The effective use of the remaining airspace on the landfill is, however, put at risk, together with a reduction in buffer zone widths, due to land invasion from various sides of the landfill [26].

Despite recommendations in the IWMP that the CoT should, due to Hatherley landfill's proximity to railway lines, establish a railway siding adjacent to the landfill in partnership with the private sector, there are various operational and financial considerations that are likely to prevent this option from being feasible. The recommendation for *non-recyclable waste from the Kwaggasrand landfill site and all waste from the Onderstepoort landfill site to be transported to the recycling facility and landfill at Hatherley by rail, thereby reducing the cost of transport and reducing the City's carbon footprint,* should **NOT** be reconsidered as the waste should be transported from the source to a nearest accessible landfill, and not via a closed landfill that may in any event not have been at a direct haul distance from the respective waste sources.

- **Bronkhorstspruit landfill site**

As with the other CoT disposal facilities, the weighbridge at the Bronkhorstspruit landfill is not working. The end-use plan for the Brickor Clay Mining quarry, located adjacent to the site, is for it to become an extension of the landfill site. This means that when the mine closes, there is an opportunity to extend the landfill onto this property. High clay content in the soil

means there is natural clay lining, which is suitable from a landfilling perspective. There are existing boreholes on site for monitoring.

The landfill is, once again, also not compliant with GNR 636 and is, therefore, not authorised to operate.

- **Kwaggasrand landfill site – general waste**

The Kwaggasrand landfill site reached its maximum capacity and had to be closed. The existing infrastructure on the site is old, non-functional and in bad condition. The City has embarked on a partnership with a private sector waste service provider for the establishment of a multipurpose waste recycling facility next to the Kwaggasrand landfill site. The facility will ensure a significant reduction of waste volumes disposed at landfill sites and is in line with the Tshwane Vision and Strategic Pillars.

Moreover, the City has not applied for and developed a new landfill site since 1998. Applying for, obtaining approval and developing a new landfill site are estimated to take close to seven years. In addition, the huge financial cost of such a process is considered rather prohibitive. Therefore, the option of developing a new landfill site will not resolve the CoT's short or medium-term challenge. The development of another landfill site will also require the CoT to demonstrate that it is actively reducing the amount of waste arriving at its existing landfill sites. Any new landfill site is likely to be further away from the source of waste. This will mean higher transportation costs with reduced productivity.

Although there are privately-owned landfills in Tshwane, the disposal costs are high, and that resulted in the CoT reportedly for financial not disposing of any of the municipal waste on private landfills. It is, however, uncertain whether such a decision was only based on the gate fee charged at the private landfills versus the perceived cost of disposal on CoT landfills or whether the significantly increased transport costs for disposal at the remaining CoT landfills, together with the replacement cost of landfill airspace consumed, was also taken into consideration when such strategic decisions are taken by the CoT.

- **Waste Tonnages**

In the absence of functional weighbridges at the CoT landfills, the waste generation rates are determined in a theoretical manner.

The volume of waste going to landfill is determined by the population density of the area that the landfill services. Various literature was reviewed to understand the demographics in line with the waste volume. For instance, in 2007, the City of Tshwane was reported as having a population of 2 345 908, consisting of 686 640 households (2007 Census). The population reported for 2010 is 2 480 191 (City of Tshwane).

The average quantity of waste disposed of at all landfills during this period reportedly amounted to 2 401 840 tons per annum. The per capita waste generation rate was 1.02 tonnes per person per annum. This is a typical waste generation rate for the United States, which is considered a high-consuming society. The CSIR reported that municipal waste generation per capita differs noticeably across income groups, with low-, middle- and high-

income groups, respectively, generating an average of 0.41, 0.74 and 1.29 kg per capita per day.

Using average waste generation rates for South African society as 0.8 kg per person per day equates to an annual waste generation rate for CoT of 685 000 tonnes per annum. This equates to a per capita contribution of 0.3 tonnes per capita per annum. The corresponding figure from Hill & Associates, July 2011 *Air Space Assessment Report* yielded a figure of 0.72 tonnes per capita per annum. The discrepancy in this varying per capita contribution may be due to the lack of functional weighbridges at the City of Tshwane's landfill sites, with the volumetric data recorded at the landfills being based on estimates based on the maximum axle load per truck.

According to the information taken from the City of Tshwane draft IDP 2018-2021, Tshwane has a population of just over 3.3 million residents. For administrative purposes and to enhance service delivery, CoT is divided into seven regions. Tshwane consists of 1 248 765 households as determined by the Community Survey 2016. This represents a 10.18% growth from 2011 to 2016. Figure 6.37 shows the distribution of the population within the different regions,

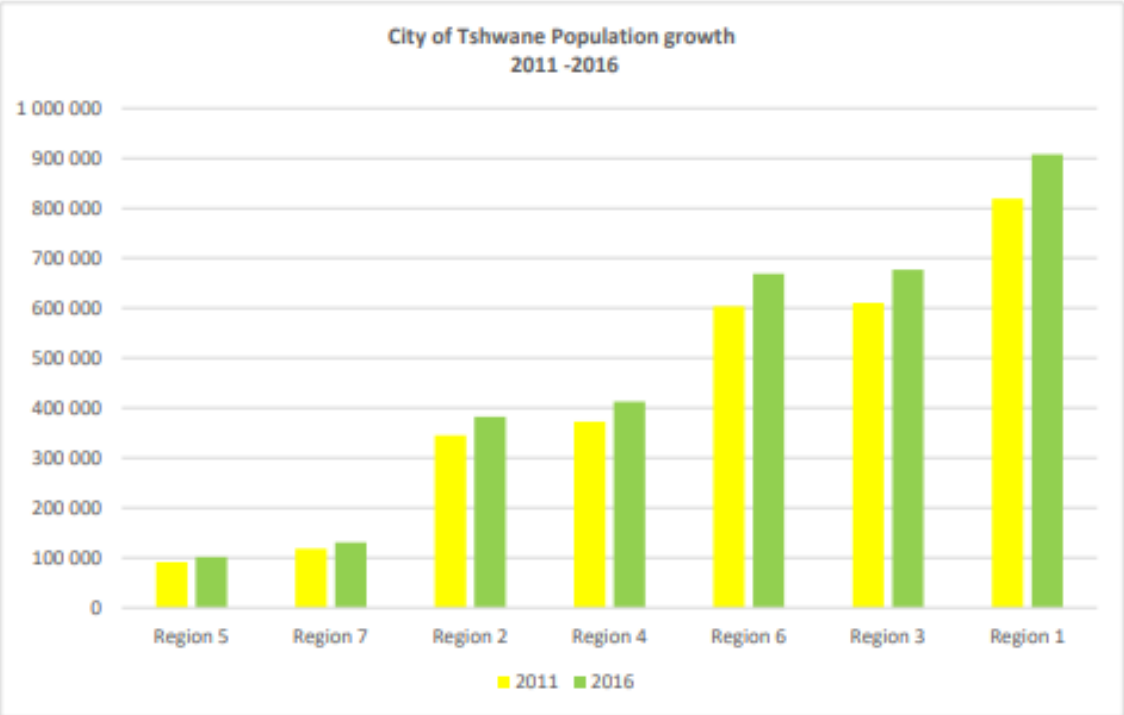


Figure 6-7: Population per region in CoT (2011-2016) ***Source: Stats SA & Community Survey***

The distribution of the current population, as well as the projected population per socio-economic level, influences the amount and type of waste generated. According to Census 2011 data, nearly 15% of households in the CoT have no source of income, and approximately 46% of households earn an annual income of less than R76 401. The average annual household income in the CoT is around R60 642, with 0.65% of households earning more than R457 600 per annum.

The population living in urban areas is 89.3%, with more than 75% of the population residing in formal housing. Approximately 84.6% benefit from formal refuse removal.

Waste arising from the densely populated southern areas of Region 1, western and central areas of Region 3, and eastern areas of Region 4 was disposed of at the Onderstepoort landfill, which was centrally located relative to these areas.

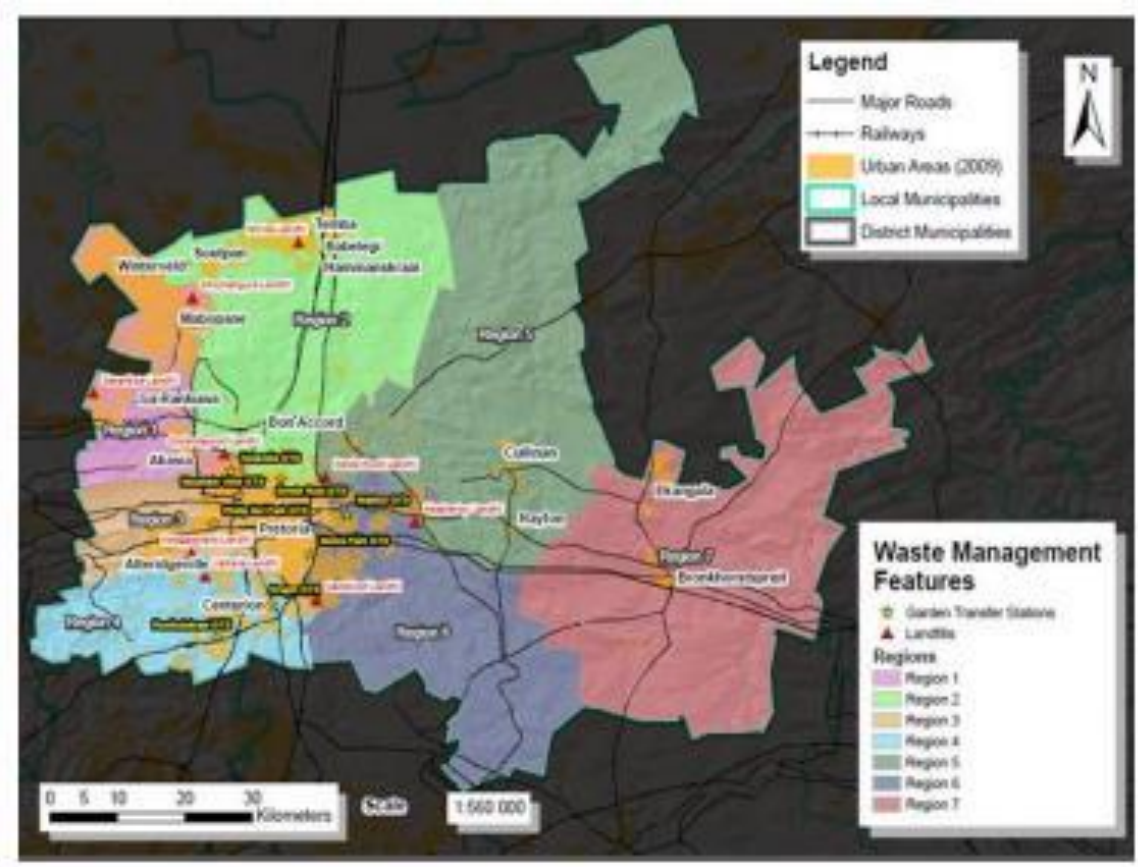


Figure 6-8: Waste disposal facilities in Tshwane

6.3.7 Waste transfer stations (WTS)

In Tshwane, several landfill sites have reached the end of their usable life and have thus been closed. These closures have left huge gaps in the management of solid waste. The waste collected in these areas is now being transported over long distances to alternative landfill sites. The high cost of these logistical issues impacts negatively on operational budgets, staff, vehicles and, ultimately, service delivery. It has become critical for the CoT to implement alternatives to address the void.

Among the recommended interventions is the establishment of waste transfer stations (WTSs), which can be constructed further away from landfill sites. It can be highly mechanised facilities where waste is compacted, placed on road trucks or rail wagons, and transported to the next available landfill site for final disposal. Alternatively, WTSs can be simplified with fewer built-in mechanics that will make the waste transfer system more robust and less vulnerable to power failures or mechanical breakdowns. Old or closed landfill sites would be ideal locations to establish WTSs. Irrespective of the technology used, all WTSs and associated equipment should be standardised across the municipality.

The following is an overview of existing waste and garden refuse transfer stations in CoT:

- **Mabopane transfer station**

The transfer station was historically used for recycling, but the recyclers were moved to the adjacent site since the situation became problematic and difficult to manage. There are currently three 20 m^3 skips on site which receive mixed waste and one 20 m^3 skip which takes dry recyclable waste.

There is a concern that small quantities of household hazardous waste are being disposed of in the skips (fluorescent tubes, etc.); this needs to be managed – specifically from a health and safety perspective. A further concern is the disposal of animal carcasses and/or abattoir waste at the site.

The signage to the site is damaged and needs attention. The site is fenced, and a municipal official on site controls access.

- **Kruger Avenue transfer station**

The City of Tshwane has a garden site on Kruger Avenue in Centurion. This was mainly due to the long distances that the compactors needed to travel in order to dispose of their waste at the closest City-owned landfill sites to Region 4, which is the Hatherley landfill site (27 km from Kruger Avenue transfer station) or Onderstepoort landfill site (29 km from Kruger Avenue transfer station). This resulted in the compactors spending a disproportionately large percentage of their time travelling back and forth to the landfill site rather than collecting waste in the service area.

The transfer station has since been refurbished, and a bulk container service is provided from the Kruger Avenue transfer station. Deploying bulk container services from the Kruger Avenue transfer station has allowed the City of Tshwane to direct some of its service fleet for Region 4 to dispose of waste into bulk containers at the Kruger Avenue transfer station. The waste is compacted using the static compactor at the transfer station, and the compacted waste is disposed of at a Tshwane landfill site.

The reduction in the distance travelled by the fleet from the collection area to the disposal point would result in each compactor being able to service more households a day. This, in turn, will mean that the City will require less compactors to service Region 4 and allow the City to realise an operational cost saving.

- **Garden refuse transfer stations**

The garden refuse transfer stations are located at the points indicated in the table below (supplied by City of Tshwane, 2014).

Table 6-6: Garden refuse and transfer stations

STATION NAME	LOCATION
Dorandia	Daan De Wet Nel Ave, Pretoria North
Magalieskruin	Koorsboom Ave, Sinoville
Menlo Park	26th Ave, Menlo Park
Mountain View	Japie Peens St, Mountain View
Phillip Nel Park	Sytza Wierda Rd, Phillip Nel Park

Waltloo	Alwyn Rd, Waltloo
Eersterust	St Joseph Ave, Eersterust
Kruger Ave	Kruger Ave, Centurion
Rooihuiskraal	M37, Rooihuiskraal

In terms of the by-laws, the following conditions apply:

- These facilities are available for private individuals only. All businesses and contractors may dispose of their garden waste free of charge at the landfill sites if the load is less than 3 000 kg per day.
- Domestic waste, business waste, oil, fluorescent tubes, builders' rubble, steel, timber rests, soil, pebbles, rocks, and logs from tree felling activities may not be disposed of at garden waste sites.

All the waste from garden refuse sites is currently transported and disposed of at landfill sites. Also, the current by-laws encourage the disposal of large volumes of garden waste at landfill sites by contractors and the general public. In terms of the provisions of the NWMS, this practice needs to be discouraged, and the composting of garden waste encouraged. The by-laws need to be amended to reflect this. The need to separate garden waste from the bin liners in which it is sometimes contained needs to be included in the amendment to the by-laws to limit the contamination of the green waste for composting.

The chipping and shredding of garden waste at the City of Tshwane's garden refuse sites needs to be implemented as a matter of urgency.

This will assist in readying the material for composting and reducing the transportation costs of garden waste from the garden refuse disposal site to the composting portion of the nearest multipurpose recycling facility.

6.3.8 Interventions by the CoT to secure waste disposal facilities.

As part of a process of identifying alternative/additional waste disposal facilities for the disposal of waste generated within the municipal boundaries, the CoT embarked on the following initiatives:

Initiative	Time frame
1. Private landfill airspace acquisition	Short term
2. Landfill sites closure plans and alternative landfills	Medium to long term
3. Alternative waste treatment	Medium to long term

The following four sites have been identified for the potential development of waste disposal facilities and recommended for feasibility studies:

- Region 2, Ward 49 - located on the Farm Groenfontein 120JR with an extent of 17 850 126 m^2 (1 785 ha). The site is characterized by an open space with grassland.
- Region 7, Ward 102 - located on the Farm Onverwacht 509 JR with an extent of 1 813 460 m^2 (181 ha). The site is owned by the Republic of South Africa.
- Region 7, Ward 102 - located on the Farm Vleiland 752 JR with an extent of 4 665 885 m^2 (466 ha). The site is owned by the Republic of South Africa.
- Region 6, Ward 101 - located on the Farm Rietfontein 21 IR. The site is owned by Transnet – 1 541 758 m^2 (154 ha).

From the studies undertaken on the feasibility of Alternative Waste Treatment technologies for use in the CoT [25], the following actions were taken with the support of the Gauteng Infrastructure Financing Agency (GIFA):

- Faced with dwindling landfill space for waste disposal Gauteng Infrastructure Financing Agency (GIFA) was appointed in March 2015 to conduct Feasibility Study into Alternative Waste Treatment Methodologies
- GIFA allocated a budget, and Transactional Advisor was appointed in November 2015
- GIFA and Tshwane signed MoU on the Project – in May 2016
- GIFA completed the feasibility study
- The study recommended a waste-to-energy plant
- A PPP approach is considered for the conversion of the Pretoria West power station as an incinerator.

It must be noted that even after the implementation of an alternative Waste Treatment Technology study, the need to still dispose of waste at the landfill is essential. It is, therefore, of critical importance to develop new landfills for non-recyclable, non-combustible waste, and tailings from the AWTT process. In addition to waste disposal facility/facilities readily accessible for waste generated within the CoT, there will also be a need for the implementation of a series of strategically positioned waste transfer stations.

To illustrate the above, reference is made to the *South Africa - State of Waste Report 2018,* that is providing an overview of the general waste composition on a national level, indicating that around 94% of C&DW is currently disposed to landfill. With this waste being non-combustible and a large part of the waste stream being mixed (for instance, illegal dumping), it will make a significant contribution to the remaining disposable waste stream. It is further to be recognised that although materials like glass and metals can be recycled, it is also non-combustible and will end up on landfills if not separated from the waste steam. Bulky green waste items like branches and tree trunks will also have to be disposed of to a landfill, should it not be feasible for such material to be chipped and processed as part of a composting program.

Table 6-7: General waste management option in 2017 (Source: South Africa – State of Waste Report 2018)

Waste type		Generated	Recovered / Recycled	Landfilled	Percentage Recovered / Recycled
GW01	Municipal waste	1 770 009	-	1 770 009	0%
GW10	Commercial and industrial waste	3 179 157	-	3 179 157	0%
GW13	Brine				
GW14	Fly ash and dust				
GW15	Bottom ash				
GW16	Slag				
GW 17	Mineral waste				
GW 18	WEEE				
GW 20	Organic waste	6 656 234	812 206	5 844 028	12%
GW 21	Sewage sludge				
GW30	Construction and demolition waste	5 360 556	305 761	5 054 795	6%
GW50	Paper	3 635 825	1 414 378	2 221 447	39%
GW51	Plastic	2 247 323	332 713	1 914 610	15%
GW52	Glass	1 395 103	320 000	1 075 103	23%
GW53	Metals	3 345 565	1 622 059	1 723 506	48%
GW54	Tyres	221 751	64 061	157 690	29%
GW99	Other	14 868 997	-	14 868 997	0%
	Total general waste (t)	**42 680 520**	**4 871 178**	**37 809 341**	**11%**

In as far as the resides from a typical incineration process is concerned, the following information was obtained from the *Whitebook Waste-to-Energy Austria* [27]:

Typical residues from waste incineration residual waste consist of humidity (water content of approximately 20%-25% in Central as well as Western and Northern Europe), combustible components (approximately 45%-50%) and ash (approximately 25%-30%). The solid residues from residual waste incineration only make up 25%-30% of the weight of the untreated residual waste. Owing to the relatively high density of these residues, the landfill volume required is only 10% of the original volume.

6.3.9 Conclusions on Waste Management in CoT

Information on remaining landfill airspace for the CoT varies significantly from one source of information to the next. The most reliable source of information obtained was a report titled *City of Tshwane Metropolitan Municipality, Operational Landfill Sites – Airspace Assessment Report*, dated June 2010. This information is further supplemented by the "Integrated Waste Management Plan – City of Tshwane", dated 2019.

Table 6-8: City of Tshwane Metropolitan Municipality, Operational Landfill Sites – Airspace Assessment

Name of landfill site	Location	Active/inactive	Remaining lifespan
Ga-Rankuwa	Ga-Rankuwa	Active	8 - 9 years
Hatherley	Hatherley	Active	15 - 20 years
Bronkhorstspruit	Bronkhorstspruit	Active	9– 10 years
Soshanguve	Soshanguve	Active	7 - 8 years
Onderstepoort	Onderstepoort	Inactive	0 years
Kwaggasrand	Kwaggasrand	Inactive	0 years
Temba	Temba	Inactive	0 years
Garskloof	Garskloof	Inactive	0 year
Valhalla	Valhalla	Inactive	0 years

			• Under care and maintenance • Sinkhole management
Derdepoort	Derdepoort	Inactive	0 years • Under care and maintenance
Pretoria North (converted to Golf course)	Pretoria North (converted to Golf course)	Inactive	0 years • Under care and maintenance
Eersterust	Eersterust	Inactive	0 years • Under care and maintenance

Based on the information presented, the CoT has an estimated population of 2.9 million. According to some information, the CoT is reportedly generating an estimated 2.4 million tonnes of general waste annually. In 2009/2010, the CoT landfills were surveyed for 2 consecutive years to determine the annual airspace consumption. The latter information provided a waste generation estimate for CoT of 1.3 million tonnes/annum rather than the 2.4 reported by the CoT. The inaccuracy of the information, as reported by the CoT, may be due to the absence of operational weighbridges at the municipal landfills.

The Airspace Assessment Report provides the following information on available airspace and remaining life on the CoT's operational municipal landfills (base date 2020).

It is further to be recognised that:

- CoT owns 1 large landfill; 1 medium landfill; and 2 small landfills operated by the municipality, which are Hatherley (GLB-), Ga Rankuwa (GMB-), Bronkhorstspruit and Soshanguve (GSB-)). The Onderstepoort landfill was reportedly receiving in the order of between 50 000 and 60 000 tonnes of waste at the time when it was closed. The latter resulted in a vast portion of municipal waste being diverted to the remaining municipal landfills in the Metro. No municipal waste is reportedly disposed of on privately owned and operated landfills.
- No municipal landfills are available towards the west and south of the CoT, which, in turn, resulted in waste having to be transported over uneconomical long distances to the Onderstepoort landfill situated towards the north of Tshwane. The long travelling distances resulted in only one instead of two collection rounds being undertaken per day, which resulted in vehicle and labour productivity is reduced by 50%. This had a significant impact on the cost of waste collection.
- The estimated remaining life for Bronkhorstspruit, Ga Rankuwa, and Soshanguve landfills is between 5-10 years. The estimated remaining life for Hatherley landfill (situated towards the east of CoT) is expected to be in excess of 20 years. Diverting the bulk of Tshwane's waste to Hatherley will not only result in increased transport costs and reduced productivity but can also result in logistical problems at the landfill. This will not only

significantly increase the waste collection vehicle turnaround time at the landfill (that will have a further negative impact on productivity), but it will also have a negative impact on the standard of the landfill's operations – which is already not legally compliant in terms of GNR 636.

- Cover material may become a determining factor in the remaining life of the Hatherley landfill.
- There are some private landfills situated within/close to CoT boundaries that can be used once the municipal landfills are no longer available. It will, however, have an impact on waste transport distances and disposal fees, as costs associated with the use of private landfills are likely to be influenced by supply-and-demand due to the limited number of landfills available within a reasonable transport distance from waste sources.
- **The last municipal landfill licensed and developed in CoT was the Hatherley landfill in 1998.**
- From the information available, there are currently no dedicated initiatives underway by CoT for the licensing and development of any new landfills – a process that can take between 5-7 years, depending on the level of public resistance.

It is thus concluded that the closure of CoT landfills will be as presented in the figure below:

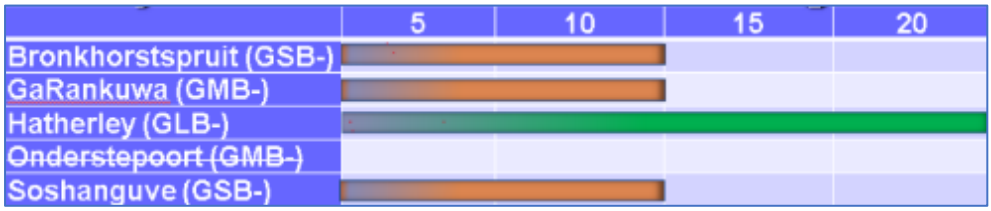


Figure 6-9: City of Tshwane's landfills are projected to have an estimated remaining life less than the final 5-year time horizons presented – other than the landfill indicated in green, where the remaining life is expected to exceed 20 years.

6.4 CITY OF EKURHULENI

6.4.1 Overview

Situated in the Eastern region of the Gauteng Province and bordered by the metropolitan municipalities of Johannesburg and Tshwane, the City of Ekurhuleni (CoE) spreads over 15.6% of Gauteng's land mass (1 975 km^2) [28]. It is the fourth largest of the eight metropolitan areas in South Africa. Established as a metropolitan municipality during the restructuring of local government in 2000, the City consists of nine towns, namely Alberton, Benoni, Boksburg, Brakpan, Edenvale, Germiston, Kempton Park, Nigel, Springs and 17 townships, including, amongst others, Daveyton, Kwa-Thema, Tembisa, Vosloorus and Katlehong.

The CoE started operating in 2000 as a fragmented City due to a legacy of nine towns and seventeen townships. It had multiple civic identities, with no single administration or City Centre, similar to the other metropolitan municipalities.

Managing waste in a sustainable and self-sufficient way is one of the key challenges for the CoE, and one in which every stakeholder has a role to play. Economic development activities,

a growing population and increasing rates of urbanization in South Africa have resulted in increased volumes of waste generation that put pressure on waste management facilities, especially in the metropolitan areas. The increased volumes and complexity of the waste stream directly affect its management, which is compounded when hazardous waste is mixed with general waste. This requires establishing and implementing effective waste management policies and programmes.

Increased air linkages between OR Tambo International Airport to regional, continental, and global destinations, with its intended investment and economic growth, increase the complexity of the waste streams due to rapid urbanization and industrialization.

The CoE is home to a population that has grown from 2.48 million in 2001 to 3.18 million in 2011, and further to 3.38 million in 2016. Over the period 2011 to 2016, the number of households in the city increased by 284 025 to 1.3 million households, which is 28% higher than what it was in 2011. This growth rate is higher than that of the province, which realised an increase of 26.7% in the number of households over the same period. The challenge of in-migration, therefore, has been particularly prevalent in Ekurhuleni and combined with the 11.1% growth (Gauteng 18.7%) in the number of households living in informal dwellings (242 498 informal settlements and backyards across the City), the magnitude of the service delivery challenge is evident.

The population density of the CoE is exceptionally high. At 1 711 people per km^2, compared to the Gauteng province average of 737.1 people per km^2 and the average national population density of 45.6 people per km^2. Ekurhuleni is also highly urbanised, with 99.4% of the population living in urban settlements, ranging from the 242 498 informal settlements mentioned above to elite urban residential suburbs. A segmented approach is thus required to address, firstly, the need for new infrastructure and services in the under-developed areas while, secondly, ensuring adequate maintenance of existing infrastructure and services in the more developed areas.

Some of the larger population centres within the CoE are Tembisa, Germiston, Kempton Park, Benoni, Boksburg and Springs, with Germiston and Boksburg being the fastest-growing towns. The CoE has low-income residential clusters, such as Tembisa, the Katorus complex, the Kwatsaduza complex, and the Daveyton Etwatwa area (comprising 61% of the City's population) that are located on the urban periphery are far removed from most social and economic opportunities in the town central business district areas. When operational, the rail and road networks provide a vital link to the main formal economy. This has created a cumulative effect as high levels of poverty and homelessness for most citizens persist.

The CoE has just over 1.9 million households, with an average of 2.9 persons per household. Between 2001 and 2011, there was a 36% increase in the number of households, with most residents (77.4%) residing in formal houses.

- **Growth Cluster Areas**

For purposes of budgeting and resource allocation, the CoE is divided into three operational service delivery areas, the South Service Delivery Area (SSDA), Eastern Service Delivery Area (ESDA) and the Northern Service Delivery Area (NSDA), as described in Table 6.17. All the SDAs are experiencing rapid population growth.

Some settlement areas in the NSDA have the most rapid growth in population compared to the other areas. The ESDA has incorporated Lesedi Local Municipality, which has increased the service area demand. The anticipated amalgamation of Lesedi Local Municipality falls within the IWMP planning period; therefore, it has been incorporated into the planning and implementation process. Table 6-17 below denotes the growth clusters in the Metro.

Table 6-9: Growth settlements in the City of Ekurhuleni service areas

SERVICE DELIVERY AREA	MAIN SETTLEMENTS	RAPID GROWTH SETTLEMENTS
Southern Germiston	Boksburg, Alberton, Katlehong, Vosloorus and surrounds	Kliprivier, Palmridge, Zonk'zizwe, Vosloorus, Palmietfontein, Van Dyk Park Ext and Villa Lizza
Eastern	Brakpan, Springs, Benoni, Daveyton, Etwatwa, Kwa-Thema, Duduza and surrounds	Benoni (Crystal Park, Chief Albert Luthuli), Brakpan (Geluksdal), Old Location and Kwatsaduza development corridor area
Northern	Kempton Park, Edenvale, Midstream and extensions, Clayvile and the extensions, Olifantsfontein, Bapsfontein, Serengeti, Glen Erasmia, Pomona, and Bredell	(Midstream and extensions, Clayvile and the extensions, Olifantsfontein, Bapsfontein, Serengeti, Glen Erasmia, Pomona, Essellen Park extension and Bredell.

- **Socio - Economic Profile**

The CoE is the manufacturing, logistics and transport hub of South Africa. It contributes about 7.51% to the country's Gross Domestic Product (GDP), with a GDP-R of R4.01 trillion in 2015. Manufacturing accounts for the largest share of the CoE's economy at 32% and, in 2015, accounted for an estimated 15.9% of the province's total gross value add (GVA), down from 21% in 2005. This is reflective of a sluggish economy and the related slowdown in the manufacturing sector. While the economy of Ekurhuleni has shown resilience in the wake of recent economic difficulties, it was not immune to the consequences of global instability. As with the rest of the country, the CoE's economy is still characterised by slow economic growth. Despite skills, job creation and economic empowerment initiatives, the unemployment rate remains a major concern, particularly the 36.9% of unemployed youth.

Table 6-10: Population growth per income level.

POPULATION GROWTH	TYPE OF SETTLEMENT				
	High Income	Middle Income	Low income	Unclassified Settlements	TOTAL
Base population 2015[7]	232 399	429 917	2 483 858	358 156	3 504 331
Current growth estimates per annum	2.47%	2.47%	2.47%	2.47%	*3.2%*
Future population estimates for year 2035	378 590	700 357	4 046 332	583 455	3 959 030

Projecting the population growth and income levels of the CoE is important to analyse the waste-management service requirements.

The contribution of income levels in the CoE waste generation overall tonnages were estimated in the *CoE IMRFS,* where around 42% of the total waste is generated by low-income groups, while 38% of the waste generated by medium and high-income groups and 20% is unclassified.

Income levels in Ekurhuleni are above the national average (which is to be expected for most urban areas in South Africa) but below that of the Gauteng province's average. The unemployment rate is lower than the national average, though higher than that of the Gauteng province, while the percentage of people in poverty is lower than the national average but similar to Gauteng's average.

6.4.2 Waste Categories Generated

Waste generated in the CoE is disposed of at its five municipal landfill facilities as well as some private facilities. The CoE facilities receive a wide range of general waste (and delisted waste in the case of Rietfontein) for disposal [29]. The figure below depicts the major waste types disposed of at CoE landfills.

[7] Population is, based on Census 2016 data with an estimated population growth of 2.47% per annum as calculated in the City of Ekurhuleni Integrated Materials Recovery Facilities Study (IMRFS). The Census 2011 to Census 2016 growth is recorded as 3.2%; however, the administrative boundaries of the City of Ekurhuleni have changed in this 10-year period.

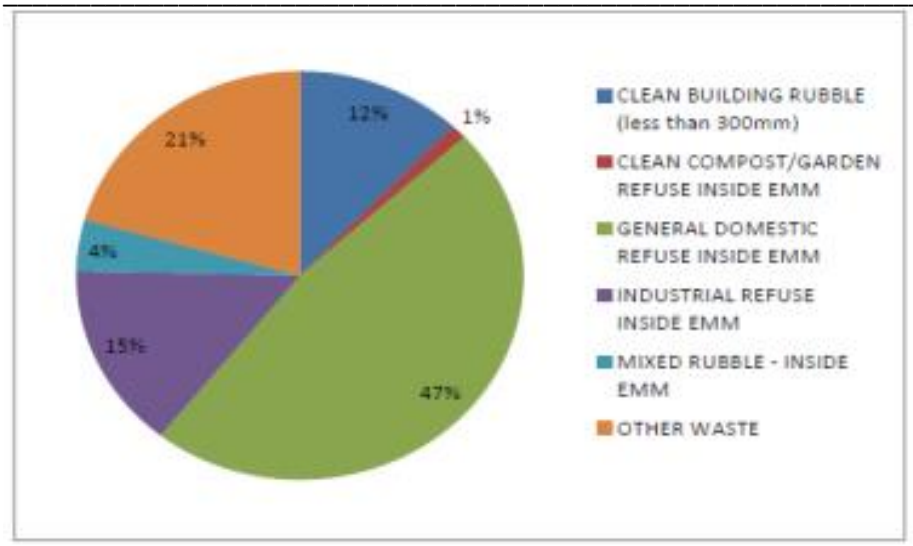


Figure 6-10: Percentage of different waste types disposed at the City of Ekurhuleni landfills

The mass of waste types disposed of at the CoE landfills is presented in the table below.

Table 6-11: Mass of various waste types disposed at the CoE landfills.

WASTE ORIGIN	TONNES PER YEAR 2014/15	% OF TOTAL WASTE
Clean building rubble (>300mm)	137 969	12%
Clean compost/garden refuse inside CoE	13 595	1%
General domestic refuse inside CoE	547 728	47%
Industrial refuse inside CoE	168 224	15%
Mixed rubble inside CoE	46 968	4%
Other waste	237 050	21%
Total waste received at CoE landfills	**1 151 537**	**100%**

Table 6-19 shows records of tonnes per annum of the various waste types shown in Figure 6-43 and shows that general domestic refuse generated in the CoE is the largest amount of waste disposed of in the metro's landfills. In addition, the FG landfill facility is estimated to receive 159 525 tonnes of waste per annum. The various waste categories include:

- General Domestic Waste
- Industrial Refuse
- De-listed Solids
- Paper Pulp
- Garden Refuse
- Ash
- Builders' Rubble

6.4.3 Waste Management Services

- **Waste Collection Services**

The CoE's Customer Care Centers, located in Alberton, Benoni, Boksburg, Brakpan, Edenvale, Germiston, Nigel and Kempton Park, are responsible for the collection of general waste

generated by its residents. FG landfill site, followed by Chloorkop landfill, received most of Kempton Park's waste. Some individual or private users dispose of their waste at the CoE landfills at irregular intervals. More than 90% of the general domestic waste in the CoE comes from within the municipal boundaries. Accordingly, there are 3 service delivery areas with 11 depots and 21 customer care areas, as shown in Table 6-21 The CoE offers a comprehensive waste management service across all 101 wards.

Table 6-12: City of Ekurhuleni service delivery areas and depots.

SERVICE DELIVERY AREA	WASTE MANAGEMENT DEPOTS
South	Germiston, Boksburg, Alberton and Bedfordview
East	Brakpan, Springs, Benoni and Nigel
North	Kempton Park, Edenvale and Tembisa

Through a combination of various business models, waste collection services in the CoE are rendered in-house and partly outsourced to private contractors at more than 674 385 service points.

The biggest challenge faced by the municipality was the accurate determination of the population size receiving waste management services both in the formal and informal settlements. This further had implications for the billing of all service points. The municipality subsequently explored various options to determine and validate the total number of service points serviced and billed by the city. The rollout of the 240 l bin project partly addressed this matter through redress and the use of ICT-based solutions. Plans are being developed to retrofit all waste containers with a chip and later the installation of an electronic device on waste trucks that would count and allocate addresses of accountholders per lifting and emptying of a bin. This technology will be piloted and later rolled out to all service areas.

Generally, the use of plastic bags as household waste receptacles created an additional burden of pollution for the municipality, and the collection process for these bags resulted in delays in waste collection as workers needed to pick up individual bags. In line with the requirements of the *National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) National Domestic Waste Collection Standards* that came into effect on 1 February 2011, the municipality made provisions for funding to procure wheelie bins. The council approved contracts on 21 November 2013 to the amount of approximately R66 million and on 2 February 2016 to the amount of approximately R126 million for the procurement and distribution of 240 l bins.

- **Waste Recycling**

The establishment of the waste minimization programme in the CoE is part of the integrated approach towards the implementation of the waste management hierarchy. The Ekurhuleni municipality has been facilitating a pilot project on waste minimization with a focus on waste sorting at source in Tembisa and the township areas in public-private partnership initiatives with funding from the European Union. This pilot constituted part of the township economy revitalization aimed at igniting local economic development through waste management initiatives.

- **Waste collected by Private Companies**

At the time, there are 41 companies registered as waste-management service providers and 17 registered as waste generators with the CoE Department of Waste Management. Only 17 of the registered waste-management service providers and one waste generator appeared in the database as CoE landfill users.

Most of the waste management service providers collect waste from industrial areas and tend to separate waste at the source, hence diverting recyclables from the landfill. Not many of the waste service providers were able to provide data on the waste types and volumes that they collect and dispose of.

- **Waste Treatment and Disposal**

The CoE Waste Management Services Department runs five operationally permitted landfill sites. The municipality does not own a landfill site in the northern service delivery region and bought airspace from private disposal sites called FG Landfill and Chloorkop Landfill. There is a concern over the lack of municipal-owned airspace in this region, given the complexity of future planning in the context of no control over airspace development and sharing with other private users. This makes planning very difficult, especially for the areas which fell in this service delivery region.

6.4.4 Diversion of Waste from Landfill

The CoE conducted the Integrated Materials Recycling Facilities Study (IMRFS), which assessed the existing waste recovery programmes in the metro. The IMRFS recommends a guide for changes, improvements and identifying the CoE's options in the decision-making process. Recommendations are to guide the CoE for the next five to twenty years with a suggested review of the IMRFS every five years.

The CoE's goal with the IMRFS is to divert much of the waste stream from landfill disposal through recycling efforts. The IMRFS was to conduct a feasibility study into the establishment of a network of Material Recycling Facilities across the CoE. While the objective is to assist the CoE in determining the viability of developing an Integrated Materials Recovery System within their jurisdiction.

A typical municipal waste stream calculated in the National Waste Information Baseline Report is in use in the IMRFS, as shown in the figure below.

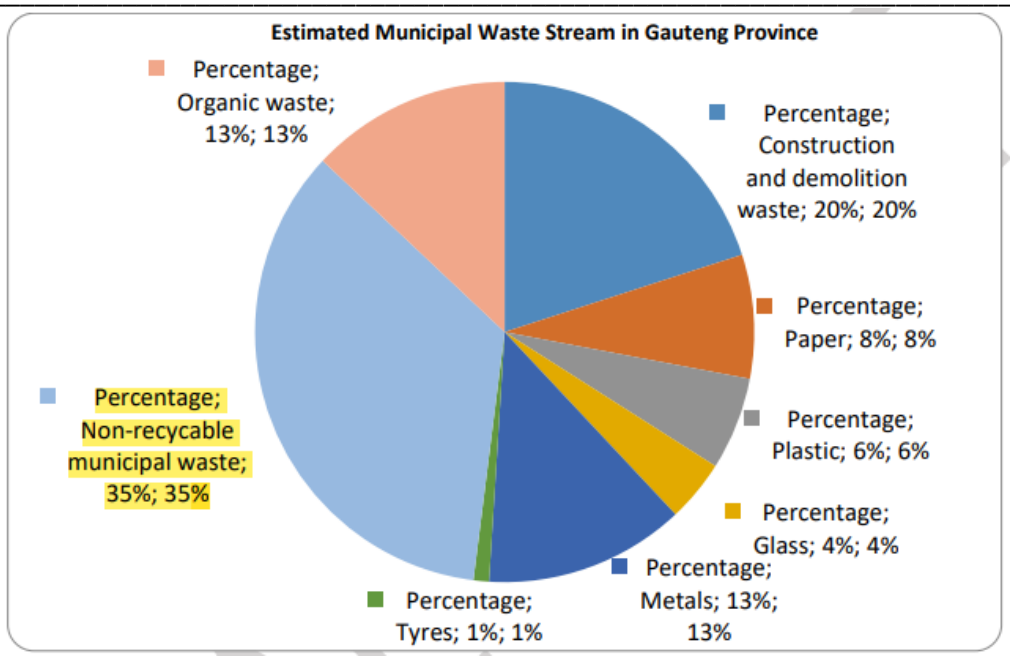


Figure 6-11: Municipal Waste Stream in Gauteng

Figure 6-44 reveals that there is an estimated 65%, which can be potentially recycled from the municipal waste stream; hence, there is an opportunity to recycle this waste.

- **City of Ekurhuleni Recycling Facilities**

There are two recycling facilities in the CoE owned by the metro, Actonville and Wattville recycling facilities.

Table 6-13: City of Ekurhuleni Recycling Facilities

RECYCLING FACILITY	FEATURES
Actonville Recycling Facility	Located in Actionville, Benoni. A community operated facility, which was established through donor funding. The facility is secure with the use of a palisade fencing and a lockable gate manned by a security guard.
Wattville Recycling Facility	Located in Wattville, Benoni. *Facility is not operational, because it does not have electricity supply.* Construction and installation of additional facilities must be undertaken before the facility can become operational. The facility is secure with the use of a palisade fencing and a lockable gate manned by a security guard.

The IMRFS states that the CoE's priority should be to establish a system of measurement and accounting that will allow an accurate diversion rate calculation between waste generators and final disposal points to establish a baseline and prior to quantifying a target for diversion of waste from landfill.

The municipality led a recycling programme in which community members operated the businesses – with some community members having received training. In addition, community member organization and formalization are in cooperation and linked with municipal-led waste minimization programmes. As part of the expansion and rollout programme, a Developmental Contractor is a preferred model in the CoE that would facilitate

the establishment of recycling cooperatives and provide for infrastructure, machinery, and equipment. The Development Contractor was to develop a criterion in consultation with the municipality to identify and recruit community-based cooperatives/SMMEs that were to implement the recycling program. In areas where community-based cooperatives and recycling SMMEs exist, the Development Contractor was to integrate them into the business plan.

The CoE Municipality was to develop and make available public offloading facilities with offices, in which case the Development Contractor is to ensure that the facility is adequately equipped to meet the operational requirements. This could include but is not limited to the supply of bailers, plastic granulators etc. To enhance the economies of scale, the community-based contractors engaged through the Development Contractor to supply or deliver recyclables at the public off-loading facilities from which the cooperatives could then source or reclaim the recyclables. Sorting-at-source operations in some of the areas is an implementation performed through the Developmental Contractors, especially where recycling facilities and cooperatives are established.

Specific performance indicators were to be developed as part of the performance scorecard to measure and monitor progress. As part of this programme, various recycling projects using community-based cooperatives and SMMEs across the length and breadth of Ekurhuleni were to be established over a five-year period. For starters, the established cooperatives were only to focus on collecting and treating recyclables. Further along the value chain, and with proper training, some of these cooperatives were to venture into composting garden refuse and organic waste from the garden refuse sites and Springs Fresh Produce Market. Part of the compost was to be used towards resuscitating soil fertility at City's Parks.

Many waste recycling activities are occurring at different scales in the CoE. The recovered waste streams and some of the companies involved in waste recycling initiatives in the CoE are currently active. Recycling waste streams include, but are not limited to, electronic waste, paper and carton, aluminium cans, oils, metals, plastics and garden and food waste. The recycling value chain includes recyclers, intermediaries, bakkie/truck collectors, cooperatives/small collection items, informal collectors - trolley pushers/landfill pickers, waste generators, scrap metals and e-waste, known as overseas exports.

Many recycling companies are based in the CoE. Recyclers reclaim recyclables and send them to manufacturing/processing plants where the manufacturing of other products from the recyclables is done. Larger recycling companies include Nampak, Mpact, Extrupet, Consol, Transpaco, Kaytech and Scaw Metals. Waste recycling companies provide a market opportunity for recyclables. The IMRFS lists 33 recycling companies located in the CoE; however, there may be many more operating in the metro.

- **Private Recycling Facilities in the City of Ekurhuleni**

A comprehensive assessment of small-scale recovery and recycling initiatives completed by Jeffares and Green in 2015 was summarised in the IMRFS which indicated 28 existing recycling facilities in the CoE with operations at these facilities covering all forms of recycling.

➢ **Private Waste Minimisation Initiatives**

There are many private service providers offering waste minimisation services in the CoE. The private waste sector forms a large part of the waste industry within the CoE. Not all waste generated in the CoE is collected, managed and disposed of by the CoE. The private waste companies doing business within the CoE range from very small companies to large, listed companies, and thus the exact volumes and breakdown of the waste managed by these companies are unclear.

6.4.5 Organic Waste Treatment (Composting)

There are no composting facilities owned or operated by the CoE, with limited chipping and stockpiling of green waste aimed at future use during the rehabilitation of landfills.

In addition to the airspace consumed by green waste disposed to landfill, it also generates methane which is one of the greenhouse gasses having a significant impact on the environment.

6.4.6 Construction and Demolition Waste Processing

The pilot project on the chipping of building rubble at the Simmer & Jack landfill was completed without any sustainable improvements on the management of C&DW in the CoE, and there are currently no plans implemented [30] for the continued processing of C&DW at any of the landfills.

6.4.7 Health Care Waste Treatment & Disposal

- **Hospitals**

Fourteen major hospitals were identified within the CoE. The Health Care Risk Waste (HCRW) generated by the hospitals comprise mostly of medical sharps, infectious waste, pharmaceutical waste, anatomical parts and cytotoxic waste. The HCRW is collected by private companies, i.e. waste management service providers. The waste management service providers which collect the HCRW are reportedly not all registered with the CoE. The collected waste is then taken to thermal treatment facilities within and outside the Gauteng province. The CoE does not provide the service for the collection and treatment of HCRW. However, after thermal treatment, some of the treated waste was previously disposed of at the Rietfontein Landfill Facility. The presence of waste pickers at the landfills, however, makes it difficult to have treated (disinfected/incinerated) HCRW disposed of without exposing waste pickers to the potential risk of injuries, assuming the HCRW treatment processes used met the required standards.

- **Clinics**

There are a number of government medical clinics within the CoE. Waste volume information was requested from these clinics, but none was reportedly forthcoming at the time when the IWMP was developed. It is assumed that the medical waste generated at such facilities is managed by private contractors and treated at legally compliant autoclaves/incinerators.

The general waste stream generated at healthcare facilities is taken to general waste landfills within the CoE.

- **Hazardous and Medical Waste Collection**

Regarding hazardous chemical substances and materials, specific mention is made of transformer insulation oils containing PCB's, insecticides and herbicides, lead contaminated bulk fuel storage tanks and asbestos-containing cladding, parts, insulation and roof sheeting. Such contaminated materials may only be disposed of at a landfill site that has a licence for the purpose once all other statutory requirements have been met that will prevent exposure of people and the environment to the associated hazards. It is illegal to have any naturally radioactive materials or materials that have been exposed to radioactive or nuclear processes disposed of at a landfill or other site within the CoE's boundaries.

Where waste will be transported via roads in CoE, only vehicles that are purpose-built, constructed, and fitted according to legal standards aimed at public, road and environmental safety will be permitted. The operation and use are subject to the necessary construction, roadworthy and identification standards and requirements, especially where it involves "hazardous" or "dangerous goods" waste.

6.4.8 Hazardous Waste and E-waste Management

- **Industrial Hazardous Wastes**

Industrial waste is generated by the many industries within the CoE. The waste comprises industrial general wastes used for packagings such as cardboard, plastics, timber, bags and some paper, as well as paper pulp, filter cake, glass, thermal insulation material, aluminium sheet, plasterboard ceiling, ash and delisted solids etc. In addition to this, various hazardous waste streams are also generated, depending on the materials and processes used in the respective industries.

Waste from industries is mainly collected by private companies (waste management service providers). Some waste management service providers separate waste at the source of collection, hence diverting some recyclables from the landfill. Most of the industrial waste that goes to CoE landfills originates from within the municipal boundaries.

- **Electronic and Electric Waste**

Electronic and electric waste (e-waste) is a problematic waste stream as e-waste is considered hazardous waste. Components of e-waste that are not sold for scrap or second-hand parts and are not recycled in an environmentally sound manner may be disposed of in illegal dumps or in registered landfills. It is thus to be noted that the waste stream data of waste types disposed of in the CoE landfills does not include e-waste as a particular separate waste stream. Given that most settlements are urban in the CoE and the affordability and accessibility to electronics are high, it is assumed that there is a large amount of e-waste requiring appropriate recycling, treatment/disposal.

The demand for appropriate processing and disposal is thus very high, as current disposal is through the general waste collection system – if not 'recovered' by informal pickers accessing precious and semiprecious metals from e-waste through illegal burning. The latter is not only resulting in a significant impact on the environment, but it is also creating a serious health risk to affected communities.

Due to the nature and composition of e-waste, no electronic waste is handled by municipal waste management teams or disposed of in the CoE landfill sites.

6.4.9 Other waste types

Other waste types include:

- Abattoirs
- Wastewater Treatment Works

6.4.10 General Waste Disposal

- **The City of Ekurhuleni Landfill Facilities**

The CoE has five operational landfill facilities: Rietfontein, Simmer and Jack, Weltevreden, Rooikraal and Platkop.

In the 'Integrated Waste Disposal Master Plan' (IWDMP) for Ekurhuleni Metropolitan Municipality (2015), the following reasoning was followed to determine a waste disposal growth rate for the CoE:

- Private landfills have been developed in recent years since private companies realised the economic potential in waste and waste management. These private landfill owners provide industries and municipalities with an economically and environmentally viable option for waste disposal and thus divert waste away from municipal landfills. With the growing cost of transportation, it makes further economic sense to take the waste to the nearest landfill site, whether publicly or privately owned.
- Transport distances to private landfills are, in some cases, shorter than the distance to the CoE operated landfills. The travel distance has an impact on the travel costs, as well as the efficiency of the fleet and making it more feasible for the CoE to transport their waste to closer, privately owned landfill sites.
- Recycling initiatives have shown an increase in the past few years, resulting in more waste being diverted from landfills. The gap between the rate of waste generation per capita and the rate of landfilled waste per capita is widening, with more of the waste being generated now being recycled or reused. The metal, glass, paper and plastic industries are driving many recycling initiatives; they are supported by waste-handling companies across the country. These companies specialize in waste minimisation and collect recyclable waste, selling it as raw materials to the manufacturing industry. Drop-off facilities and buy-back centres have been established where members of the public can take their recyclable material, and people are encouraged to support recycling initiatives through various marketing campaigns.
- Legislation is now geared towards waste minimisation. The Waste Act came into effect in 2008 and addresses waste minimisation specifically. The Waste Act required the establishment of a National Waste Management Strategy (NWMS) that included objectives, plans, guidelines, systems and procedures for re-use, recycling, recovery, treatment, disposal, use, control, and management of waste. *One of the NWMS targets*

was to divert 25% of recyclables from landfill sites for reuse, recycling, or recovery by 2016.

- Municipalities and Industrial facilities must have a Waste Management Plan that must include measures for waste minimisation.
- Groups and forums like the Institute of Waste Management of Southern Africa (IWMSA) and the National Recycling Forum (NRF) have been formed to encourage waste minimisation and to educate citizens about the value of waste.
- The population's mindset has been changing towards recycling and waste minimisation. Changes in legislation, awareness campaigns and educational initiatives have made the population aware of their responsibility towards the environment and the benefits of recycling. Although not everybody adheres to the principles of waste minimisation, it is a trend that is much more apparent than in the past and needs to be considered when planning for future landfilling needs.

To calculate the available airspace at the landfill facilities, the actual recorded weighbridge data is used. With the above in mind, a waste-disposal growth rate of 1.5% was used to calculate the available airspace at each of the landfill facilities.

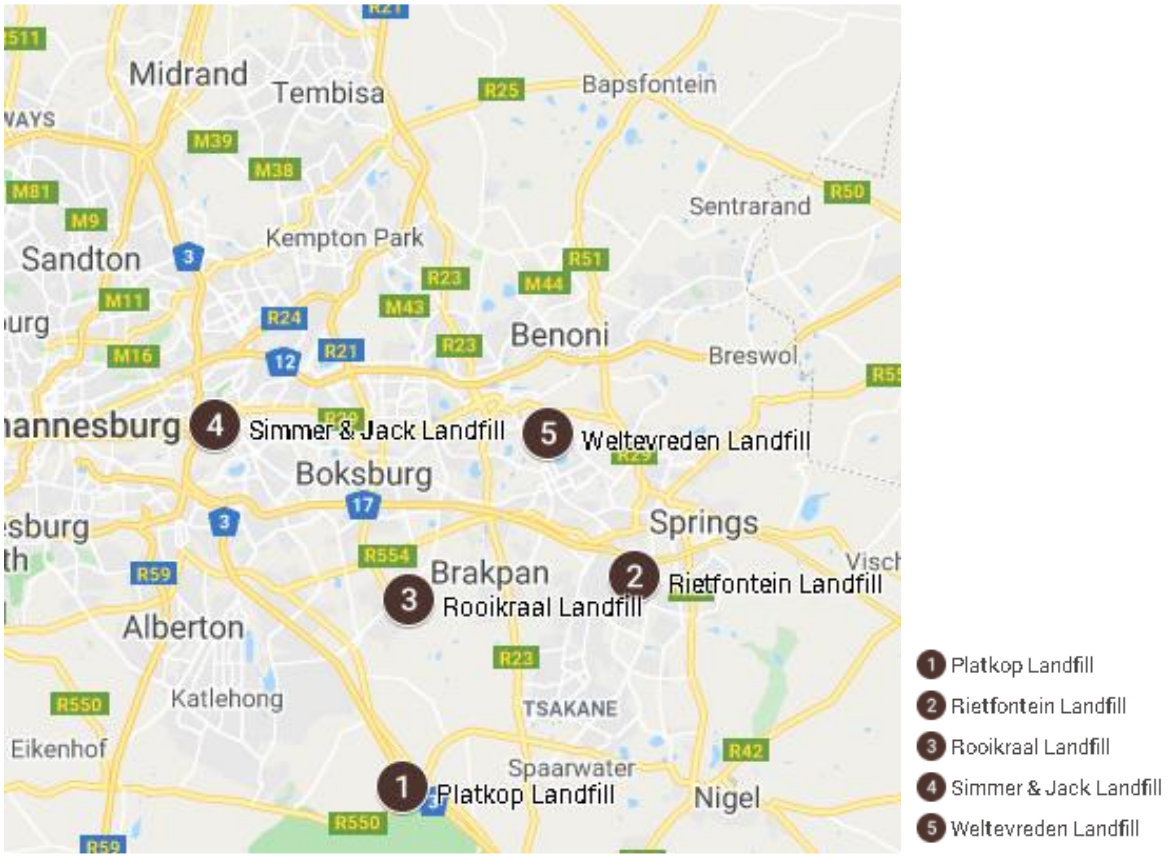


Figure 6-12: CoE landfill site locations

Table 6-14: Classification, disposal rate, and remaining airspace of City of Ekurhuleni landfills (2014/15)

Landfill Site	DWAF site classification	Disposal rate CoE waste (tonne/month)	Disposal rate Waste from outside CoE (tonne/annum)	Remaining Airspace (years from February 2018)	Remaining Airspace (m^3)	Landfill Gas Extraction and utilisation
Rooikraal	GLB-	22 454	17.90	25+	6 028 092	Yes
Weltevreden (10m)	GLB-	31 372	0.0	3	1 189 859	Yes
Simmer & Jack (Add graveyard) (Add stockpile)	GLB-	24 226	7.23	6 months	198 017 981 300 800 289	Yes
Rietfontein	GLB+	20 100	354.34	6	1 535 608	Yes
Platkop	GLB-	11 020	26 887	25+	3 154 960	
Total		**109 172**	**27 266**	**25+**		

Four of the CoE landfills have implemented landfill gas extraction and utilisation projects. The municipality is reportedly producing 1 megawatt of electricity from methane gases harvested at the Simmer and Jack landfill site that feeds into the Eskom grid. A rollout plan was developed in partnership with the Energy Department within the CoE for the other landfill sites. Currently, all four sites have installed gas wells for flaring. Specific key performance indicators are in place to measure performance and progress on this project.

The rollout plan is reviewed annually with a view to install generators that will convert the harvested gasses into turbines feeding into the municipal electrical grid. There was also provision for an independent contractor to assist with technical issues, including accurate monitoring and recording of harvested gasses. This, however, was in conjunction with skills transfer to the CoE officials to retain the system and operationalize it internally. In addition to the five-landfills data, there are privately owned landfill facilities inside the CoE's boundaries or close to the CoE as indicated in Table 6.26. There are four licenced privately owned landfills in the CoE, one of which is a hazardous landfill facility, Holfontein.

Table 6-15: Waste generation at privately owned landfills in the City of Ekurhuleni

Landfill Site	Owner	Year the CoE started to dispose of in landfill	Disposal rate Waste from inside the CoE (tonne/annum)	Remaining Airspace (years from January 2015)
FG Landfill Facility	Interwaste	2012	Kempton Park area 17 304 Ekurhuleni Metro Parks 27.6 Tembisa 58 536	Subsequently closed due to public objections
Chloorkop Landfill Facility	EnviroServ		0	Near end of life – extension approved.

Landfill Site	Owner	Year the CoE started to dispose of in landfill	Disposal rate Waste from inside the CoE (tonne/annum)	Remaining Airspace (years from January 2015)
Holfontein Hazardous Landfill Site	EnviroServ		Only hazardous waste received - volume from the CoE unknown	Unknown
Tonk Meter Resource Facility		Not yet in operation	Not yet in operation	Unknown
Olifantsfontein Resource Facility		Not yet in operation	Not yet in operation	Unknown

The following landfill sites were closed in 2010 by the CoE: Chloorkop (municipal) Landfill Facility, Nigel Landfill Facility, Deep Levels (Kwa-Thema) Landfill Facility, Sebenza Waste Site, Bull Frog Pan Landfill, Brakpan Landfill Facility, Wadeville Landfill, Southern dumping site, and Alberton North waste site.

Given the dense population surrounding the CoE, there is a need to dispose of waste at the CoE's landfills from non-residents. Table 6.27 quantifies the waste tonnage received from non-residents or private users.

Table 6-16: Tonnes of waste received from non-residents or private users

WASTE TYPE	COE CUSTOMER CARE CENTRES (TONNES)		PRIVATE USERS (TONNES)	
YEAR	**2014**	**2015**	**2014**	**2015**
Combustible Within the CoE	658 622	686 107	21 468	14 824
Non-combustible Within the CoE	101 464	130 475	140 126	198 911
Total	**760 086**	**816 582**	**161 594**	**213 735**

- **Illegal Dumping In the metropolitan municipal area**

Illegal dumping occurs in open spaces. Additionally, illegal dumping may occur in informal and formal settlements, as well as commercial areas. The CoE spends a considerable budget for clearing illegal dumping on an annual basis. Besides the aesthetics and the health problems associated with illegal dumping, clearing illegal dumps costs more than planned waste collection.

- **The City of Ekurhuleni Landfills Summary**

The CoE operates and owns five landfill sites. In addition to this, the CoE is responsible for managing 11 closed landfill sites through external service providers. The operational sites are strategically located in the CoE, though it must be noted that in the Northern Service Delivery Area, the municipality does not have a waste disposal facility. In four of the sites, the municipality is extracting gas, which, in turn, is used for energy production. A list of all the

sites and their status is provided below. The sites do not accept household hazardous waste or health care risk waste.

Table 6-28 shows the service areas which dispose of waste in the different landfill facilities and the average daily waste disposal tonnage.

Table 6-17: Active landfill sites in the City of Ekurhuleni: Service area, waste received, remaining life and remaining airspace.

Name	Service Areas	Tonnes of waste disposed of per day	DWAF site classification	Disposal rate (tonne/month)	Remaining Airspace (years from February 2018)	Remaining Airspace (m^3)
Weltevreden (10m)	Eastern Region: Benoni, parts of Brakpan & Boksburg	827	GLB-	31 372	3	1 189 859
Rietfontein	Eastern Region: Nigel, Tsakane, Kwa-Thema & Springs	571	GLB+ Co-disposal De-listed materials.	20 100	6	1 535 608
Rooikraal	Southern Region: Katlehong, parts of Germiston & Boksburg	741	GLB-	22 454	25+	6 028 092
Simmer & Jack (Add graveyard) (Add stockpile)	Southern Region: Parts of Boksburg, Germiston & Bedfordview	614	GLB-	24 226	6 months 2 2	198 017 981 300 800 289
Platkop	Southern Region: Alberton, Thokoza, Voslorus & part of Katlehong	314	GLB- Disposal of asbestos powder/solids	11 020	25+	3 154 96
Total		**109 172**			**25+**	

Table 6-29 provides a summary of the various waste types received annually at the CoE landfill facilities as per the weighbridge recordings.

Table 6-18: Waste Types received at the City of Ekurhuleni Landfill Facilities

WASTE TYPE	ANNUAL TONNES DISPOSED OF	% OF TOTAL
Clean building rubble (less than 300mm)	137 969	11.9
Clean compost/garden refuse inside the CoE	13 595	1.2
General domestic refuse inside the CoE	547 728	47.5
General domestic refuse outside the CoE	1 090	0.1
Industrial refuse inside the CoE	168 224	14.6
Industrial refuse outside the CoE	357	0.03
Industrial Waste outside the CoE	2.90	< 0.1
Mixed rubble inside the CoE	46 968	4.1
Recycling	77	<0.1
Soil (usable as cover material)	121 789	10.6
Ash cover material	6 588	0.5
Ash Cover Material - Clean	0	0
De-listed liquids (trench and cover)	6.48	<0.1
De-listed sludge (trench and cover)	488	0.04
De-listed solids (less than 300mm in diameter)	28 381	2.5
Nigel waste	36 142	3.1
Safe disposal of products: crushed/buried	7 740	0.7
Asbestos	7 619	0.7
Lesedi local municipality	25 800	2.2
Mixed rubble outside the CoE	11.84	<0.1
WEIGHING ONLY	22.30	<0.1
TOTAL	**1 151 520**	**100**

Waste record keeping at the CoE landfills has reportedly been good and again shows the combined landfill waste statistics as reported earlier.

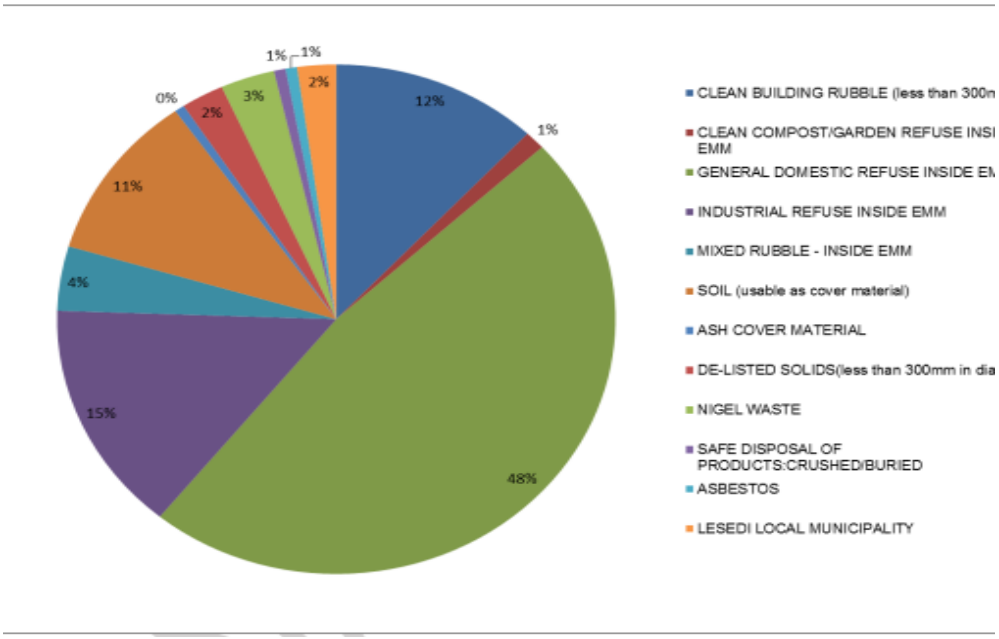


Figure 6-13: Combined Composition of Landfill Waste across the City of Ekurhuleni

From this figure, it is clear that the majority of the CoE waste ending up in landfill is general domestic waste (48%), non-hazardous industrial waste (15%) and builders' rubble (12%). Together these waste streams make up 75% of the CoE landfill waste (close to one million tonnes per year). Most waste that arrives at the landfill gates is not separated, so it is important to note that a truck carrying general household waste could possibly contain a portion of builder's rubble, garden waste or hazardous wastes like paint, pesticides, batteries, etc.

For a breakdown of waste quantities to be accurately reflected, the data from the detailed Waste Characterisation study is required, and this could require the breakdown of waste within the industrial waste stream as well.

The following is a summary of the private waste landfills in the CoE:

- **FG Landfill Facility**

FG landfill facility is owned and was operated by Interwaste. The landfill is however closed due to complaints from nearby residents and will no longer be operated.

Waste Quantities:

According to information received from Interwaste, the CoE started disposing of waste at FG landfill facility late in 2012. Waste received at FG landfill facility at the time was recorded as waste from the Kempton Park area (approximately 17 304 tonne/year), Ekurhuleni Metro Parks (27.6 tonne/year) and the Tembisa area (58 536 tonne/year).

- **Chloorkop Landfill Facility**

The Chloorkop landfill facility is owned and operated by EnviroServ. Due to the limited airspace available at the Chloorkop landfill facility, EnviroServ applied for an amendment to the waste management licence. The application was successful, and the landfill footprint is therefore extended. The extension is however only making a relative small contribution towards the remaining life of the landfill.

At the time when the IWMP was compiled, Chloorkop Landfill facility did not receive any municipal waste from the CoE.

- **Holfontein Hazardous Landfill Site**

The Holfontein Hazardous landfill site is owned and operated by EnviroServ. The landfill site only receives hazardous waste, and no municipal waste is accepted. This facility receives waste from various municipalities and industries across Gauteng as well as from other parts of South Africa.

- **Tonk Meter Resource Facility**

The Tonk Meter Resource Facility was initially licensed as the Tonk Meter Road Landfill - a GLB+ facility allowing for provision of integrated waste management services. The

facility is situated immediately next to the existing CoE Rietfontein GLB+ landfill and will be used for disposal of most waste currently disposed of at the Rietfontein landfill.

Considering the licenced footprint of the facility, it is expected to contribute significantly to the available landfill airspace in the Springs area once operational.

- **Olifantsfontein Resource Facility**

Olifantsfontein Resource Facility applied to amend its Class D Waste Management Licence (WML) to also dispose of general waste to landfill. In terms of the Class D WML, they are currently licenced for the disposal of building and demolition waste only. Should the amendment application be approved, the site will be licensed for the disposal of domestic waste by including the following waste management activities:

- Category B Activity 8: The disposal of general waste to land covering an area in excess of 200m2 and with a total capacity exceeding 25 000 tons.
- Category A Activity 1: The storage of general waste in lagoons.

The facility is situated in Olifantsfontein but will have limited airspace due to its small footprint.

- **Other City of Ekurhuleni Waste Disposal Infrastructure and Facilities**

In addition to the operational landfills in the CoE, there are other waste disposal infrastructure and facilities, as shown in Table 6-30.

Table 6-19: City of Ekurhuleni additional waste infrastructure

Location	Mini Garden sites	Transfer stations	Depots	Recycling facility
Benoni	3	-	1	2
Brakpan	3	-	1	-
Springs	5	-	1	-
Boksburg	14	-	1	-
Germiston	4	-	1	-
Edenvale	1	1	2	-
Kempton Park	1	4	1	-
Alberton	-	2	1	-
Nigel	-	1	1	-
TOTAL	**31**	**8**	**10**	**2**

***Note**: The number of facilities listed above are, for various reasons, not all operational and in use.*

6.4.11 Informal Recyclers and Cooperatives

In addition to private companies, there are many informal and cooperative recyclers in the CoE. Informal recycling of the waste within the CoE takes place through individuals and small cooperatives that gather recyclables and sell their waste to larger recycling companies. Two

groups of informal recyclers are identified in the CoE; these are street recyclers and landfill waste pickers. Although informal street recyclers contribute to waste recovery, their contribution is minimal, and they supply their materials to companies which will bulk and resell the materials. However, there is a need to consider their contribution and develop solutions that will make it easier to operate.

The value chain consists of informal recyclers (trolley pushers/landfill pickers), cooperatives/small collection teams, pickup/truck collectors and some intermediaries that collect recyclables. The intermediaries are typically buyback centres and waste management companies that buy recyclables from other collectors of recyclables and sell the recyclables to recyclers. The recyclers buy their recyclables mostly from intermediaries and directly from the lower levels of the recycling hierarchy in some cases. There is an exchange of recyclables between some intermediaries. However, all recyclables finally flow to the recyclers that convert the recyclables into finished products.

It is important to promote cooperatives of recyclers so recycling groups can get higher revenue from their collections and minimum quantities for intermediaries' collectors can be achieved faster. The salvage of waste by informal recyclers and waste pickers is not quantifiable. The waste streams that are picked by the informal recyclers include mainly paper, cardboard, plastics and, to a lesser extent, glass and metal.

There is an informal buy-back centre at the Rooikraal Landfill Facility where landfill waste pickers take their goods for recycling companies to buy. The area has a roof and a lockable gate. The surrounding community operates the facility.

Numerous waste pickers salvage waste from generators and from landfills. Most recyclables picked from the CoE landfills are not on record or quantified. However, such recyclables pass through the intermediaries and end up in the top level of the recycling hierarchy. Generally, within the CoE, waste separation is not at the source. Some big industries such as the Airports Company of South Africa (ACSA), Transnet, Scaw Metals and Aveng Rail do, however, practice waste separation at source, keep records of their recyclables and register themselves as waste generators with the CoE Waste Department.

Table 6-31 shows the type, code, and description of common recyclables.

Table 6-20: Description of recyclables

TYPE	CODE	DESCRIPTION
Paper	CMW	Common Mixed Paper and Board
	FN	Flat Newspaper
	HL1	Heavy Letter 1 White Office Paper
	HL2	Heavy Letter 2 Coloured Office Paper
	SBM	Unsold Magazines from Magazine Printers
	SN	Special News newspaper, magazines, graphic paper
	M1	Unprinted White Paper
Cardboard	IMW	Carton board cuttings
	K3	Corrugated cuttings, unused boxes
	K4	Cardboard
Plastic	LDPE	Light Density Polyethylene

TYPE	CODE	DESCRIPTION
	LDPE Mix	Light Density Polyethylene (mixed)
	PET	Polyethylene Terephthalate
	HDPE	High Density Polyethylene
	Shrink	Wrap Plastic
Paper/Plastic	TetraPak	TetraPak (Plasticized paper)

- **Waste disposed in the City of Ekurhuleni from other Municipalities.**

The CoE owned landfill facilities received 27 266 tonnes of waste from outside the CoE borders during the 2014/15 year. This amounts to about 2% of the total waste disposed of in that year. The tonnages as received from July 2014 to June 2015 with the weighbridge descriptions of the waste type are shown in the table below, and most of this waste comes from the Lesedi Municipality and is disposed of at the Platkop landfill.

Table 6-21: Waste received from outside City of Ekurhuleni

LANDFILL FACILITY	TONNAGES RECEIVED PER WASTE TYPE						
	Domestic waste outside CoE	General domestic refuse outside CoE	Industrial refuse outside CoE	Industrial waste outside CoE	Mixed rubble outside CoE	Lesedi Local Municipality	Total
Rooikraal		15.10	1.94	0.86			18
Rietfontein	0.26		352	1.88			354
Platkop		1 075			11.84	25 800	26 887
Simmer & Jack			3.66	3.66			7.32
Weltevreden							0.00
Total	**0.26**	**1 090**	**357**	**6.40**	**11.84**	**25 800**	**27 267**

6.4.12 Waste transfer stations (WTS)

- **Refuse Transfer Stations**

The CoE owns eight Refuse Transfer Stations. A study done in 2015 by Jeffares & Green concluded that the sites are generally in poor condition and will require some refurbishing. According to the Jeffares and Green report, two refuse transfer stations in Kempton Park are closed.

- **Mini Waste Disposal facilities**

The CoE operates the 31-mini waste-disposal sites mostly located in residential areas and industrial areas. The sites are not permitted. A service provider has been appointed to develop a mini waste site master plan. The master plan seeks to develop small, medium and large sites to serve the needs of the community. Each site will be allocated certain responsibilities for waste minimization.

A study done in 2015 by Jeffares & Green concluded that the sites are generally in poor condition and will require some refurbishing. Most of them have no access control, so a record of tonnages, etc., could not be obtained.

6.4.13 Interventions by the CoE to secure waste disposal facilities.

Future Development Influencing Waste Generation, according to the CoE Draft Metropolitan Spatial Development Plan Review (SDP, 2015), lists the proposed Aerotropolis development as one of the key factors that will contribute to waste generation. The report states that the existence of OR Tambo International Airport (ORTIA) within CoE serves an integral purpose to connect South Africa both internally and with the rest of the world. As ORTIA is situated in CoE, the opportunity for a well-developed Aerotropolis exists. The compact urban structure of an Aerotropolis presents a mixed node use, i.e. a central airport with relevant facilities, surrounding freight and industrial uses and commercial and retail uses integrated with the airport, hotel and conference facilities to accommodate business tourists, as well as civil buildings, including sports stadia and educational institutions.

The Aertropolis developments will influence future waste generation and waste management in the CoE. As the nodes grow denser, the waste generation will increase; it is expected that the main areas with an increase in waste generation will be the areas immediately surrounding the airport. The other geographical areas will only experience waste increases resulting from population growth.

6.5 Conclusions on Waste Management in CoE

Information on remaining landfill airspace for the CoE varies from one source of information to the next, mainly due to uncertainty regarding height increases for which applications were submitted. The most reliable source of information obtained was the Draft Integrated Waste Management Plan.

Table 6-22:CoE Landfill airspace according to the IWMP

NAME	LOCATION	DWAF SITE CLASSIFICATION	REMAINING LIFE (YEARS FROM FEBRUARY 2018)
Weltevreden (10m)	Brakpan	GLB-	3
Rietfontein	Springs	GLB+	6
Rooikraal	Boksburg	GLB-	25+
Simmer & Jack **(Add graveyard)** **(Add stockpile)**	Germiston	GLB-	6 months + 2 + 2
Platkop	Suikerbosrand	GLB-	25+
Total			**25+**

Based on the information presented, the CoT has an estimated population of 3.38 million (2016). The CoE is reportedly generating an estimated 1.3 million tonnes of general waste annually.

It is further to be recognised that:

- CoE owns 5 large landfills operated under contract to the municipality, which are Weltevreden (GLB-), Platkop (GLB-), Simmer & Jack (GLB-), Rietfontein (GLB+), Rooikraal (GLB-).
- Despite substantial airspace on three of the five CoE landfills, there are no municipal landfills towards the north of CoE. This is resulting in some municipal waste from the Kempton Park/Tembisa area having to be disposed of on privately owned and operated landfills situated in the area. With most of the transfer stations previously operated in the Kempton Park/Tembisa area not being functional, this is resulting in waste having to be transported over long distances with REL waste collection vehicles. The latter is not only causing significantly increased transport costs, but it is also having a negative impact on waste collection efficiencies since 1 instead of 2 collection rounds are undertaken per day – requiring additional trucks and crews.
- The estimated remaining life for Simmer & Jack and Rietfontein landfills is less than 10 years. The estimated remaining life for Weltevreden, Rooikraal and Platkop is however, expected to be more than 20 years. Although it may be possible to divert waste from Rietfontein to the new Tonk Meter Road private landfill, the closure of Simmer & Jack will require that a waste transfer station be erected near the closed landfill for waste to be transported cost-effectively to an alternative landfill.
- The use of legally compliant private landfills will have an impact on disposal fees, as costs associated with the use of private landfills are likely to be influenced by supply and demand due to the limited number of landfills available within a reasonable transport distance from waste sources.
- Cover material may become a determining factor in the remaining life of the Rooikraal landfill.
- **The last municipal landfill licensed and developed in CoE was the Rietfontein landfill in 1997.**
- From information the available, there are currently no dedicated initiatives underway by CoE for the licensing and development of any new landfills – a process that can take between 5-7 years, depending on the level of public resistance.

It is thus concluded that the closure of CoE landfills will be as presented in Figure 6-52 below:

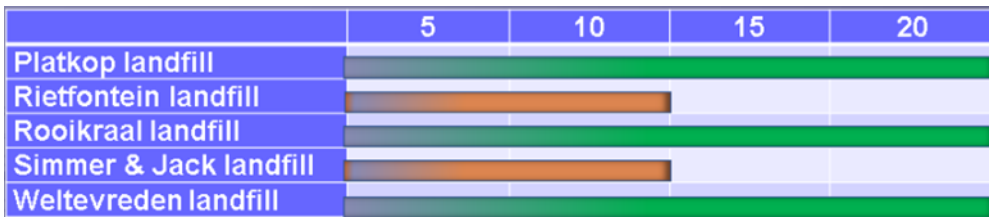


Figure 6-14: City of Ekurhuleni's landfills are projected to have an estimated remaining life less than the final 10-year time horizons presented – other than the landfill indicated in green, where the remaining life is expected to exceed 20 years.

7. GAPS AND NEEDS

Having undertaken the Situation Analysis on waste management activities and having decided on an end-state, the next step was to determine the 'gaps' that exist between the Status Quo and the desired end state and the 'needs' that, if fulfilled, will facilitate achievement of the desired end state. Gap and needs analysis was undertaken for each of the metros and the detailed analysis is in the Master Report in the Needs Analysis. Below we highlight the gaps and needs that are cross cutting across all the metros:

7.1 Waste Categories Generated

- **Review of waste characterisation study**

The table below indicates the gaps and needs identified in terms of the waste categories generated. The consultants had sight of the CoJ waste characterisation study conducted in August 2015, whilst CoT and CoE did not have waste characterisation reports.

Table 7-1: Waste characterisation gaps and needs.

GAPS	NEEDS
The waste categorisation study of August 2015 undertaken by CoJ is not considered to be representative of overall waste generation patterns in the CoJ.	The Waste Categorisation study is to be considered against the background of the representative waste sources currently directed to the various destination landfills. This will determine what percentages of the waste stream going to existing landfills is viable for processing (recycling, composting, crushing, or energy recovery) and what percentage is to be transferred for safe disposal at legally compliant landfills.
To date there is still no comprehensive database or overarching management information system to produce reliable data and manage information for all 3 metros	Metros to commission studies to undertake accurate waste characterisation and waste generation

- **Garden waste**

The table below details gaps and needs associated with garden waste.

Table 7-2: Organic waste gaps and needs

GAPS	NEEDS
No consistent strategy in place for the diversion of garden waste within each of the metros.	Policy decision is required in respect of the diversion of organic waste from Pikitup landfills. This policy is to be based on an assessment of the requirements and an economic evaluation of the options available for diversion and/or treatment.
Contracts for garden waste diversion have either lapsed or no contract in place.	If justified by means of a financial comparison of in-house vs. outsourced green waste diversion,

	enter into new contracts for green waste collection and diversion from selected garden waste drop off facilities.

- **Construction and Demolition waste (C&D)**

The table below details gaps and needs associated with C&D waste.

Table 7-3: C&D gaps and needs

GAPS	NEEDS
High density and high transport cost of C&D waste from the source to a central processing facility is an obstacle to financial viability.	The option of making more mobile crushing plants with various capacities available at demolition sites should be investigated. This should include crushing/screening of C&DW onsite, from where the products may then be sold for appropriate use in the construction industry.
C&D waste is mostly mixed at source, resulting in both inert as well as other materials being included in the waste stream.	Source separated C&D waste will increase its options for further processing, and achieving that should be investigated as part of the C&DW strategy.
Steel reinforcement in C&DW will impact the ease with which such waste can be crushed and screened.	Cognisance is to be taken of the potential impact of steel reinforcement in C&DW, and whether it is financially justified to make special provision for that when specifications for plants are compiled.

- **Health Care Risk Waste (HCRW), Hazardous waste and E-waste**

Although local municipalities are legally not responsible for the management and safe disposal of HCRW, hazardous waste and e-waste generated by major businesses and industries within their area of jurisdiction, they do need to ensure that no hazardous waste is disposed of on municipal landfills that are not licenced, developed and operated to the required standards.

Table 7-4: HCRW, Hazardous waste and E-waste gaps and needs

GAPS	NEEDS
There are no containers for the safe disposal and storage of household hazardous waste at the drop-off/transfer station facilities.	Provide service for household hazardous waste.
Lack of awareness about household hazardous waste.	Raise awareness regarding household hazardous waste.
Lack of information on hazardous waste types and generation rates.	Improve hazardous waste information system.

7.2 Waste Quantities

- **Landfill weighbridge tonnages**

The table below details gaps and needs associated with landfill weighbridge tonnages.

Table 7-5: Landfill weighbridge gaps and needs

GAPS	NEEDS
When weighbridges are not functioning (e.g., due to power outages) loads are manually logged, with GVM (gross vehicle mass) and tare mass of trucks recorded. This gives an inaccurate picture of waste tonnages.	Functional UPS and generator to be provided at all landfill sites.
CoT does not have any operational weighbridges, with waste classification and recording at landfills based on volumetric reading system developed by CoT. This is resulting in conflicting reporting on waste generation rates	The CoT should implement (and operate) a weighbridge recording system with waste mass recordings rather than volumetric recordings.
The weighbridges at CoE landfills are in some instances not functional for extended periods of time	The CoE should ensure alternative arrangements can be made when the weighbridges are down.
No confirmation of accuracy of monthly waste disposal tonnages at landfills.	Site managers to 'sign off' monthly waste tonnage reports for their sites, stating that recorded tonnages are deemed accurate or, alternatively, providing an explanation why tonnages may have been under-/overstated.
Historical waste disposal tonnages not always reliable due to weighbridge/weighbridge system issues stated above.	This will be resolved over time, provided that the needs set out are addressed.

7.3 Waste Recycling and Treatment

- **Receptacles**

The table below details the gaps and needs associated with receptacles.

Table 7-6: Receptacles gaps and needs

GAPS	NEEDS
Plastic Liners (85-litre)	
Thin plastic liners create a risk of liner damage and subsequent waste spillage during the collection process.	Standards on minimum liner thickness for use as waste receptacles are to be set, and public awareness around this is to be created.
Liners are not suitable for collection and storage of high-density waste, and there is, in such instances, a risk of liner damage and waste spillage.	Public awareness should be created around the type (and required thickness) of plastic liners to be used for the containerisation of high-density waste.
Plastic liners used as waste receptacles are often damaged by animals, resulting in waste spillage and wind-blown litter on the day of collection.	The public is to be encouraged to place plastic liners used as waste receptacles on an elevated support platform, or in a cage, before collection.
Collection of waste in 85-litre liners is, in most instances, quite effective, as there is no need for collection vehicles to be static during the loading of waste. It can also be	The potential advantages and disadvantages of the alternative receptacles should be investigated before a decision is made on the type of receptacles to be used.

collected with a variety of waste collection vehicles.	
Biodegradable bags used as receptacles are expensive and have negative impacts on recycling programmes when such bags are mixed with other recyclable plastics.	The use of biodegradable bags for use as receptacles should be considered against its cost and potential impact on recycling programmes.
Plastic/steel bins (85-litre)	
Receptacles like bins of various sizes used for waste collection are not always compatible with the type of waste collection vehicle used, thus resulting in less effective waste collection.	It is to be ensured that waste receptacles used/recommended for use are compatible with the type of waste collection vehicles used/to be used in the area.
Depending on the density of the waste and the condition of bin handles (where applicable), two persons may be required for the handling and loading of waste. The situation is aggravated as waste collection vehicle loading heights are increased.	Handling and lifting of bins by more than one person during waste collection should be avoided due to the increased need for labour, risk of injuries and risk of waste spillage.
When warm ash is being disposed of in 85-litre bins, it can damage the galvanising, and bins subsequently rust to a point where waste is no longer contained. Warm ash disposed of in plastic bins results in plastic bins melting to a point where waste is no longer contained. There is a risk of fires being ignited when warm ash is disposed of in waste receptacles – not only in the receptacles, but also inside the waste collection vehicle.	Members of the public should be made aware of the damage that certain waste types, particularly hot ash, may cause to plastic or galvanised steel receptacles.
Where waste bins are not equipped with lids, this can give access to the waste to stray animals, cause windblown litter, or result in water entering the waste whilst being stored.	Public awareness is to be created regarding the need for all waste bins used to be provided with suitable lids.
Loading waste directly from 85-litre bins without the use of liners is time consuming, with the situation worsening with increased loading heights. Such receptacles are also not compatible with waste collection vehicles with a high loading height.	It is to be ensured that waste receptacles used/recommended for use are compatible with the type of waste collection vehicles used/to be used in the area.
Steel drums (up to 210-litre)	
The disposal of hot ash can, once again, lead to waste being ignited in the drums, paint being damaged by the hot ash, and drums subsequently being damaged by rust.	Members of the public should be made aware of the damage that certain waste types, particularly hot ash, may cause to painted steel receptacles.
Based on the drum size and in the absence of handles, at least two labourers are required to handle and load waste from 210-l steel drums. Such receptacles are not compatible with any type of waste collection vehicle.	Handling and lifting of bins by more than one person during waste collection should be avoided due to the increased need for labour, risk of injuries and risk of waste spillage.

The speed at which waste is loaded is slowing down where waste is to be loaded into collection vehicles with increased loading heights.	It is to be ensured that waste receptacles used/recommended for use are compatible with the type of waste collection vehicles used/to be used in the area.
The handling/decanting of heavy waste materials, like building rubble or recyclable scrap metal, is likely to cause damage to plastic waste receptacles.	Heavy waste materials, like building rubble or recyclable scrap metal, are to be placed in steel drums that are less likely to be damaged than when plastic containers are used.
Wheelie Bins (120, 130 or 240 litre)	
The size and/or number of receptacles are not always aligned with the volume of waste generated between collection rounds at any generation point. This is more problematic where there is more than one household living on a single stand.	The number and size of waste receptacles should be aligned with the volume of waste expected to be generated between collection rounds, with incentives provided for people to participate in recycling/composting, thereby sending less waste to landfill.
Waste is not always stored in receptacles protecting it against animals and natural elements.	Based on the receptacle design, waste should be protected against natural elements and stray animals.
Wheelie bins are not to be used for the disposal of hot ash.	Members of the public should be made aware of the damage that certain waste types may cause, in particular hot ash, to plastic receptacles.
Theft/vandalism of bins is a problem. Due to their versatility, wheelie bins can be used for various applications other than waste storage, resulting in bins being stolen from sidewalks on collection days.	Collection rounds should be punctual, allowing residents to return empty wheelie bins after collection rounds are completed.
Wheelie bins can be damaged when used for storage of heavy waste materials like building rubble or recyclable steel. Bin lids are also damaged due to manhandling or due to the plastic pivot 'plugs' working loose and eventually falling out.	Public awareness around the appropriate handling of wheelie bins is important, with waste collection teams also to be trained on the appropriate handling of wheelie bins to limit the risk of damage.
Wheelie bins are not compatible with waste collection vehicles without bin lifters, resulting in delayed waste collection and a risk of injuries to workers manually loading waste from wheelie bins.	It is to be ensured that waste receptacles used/recommended for use are compatible with the type of waste collection vehicles used/to be used in the area.
Random reusable/disposable receptacles	
The use of small/random containers results in the need for repeated movement between sidewalks and waste collection vehicles. This has a significant impact on the speed at which waste is collected. Collecting waste from small containers with subsequent spillage is similar to the collection of illegally dumped waste. The absence of appropriate receptacles is resulting in waste spillage/windblown litter and also making waste accessible to natural elements and stray animals.	Formal (uniform) receptacles that are compatible with the waste collection vehicles results in less waste spillage and increased waste collection rates.
Wheelie bins larger than 240-litre	

Bulk containers used at public drop-off facilities for the collection of disposables, recyclables, garden waste and C&D waste are not always easily distinguishable - with waste also not effectively separated into different categories.	Waste is to be separated effectively at public drop-off facilities as part of any waste minimisation programmes. Although Pikitup is not responsible for the management of hazardous waste, it is important for such containers to be provided to CoJ households and serviced. Hazardous waste containers should also be clearly identifiable.
Bulk waste containers (skips and ro-ro containers) are not all fitted with reflectors to avoid accidents in instances where skips may temporarily be positioned in road reserves.	All bulk containers potentially placed in public areas (particularly road reserves) should be clearly visible at all times, with reflective strips used for improved visibility at night.
Appropriate measures are not always put in place to prevent the spread of windblown litter/waste during the transportation of bulk containers between the point of generation and the landfill/recycling facility.	All bulk waste containers are, as a minimum, to be covered with a net to prevent windblown litter. The preferred option would, however, be for the waste to be covered with water resistant covers to prevent rain from infiltrating the waste.
Litter Bins/Bulk Waste Containers in Public Places	
The number/size of street litter bins does not always meet the disposal capacity required between collection rounds. Such shortcomings are especially problematic in the vicinity of public areas such as schools, supermarkets, parks, etc., where large numbers of people gather.	Appropriately sized/enough street litter bins are to be positioned in public areas to accommodate the volume of waste expected to be generated between collection rounds.
Increased volumes of waste generated in the vicinity of informal vendors can often not be accommodated in the available street litter bins.	In areas where there are street vendors, more (regularly serviced) street litter bins are to be provided due to the additional waste generated by the vendors (e.g., discarded fruit and vegetables, etc.)
Solid street litter bins (plastic and metal) are often contaminated and not cleaned at regular intervals, thus generating odours and attracting flies.	Plastic bin-liners are to be placed in street litter bins to remain hygienic and to avoid any fine waste particles remaining in the bins or surrounding area once emptied.
Waste disposed of in the street litter bins does, in some areas, contain health care risk waste (e.g., syringes used by diabetics or drug addicts).	Formal and informal users of syringes are to be made aware of the risk that inappropriate disposal thereof can cause. Users of the bins and those servicing the bins should be made aware of the potential risk of HCRW being present inside the bins.
Shop owners are, in some instances, making use of street litter bins outside their shops for the disposal of commercial waste. This results in street litter bins being overfilled.	Awareness is to be created amongst shop owners to make use of formal (and appropriate) waste management practices for storage and removal of waste generated on their premises.
Street litter bins are, in some instances, not well secured, resulting in them being vandalised or removed for the bin material to be recycled.	Cognisance is to be taken of the potential risk of bins being vandalised/stolen during the selection and rollout of street litter bins.

7.4 Waste Collection

- **Waste Collection Vehicle Fleet**

The table below details gaps and needs associated with waste collection vehicle fleet.

Table 7-7: Collection fleet gaps and needs.

GAPS	NEEDS
Waste collection and transportation are an operational responsibility of the regions, but due to significant differences in amongst others population densities, waste generation rates, and transport distances, it is not possible to implement a uniform system across all regions.	Investigate the waste management needs for each region and develop systems that are tailor-made to address such needs. Cognisance is even to be taken of varying circumstances within each region.
Most of the trucks in the metros own Rear-End-Loader (REL) fleet are older than their economic life.	As a matter of urgency, a new FML contract(s) should be entered into between the metros and a reputable vehicle leasing company/companies.
CoT and CoE make use of large numbers of 'outsourced' RELs (incl. drivers, and sometimes also crews) daily.	The use of 'outsourced' REL's should only be used as emergencies and not as standard practise, unless outsourcing of waste collection services is undertaken based on sound tender letting.

7.5 Garden Waste Sites

The table below details gaps and needs associated with garden waste sites.

Table 7-8: Garden waste and transfer stations gaps and needs

GAPS	NEEDS
The garden waste drop-off facilities are predominantly positioned in previously advantaged suburban areas, and are very few and far apart in the populous previously disadvantaged townships.	Appropriate garden waste drop-off facilities are to be accessible to all income levels within the metros. *It is however important to note that the type of facility will depend on the waste volumes nd categories generated, as well as the means of transport available to members of the community.*
The poor distribution of garden waste drop-off facilities is exacerbated by the issues of spatial constraints and land	During positioning and development of garden waste drop-off facilities for all income levels, cognisance is to be taken of

availability in the light of the rapid population growth in the metros.	the mode of transport available to members of the community. The access height of the container is also important where waste is transported by wheelbarrows or carried by children.
Some garden waste sites not suitably sized or laid out, leading to vehicle congestion, and overflowing skips/containers.	Identify 10 busiest garden waste sites and assess whether a layout change or increase in overall size is appropriate/feasible.
Some garden sites not operated conscientiously or adequately maintained.	As contact points between residents and metros, garden sites should be user-friendly, tidy, hygienic, and safe places. Management of the sites should therefore reflect the metros image in the most positive light.
Transport of bulky, uncompacted garden waste is resulting in poor payloads, requiring more human and financial resources, thus making the transport thereof more expensive.	Determine the feasibility of having bulky items like pruning's and branches chipped at the garden waste facilities for cost effective transport thereof over long distances.
Compostable materials are transported to landfills for disposal, resulting in more airspace being consumed whilst methane greenhouse gasses are generated.	Negotiate and enter into agreements with private composting facilities for chipped garden waste to be transported to such facilities for composting rather than disposal.

7.6 Separation at Source

The table below details gaps and needs associated with separation at source.

Table 7-9: Separation at source gaps and needs.

GAPS	NEEDS
Contributions (financial or otherwise) made by the metros towards separation at source programmes (i) are not aimed at getting the best value for money, and (ii) do not seem to be related to the avoided costs through savings in landfill disposal costs.	As part of the design of waste minimisation programmes, feasibility studies should be undertaken to determine what the unit cost for the recovery of waste will be for a proposed programme. Contracts for the implementation of such services should only be awarded where the potential benefits are aligned with the costs due to be incurred.
The public is often unaware of methane generated by organic waste and the negative impact of methane on the ozone layer.	Public awareness is to be created around the potential impact of methane generated by organic waste on the environment. Waste is to be effectively separated at source, with composting facilities provided to treat organic waste in an environmentally sound manner.

GAPS	NEEDS
There is little emphasis on backyard composting as a means of reducing the organic waste stream going to landfills. No guidance (or equipment) is made available to homeowners to implement backyard composting programmes.	With organic waste separated at source, backyard composting will significantly reduce the amount of organic waste to be collected and transported to landfills. This will subsequently reduce the methane generation rate at landfills.
Recent studies undertaken revealed that there is a high proportion of garden (organic) waste generated in medium to high income areas, with a similar trend in food (organic) waste generated in low-income areas. This does not seem to be considered during organic waste diversion programmes.	Despite the organic waste streams from different income areas being different, the potential impact of all organic waste on the environment remains significant. Appropriate systems are, therefore, to be developed for effective and environmentally sound management and treatment of organic waste from all income categories.
There are insufficient markets to absorb all the recyclables and compostable materials available for extraction from the waste stream. This is likely to result in a drop in prices for the commodities, making it even more difficult for such processes to be financially viable.	With appropriate markets created for the offtake, recycling and composting will become financially viable. This will allow for a significant increase in the extent to which such activities are undertaken in the metros.
Cognisance is not taken of Maslow's Hierarchy when voluntary separation at source programmes is implemented, resulting in low participation rates by some members of the community.	The socio-economic conditions of the affected community should be taken into consideration when decisions are made on how waste separated at source is to be collected for different income groups.
There seems to be little coordination/cooperation between the metros (as the organic waste 'generator' collecting from residents) and the private composting operations that need a source of organic material.	Metros to take cognisance of the offtake for recyclable and compostable material in the area, using that as a basis for the development of waste minimisation programmes.
Facilities provided for separation at source are not always effectively serviced, with material separated at source for recycling ultimately sent for disposal.	Source separated recyclables and organic materials are to be collected at regular intervals for transport to appropriate processing facilities. Poorly serviced containers will result in waste spillage and windblown litter.
Readily accessible buyback centres are not always positioned based on environmental and socio-economic conditions.	Locations of buyback centres developed to purchase source-separated recyclable material should be selected based on environmental and socio-economic conditions, thereby meeting the needs of the community that the facility is expected to serve.

7.7 Collection of recyclable waste

The table below details gaps and needs associated with the collection of recyclable waste.

Table 7-10: Collection of recyclable waste gaps and needs

GAPS	NEEDS
Collection routes are designed to ensure effective round collection, but the late placing of waste containers is delaying collection.	Public to be aware of the waste collection schedule, with the waste collection trucks keeping to the proposed schedule. Waste collection vehicles should not wait for individual waste bins.
Heavy/large containers are on wheels, with loading mechanisms provided on REL trucks. Without loading mechanisms, waste cannot be collected from such containers.	It is to be ensured that waste containers are compatible with waste collection vehicles, even where replacement/backup RELs are used.
Plastic liners of inappropriate thickness for the waste type and density results in waste spillage. Damaged containers are also causing spillage.	It is to be ensured that waste receptacles used are compatible with the type and density of waste generated, and that damaged/unserviceable containers are replaced.
Bulk containers, like skips, are sometimes not serviced (emptied) when full. This is resulting in waste spillage, windblown litter, and/or waste inside the bulk containers being set alight.	It is important that bulk containers be serviced at regular intervals based on the storage capacity of the container(s) and the waste generation rate in that area.
Illegal dumpsites are often developed in the vicinity of recently closed landfills. This is partly aimed at providing informal waste pickers with a continued source of recyclable material and partly for the illegal operators to generate an income from waste being disposed of at such facilities.	The underlying causes of illegal dumpsites are to be determined, with the core reasons addressed. There is also a need for increased public awareness programmes on responsible waste management by all members of society.
Recyclable Waste	
Waste is not always effectively separated at source where separate collection programmes are implemented.	Effective awareness creation programmes are to be implemented for waste generators to understand and embrace the concept of source separation.
The communities where separation at source programmes are implemented are not always prepared to recycle without a financial incentive. This is very prominent in low-income areas.	It is important that the recycling programmes be tailored in accordance with the socio-economic conditions where the recycling is to be undertaken. Buyback centres should be made accessible where voluntary drop-off facilities cannot be implemented effectively.
Procurement of reusable/disposable bags used to collect recyclable materials is not always cost-effective, thus impacting the financial viability of the system.	Feasibility studies are to be undertaken on all components of recycling programmes to ensure their financial viability and subsequent sustainability.
Households participating in source separation programmes are not always serviced as per the agreed schedules, and this is having a negative impact on ongoing participation by households.	Collection of source-separated recyclable materials should be consistent and punctual to ensure its continued support by households.
Buyback Centres	
Recyclable waste not separated at source makes it difficult and time-consuming for waste pickers to do daily collections from	Waste should be separated at source, even if there is no formal collection system, with recyclable materials placed in shopping bags

GAPS	NEEDS
individual waste bins, thus reducing their productivity and requiring them to spend more time in a residential suburb.	adjacent to waste receptacles on waste collection days. This will allow waste pickers to collect recyclables without the need to scratch through refuse bins placed on sidewalks.
The viability of recycling is extensively influenced by fluctuating market prices for various recyclable materials.	Recycling should be implemented with the aim of developing buffers against price fluctuations, e.g., by undertaking multi-material recycling that can provide some buffer against market price fluctuations on any one product.
Members of low-income communities are mostly not interested in participating in recycling projects if there are no financial benefits through the sale of recyclable materials separated at source.	Buyback centres should be made accessible to communities where voluntary drop-off facilities cannot be implemented effectively.
The waste pickers do not always have a means of transporting recyclable materials from the source to the buyback centres, resulting in them having to pull their trolleys over long distances.	Coordinated programmes are to be developed for integration of waste pickers into the formal waste sector, thereby providing opportunities for waste pickers to make use of combined infrastructure.
Waste pickers are, in many instances, sorting their waste in front of buyback centres, resulting in discarded waste being left on sidewalks, resulting in various nuisances and health risks.	Sorting of waste should not be allowed in any public places or open spaces.

7.8 Material Recovery Facility (MRF) and Recyclable material processing

The table below details gaps and needs associated with MRFs and Recyclable material processing.

Table 7-11: MRF gaps and needs.

GAPS	NEEDS
MRF	
The financial viability of MRFs is influenced by the quality of feedstock received. Without a constant supply of source-separated recyclable materials, there is a strong possibility of such facilities not being financially viable and sustainable.	Ensure that there are effective source-separation programmes in place to provide high-quality feedstock to MRFs, thus increasing their financial viability and sustainability.
Fluctuating market prices of the various recyclable materials impact the financial viability of recycling. This is, amongst other factors, impacted by local and international demand for materials, the ZAR exchange rate, crude oil price, etc.	It is important that the recycling programmes be tailored in such a manner that they will be financially viable. This could, amongst others, be achieved through financial contributions made by municipalities for avoided costs by not having to collect and dispose of waste recovered for recycling.
Production quotas are not always implemented for workers appointed to sort	For recycling infrastructure to be used optimally, it is important that production

waste at MRF's. This is, in some instances, having a negative impact on production rates.	targets be set, monitored, and maintained throughout recycling operations.
Recyclable material processing	
Effective quality control systems are not always maintained during the sorting of plastics into the seven categories, thus resulting in low quality recycled products, in turn, making the use of recycled materials less attractive. This is, among other factors, due to mixing of plastics with different chemical compositions.	Plastics should always be sorted into the seven categories, without intentional/unintentional mixing of plastics from different categories. Poor quality assurance will ultimately reduce the value of the recycled products and thus reduce the demand for such products.
Insufficient throughput of recyclable plastics at plastics processing plants is often resulting in processing plants not being financially viable, especially where high capital investments are required.	Feasibility studies should be undertaken to determine whether there are sufficient plastics of the same category available to ensure long term sustainability of capital investments made.

7.9 Waste Disposal

The table below details gaps and needs associated with waste disposal.

Table 7-12: Waste disposal gaps and needs

GAPS	NEEDS
The main challenge at the metros waste landfill sites remains the availability of airspace for the disposal of waste generated. A further concern is the fact that the rate of disposal is not equal throughout the metros sites and the remaining airspace on some landfills is depleted rapidly.	Short to medium-term: Waste transfer stations (WTS) need to be constructed at various facilities. From these facilities waste needs to be hauled to private (legally compliant) landfills for final disposal. Long term: A new landfill(s) needs to be developed to cater for all or most of the waste generated in the metros; design life of new landfill(s) to be a minimum of 30 years. Additional WTSs to be constructed as required by each of the metros
Waste-disposal tariffs are not fully cost-reflective.	Tariffs should be set at levels that will recover all direct and indirect (overhead) costs associated with operation of the landfills and the costs associated with disposal of hauled waste at private landfills. Tariffs should also take cognisance of the development cost of new airspace, and of the end-of-life costs associated with capping and rehabilitation of the landfill.

7.10 Waste Transfer

The table below details gaps and needs associated with waste transfer.

Table 7-13: Waste Transfer

GAPS	NEEDS
The CoT's and CoE's waste transfer stations are often not operational. This is resulting in waste having to be transported with RELs over long distances, which is uneconomical and unproductive. There are two transfer stations and nine garden refuse transfer station.	Operational problems are to be addressed for existing waste transfer stations are to be reopened for more cost effective transport of waste over long distances.

7.11 Waste Pickers and the Informal Waste Sector

The table below details gaps and needs associated with waste pickers and the informal sector.

Table 7-14: Waste pickers and the informal waste sector gaps and needs

GAPS	NEEDS
Institutional	
The needs of waste pickers are currently not considered, despite claims of them being represented by democratically elected bodies.	Waste pickers should be incorporated into formal bodies to ensure that there is an organised system for collection of recyclables.
Informal waste pickers are, in some instances, required to pay 'royalties' to criminal elements for the 'right' to do informal waste picking at landfills.	The risk of informal 'landlords' being active on municipal landfills should be investigated and the necessary action taken against people illegally demanding money from waste pickers.
Informal buyers of recyclable materials are forming cartels to manipulate the pricing structure.	On-site buy-back centres for mixed recyclables will allow waste pickers more time for waste recovery and eliminate offsite transport costs. Such mixed recyclables are then to be transported to organised low-technology sorting facilities.
Undocumented waste pickers (often illegal immigrants) lead to overcrowding of landfills.	Waste pickers that are illegal foreigners should be required to register with the Dept of Home Affairs and obtain temporary work permits.
Overcrowded landfills and unfair competition for access to materials pose a threat to women and older waste pickers.	The number of waste pickers on all fenced and secured landfills is to be controlled, with women and the elderly given preference at organised sorting facilities.
Informal sorting and storage of recyclables at landfills is interfering with landfill operations.	Waste picking at landfills should be prevented by encouraging source separation of waste. Where still required,

GAPS	NEEDS
	waste picking on landfills should be organised.
Recyclable waste is unnecessarily taking up airspace (capacity) on landfills that are, in most instances, already reaching capacity.	Waste minimisation should be effectively increased to reduce the volume of waste going to landfills, whilst at the same time conserving natural resources.
Disposal of materials that could have been recycled is resulting in REL waste collection vehicles having to undertake more trips to and from the landfills, during which time waste collection teams are unproductive.	The various benefits of waste minimisation should be recognised, and financial benefits gained from this should be utilised to further increase initiatives aimed at minimising the volume of waste going to landfill.
Despite an international drive towards protection of the environment through waste minimisation and conservation of natural resources, there are limited/no recycling facilities for waste from secured residential, commercial, and industrial areas. This results in natural resources being lost when disposed of at landfills.	Source separated materials from secured areas are to be: (i) placed in separate bags for collection by approved/accredited service providers, or (ii) delivered to secured central drop-off facilities from where it is to be collected by approved/accredited service providers.
Recyclable material from secured residential, commercial, and industrial areas is only becoming accessible to landfill waste pickers once the materials are contaminated, resulting in its value being significantly reduced.	Recyclable material that is source-separated and collected from secured areas will remain clean and therefore have a higher value.
Despite the the Bylaws requiring waste separation at source, there is currently no incentive (positive or negative) encouraging ratepayers to separate recyclable materials at source.	The opportunity exists for municipalities to issue ratepayers with smaller (say 130-litre) wheelie bins in areas where the public has access to safe recyclable material drop-off facilities, also providing them with a financial incentive for having to collect waste from smaller receptacles.
Security Risks/Nuisances	
Due to a perceived security risk, waste pickers are often harassed by formal residents and security guards. Waste pickers are often also considered to cause nuisances due to waste spillage on sidewalks. Waste picking is therefore mostly not supported by formal residents.	Participation in source separation by members of the community will speed up collection of recyclable materials in the neighbourhood. Recyclable materials are to be placed in shopping bags next to wheelie bins on the day of collection. Community engagement is required to promote collection of source-separated recyclable material by waste pickers.
Waste frequently accumulates at informal waste picker sorting and storage areas - situated in open spaces near residential, commercial, and industrial areas. It may also result in the erection of informal dwellings. This can cause nuisances,	Official sorting and storage areas for recyclable waste will prevent the risk of scattered waste, windblown litter, and pollution of the environment.

GAPS	NEEDS
various forms of pollution and a security risk to the formal community.	
Non-recyclable/low value waste is often dumped and sometimes burnt in the vicinity of, amongst others, residential areas, thus creating environmental risks due to spillage, windblown litter and various forms of soil, water, and air pollution.	Official sorting and storage areas for recyclable waste will prevent the risk of scattered waste, windblown litter, and pollution of the environment.
There are informal sorting activities on landfill sites, as well as in proximity of landfills where non-recyclable waste is dumped and sometimes burnt, resulting in various forms of pollution	Official sorting and storage areas for recyclable waste will prevent the risk of scattered waste, windblown litter, and pollution of the environment.
Sorting of recyclable materials is often done outside buyback centres, with non-recyclable materials remaining on sidewalks.	Official sorting and storage areas for recyclable waste will prevent the risk of scattered waste, windblown litter, and pollution of the environment.
There is a security risk with buyback centres paying waste generators/waste pickers in cash for sorted recyclable materials, delivered to it before the material is bulked.	It is preferred that waste pickers be given access to a cell-phone App that will allow for payments to be made electronically, preventing the need for cash to be handled by either the buyback centres or the waste pickers.
Access to Services	
There is limited/no access to clean potable water or ablution facilities where waste picking is done from waste receptacles placed on the sidewalks for collection in unsecured residential, commercial, and industrial areas.	Formalisation of the street waste picking will speed up the collection process in any suburb and will provide the opportunity for some essential facilities to be provided to waste pickers.
There is limited/no access to clean potable water or ablution facilities where waste picking is done on uncontrolled landfills.	Formalisation of the landfill waste picking will provide the opportunity for some essential facilities to be provided to waste pickers.
Health and safety	
There are various health impacts to the pulling of trollies for extended periods of time and over long distances – even more so for women and the elderly.	By coordinating waste picking activities, it is to be ensured that waste pickers do not need to pull their trolleys over long distances; either transporting unsorted or sorted recyclables.
There are various health and safety hazards for waste pickers recovering waste on landfills.	Coordinate waste picking activities and provide on-site PPE and safety training for waste pickers operating on landfills.
Women and the elderly waste pickers are injured when pushed aside by younger/stronger men wanting to get first access to higher-value waste items.	With source-separated materials made available to waste pickers at the landfills, preference should be given to the elderly and women when providing access to recyclable materials.

GAPS	NEEDS
There is a risk of being injured or killed by vehicles when waste pickers are pulling trollies along busy roads.	Coordinate waste picking operations that will prevent the need for waste pickers to pull trollies along busy roads.
There is a risk of waste pickers being injured or killed by waste trucks or plant used on landfills.	Waste picking at landfills should be limited by making source-separated waste available to waste pickers. Health and safety awareness programmes should be introduced for the remaining waste pickers.
Waste pickers do not have personal protective equipment when collecting waste on streets, or when waste picking is done on landfills.	Waste picker systems in all areas should be coordinated in the sense that only registered people be allowed to participate in the programmes and that such people be issued with PPE once for it to be used on an ongoing basis.
There is a high health risk in the absence of occupational health measures.	By coordinating waste picking operations, occupational health awareness creation should be done, informing waste pickers of the risks associated with both their legal (and illegal) waste management activities, e.g., burning waste.
Coordination/Economies of scale	
Exceptionally long distances travelled by waste pickers pulling trolleys to get to collection areas, then transporting mixed recyclables to sorting areas, and then transporting sorted recyclable materials to buyback centres. Individuals undertake their operations independently, thereby losing the possible advantages of economies of scale.	Coordinated programmes are to be developed for integration of waste pickers into the formal waste sector, thereby providing opportunities for waste pickers to make use of combined infrastructure and services.
The uneven spread of buyback centre locations, together with variations in prices paid by different buyback centres, is resulting in sorted recyclable materials being transported over long distances by waste pickers.	There is a need for waste picking operations to be coordinated, which should also include the accessibility of buyback centres.
Waste pickers collecting recyclables in residential areas only fill one bag of material per day due to time lost by traveling over long distances.	There is a need for waste picking operations to be coordinated, which should also include the accessibility of buyback centres.
Buyback centres are often situated far from low-income communities that need to generate an income through the sale of recyclable materials, thus limiting the opportunity for them to generate an income.	There is a need for waste picking operations to be coordinated, which should also include the accessibility of buyback centres.
Limited volumes of recyclable materials at buyback centres result in material having to be sent to private MRFs for bulking and subsequent transport to recycling	Coordinate waste picking initiatives to achieve larger volumes of recyclable materials handled at selected facilities, which will, in turn, have an impact on the

GAPS	NEEDS
industries, thus reducing the income generated by waste pickers.	economies of scale and subsequently on the income generated by waste pickers.
Source separate off-cut materials from industries/packaging from businesses transported to buyback centres situated near/within residential areas is having an impact on surrounding communities.	Source separate off-cut materials from industries are to be transported to buyback centres located in industrial areas.
Recyclable materials not being separated at source in secured areas is resulting in such being contaminated with food waste and its value reduced.	Clean, high value recyclable materials are to be separated at source to generate additional income for waste pickers.

7.12 Illegal Waste Dumping

The table below details gaps and needs associated with illegal dumping.

Table 7-15: Illegal dumping gaps and needs

GAPS	NEEDS
Unavailability or inaccessibility of municipal waste transfer/disposal facilities.	
Illegal dumping and littering are serious challenges for the metros with a lack of by-law enforcement and lack of awarenesss and education exacerbrating the problem	Serious efforts will be required to address this problem and it will require coordination for a combined effort by the relevant municipal role-players
Residents sometimes need to discard excess waste, or waste not suitable for collection and transport by means of RELs, without access to suitable drop-off facilities.	Appropriate waste transfer/disposal facilities are to be provided based on the socio-economic conditions in the community it is to serve.
Not all residents have access to vehicles suitable to transport waste over long distances, resulting in waste being dumped illegally.	Appropriate waste transfer/disposal facilities are to be provided based on the socio-economic conditions in the community they are to serve.
People transporting waste by wheelbarrow, or children carrying waste to the bulk containers, may not make the effort required to dispose of the waste into containers with sides as high as 1.5-m above ground level.	Appropriate waste transfer/disposal facilities are to be provided based on the socio-economic conditions in the community they are to serve.
Where skips are not regularly serviced and subsequently overfilled, this inevitably results in waste being disposed of adjacent to the full skips or waste inside the skips alternatively being put on fire.	Skips are to be serviced in accordance with the rate at which it is filled with waste, or alternatively, more skips are to be provided (subject to cognisance being taken of the risk of odour generation).
Members of the public that have to transport some of their own waste to	Cognisance is to be taken of the mode of transport available to members of the

landfills sometimes experience long travelling distances or inaccessibility of such facilities from a logistical or safety point of view.	public having to dispose of waste. Where landfills are to be used, the disposal area should be accessible for passenger vehicles and must be secured.
Safety/security risks to members of the public during the time that waste is offloaded are resulting in such facilities not being used effectively.	Safety/security of members of the public is to be taken into consideration during the time that waste is offloaded.
By not having the required infrastructure at municipal waste drop-off facilities for disposal of all waste categories generated at households, it can result in waste streams not provided for at such facilities being disposed of illegally.	Cognisance is to be taken of the various waste streams generated by members of the community, allowing for all such waste streams to be disposed of at public drop-off facilities.
Illegal dumping is not only costly to remove, but it is also resulting in pollution to the environment that can have health impacts. For instance, where the waste disposed of may attract pests/rodents.	Illegal dumping is to be prevented, even though it will require both capital and operational expenditure.
Closure of local landfills disrupting access to recyclable materials.	
There is a tendency for closure of landfills not only to result in limited ad hoc or arranged illegal dumping in an area near the closed landfill, but it is also resulting in the establishment of informal landfills.	Where landfills are to be closed, provision should be made for (i) public drop-off facilities in the vicinity and (ii) for alternative sources of recyclable waste to be made available to people that reclaimed waste at the landfill.
With the disposal fees at informal landfills described above being much lower than that of formal, legally compliant landfills, it tends to attract waste from small commercial waste transporting companies for disposal at such facilities.	Strict action is to be taken at an early stage to detect and prevent the development of informal landfills near formal landfills that are to be closed.
Clearing the waste from informal landfills (rather than illegal dumping) becomes very difficult; if possible.	Strict action is to be taken at an early stage to detect and prevent the development of informal landfills near formal landfills that are to be closed.
With vast volumes of waste accumulated in areas where illegal landfills were established, leachate generated at such facilities creates a significant risk to the environment.	Strict action is to be taken at an early stage to detect and prevent the development of informal landfills near formal landfills that are to be closed.

8. SUMMARY CONCLUSION

In summary with respect to all 3 metros the following is highlighted:

8.1 Landfill Findings

Although there are several shortcomings with the design, construction, and operation of municipal landfills in Gauteng, the following discussion is aimed at highlighting the most prominent shortcomings:

- Shortage of landfill airspace available to metros is of real concern due to financial implications of licensing and development of integrated waste management facilities, as well as the timeframes required to establish such facilities.
- Limited use of private landfills by metros - often not taking high transport costs to distant municipal landfills into consideration. During the comparison of municipal landfill costs to that of private landfills, not all landfill costs are taken into consideration on municipal landfills. This is also resulting in waste disposal fees charged at municipal landfills not being cost reflective.
- Insufficient waste is diverted from landfills. This is, to some extent, due to a lack of recycling, composting and C&DW processing facilities, but it is also influenced by the costs associated with the operation and maintenance of such facilities in relation to the market demand for, and the value of the offtake. Effective diversion of such waste streams will have a significant impact on conservation of airspace on municipal landfills.

- **All Gauteng Metro Landfills**

Although the metros in Gauteng do not allow for municipal collected waste from neighbouring metros to be disposed of on their landfills, it is important to consider the location of the existing metro landfills from a provincial perspective. The remaining landfills (excluding Onderstepoort, which was recently closed), are all indicated in the figure below. It is important to note that the remaining metropolitan municipal landfills are all situated towards the north and the south of the densely populated urban areas.

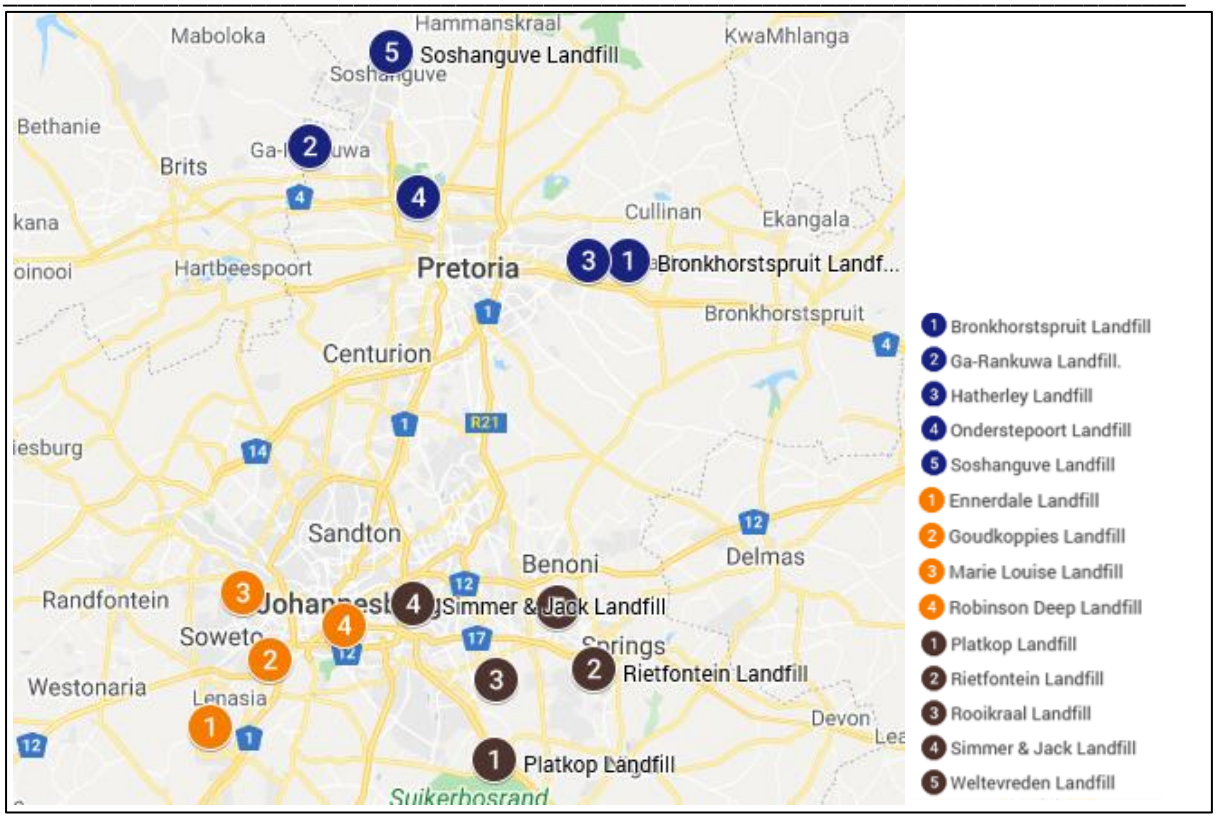
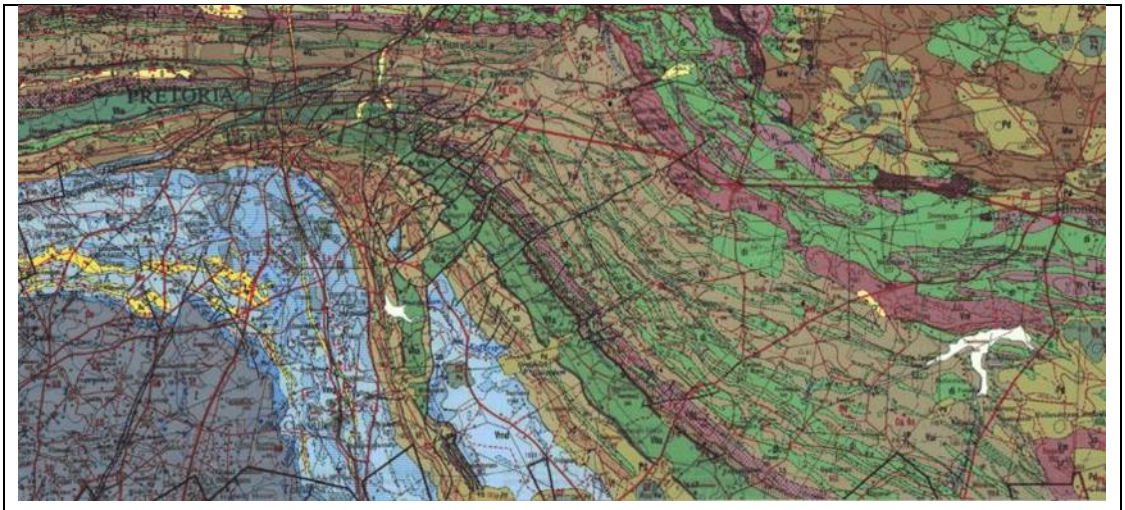


Figure 8-1: ***The remaining metro landfills are situated towards the north and south of the province, with no landfills in the Centurion/Midrand/Tembisa area. The situation created the need for an integrated regional waste management facility to be developed in the Centurion/Midrand/Tembisa node, capable of treating recyclable waste, compostable waste and C&DW from the three neighbouring metros. The remaining tailings are to be disposed of on a landfill forming part of the integrated waste management facility.***

Despite the demand for such an integrated waste management node between the three metros, it is important to take cognisance of the fact that the area under investigation is, due to the presence of dolomite, from a geological point of view not ideal for development of a landfill. With the dolomitic areas on the geological map in the figure below indicated in light blue, it is evident that cognisance be taken of this potential risk during the integrated waste management facility site selection process.



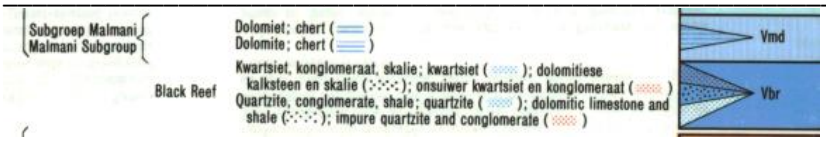


Figure 8-2: 250 000 Geological Series – 2528 Pretoria, indicating the areas between Tembisa, Centurion and Midrand that are underlain by dolomite - indicated in light blue.

Based on the current waste disposal rates recorded at the existing landfills in the 3 Gauteng metros, and assuming that no new metro landfills are developed over the next five years, it is expected that by the end of the decade, i.e. by 2030, the only remaining metro owned landfills in Gauteng will be Hatherley in CoT, as well as Weltevreden, Rooikraal and Platkop in CoE. *The situation will, however, be aggravated due to {i) the 'domino effect' when waste from closed landfills is diverted to the remaining operational landfills, (ii) if landfills are to be closed early due to land invasion, or (iii) if landfills are to be closed due to environmental risks created by poor landfill operating conditions.*

The positions of the 4 metro landfills expected to remain in Gauteng by 2030 are indicated in the figure below.

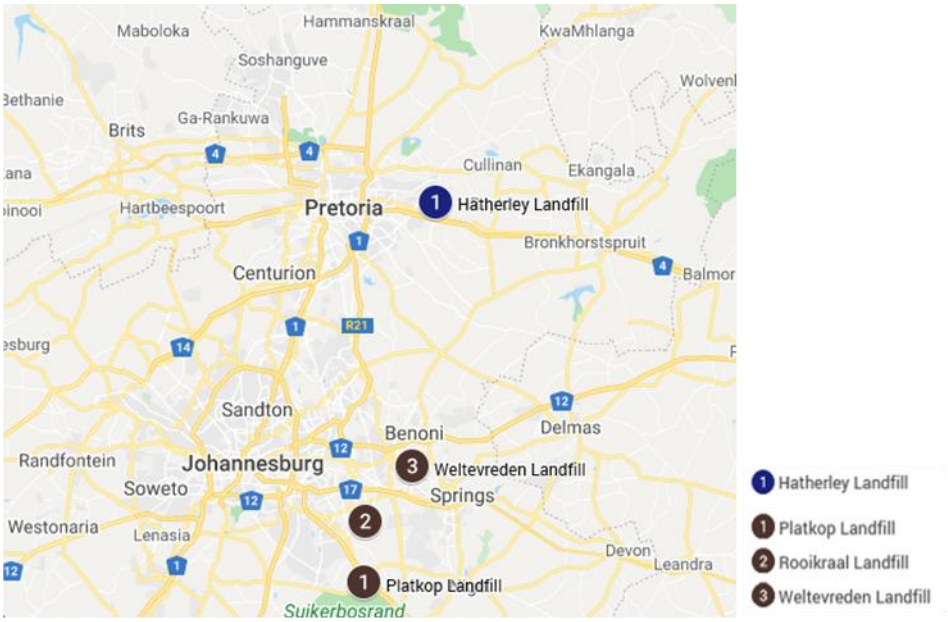


Figure 8-3: The only four metro landfills potentially being in operation by 2030. External factors may however result in earlier closure of these landfills.

Investigations on the operations of metro landfills in Gauteng over several years indicate that landfill management is not in compliance with the required standards – resulting in various environmental, health and safety impacts on the surrounding areas. Further, there are poor standard of waste management at Gauteng metro landfills as evidenced by poor plant management resulting in wasteful expenditure, absence of weighbridges, poor landfill operations resulting in environmental health and safety issues, significant amounts of garden waste disposed of on landfills is resulting in the generation of large volumes of methane.

From the above, it is evident that there is an urgent need for the development of an integrated waste management facility in Gauteng that can accommodate all processable and remaining disposable waste generated in the three metros.

8.2 Preliminary High Level Action List

Below is an indication of a high level action list to undertake:

Short term:

- Address problems with operation of existing waste management services and infrastructure (including landfills) at Metros.
- Negotiate and enter into airspace procurement agreements with private landfill owners.

Medium term:

- Implement waste diversion systems and construct strategically positioned transfer stations throughout the Metros.

Long term:

- Implement (and sustainably operate) Regional Integrated Waste Management Facility/Facilities in Gauteng.

9. SWOT ANALYSIS

A SWOT analysis was conducted for the 3 metros generally covering these key components: :

- Waste diversion;
- Waste collection;
- Landfills;
- Waste transfer;
- Legislative tools;
- Budgeting and financing

The full SWOT analysis report is attached as Annexure A in the Master Report

10. SITE IDENTIFICATION

A site identification process was undertaken to identifying candidate sites for development of integrated regional waste management facility for CoJ, CoE and CoT, started with development of a system for site identification. More detailed information on the site identification is contained in Annexure B in the Master Report.

Step 1:

Process of negative mapping was utilised, with Google Earth maps as the baseline information. The items below, amongst others are some of the prominent **fatal flaws** listed in *Minimum Requirements*:

- Water courses with associated 1:50 year flood plains;
- Wetlands;
- Dolomitic land;
- Protected areas/preserved natural areas (parks, reserves etc.);
- Airports

Step 2:

A scoring matrix was then used with the following elements as the base:

- Waste capture potential
- Property size (future development)
- Access to highway
- Dolomite detection
- Current land use
- Purchase affordability
- Accessibility from adjacent roads
- Site slope
- Development cost

Taking into consideration that the facility must ideally be centralized in a node between the three Metro’s of CoT, CoJ and CoE, a 35km radius was used to eliminate outlying sites. The figure below illustrates all the sites identified as part of the desktop study:

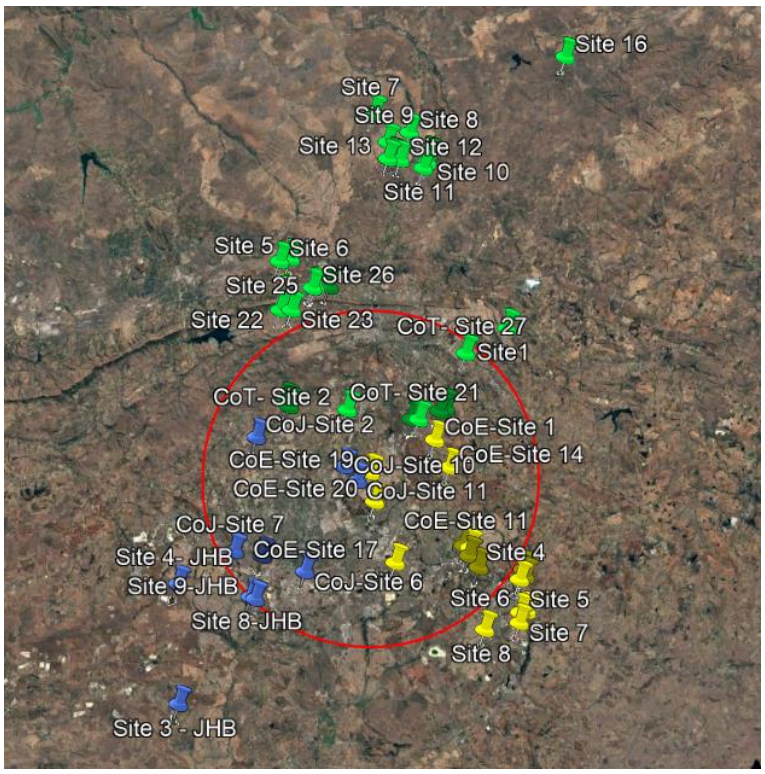


Figure 10-1: Site identifictaion

The top 5 sites identified within the 35km radius from no. 1-5 using a scoring matrix. These included the following as per diagram below:

1. **CoE Site 20** – The site was chosen due to its arid nature and proximity to industrial areas. The location between the CoJ and CoE node was considered. Previous used as an ash dump.
2. **CoJ Site 11** - The site was chosen due to the close proximity of highways, the nature of the site being scarred and the centralized location between the three Metro’s.
3. **CoJ Site 1** -This site was chosen due to its proximity to major roads and the disturbed land due to quarrying.
4. **CoT Site 2** - the site was chosen due to quarrying activities and the close proximity of the site to the N1 highway. The site is centralized between the three Metro’s.
5. **CoT Site 3** - the site was chosen due to quarrying activities and the close proximity of the site to the N14 highway.

11.KEY STAKEHOLDERS AND CAPACITY TO UNDERTAKE THE PROJECT

It is critical that there is sufficient capacity and commitment to move this project forward. There are a number of key stakeholders and there is a need for them to all be participants in ensuring the success of this project.

Key Stakeholders

There are a number of key stakeholders to this project with the key stakeholders being:

Table 11-1: Key stakeholders

STAKEHOLDER	ROLE AND RESPONSIBILITY
GDARDE	Institution promoting and guiding the project Provincially responsible for waste
City of Tshwane Metropolitan;	Legally responsible for waste in the metropolitan
City of Johannesburg	Legally responsible for waste in the metropolitan
City of Ekurhuleni	Legally responsible for waste in the metropolitan
Pikitup	Service provider to City of Johannesburg to assist with waste

11.1 OVERSIGHT AND MANAGEMENT OF THE ASSIGNMENT

11.1.1 Project Steering Committee

The PSC has been established by the key organisations that are partners in the project, namely the metropolitan municipalities. The PSC comprised members from:

GDARDE (Project Lead)
GDARDE: Infrastructure Development
GDARDE – Impact Management
GDARDE: Legal Services
GDARDE – Air Quality
GDARDE - Environmental Policy Planning and Coordination
GDARDE – Pollution and Waste Management
City of Tshwane Metropolitan
City of Ekurhuleni
City of Johannesburg
Pikitup

Purpose and Objective of the PSC:

The terms of reference for the PSC indicate that the established PSC members will serve as representatives of their respective organisations with the primary objectives being to:

- Guide the project
- Provide technical inputs
- Oversee progress to get the project to its successful conclusion.

Primary roles of the PSC

- Review reports
- General project execution oversight
- Review of project schedule/programme and budget
- Pre-feasibility study/report endorsement
- Feasibility study endorsement
- Project monitoring.

Role of Metropolitan Municipalities:

The participating three Metropolitan Municipalities are key stakeholders in this project, and the key roles include the following:

- Promote networking, public and private sector partnerships
- Technical and information support
- Review project progress
- Facilitate stakeholder management.

11.1.2 Project Team (PT)

A Project Team was established to act as the administrative body for the PSC. Its key role being:

  - Overall project management and oversight
  - Prepares plans and budget
  - Project secretariat
  - Appointing of the Service Provider for the Pre-Feasibility Study
  - Appointing of the Transaction Advisor for the Feasibility Study.

12. LEGISLATIVE AND REGULATORY ENVIRONMENT

It is important to review the legal and regulatory environment to determine whether or not the project to establish an Integrated Regional Waste Management Facility in the Midrand/Centurion/Tembisa Node with participation from the three Metros: City of Johannesburg, City of Tshwane, and the City of Ekurhuleni is aligned and is within a legal and strategic framework.

As part of this legal due diligence, there will be a review of the applicable legislation and regulations.

In terms of Chapter 3 of the Waste Act 59 of 2008 places a responsibility on all spheres of government to develop an IWMP. In terms of section 11(4) (a) (ii) of the Waste Act, the municipality must incorporate the approved IWMP in the IDP, as per requirements of chapter 5 of the Municipal Systems Act 32 of 2000.

This section describes the legal framework of the IWMP. Historically, the management of waste defined by various pieces of legislation governed by different government departments results in gaps and poor waste management practices. Of the waste defined by various pieces of legislation, government departments result in gaps and poor waste management practices. Other pieces of legislation, such as the National Water Act 36 of 1998: Hazardous Substance Act 15 of 1973, Occupational and Safety Act 85 of 1993, and The National Environmental Act, define how waste is managed within municipalities.

There is a myriad of legislation which have relevance to waste management in South Africa. Below are the key national, provincial and municipal pieces of legislation and policies relevant to this study. This section considers the following:

- first, the national legislative framework, policies, and strategies;
- secondly, the provincial legislative framework, policies, and strategies; and
- the municipal/local government legislative framework.

12.1 National Legislation

Constitution of South Africa

The Constitution of the Republic of South Africa (Act 108 of 1996) is the supreme law of the country and provides the legal foundation of the country. As such, no government policy or plan will be complete without reference to the relevant sections in the Constitution.

The Constitution makes the three spheres of government, national, provincial and municipal legislatively responsible for waste management. Section 146 of the Constitution assigns concurrent legislative competence to national and provincial governments with respect to the environment and pollution control.

In Section 24 of the Bill of Rights, it states that:

Everyone has the right to -

(a) an environment that is not harmful to their health or well-being; and
(b) have the environment protected, for the benefit of present and future generations, through reasonable legislative and others.

Waste management service delivery is a local government function in terms of Schedule 5B of the Constitution of the Republic of South Africa (RSA, 1996). Furthermore, Section 152(1) of the Constitution states that one of the responsibilities of local government is to ensure that the provision of services to communities is done in a sustainable manner.

National Environmental Management Act (NEMA), Act 107 of 1998

The NEMA is the legislative framework that provides environmental protection. The environmental management principles, as outlined in this Act, form the basis for dealing with environmental issues in South Africa.

The overarching principle is stated to be sustainable development, while the more specific principles addressing waste management are:

- "Polluter pays"- those responsible for environmental damage must pay both the costs to repair the damage to the environment and human health as well as the cost associated with preventative measures to reduce or prevent further pollution or environmental damage.
- "Cradle-to-grave"- responsibility for the environmental health and safety consequences of a policy, program, project, product, process, service, or activity that exists throughout its lifecycle. It starts with conceptualization and planning and runs through all stages of implementation to reuse, recycle and ultimately the disposal of products and waste or decommissioning of installations.
- "Precaution"- the government will apply a risk-averse and cautious approach that recognises the limits of current knowledge about the environmental consequences of decisions or actions.
- "Waste avoidance and minimisation"- waste management must minimise and avoid the creation of waste at source, especially in the case of toxic and hazardous waste. Government must encourage waste recycling, separation at source and safe disposal of unavoidable waste.

National Environmental Management: Waste Act (NEMWA), 59 of 2008

In terms of the National Environmental Management ("Waste Act"), a municipality must exercise its executive authority to deliver waste management services, including waste removal, waste storage and waste disposal services, in a manner that does not conflict with the Waste Act.

Each municipality must exercise its authority and perform its duty in relation to waste services, including waste collection, waste storage and waste disposal services, by:

- Adhering to all national and provincial norms and standards.

- Integrating its waste management plans with its integrated development plans.
- Ensuring access for all to such services.
- Providing such services at an affordable price, in line with its tariff policy in accordance with the Municipal Systems Act.
- Ensuring sustainable services through effective and efficient management.
- Keeping separate financial statements, including a balance sheet of the services provided.

The National Health Act

The National Health Act of 2003 defines "municipality health services "to include water quality monitoring; food control; **waste management;** health surveillance of premises; surveillance and prevention of communicable diseases, excluding immunizations; vector control; disposal of the dead; and chemical safety, but excludes port health, malaria control and control of hazardous substances.

12.2 National Standards and Regulations

National Domestic Waste Collection Standards

The National Environment Management: Waste Act stipulates that standards are required to "give effect to the right to an environment that is not harmful to health and well-being of the people." The standards (DEAT, 2009), stipulate the levels as varying between:

(a) On-site appropriate and regularly supervised disposal (applicable mainly to remote rural areas with low density settlements and farms supervised by a waste management officer);
(b) Community transfer to central collection point (medium density settlements);
(c) Organised transfer to central collection points and/or kerbside collection (high density settlements); or
(d) Mixture of 'b' and 'c' above for the medium to high density settlements.

The standards also stipulate waste collection in terms of:

a) Separation at source: all domestic waste must be sorted at source.
b) Collection of recycling waste: the municipality must provide an enabling environment for households to recycle domestic waste.
c) Receptacle: Receptacle for the storage of non-reusable and non-recycle domestic waste.
d) Receptacle: Receptacles for the storage of non-reusable and non-recyclable waste must be easily distinguishable from those storage of recyclable waste.
e) Bulk Containers: Bulk containers for the storage of non-reusable and non-recyclable waste must be easily distinguishable and in addition, they must be fitted with reflectors and where appropriate be placed next to a platform for ease of access.

f) Communal collection points: These must be clearly demarcated areas with appropriate receptacles where household waste can be deposited for collection by the service provider/municipality.
g) Frequency of collection: Non-recyclable waste must be removed at least once a week, while recyclable waste must be removed at least once every two weeks.

Waste Information Regulations

The National Waste Information Regulations of 2012 give effect to section 60 of NEMWA and regulate the procedure and criteria for the submission and processing of applications to register on the National Waste Information System, referred to as SAWIS. This regulation is supported by the Gauteng Waste Information System (GWIS).

Waste Tyre Regulations

The Waste Tyre Regulations (No. 31901 of 2009) are designed based on Section 24C of ECA (Act No. 73 of 1989). These regulations are intended to regulate the handling, storage, and disposal of used tyres and to be included in IWMPs for enforcement.

National Policies and Strategies

There are a number of policies and strategies applicable at national level including the following:

- **National Waste Management Summit: Polokwane Declaration**
- **National Policy Thermal Treatment of General and Hazardous Waste**
- **Free Basic Refuse Removal Policy**
- **National Waste Management Strategy**
- **Development of core set of Environmental Performance Indicators**
- **Municipal Structures Act (Act 117 of 1998)**
- **Municipal Systems Act (Act 32 of 2000)**

12.3 Provincial Legislation

The Gauteng Provincial Government (GPG) embraces the adoption and enforcement of all legislation dealing with the safe management, handling and transportation, treatment and disposal of waste, as well as the adoption of appropriate waste management standards and performance indicators with respect to all aspects of IWM to improve waste management service delivery.

At Gauteng provincial level, the relevant documentation on legislative frameworks and policy with respect to waste management includes the following:

- Gauteng Provincial Integrated Waste Management Policy (2006)
- First Generation Integrated Hazardous Plan for Gauteng (2008)

- Gauteng General Waste Collection Standards (207)
- Gauteng Waste Information Regulation (2004).

Gauteng Provincial Integrated Waste Management Policy

The GPG has developed an appropriate legislative regime to support and enable the Gauteng IWM Policy, and to foster consistency between national, provincial, and local waste management requirements, capacity building and filling of gaps in existing waste management regulations and requirements. Key issues addressed in this policy include the following:

- **Waste reduction minimisation**
  - **Waste Recovery and Recycling**
  - **Waste Collection and Transportation**
  - **Waste processing**
  - **Waste treatment and disposal**
  - **Waste information**

First generation integrated Hazardous Waste Management Plan for Gauteng

According to GDACE 2008, there are several major factors in the hazardous waste sector in the Gauteng Province that when acting in combination hamper integrated Waste Management and recycling and treatment of hazardous waste.

The factors are as follows:

- Recycling
- Lack of proper coordination
- Lack of proper waste separation at source
- Lack of testing and analysis facilities
- Lack of incentives
- Insufficient waste volume and a lack of economy of scale.

Treatment

- Lack of facilities
- Access to and location of existing facilities
- Limited comprehensive separation at source of hazardous waste
- Insufficient waste volumes and a lack of economy of scale.

In addition, the document records some of the key risks, such as the storage of hazardous waste on the premises of the waste generators without the necessary permit to do so.

12.4 Gauteng Provincial Standards and Regulations

Of importance to this assignment are the General Waste Collection Standards and Waste Information Regulations that the provincial government set in 2007 and 2004, respectively.

Gauteng General Waste Collection Standards

The following General Waste Collection Standards (GWCS) have been developed to ensure the provision of consistent, uniform waste collection and cleaning services which are equitable, appropriate, environmentally and socially acceptable to the communities in Gauteng. Section 152 (1) of the constitution (RSA, 1996) states that one manner. It indicates that provincial government has the exclusive responsibility to ensure that local governments carry out these functions effectively.

The standards are thus made up of two components, namely:

- Waste Collection (domestic and business/non-hazardous industrial waste); and
- Cleaning (street sweeping, litter picking, littering and illegal dumping).

In addition, the standards also cover other waste management activities and related issues such as health and safety, and transport.

Waste information Regulations

The GPG promulgated Waste Information Regulations in 2004 for the development of a Provincial WIS to:

a) enable GDACE to compile and make available- to the public and other organs of state –date and information regarding waste in the province, to further the protection of the environment and the continuous improvement of integrated waste management throughout the province
b) make information available to organs of state and the public regarding waste for
    I. education, research, and development
    II. spatial planning and environmental impact assessment
    III. public safety and disaster management
    IV. the development of waste streaming and the assessment of the quantities of various waste streams for monitoring government strategies for waste management
    V. state of the environment reporting
c) To create a uniform reporting method which incorporates secure internet reporting formats and monitoring intervals.

12.5 Local Level Legislation

Waste By-laws

The municipalities have waste by-waste by-laws that are currently operational. The by-laws were approved to give effect to the Constitution, the principles of NEMA and NEMWA. The

waste by-laws are specific in terms of the waste management service provided by the municipality and regulate those not provided by the municipality. They further address the participation of private companies and person in waste management services detailing the processes, conditions and requirements for permitting facilities. The waste by-laws cover the full spectrum of the waste hierarchy to ensure that all aspects of waste management are covered.

12.6 Summary and Conclusion:

The Waste Act, the NWMS, and the GDS strive for the reduction of waste to landfill, whilst advocating for hierarchical approach to waste management where first choice of measures in the management of waste is through avoidance and reduction. Where waste cannot be avoided, it should be recovered, reused, recycled and treated. Waste should only be disposed of at landfills as a last resort. The establishment of waste minimization infrastructure is still in very early stages in South Africa; therefore, municipalities are still highly dependent on disposing of waste at landfills.

This project is aligned with the legislation, regulations and international, national and provincial strategies, as it seeks to explore effective waste management through reuse, recycling, recovery and waste treatment.

13.TECHNICAL ANALYSIS

Based on the current shortage of landfill airspace (capacity) available to the City of Johannesburg (CoJ), City of Tshwane (CoT) and City of Ekurhuleni (CoE) Metropolitan Municipalities in Gauteng, ambitious (aggressive) goals must be set. Strategic goals are therefore divided into:

- Immediate: 1 year
- Short term: 2 to 3 years
- Medium term: 4 to 5 years
- Long term: 6 to 10 years.

Long-term goals relate to targets that extend beyond a 5-year period required for implementation. Long-term goals, for instance, decommissioning existing landfills and developing a new integrated waste management facility.

It is from the offset to be recognised that the successful development and operation of an integrated management facility/facilities entails much more than merely the erection of infrastructure. It requires the successful implementation of integrated waste management systems in each of the 3 metros. Such integrated waste management systems are required to source separate and supply high quality feedstock to the different components of the integrated waste management facility/facilities.

‘Clean MRFs’, with recyclable materials already separated at source, are, for instance, more viable than ‘dirty MRFs’ where recyclable materials (including paper and cardboard) are to be extracted from the mixed waste stream. Increased recovery rates and higher quality offtake will thus improve the recycling[8] process. The latter will, however, require that recyclable materials be separated at source for the 2 waste fractions to be collected and transported to MRFs and disposal facilities, respectively. Should incineration, in turn, be considered as part of a waste-to-energy process, it is important that combustible waste materials with higher calorific values be selected as feedstock, which is once again highlighting the need for integrated waste management systems to be implemented - starting at source, continuing through collection and transport, and extending to final treatment and/or disposal.

For such systems to be implemented in a financially viable and sustainable manner, the ‘desired-end-state’ for metropolitan waste management strategic goals is to be considered, with all underlying waste management systems integrated towards the achievement of such goals. For this study, the goals were developed in line with the National Waste Management Strategy (NWMS), 2020. It is further important that all metros agree on, and commit to, achieving the set strategic goals.

- **Goal 1:** Promote recycling and recovery of waste
- **Goal 2:** Ensure the effective and efficient delivery of waste services
- **Goal 3:** Ensure that legislative tools are developed to deliver on the Waste Act and other applicable legislation
- **Goal 4:** Sound budgeting and financing of waste management services

[8] Although ‘recycling’ is in terms of the definition only referring to the final processing of recovered materials, the term is, in general, used to describe the overall process and will, for the purpose of this study, be used in a similar manner.

- **Goal 5:** Ensure the safe and proper disposal of waste
- **Goal 6:** Education and awareness
- **Goal 7:** Compliance and enforcement.

Having undertaken the Situational Analysis in respect of waste management activities in the 3 metros and having agreed on a 'desired-end-state', the next step was to determine the 'gaps' that exist between the situational analysis and the 'desired-end-state', and the 'needs' that, if fulfilled, will facilitate achievement of the 'desired-end-state'.

The overall objective of the project is to achieve the set goals for development and continued operation of the Regional Integrated Waste Facility/Facilities "Ecopark/s" in Gauteng.

*When considering the Gauteng metropolitan landscape, mostly consisting of urban transport conditions between waste sources and any proposed treatment/disposal facilities, the following **3 Strategic Options** were identified, which are in turn achieved by implementing several **Operational Options[9] listed in Table 3-1.***

Strategic Option 1:

One integrated waste management facility provides the necessary waste minimisation, treatment, and disposal facility in Gauteng at a single location that is, from a logistical point of view, central to the 3 metros.

Strategic Option 2:

A single landfill in Gauteng that is, from a logistical point of view, central to the 3 metros, with the bulk of the waste minimisation and treatment facilities decentralised at several facilities aimed at ensuring shorter transport distances between waste sources and the minimisation/treatment facilities. Although this will result in lower transport costs for low-density material separated at source, the option is to be considered against possible loss in economies-of-scale forfeited by having several smaller and decentralised facilities.

Strategic Option 3:

All waste minimisation, treatment and disposal facilities are decentralised and positioned across the 3 metros to ensure shorter transport distances between waste sources and several integrated waste management facilities. Although this will result in lower transport costs for low-density material separated at source, the option is, however, to be considered against possible loss in economies of scale forfeited by having smaller decentralised facilities. Licencing more than one landfill can also be expected to be more complex than licencing a single centrally situated waste management facility.

A breakdown of the Goal Objectives generated for implementation of the Ecopark is presented in Appendix C in the Master Report with the Option Selection provided in Appendix D. It is important to recognise that the **operational objectives** identified are to be

[9] A series of integrated Operational Options are to be implemented as a means of achieving any one of the Main Options.

implemented under each of the **strategic options** listed above - all required to reach the respective **objectives**.

The following technology options were explored for possible inclusion in the regional integrated waste management facility.

During the final evaluation of the technologies, the following matters were taken into consideration:

- Waste streams accepted/dependent on effective waste separation at source.
- Input capacity ranges
- Typical outputs
- Purposes
- Indicative capital cost (with cognisance taken on financial risks)
- Indicative operational cost (with cognisance taken on financial risks)
- Life span
- Skills requirements
- Job creation opportunity
- Need for uninterrupted power supply
- Robustness and access to maintenance and spares.

Capital expenditure requirements were not verified according to the fluctuating ZAR/US$ exchange rate. With the current study only undertaken as a *preliminary feasibility*, detailed costing (including sensitivity analysis on major financial impacts) was excluded from the study, as it is intended to form part of the next phase of the project.

13.1 Open Windrow Composting

Composting takes place in the open air in large, elongated, uniform prism shaped ‘piles’ of waste known as windrows. The waste feedstock is mechanically shredded and placed into long windrows on a solid, non-permeable surface. Water may be added, depending on the moisture content of the waste.

The windrows are turned regularly, either with a wheeled loader or by a specialist windrow turner machine (pulled along by a tractor/dedicated vehicle). The windrows are turned several times during the compost process, which takes in the region of twelve to sixteen weeks.

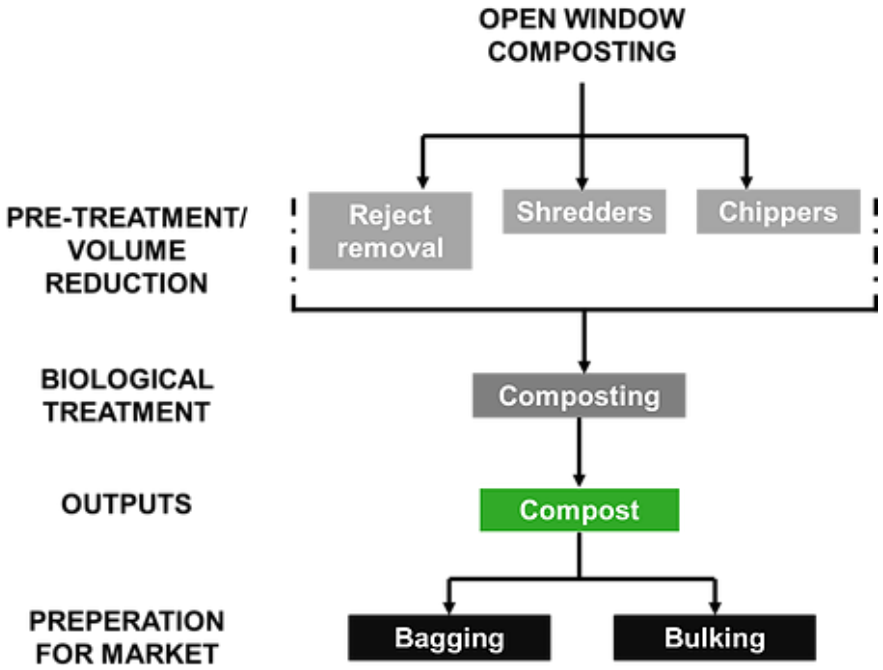


Figure 13-1: Open windrow composting

13.1.1 Advantages/Disadvantages/Restrictions

Table 13-1: Advantages, disadvantages, and restrictions of open windrow composting

ADVANTAGES	DISADVANTAGES	RESTRICTIONS
• Open windrow composting is a relatively low capital waste treatment process • Saleable product • Land application when convenient • Improves nutrient quality.	• Green waste dependent on the weather conditions • Collection infrastructure impacts waste types received • ***There can be respiratory/health issues associated with bio aerosols from turning compost, and some odour issues*** • ***High use of water.***	• OWC is a process that can take up to 12 weeks • ***The technology requires mechanical treatment to remove contaminants*** • ***Compost turned by mechanical means should not be practised in close proximity to settlements in case of odour / bio aerosol issues***

13.1.2 Technology Evaluation

Open Windrow Composting										
Waste Accepted	Input capacity ranges	Typical outputs	Purposes	Indicative capital cost*	Indicative operational cost	Life span	Skills requirement	Job creation opportunity	Electricity dependency	Robustness
Putrescible / organic waste, garden / food waste collections	5k-500k tonnes per annum	Compost	To recycle biodegradable waste into compost for land application / soil improvement	Upwards of R7,75m for small scale simple windrow system	Low	15-20 years	Low	High	Low	High

• Not verified for ZAR / USD exchange rate variations

Advantageous for SA Conditions

Not Advantageous for SA Conditions

13.2 Clean Material Recovery Facility

A clean material recovery facility (cMRF) is suitable for the processing of dry, mixed recyclables that have been segregated.

The recyclables can be sourced from a number of suitable collections, namely a domestic household recycling collection, a commercial dry recycling collection or recycling collected by authorities at transfer sites/civic amenity sites/drop off points. A cMRF will typically handle metals, plastic, glass, paper and card, cardboard, textiles and waxed cartons.

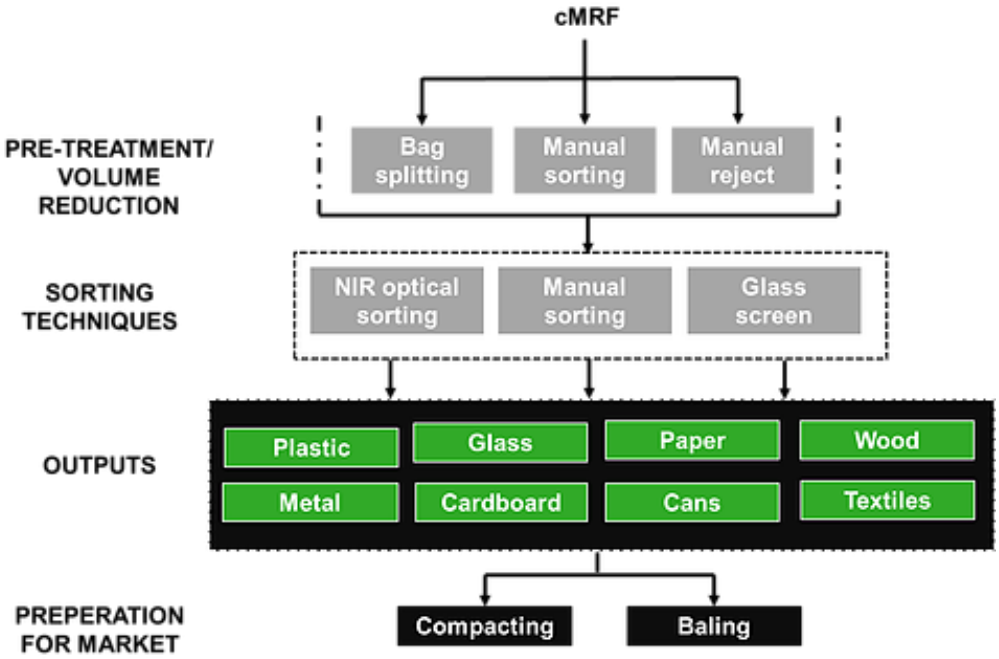


Figure 13-2: cMRF process

13.2.1 Advantages/Disadvantages/Restrictions

Table 13-2: Advantages, disadvantages, and restrictions of cMRF

ADVANTAGES	DISADVANTAGES	RESTRICTIONS
• Clean MRFs can be low technology • The utilisation of manual pickers increases low skilled job creation • Community involvement is key for collection and separation at source • By-products have strong buy-back markets that will contribute to economic sector	• ***Limited to operate on dry recyclable material that has already been segregated*** • Quantity and characteristics of waste and quality assurance cannot be guaranteed • ***Require cooperation and support from households to separate at source*** • ***High use of water.***	• Mixing of glass and paper will reduce the output quality of both materials • ***Mechanical technologies required for separation of materials by grade are capital intensive*** • Hand sorting can be used to varying degrees within the process • ***Requires diligent separation of materials at source and low contamination***

13.2.2 Technology Evaluation

Clean Material Recovery Facility										
Waste Accepted	Input capacity ranges	Typical outputs	Purposes	Indicative capital cost*	Indicative operational cost	Life span	Skills requirement	Job creation opportunity	Electricity dependency	Robustness
Mixed dry recyclable material from domestic and commercial sources	1k-500k tonnes per annum	Recyclate, aggregate, refuse derived fuel (RDF)	Separate different recyclate streams by material and then by grade.	R80m as a base-price. Will increase with size	High (depending on size)	20 years	Low	High	Low (manual table sorting possible)	High (limited moving parts with table sorting)

• Not verified for ZAR / USD exchange rate variations

Advantageous for SA Conditions

Not Advantageous for SA Conditions

13.3 Dirty Material Recovery Facility

A dirty material recycling facility (dMRF) involves segregating valuable materials from a mixed 'dirty' waste stream rather than separating the components of a segregated 'clean' waste stream.

A dMRF may accept mixed solid waste, mixed commercial waste or construction and demolition waste. Target materials for a dMRF will usually include aluminium and steel and may also include mixed plastics, mixed paper/card, wood, textiles and aggregate/glass. The remaining materials may be used to produce a refuse derived fuel (RDF) for energy recovery facilities.

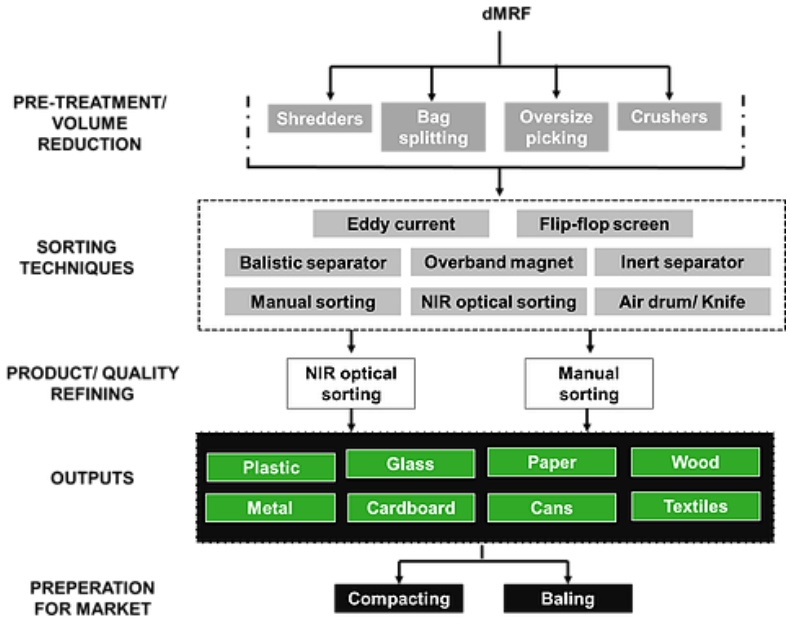


Figure 13-3: dMRF process

13.3.1 Advantages/Disadvantages/Restrictions

Table 13-3: Advantages, disadvantages, and restrictions of dMRF

ADVANTAGES	DISADVANTAGES	RESTRICTIONS
• Relatively simple technology and systems to extract recyclables from mixed waste • Possibly provide residual material for fuel production • Technology may be applied to a wide range of waste streams • Provide significant employment through hand sorting and operation of the plan	• Possible injury risk from handling and machinery • ***Few employment opportunities (compared to cMRF)*** • ***Quality of recycling materials is compromised as sorting needs to be done effectively and efficiently in dMRF facility*** • ***High use of water.***	• Not suitable for hazardous materials • ***Will only recover a small amount***

13.3.2 Technology Evaluation

Dirty Material Recovery Facility										
Waste Accepted	**Input capacity ranges**	**Typical outputs**	**Purposes**	**Indicative capital cost***	**Indicative operational cost**	**Life span**	**Skills requirement**	**Job creation opportunity**	**Electricity dependency**	**Robustness**
Residual waste, commercial and industrial waste, construction and demolition waste	10k-500k tonnes per annum	Recyclate, aggregate, refuse derived fuel (RDF)	Recover recyclables from a mixed solid waste stream. The residual waste will thereafter be used to produce RDF	R62m-R108,5m for a 50k tonnes per annum facility	Low	20 years	Low	High	High (manual conveyor belt sorting)	Low (dependent on conveyors)

• **Not verified for ZAR / USD exchange rate variations**

Advantageous for SA Conditions

Not Advantageous for SA Conditions

13.4 Landill Gas to Energy

Landfill gas to energy is the process of generating energy in the form of electricity. Waste to energy (WtE) is a form of energy recovery and consists of the construction of pipelines to extract gas (e.g. gas turbine). Waste to energy options in landfills, particularly extraction of methane, should be pursued in all metros where it is technically viable and financially feasible.

Most WtE processes produce electricity and/or heat directly through combustion or produce a combustible fuel commodity, such as methane, methanol, ethanol or synthetic fuels.

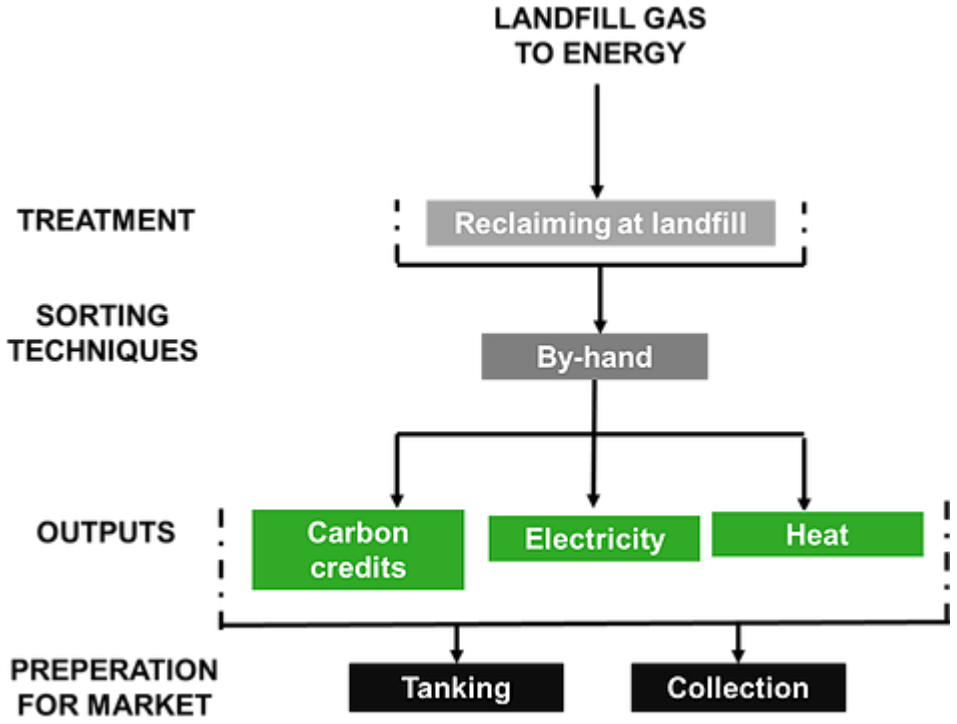


Figure 13-4: Landfill gas to energy process

13.4.1 Advantages/Disadvantages/Restrictions

Table 13-4: Advantages, disadvantages, and restrictions of Landfill Gas to Energy

ADVANTAGES	DISADVANTAGES	RESTRICTIONS
• Between 60% and 90% of methane is captured and converted to water and carbon dioxide • Producing energy from LFG displaces the use of non-renewable resources • Displacement avoids GHG emissions from fossil fuel combustion by an end user facility or power plant.	• ***Requires large area of land for infrastructure*** • ***Operational landfill site must be open for a long period of time*** • Pipelines need to be constructed during design phase • Unwanted and unsorted waste may contaminate existing landfill site.	• ***Capture of gas from decomposition requires significant infrastructure to cover entire site*** • There will always be landfill gas that escapes to atmosphere and smaller quantities that are uneconomic to capture • ***Land intensive option with no material recovery***

13.4.2 Technology Evaluation

Landfill Gas to Energy										
Waste Accepted	**Input capacity ranges**	**Typical outputs**	**Purposes**	**Indicative capital cost***	**Indicative operational cost**	**Life span**	**Skills requirement**	**Job creation opportunity**	**Electricity dependency**	**Robustness**
Residual waste, commercial and industrial waste, construction and demolition waste	10k-500k tonnes per annum	Recyclate, aggregate, refuse derived fuel (RDF)	Recover recyclables from a mixed solid waste stream. The residual waste will thereafter be used for residual waste	Landfill gas plant (5 MW): R90m-R100m for a plant that can receive 335,000 tonnes of waste	High	15 years	High	Low	Low (passive extraction)	High (limited moving parts)

• **Not verified for ZAR / USD exchange rate variations**

Advantageous for SA Conditions

Not Advantageous for SA Conditions

13.5 Mechanical Biologial Treatment

Mechanical biological treatment (MBT) combines both mechanical and biological treatment methods (open windrow composting, materials recycling facilities, anaerobic digestion and in-vessel composting). These are supported by a combination of pre-treatment and sorting techniques at the beginning of the process and a selection of emissions control and quality control techniques at the end of the process.

The mechanical and biological processes can be arranged in either order, with mechanical treatment preceding biological treatment or vice versa. Typical mechanical treatments will include a range of sorting technologies, from simple sieve/trommel separation techniques to more advanced positive selection techniques like near-infrared segregation.

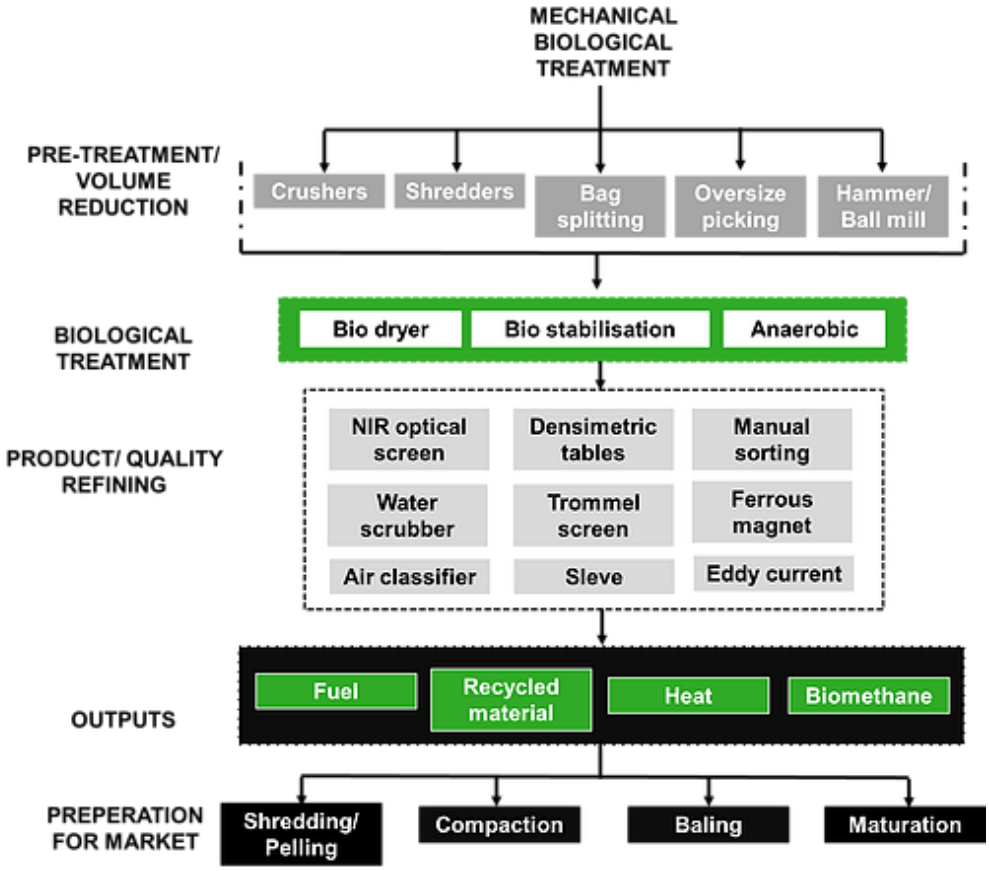


Figure 13-5: MBT process

13.5.1 Advantages/Disadvantages

Table 13-5: Advantages and disadvantages of MBT

ADVANTAGES	DISADVANTAGES	RESTRICTIONS
• Conserving resources and reducing emissions harmful to the environment • Reduce volume and more rapid waste stabilisation • Stabilisation of the waste reduces side effects at the landfill site • Hazardous waste contaminants will not reach municipal landfill sites due to the sorting of the waste prior to treatment.	• ***Potential for odour issues*** • ***A variety of occupational health and safety issues*** • ***Dry recyclables separated out during the process will be of poor quality*** • Demand fixed tonnages of waste.	• ***Not suitable for hazardous materials.*** • Not suitable for bulky or large waste streams. • ***Will only recover a small amount of relatively low grade recyclables***

13.5.2 Technology Evaluation

Mechanical Biological Treatment										
Waste Accepted	Input capacity ranges	Typical outputs	Purposes	Indicative capital cost*	Indicative operational cost	Life span	Skills requirement	Job creation opportunity	Electricity dependency	Robustness
MSW, commercial and industrial waste, wet type	50k-500k tonnes per annum	Energy, recyclate, fines, stabilised material	Stabilise waste, producing useable recyclable and organic products in the process	R852,5m-R1,162,5m for a 100k tonnes per annum facility	High	20-30 years	High	Low	High	Low

• Not verified for ZAR / USD exchange rate variations

Advantageous for SA Conditions

Not Advantageous for SA Conditions

13.6 Anaerobic Digestion

Anaerobic digestion (AD) is a biological process that produces a gas, which is mainly composed of methane and carbon dioxide, otherwise known as biogas.

Anaerobic digestion of organic waste focuses on the biological degradation (process operates in the absence of oxygen) of biodegradable wastes by microbes under controlled conditions.

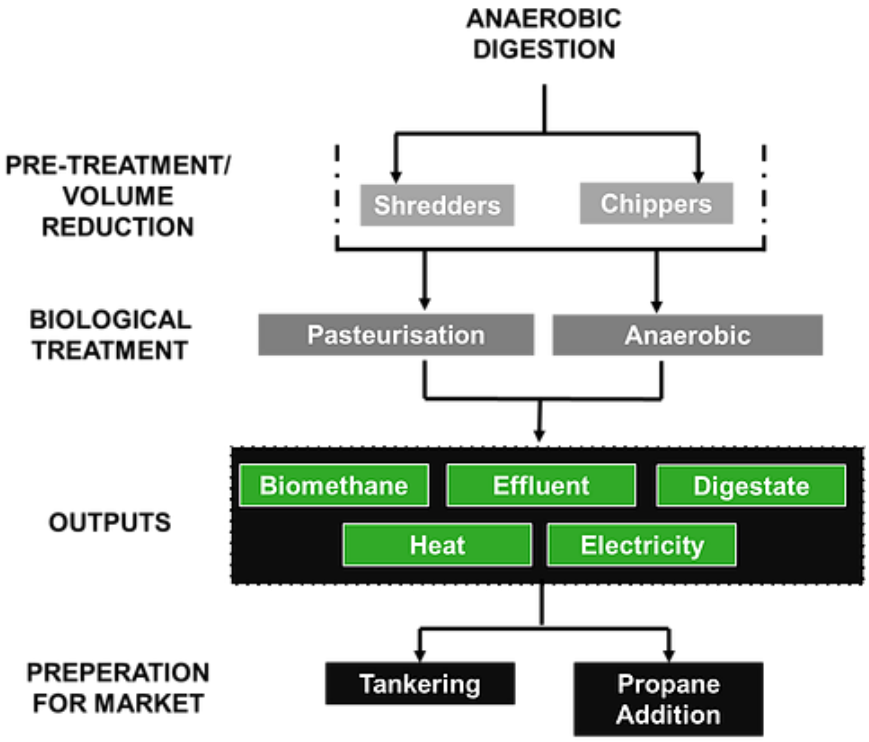


Figure 13-6: AD process

13.6.1 Advantages/Disadvantages/Restrictions

Table 13-6: Advantages, disadvantages, and restrictions of AD

ADVANTAGES	DISADVANTAGES	RESTRICTIONS
• AD has potential for treating a variety of organic waste streams • Greenhouse gas and harmful gases are prevented • AD has the potential for energy production.	• Requires ongoing management and monitoring • Health and safety issues can arise at AD plants • Significant odour issues • Quality is often insufficient for the digestate to be used as soil enhancer.	• ***Requires an intensive monitoring and control over conditions to maintain the digestion process*** • Can be sensitive to imbalances in feedstock (e.g. high quantities of food versus garden waste or vice versa)

13.6.2 Technology Evaluation

Anaerobic Digestion										
Waste Accepted	**Input capacity ranges**	**Typical outputs**	**Purposes**	**Indicative capital cost***	**Indicative operational cost**	**Life span**	**Skills requirement**	**Job creation opportunity**	**Electricity dependency**	**Robustness**
Putrescible / organic waste, garden / food waste collections, slurries, energy crops	5k-150k tonnes per annum	Biomethane heat and electricity, nutrient rich digestate	Recover biodegradable waste into a digestate for land application / soil improvement and recover energy as either gas or heat and power	R124m-R217m for a 25k tpa wet AD process	High	20-30 years	High	Low	High	Low

• **Not verified for ZAR / USD exchange rate variations**

Advantageous for SA Conditions **Not Advantageous for SA Conditions**

13.7 Incineration

Incineration is the direct combustion of material coupled with subsequent energy recovery. The heat resulting from the combustion process can be used to generate heat and electricity through a steam circuit system. It is however important to note that the technology used should be able to comply with the Minimum Emission Standards (NEMAQA) for sustainability on the market.

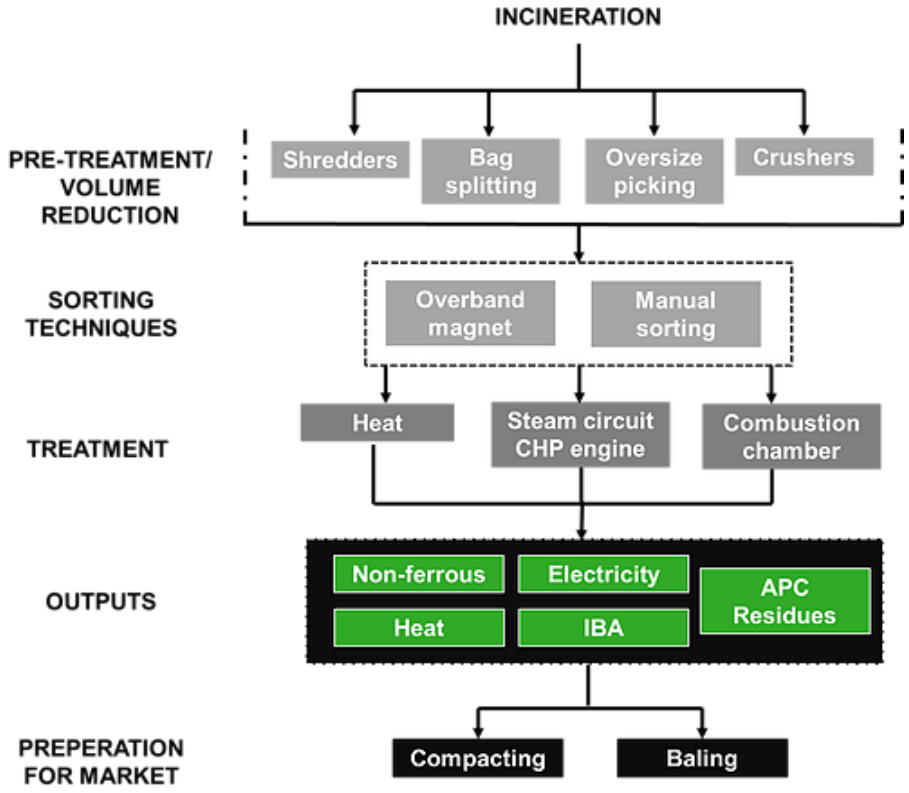


Figure 13-7: Incineration process

13.7.1 Advantages/Disadvantages/Restrictions

Table 13-7:Advantages, disadvantages, and restrictions of incineration

ADVANTAGES	DISADVANTAGES	RESTRICTIONS
• Incineration is a robust technology that can be used to treat a variety of waste streams • Revenue from both gate fees and energy generation can make the technology competitive.	• Incineration is capital intensive • Large quantities of waste to incinerate can alter plans for recycling and reuse of waste • Flue gases can pollute the environment • Requires feedstock to be pre-treated to an RDF or a local producer of RDF.	• Not suitable for bulky or large items • Will destroy all non-metal recyclable materials • Requires a specialist grate to handle higher temperatures generated by refuse derived fuel (RDF) • Energy recovery efficiencies are lower for electricity than heat

13.7.2 Technology Evaluation

Incineration

Waste Accepted	Input capacity ranges	Typical outputs	Purposes	Indicative capital cost*	Indicative operational cost	Life span	Skills requirement	Job creation opportunity	Electricity dependency	Robustness
Residual waste, commercial and industrial waste, certain fractions of C&D waste, RDF	10k-500k tonnes per annum	Electricity, heat, incinerator bottom ash, air pollution control residues	Recover energy from non-recyclable mixed waste streams	R1,395m-R1,860m for 100k tpa facility	Low	20-30 years	High	Low	High	Low

• Not verified for ZAR / USD exchange rate variations

Advantageous for SA Conditions

Not Advantageous for SA Conditions

13.8 In-vessel Composting

In-vessel composting (IVC) is a way of accelerating the composting process within an enclosed environment. Waste will be screened, and any oversize items are to be removed. The waste will then be shredded or chipped to increase the surface area and reduce the average material size. Source segregated of organic wastes will often require a limited amount of treatment prior to composting.

The composting process takes place under controlled conditions in an enclosed environment, either within buildings (bays, beds) or in composting vessels (tunnels, drums, towers).

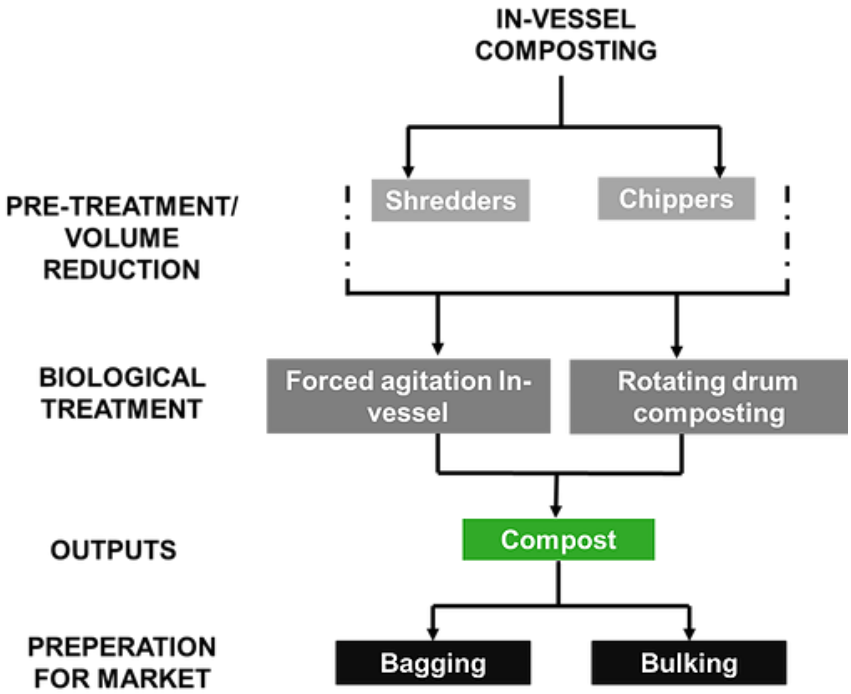


Figure 13-8: In-vessel composting

13.8.1 Advantages/Disadvantages/Restrictions

Table 13-8: Advantages, disadvantages, and restrictions of In-vessel composting

ADVANTAGES	DISADVANTAGES	RESTRICTIONS
• Completed rapidly, resulting in product stabilisation/sanitation in 3 to 4 days • Relatively small footprint allows entire process to take place within a controlled environment (inside a building) • Maintain a rapid decomposition process year-round regardless of external ambient conditions.	• Requires active management to ensure a good mix of materials is processed to develop and maintain good quality compost outputs • Potential for odour issues • ***High use of water.***	• Require several weeks to decompose and stabilise materials • Requires mechanical agitation techniques • Moisture content must be controlled through blending with co-substrates or dry feedstock

13.8.2 Technology Evaluation

In-vessel Composing										
Waste Accepted	**Input capacity ranges**	**Typical outputs**	**Purposes**	**Indicative capital cost***	**Indicative operational cost**	**Life span**	**Skills requirement**	**Job creation opportunity**	**Electricity dependency**	**Robustness**
Residual waste, commercial and industrial waste, certain fractions of construction and demolition waste, refuse derived fuel (RDF)	10k-500k tonnes per annum	Electricity, heat, incinerator bottom ash, air pollution control residues	Recover energy from non-recyclable mixed waste streams	R1,395m-R1,860m for 100k tonnes per annum facility	Low	20-30 years	High	Low	High	Low

• **Not verified for ZAR / USD exchange rate variations**

Advantageous for SA Conditions

Not Advantageous for SA Conditions

13.9 Gasification

Gasification is a process that converts organic or fossil fuel based carbonaceous materials into carbon monoxide, hydrogen and carbon dioxide. This is achieved by reacting the material at high temperatures (>700 °C), without combustion, with a controlled amount of oxygen and/or steam. It is once again to be recognised that technology used should be able to comply with the Minimum Emission Standards (NEMAQA) for sustainability on the market.

Typically, advanced thermal treatment processes will treat prepared fuels (e.g. Refuse Derived Fuels) derived from municipal (or other) waste streams. This Refuse Derived Fuel (RDF) or Solid Recovered Fuel (SRF) comprises the energy-rich elements of the waste stream, typically paper, card and plastics.

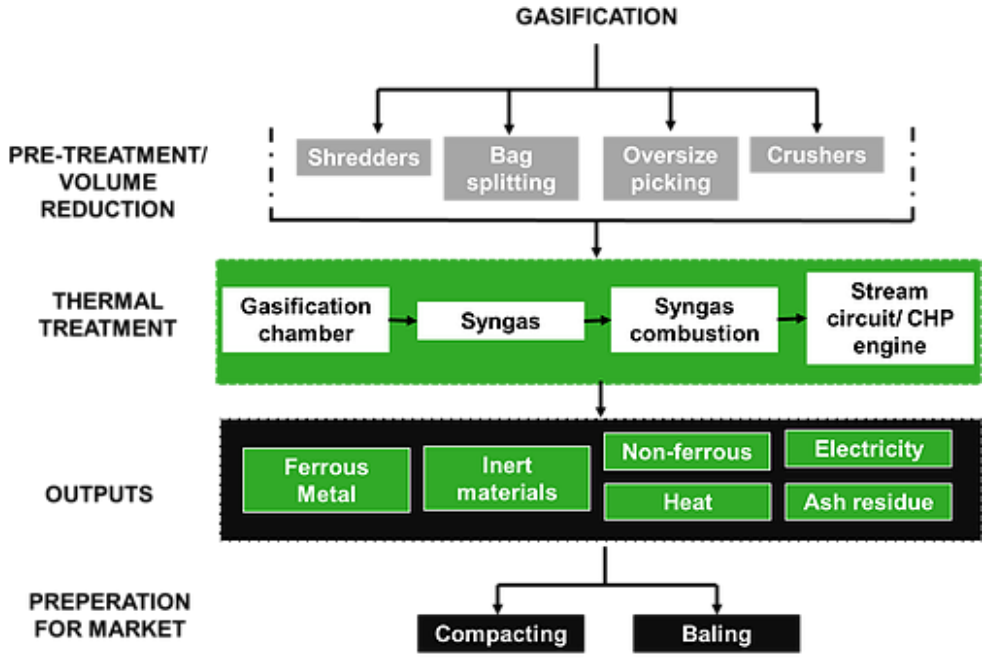


Figure 13-9: Gasification process

13.9.1 Advantages/Disadvantages/Restrictions

Table 13-9: Advantages, disadvantages, and restrictions of gasification

ADVANTAGES	DISADVANTAGES	RESTRICTIONS
• Captures carbon dioxide, which is harmful to the environment • Provides energy security.	• Significant capital costs for these facilities • Requires highly skilled operators • Requires specific feedstock to gain the full potential.	• Gasification systems is capital intensive. • All non-metal recyclable materials will be destroyed. • Fuel is bulky and frequent refuelling is often required for continuous running of the system.

13.9.2 Technology Evaluation

Gasification										
Waste Accepted	Input capacity ranges	Typical outputs	Purposes	Indicative capital cost*	Indicative operational cost	Life span	Skills requirement	Job creation opportunity	Electricity dependency	Robustness
Commercial and Industrial waste, certain fractions of Construction and Demolition waste, Refuse derived fuel (RDF)	10k-100k tonnes per annum	Electricity, heat and ash	Recover energy from non-recyclable mixed waste streams	R387,5m-R620m for a 60ktpa facility	High	20-30 years	High	Low	High	Low

• Not verified for ZAR / USD exchange rate variations

Advantageous for SA Conditions

Not Advantageous for SA Conditions

13.10 Pyrolysis

Pyrolysis is a thermal degradation of a substance at high temperatures in the absence of oxygen.

It involves the simultaneous change of chemical composition and physical phase and is irreversible and requires a relatively consistent waste stream. Technology should as before being able to comply with the Minimum Emission Standards (NEMAQA) for sustainability on the market.

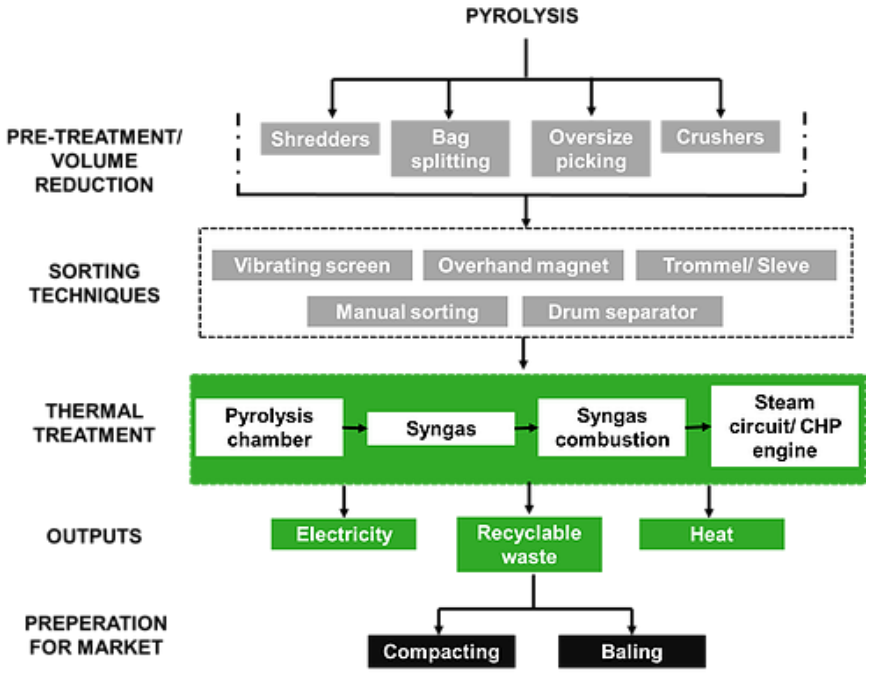


Figure 13-10: Pyrolysis

13.10.1 Advantages/Disadvantages/Restrictions

Table 13-10: Advantages, disadvantages, and restrictions of pyrolysis

ADVANTAGES	DISADVANTAGES	RESTRICTIONS
• May be used for all types of solid products • Can be easily adapted to changes in feedstock composition • Can be integrated into micro turbine, fuel cell or thermophotovoltaic (TPV) systems for power generation.	• ***High capital costs*** • ***Qualified and experienced personnel needed to operate machinery.***	• ***Pyrolysis technology is capital intensive*** • ***Pyrolysis is energy intensive which reduces the gross energy output of plant significantly*** • Metal and inert material require separation before thermal treatment if they are intended for removal

13.10.2 Technology Evaluation

Pyrolysis										
Waste Accepted	Input capacity ranges	Typical outputs	Purposes	Indicative capital cost*	Indicative operational cost	Life span	Skills requirement	Job creation opportunity	Electricity dependency	Robustness
Residual waste, commercial and industrial waste	8k-150k tonnes per annum	Electricity, heat and char	Energy recovery from non-recyclable and mixed waste	R387,5m-R620m for a 60k tpa facility	High	15 years	High	Low	High	Low

• Not verified for ZAR / USD exchange rate variations

Advantageous for SA Conditions

Not Advantageous for SA Conditions

13.11 Plasma Gasification

Plasma gasification is a variation on gasification which uses a plasma torch/arch to produce gas. Plasma arc gasification is a waste treatment technology that uses high electrical energy and high temperature created by an electrical arc gasifier. This arc breaks down waste primarily into elemental gas and solid waste (slag) in a device called a plasma converter. The process is intended to be a net generator of electricity, depending upon the composition of input wastes, and to reduce the volumes of waste being sent to landfill sites. Technology should be able to comply with the Minimum Emission Standards (NEMAQA) for sustainability on the market.

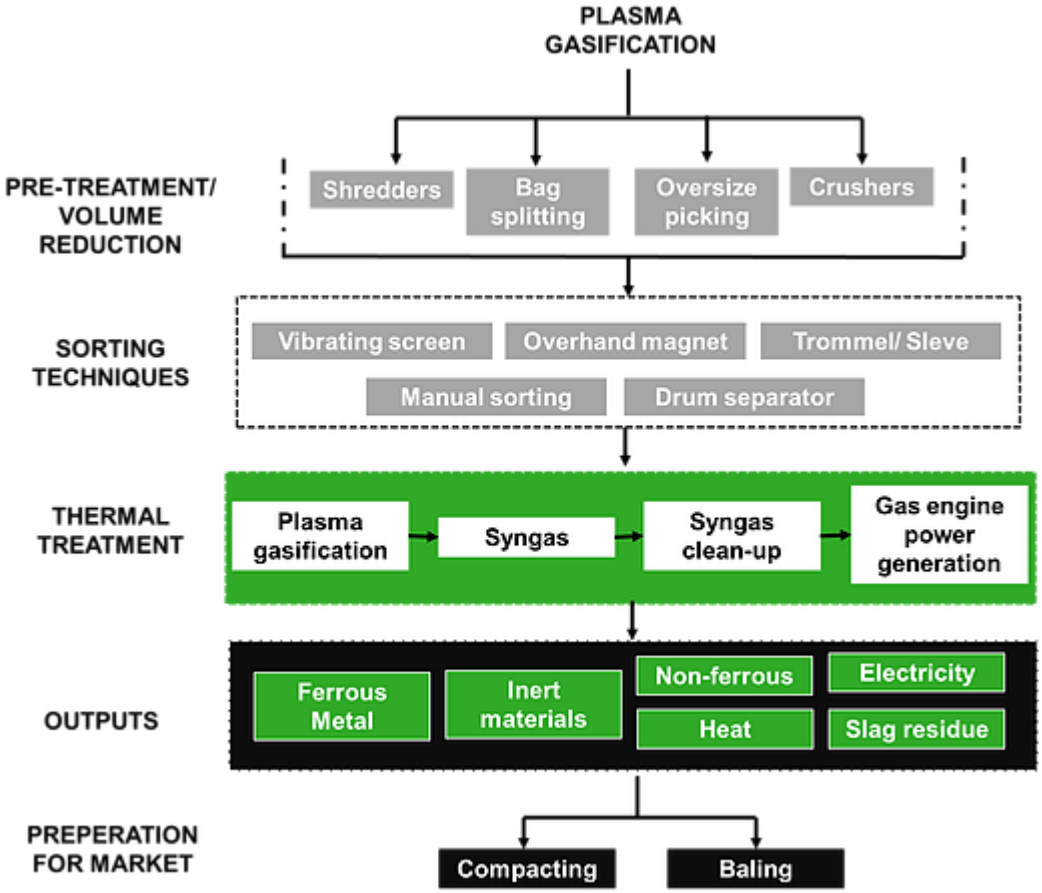


Figure 13-11: Plasma gasification process

13.11.1 Advantages/Disadvantages/Restrictions

Table 13-11: Advantages, disadvantages, and restrictions of Plasma gasification

ADVANTAGES	DISADVANTAGES	RESTRICTIONS
• Potential to utilise higher efficiency energy recovery systems • Production of clean slag, which could be used as construction material • Processing of organic waste into combustible syngas for electric power and thermal energy.	• ***Requires highly skilled operators*** • ***Requires specific feedstock*** • ***Large initial investment costs.***	• ***Requires expenditure for the purchase and operation of plasma torches/arc.*** • ***Energy intensive and will drastically reduce the gross energy output of the facility.***

13.11.2 Technology Evaluation

Plasma Gasification

Waste Accepted	Input capacity ranges	Typical outputs	Purposes	Indicative capital cost*	Indicative operational cost	Life span	Skills requirement	Job creation opportunity	Electricity dependency	Robustness
Refuse Derived Fuel, treated residual waste, Commercial & Industrial waste or selected Construction & Demolition waste	50k – 500k tonnes per annum	Electricity, heat, slag	Recover energy from non-recyclable mixed waste streams	Too limited examples to provide indicative Capex range	High	20 years	High	Low	High	Low

• **Not verified for ZAR / USD exchange rate variations**

Advantageous for SA Conditions **Not Advantageous for SA Conditions**

13.12 Mechanical Heat Treatment

Mechanical Heat Treatment (MHT) facilities combine mechanical and thermal treatment techniques, often with the aim to extract either relatively high-quality recyclables and/or fuel fractions (refuse derived fuel) from the waste.

In addition, and dependent on the technology employed, they reduce the volume of the waste; derive an organic fibre for use as a raw material/substitute fuel. Heat treatment can be in the form of autoclaving (pressurised process) or thermal drying (non-pressurised process). Both are designed to sanitise and stabilise waste feedstock.

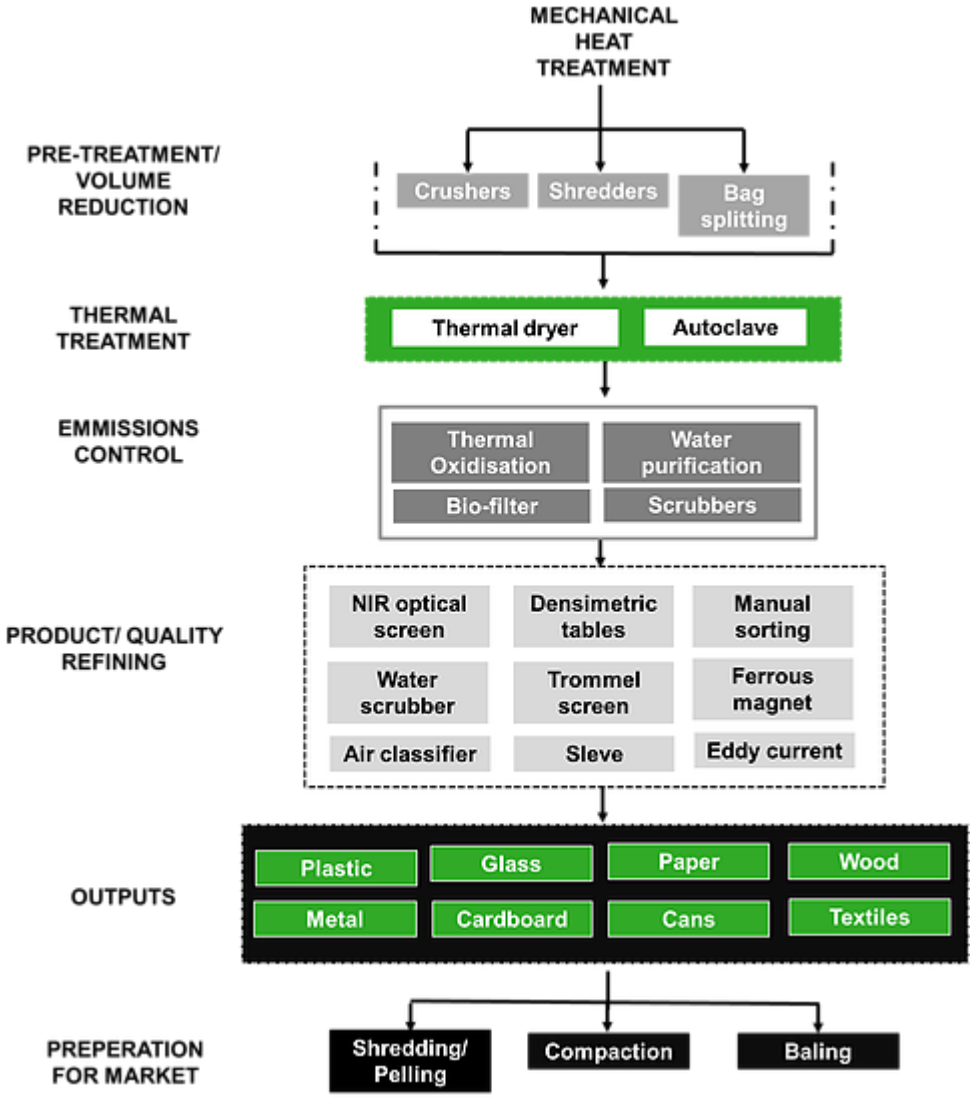


Figure 13-12: MHT

13.12.1 Advantages/Disadvantages/Restrictions

Table 13-12: MHT, disadvantages, and restrictions disadvantages

ADVANTAGES	DISADVANTAGES	RESTRICTIONS
• MHT has benefits in terms of storage, transport and handling of the outputs as they are sanitised • Minimises odour problems • Significant volume reduction of the waste.	• ***The application of MHT to municipal waste has a limited track record internationally*** • ***Viability is likely to be determined by the potential markets and outlets for the fibre/ fuel fractions derived from the process.***	• ***Not suitable for hazardous materials.*** • Not suitable for bulky or large waste streams. • ***Due to the nature of accepted waste streams will only recover mid-grade and low quantities of recyclables***.

13.12.2 Technology Evaluation

Mechanical Heat Treatment										
Waste Accepted	**Input capacity ranges**	**Typical outputs**	**Purposes**	**Indicative capital cost***	**Indicative operational cost**	**Life span**	**Skills requirement**	**Job creation opportunity**	**Electricity dependency**	**Robustness**
MSW, Commercial & Industrial waste or selected Construction & Demolition waste, Clinical/ Hazardous wastes	50k – 500k tonnes per annum	Recyclate, fines, stabilised material, Refuse derived fuel (RDF)	Stabilise waste, producing useable recyclable and organic products in the process	R 186m – R 542.5m for a 100k tonnes per annum facility	High	20-30 years	High	Low (MRF) and High (Thermal Treatment)	High	Low

• **Not verified for ZAR / USD exchange rate variations**

Advantageous for SA Conditions **Not Advantageous for SA Conditions**

13.13 Recommendation on AWTT for an Ecopark

Considering the high number of constraints associated with waste management in Gauteng (poor separation at source, financial constraints, disruption to power supply, limited skilled operators, etc.), coupled with a need for increased job creation, the number of options viable for implementation at the proposed regional integrated waste management facility are limited.

During the detailed feasibility study, there is a need for the use of a ranking matrix based on weighted criteria – agreed to by the major stakeholders. In addition to that, ongoing fluctuations in the ZAR/US$ exchange rate are also causing instability in the CAPEX and OPEX requirements for imported plant and equipment. Coupled with this is the market for the expected offtake. It is thus recommended that the detailed feasibility study also include market research to determine the long-term demand for offtake despite the increased supply, together with a sensitivity analysis to determine the potential impact of the various risks identified, e.g. fluctuations in the ZAR/US$ exchange rate.

Since the only viable options seem to be recycling with source-separated materials, in combination with windrow composting and chipping of building rubble at source, the need for a landfill remains. The detailed feasibility study should, however, identify and investigate potential mitigating measures that can be implemented to address some of the constraints currently considered to be of significance.

14. FINANCIAL ANALYSIS

This section will focus on the following key aspects:

- Budget Analysis – review of available capital and operational budgets of the three Metros.
- Value Assessment – compare an internal procurement option vs. an external procurement option.
- Funding and Financing Options – review options for procurement of the Project based on the Budget Analysis and Value Assessment.
- Recommend procurement option for consideration in the Full Feasibility Study phase.

14.1 Project Requirements

As articulated in the Technical Options Section of the report, there are a number of considerations that go into ultimately determining the composition of the IRWTF project. While the ultimate desired state project would include a whole host of activities, including pre-treatment sorting, volume reduction and the use of various treatment technologies on the different types of waste, before ultimately landfilling what is left, the reality is that there is a number of constraints that make such a facility non-viable and unsustainable at this point in our economy's development. The recommendation from the Technical Options Section is that at the Full Feasibility stage, a ranking matrix be developed, with weighted criteria, that would help determine the configuration of the regional waste management facility overall.

The below analysis focuses on the base landfill requirements, a composting facility and a Materials Recovery Facility, which would be the first phase of the IRWTF. The Landfill Capex is based on the following assumptions:

- Landfill life – 20 years
- Landfill height – 30 m
- Monthly disposal tonnage – 60 365 tonnes/month (this is the estimated amount of waste that would be diverted to the IRWTF, thus allowing for each of the metros to make use of the landfill in the Node area, on a similar scale to what it would have been if they had their own landfills). Should the waste disposal rate be reduced, the landfill life will be increased accordingly.
- Total capacity – 14 487 600 cubic metres

Composting Facility is based on the following assumptions:

- Assumed a 60ha land (land purchase price excluded)
- The development cost was done for a 45Ha area
- Shaping of area to allow no ponding and bringing in a wearing course.
- Run-off management pond included
- Warehouse/a shed/offices and fencing included in the CAPEX cost
- Not allowed for impermeable surface of composting area

The MRF capex is based on the published cost of setting up a similar facility recently in Cape Town at the Coastal Park landfill site.

Below is the estimated capital cost to develop the landfill:

Table 14-1: Estimated capex cost

	QUANTITY	CAPEX (RANDS)
Landfills	1	520 967 165
Transfer Stations	3	244 065 184
Composting Facility	1	207 000 000
MRF	1	186 000 000
Total		**1 158 032 348**

Ultimately, the IRWFP Project is likely to incorporate a bespoke combination of transfer stations and various other AWTs (which are yet to be determined), but the base would still be as stated above.

14.2 Available Budgets

Capital and Operational Budgets were obtained from the Metros as well as publicly available information. All three Metros account differently for their waste management/refuse services, and the information at hand also shows differences in the tariff structures for two of the Metros. As a result of the differences in the granularity of information that we were able to obtain, it was not possible to make like-for-like comparisons. However, this section does give an indication of the state of Capital and Operational budgets of the Metros for this service.

14.2.1 Capital Budgets

As a general observation, as with most municipalities in South Africa, and indeed Government in general, there is a huge need for investment in public infrastructure, be it for new infrastructure or the renewal and maintenance of existing infrastructure. There are so many projects competing for funding at a time when the Government is simply unable to keep up with the demand for funding. As a result, municipalities are currently only budgeting for essential capital expenditure, and even then, find at times that approved budgets are revised downwards to cater for other urgent requirements. In the case of Waste Management and the cycle that the Gauteng Metro waste management facilities find themselves in, this is problematic, as the landfills and the rest of the waste management infrastructure need capital investment.

City of Johannesburg/Pikitup

Generally, large infrastructure projects such as WTE and Gas are led by the CoJ, while the Pikitup capital budget is to cater for capex improvements within the regular service delivery asset portfolio. The current focus for Pikitup, as we understand it, is to extend a couple of cells at existing landfills to extend their lifespans and generally upgrade facilities to get them to a point where they are compliant with licensing conditions. The current capital budget looks at things like fixing damaged security fences, fixing damaged stormwater systems, fixing damaged roads, upgrades and alterations, etc.

The 2022/23 budget was initially approved at R150 million to cover these activities. This was subsequently reduced to R150 million as funds were required elsewhere. It is, therefore,

evident that there is no room to consider a project as large as Ecopark within Pikitup’s capital budgets. It would typically turn to CoJ for this quantum of investment.

For its part, CoJ is currently exploring the feasibility of some WtE and Gas projects, which they intend to fund through Public Private Partnerships due to the aforementioned budgetary challenges. As a result, CoJ would also look to alternative funding mechanisms for its involvement in the Ecopark Project.

City of Tshwane

Like their compatriots, the CoT find themselves in a position where they have many smaller projects to fund to remain compliant with license conditions while at the same time needing to take urgent steps towards finding affordable and sustainable solutions for the impending closure of the existing landfills. Like the other Metros, the capital budget allocations barely cover their normal service delivery asset requirements. For any high-impact projects, such as what would be represented by Ecopark, they do not have the capital budget that would be required for their contribution.

14.2.2 Revenue sources and tariff structures

The primary source of revenues in the Metros for Waste Management is service fees paid by residential and non-residential/commercial customers. For example, in the CoJ (Pikitup), these categories make up 12.6% and 77.3% of revenues, respectively (excluding grants). These tariffs are generally designed to cover the costs of refuse collection, transportation and dumping at landfill sites, as well as the operations and maintenance of waste disposal sites. The fees also need to cater for the subsidisation of the poorer sections of society, including the indigent, who receive this service for free in the areas that are serviced formally by the Metros.

The level of tariff charged for residential waste removal services is based on the value of the property, as shown in the following schedule for CoJ rates payable:

Table 14-2: CoJ rates payable

Property Categories		Tariffs (2021/22)	Tariffs (2022/23)	Increase
From	To			
0	R 350 000	Exempt	Exempt	-
R 350 001	R 500 000	R 201	R 211	5%
R 500 001	R 1 500 000	R 203	R 213	5%
R 1 500 001	R 2 500 000	R 291	R 306	5%
R 2 500 001	R 5 000 000	R 299	R 314	5%
R 5 000 001	R 7 500 000	R 464	R 487	5%
R 7 500 001	R 10 000 000	R 484	R 508	5%
R 10 000 001	R 30 000 000	R 650	R 683	5%
R 30 000 000 >		R 825	R 866	5%

For commercial properties, service tariffs are based on the type of waste and waste/tonnage.

Tariffs are reviewed annually, and the main cost drivers for Waste Management Services are transport expenses and labour costs.

Other sources of revenue would include fees charged when customers bring their own waste to dump it at transfer stations or waste disposal sites, e.g. Garden waste or rubble, or Bulk container services, including once-off fees such as rental of waste containers for specific functions.

There are also specific grants that the Metros access for specific programmes, such as the EPWP/PEP Grants.

14.2.3 Operational Budgets

While the information obtained for Pikitup was detailed, the information for CoE was consolidated, and no budget information was obtained for CoT.

City of Ekhuruleni

The following consolidated information was obtained:

Table 14-3: CoE operational budget

	2022/23	2023/24	2024/25
Revenues	2 578 261	2 761 430	2 947 169
Expenses	1 836 465	1 955 738	2 092 164
Surplus/ Deficit	741 796	805 662	855 005
Surplus %	40.4%	29.2%	29%

Waste Management Services in the CoE operates as a division within the Municipality. As such, any surpluses generated may be utilised to subsidise other Municipal activities.

City of Johannesburg

Unlike in the CoE, CoJ houses the Waste Management Service function in a standalone entity, Pikitup. The following table is taken from Pikitup's MTEF 2023/24 -2025/26 presentation:

Table 14-4: CoJ Statement of Financial Performance

Statement of Financial Performance	2021/22	2022/23			2023/24			2024/25			2025/26
	Actual	Original Budget	Proposed Revised Budget	Variance	Approved Budget	Proposed Budget	Variance	Approved Budget	Proposed Budget	Variance	Proposed Budget
	R'000	R'000	R'000	R'000	R'000	R'000	R'000	R'000	R'000	R'000	R'000
Commercial	314 713	291 470	286 024	- 5 446	304 584	311 104	6 520	318 287	326 661	8 374	342 996
Domestic	1 931 551	1 857 749	1 860 126	2 377	1 959 624	2 001 947	42 323	2 083 656	2 102 046	18 390	2 207 147
City Cleaning Levy	203 093	248 750	241 226	- 7 524	259 944	258 112	- 1 832	271 642	271 019	- 623	284 569
Interest on Outstanding Debtors	28 066	28 524	28 524	-	29 808	29 951	143	31 150	31 449	299	33 021
Other Income	2 936	5 600	5 600	-	5 856	5 883	27	6 123	6 180	57	6 491
Interest Earned on Sweeping Account	17 304	21 814	21 814	-	22 796	22 905	109	23 822	24 050	228	25 253
CoJ Service Fee & EPWP/PEP Grant	1 098 988	1 229 923	1 043 268	- 186 655	1 284 434	1 029 166	- 255 268	1 344 818	973 292	- 371 526	843 489
Total Income	**3 596 651**	**3 683 830**	**3 486 582**	**- 197 248**	**3 867 046**	**3 659 068**	**- 207 978**	**4 079 498**	**3 734 697**	**- 344 801**	**3 742 966**
Staff Costs	1 409 261	1 517 091	1 490 248	- 26 843	1 585 352	1 570 703	- 14 649	1 656 686	1 646 092	- 10 594	1 720 167
Provision for Bad Debt	415 311	288 848	315 621	26 773	304 149	357 849	53 700	344 890	380 805	35 915	406 335
Depreciation	64 896	93 859	67 086	- 26 773	104 629	70 437	- 34 192	110 643	73 960	- 36 683	77 654
Repairs and Maintenance	2 903	16 231	12 947	- 3 284	16 796	13 630	- 3 166	17 555	12 796	- 4 759	13 401
Fleet	1 138 403	985 141	941 047	- 44 094	1 029 466	965 395	- 64 071	1 075 788	937 435	- 138 353	823 111
Third Party Contractors	222 437	244 513	177 408	- 67 105	254 864	184 072	- 70 792	267 586	177 089	- 90 497	185 412
Other Expenses	278 347	363 122	298 054	- 65 068	388 234	313 003	- 75 231	412 795	324 834	- 87 961	337 475
Interest Paid	81 485	114 918	130 034	15 116	120 892	126 983	6 091	127 650	121 903	- 5 747	116 828
Intercompany Costs	36 717	60 107	54 137	- 5 970	62 664	56 996	- 5 668	65 905	59 783	- 6 122	62 583
Total Overheads	**3 649 760**	**3 683 830**	**3 486 582**	**- 197 248**	**3 867 046**	**3 659 068**	**- 207 978**	**4 079 498**	**3 734 697**	**- 344 801**	**3 742 966**
Surplus/(Deficit)	**- 53 110**	-	-	-	-	-	-	-	-	-	-
						4.95%			2.07%		0.22%

The above table shows that the entity's budget targets a break-even position. The information on expenses validates an earlier statement in this report that stated that the key cost drivers are Staff Costs (38.6%) and Transport/Fleet costs (31.2%). Bad debts are also high and need to be managed over time.

Overall Budget Observations

From the above information from CoE and CoJ, as well as information obtained in meetings with the Metros, the overall observations were that:

- Waste Management Services is one of the areas where the Metros are able to generate revenue directly from users for services rendered.
- Ideally, if tariff setting is optimally done, these departments/ entities should be able to break even or even generate a surplus.
- Revenues are driven by service charges, and expenses are driven by staff and transport expenses.

The Value Assessment is the financial assessment that evaluates whether the Preferred Option (from the Options Analysis) provides superior value to GDARD (the Public Party) as compared to the scenario whereby the Public Sector Party funds, operates and maintains the facility. The following represent the two procurement methods that were evaluated to identify the optimal procurement method for the project:

- Conventional/Internal Procurement Method (evaluated through the development of the Public Sector Comparator Financial Model – PSC);
- External/Public Private Partnership Method (evaluated through the development of the PPP financial model).

For the External/PPP procurement model to be deemed appropriate, there are three tests that have to be applied against it to assess whether or not it is the better procurement method to deliver the project. These tests are as follows:

- Is the project affordable to the public sector party under the procurement method under review?
- Does the procurement method allow the appropriate transfer of risks to the party that is best able to manage them?
- Does the procurement method provide Value for Money?

For the PPP procurement method to be selected as the best method, the above tests have to be adequately satisfied.

14.2.4 Technical definition of project

The key output for this project is to design, finance, construct, operate and maintain the proposed IRWTF project, starting with the landfill component.

14.2.5 Financial Model Assumptions

Financial models were developed representing the PSC procurement and the PPP procurement methods. The following were key assumptions in the models:

Capital Costs

The capital costs were determined through the use of benchmark capex estimates and the expected amounts of waste that will be redirected to the proposed facility. The following table shows the estimated project capital costs:

Table 14-5: Capital Costs

	QUANTITY	CAPEX (RANDS)
Landfills	1	520 967 165
Transfer Stations	3	244 065 184
Composting Facility	1	207 000 000
MRF	1	186 000 000
Total		**1 158 032 348**

Revenues

The Revenues for this project are in the form of Gate Fees to be levied to the Metros by the facility operator. The fees in the financial modelling are based on market benchmarks.

Income has also been factored in for sales from the Composting facility. These sales are based on an assumption of R300/m^3 – this is very dependent on the market.

No revenue has been ascribed to the materials recovered from the MRF as these are dependant on the waste composition and the market for the material recovered. This component requires specific quantification as part of the full feasibility study.

Revenue Escalations

Revenues are assumed to increase annually at CPI.

O&M Expenses

Operations and Maintenance costs are assumed to be:

- 33% of total revenues for the landfill. This is the benchmark ratio obtained in a study for the Department of Forestry, Fisheries and the Environment.
- R3.5m/month for the Composting Facility, based on the Consultant's estimates.
- R300/tonne for the MRF opex. This is the benchmark ratio obtained in a study for the Department of Forestry, Fisheries and the Environment.

Project and Debt Tenor

Both financial models assume a project term of 20 years and a debt tenor of 15 years.

Discount Rate

Typically, a Government bond rate is used to discount the model cash flows over the Concession term. This bond should, ideally, match the term of the cash flows being discounted. The 20-year South African Government Bond yield curve was used. As of 8 August 2023, it was trading at 12.28%.

Funding – PSC Model

Where the traditional Government conventional procurement methods are followed, the procuring institution would have to find the project capital required, most likely through an allocation from the National Treasury within the MTEF cycle. In their planning and project appraisal, they would likely not assign a cost to this funding. However, to compare the PSC meaningfully to the PPP model, this capital is assumed to be 100% debt-funded at the Government's risk-free rate of borrowing, which is the same as the Discount Rate discussed above.

Funding - PPP

The following key funding assumptions were made for the preferred option:

- The SPV will be financed by a combination of debt and equity
- The project will have a Debt Equity Ratio of 80/20
- Cost of debt finance has been assumed to be CPI + 5% for Senior debt and CPI + 7% for Mezzanine funding
- The debt is to be repaid over a 20-year period.

Payment Mechanism

The PPP structure operates on a User-pay mechanism basis. This entails the SPV charging the GDARD an amount for annual usage, which they, in turn, collect from the ultimate commercial and domestic users of the service.

14.2.6 Base Financial Model Outputs

The following table illustrates the outcomes of the base PSC model:

Table 14-6: Base PSC Model

CASH FLOWS	ZAR
Capex and major maintenance	(1 158 032 348)
Opex	(2 965 637 673)
Revenue	4 030 930 677
Debt	1 158 032 348
Equity	-
Shareholders' loans	-
Loan repayments	(1 299 603 842)
NPV of Total Net Cash Flow	**(234 310 838)**

The following table illustrates the outcomes of the base PPP model:

Table 14-7: Base PPP Model

CASH FLOWS	ZAR
Capex and major maintenance	(1 158 032 348)
Opex	(3 129 292 249)
Revenue	4 526 853 635
Debt	810 622 644
Equity	173 704 852
Shareholders' loans	173 704 852

CASH FLOWS	ZAR
Loan repayments	(1 155 956 410)
NPV of Total Net Cash Flow	**241 604 976**

14.2.7 Risk Assessment

Risk assessment provides an understanding of what the possible risks to the Project are, their sources, consequences should they occur and their likelihood of occurring. This assessment allows the project owner to identify the risks that require to be treated and, therefore, a risk mitigation plan can be developed for these risks.

Risk assessment is a stepwise process with the following activities:

- Identifying the risks – recording all the potential risks that could impact the Project and the consequences should each risk occur.
- Analysing the risks
  - Likelihood – estimating the probability of each risk occurring. A scale of **Unlikely** (green), **Likely** (amber) and **Highly Likely** (red) is used below.
  - Impact – classifying the risks in terms of the likely impact should each risk occur. A scale of **Low** (green), **Medium** (amber) and **High** (red) is used below.
- Risk mitigation – for those risks that have been identified as requiring mitigation during the risk evaluation phase, a risk mitigation plan is developed to treat the risk; and

- Risk Quantification – Quantify the identified risks.

The outcome of the risk assessment process is a risk matrix that documents the findings of this process in Annexure H.

14.2.8 Interpretation & Conclusion

In terms of general project management, greater attention needs to be paid to risks that demonstrate combinations of Likely to Highly Likely Probability of occurring and Medium to High Impact. In the case of the above Risk Matrix, the following risks would require closer consideration as the Project is further structured and developed:

Table 14-8: High Priority Risks

PRE-COMPLETION PHASE	OPERATIONAL PHASE
Site	Waste Composition
Community risk	Operations
Legislation (Licensing)	Disputes
Construction delays	Waste Offtake
Currency risk	Invasion risk
Contracting risk	Contracting risk
Inflation	Inflation
Interest rates	Interest rates
Currency risk	Currency risk

Should the project be taken further, these are the risks that rank higher as priorities when risk allocation and risk mitigation plans are being developed.

14.2.9 Risk Transfer

The following table shows the results of the risk quantification exercise:

Table 14-9: Estimated capex cost

	VALUE
NPV of PPP retained risk cash flows	326 588 088
NPV of PSC retained risk cash flows	927 514 404
Difference	600 926 316
Percentage risk transfer	**65%**

The diagram below illustrates the risk transfer:

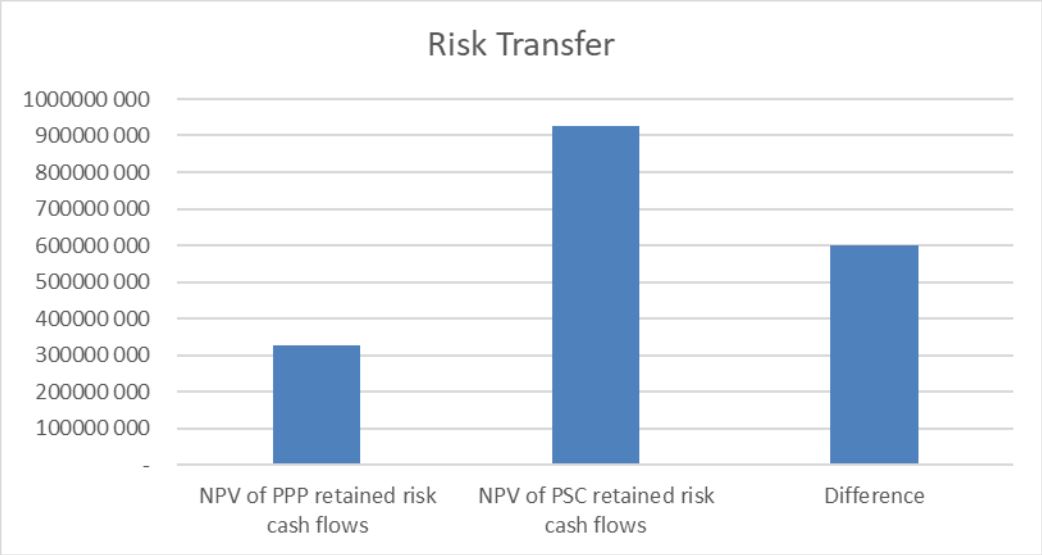


Figure 14-1: Risk Transfer Diagram

Given the above graph, the project illustrates a significant transfer of risk (65%) from Government (PSC) to the Private Party where a PPP model is used as opposed to a PSC model.

14.2.10 Risk-adjusted Cash Flows

The following table illustrates the outcomes of the risk-adjusted PSC model:

Table 14-10: Base Risk-adjusted PSC Model

CASH FLOWS	ZAR
NPV of Net cash flow	(234 310 838)
NPV of Risk Impact Cash Flows	(927 514 404)
Total NPV	**(1 161 825 242)**

The following table illustrates the outcomes of the risk-adjusted PPP model:

Table 14-11: Base Risk-adjusted PPP Model

CASH FLOWS	ZAR

NPV of Net cash flow	241 604 976
NPV of Risk Impact Cash Flows	(326 588 088)
Total NPV	**(84 983 112)**

14.2.11 Affordability

As explained earlier, the first test of the suitability of a procurement method is that of Affordability – can Government afford to procure the project using the proposed PPP procurement method?

The Project requires capital expenditure of R1.158 bn. The Capital Budget Analysis established that the Metros do not currently have adequate capital budgets for their current requirements and do not have any means to fund this facility internally, hence the decision to explore the project being developed through a PPP procurement process.

The project would then require the payment of a unitary fee to the facility operator (escalating annually) to operate and maintain the facility. This amount would have to be funded through redirecting operating expenditure in the current budgets that goes towards operating the existing landfills. There will also be savings that will accrue from the Metros being able to transport their waste over shorter distances once the facility is operational. It is likely that the project would be affordable on this basis, but the budget information available was not at a level of detail to allow this analysis to be definitive.

14.2.12 Attractiveness to the Private Sector

During their capital budgeting activities, private sector parties have two key decision-making points:

1) Project NPV – a project with a negative NPV is not worth pursuing as it loses money overall, while a positive NPV indicates a project that makes money overall and is therefore worth considering; and
2) Project IRR – what is an acceptable return on an investment in a particular project, based on the investors' perspective on risk allocation?

When looking at this project, a potential investor would consider the following:

- The 20-year South African Government Bond Rate (Risk Free Rate) is currently 12.8%
- The risk profile of this project structure would entitle the investor to expect a premium on these return levels.

This project's NPVs and IRRs were calculated and are as shown below:

Table 14-12: Project viability indicators

CONCESSION LENGTH	20 YRS
NPV	R 204 274 651
Project IRR	14.83%

A positive NPV is achieved over the concession period. Also, the IRR is comfortably above the risk-free return levels discussed above.

14.2.13 Value for Money

The VfM of delivering a project as a PPP should always be compared to delivery through the non-PPP alternative, and the PPP is only accepted if it provides better VfM. VfM does not just mean the cheapest possible outcome. VfM is about obtaining the best outcome in the delivery of services across several factors, including price, quality of service, design amenity and sustainability of the arrangement. A complete VfM assessment requires consideration of qualitative factors along with a quantitative assessment.

Qualitative advantages of the PPP model over conventional Government procurement include the following:

- the PPP will mobilise private sector finance, alleviating dependence on a strained fiscus;
- Private sector tends to execute projects quicker than Government;
- Less legal complexity than if the Project is to be implemented by the three Metros; and
- Improved efficiency of service for the Metros and their citizens.

PPPs are typically also subject to quantitative VfM tests to assess if the PPP approach is superior to delivery through a conventional, budget-funded project. For this project, we compared the risk adjusted cash flows of the PSC model to those of the PPP model. VfM is present if the risk adjusted NPV of the PPP model cash flows is higher than that of the PSC.

The following table illustrates the VfM calculation for the project based on the Base PPP Model:

Table 14-13: Value for Money

	PSC	PPP
NPV of Net cash flow	-234 310 838	241 604 976
NPV of Risk Impact Cash Flows	-927 514 404	-326 588 088
Total NPV	-1 161 825 242	-84 983 112
Difference between PPP and PSC (VfM)		**1 076 842 130**

As shown above, the PPP model shows more value than the PSC model.

The VfM assessment will need to be updated at the full Feasibility Study stage and then after the completion of negotiations, when actual budgets will be known.

14.3 Funding and Financing Options

Waste Management infrastructure for the Municipalities, as envisioned for this Project, would be classified as Public Infrastructure. This section, therefore, explores funding options for Public Infrastructure, which together with Financing Options, would inform the appropriate Procurement Option.

Firstly, a distinction in terms needs to be made between Funding and Financing.

14.3.1 Funding

Funding refers to how the money outlaid for the infrastructure/assets will be paid. The most common funding source for Public assets is the fiscus. However, with the shrinking of the fiscus compared to the demand for Public Infrastructure, there has been a trend toward funding revenue-generating infrastructure differently. For instance, if it is a revenue-generating asset, proceeds from those revenues can be used to pay off the asset over time. Typically, this revenue is collected from users of the asset, hence the term "user-pay". Under a "user-pay" arrangement, financing can be sourced from sources other than the fiscus, e.g. Banks, Investors, and repaid over time.

14.3.2 Financing

Financing refers to the manner/form in which the initial capex outlay is raised. Financing can be in the form of equity, debt, bank loans, bonds, shares issued, grants or any such instrument. The source of financing has an impact on the cost of funding a project, as different sources of finance require different levels of return. A number of factors could potentially impact the financing sources and structure, including:

- Project configuration – is the project configured such that it can only be operated by one party?
- Institutional and operating structure – are the Metros involved in management and operations? Is a component somewhat separate from other components, e.g. a landfill with an incinerator run as an IPP?
- Level of regulation of allowable pricing – affordability levels may impact possible financing sources.

From an Investor's point of view, Financing considerations would include the following:

- the respective rates of return, which vary with market conditions
- gearing opportunities which depend on market conditions as well as the investment
- strategy of the prospective investor
- the complementary business opportunities
- the regulatory environment/framework
- the risk factor, which in addition to the standard risk elements, inevitably contains a political dimension because of the public- or quasi-public goods characteristics of infrastructure, especially if profit margins (and prices) become suspect under the applicable regulatory and competitive environment.

These considerations not only determine the decision to invest, but also the nature of the investment, i.e. equity or loan investment and whether to invest in another country. The prospective investor's interest in the particular sector (e.g. telecommunications or energy) or country then comes into play.

14.4 Financing Models

14.4.1 Public Finance

Funding from the Fiscus can be done by utilising budget surpluses or by issuing Government debt. As explained when analysing the capital budgets of the Metros, there are no surpluses to speak of – all three Metros are suffering from budget constraints. They would, therefore,

need to consider the issuance of debt in the form of Municipal Bonds or obtaining debt from banks or other lenders. The challenge with Municipal debt issuance in South Africa is that most municipalities are not investment grade, resulting in investors being reluctant to take up their Municipal Bonds and lenders being reluctant to grant them long-term loans.

A project of this nature also introduces additional complexity in that the three Metros have different levels of credit rating, which may impact the ability of each to issue debt for the same project. Government Guarantees used to be one way of mitigating credit-related risks where municipalities sought to borrow. However, the fiscus is not in a position to underwrite any new debt through issuing guarantees at this time. Hence, alternative ways of financing Public infrastructure are required.

Advantages

- The Metros are in full control of the development of the project and service delivery.
- Potential to proceed with fewer legal obstacles than is the case where Private Sector Party is involved.
- The Metros retain control and ownership of the Project and related project assets.
- Metros retain all the associated revenues and surpluses generated by the Project.
- In the event that the Metros outsource elements of the Project, they have an opportunity to ensure Broad-Based Black Economic Empowerment (BBBEE) participation.

Disadvantages

- The size of project is limited by financing capacity of the Metros.
- Delay in the project due to difficulty in getting funds allocated in the Metro’s capital budgets.
- The Metros retain all the project risks.
- Municipalities have other more pressing service delivery issues and might stall the Project as others may be considered higher priority.
- The Metros retain all the associated losses that may be incurred by the Project.

14.4.2 Private Sector Finance

Private Sector financing entails Public infrastructure being financed entirely through the private sector. Funding (or repayment would then come from the fiscus or users, depending on the project and how it is structured.

Where it is possible for the Private Sector Party to finance, construct and hand over the infrastructure/asset, this is a viable financing model. However, the fiscal constraints stopping the Metros current would still exist, making this method non-viable.

The alternative would be for the Metros to get the Private Sector to finance the infrastructure then the Metros would pay them back over time. This structure entails the Private Sector taking risks on the Metros and the entire project risks until they are paid out in full. This model is also not attractive to the Private Sector.

As such, some sort of hybrid model is required, which allows both parties (Public and Private) to participate and play a role in the delivery of the project according to their strengths.

Advantages

The following are the advantages of a PPP structure:

- Attracts investment from the private sector
- Financing risks shared by both parties
- Asset is owned by the Metros at the end of the concession period
- Facilitates the development, rollout and participation of BBBEE initiatives.

Disadvantages

The following are the disadvantages of a PPP structure:

- Perceived lack of control by the Metros
- Poor risk allocation
- Contracts are more complex and tendering process can take very long
- Unlikely to be attractive to the Private Sector.

14.4.3 Public Private Partnerships

A PPP is a relationship between the public and the private sectors that brings together, for mutual benefit, a public body and a private company in a long-term partnership for the delivery of public services, drawing on the best of the public and private sectors. Under PPP arrangement the private sector is typically contracted to design, build, operate, manage and finance new infrastructure and meet government obligations for a set period of time. In this way, PPPs provide additional resources for investment in the public sector and the efficient management of the investment. These arrangements can be structured in various ways to result in the best financing structure, given the project type and the parties participating in the project. PPPs have been used as an alternative financing model for Public infrastructure in South Africa for many years now, and there is a documented process governing their implementation (managed by the National Treasury), giving comfort to the Government, Investors and financiers.

One important aspect that PPPs bring to infrastructure projects is risk sharing, whereby each party manages those risks that it is best positioned to manage. A PPP arrangement would thus allow the project to be funded by users (through the normal service charges) while collections are still the responsibility of the Metros, fully Private Sector financed (alleviating the budgetary constraints of the Metros), and possibly provide management and operational flexibility (Feasibility Study to determine).

Advantages

The following are advantages of a PPP structure:

- Attracts investment from the private sector
- Financing risks lie with the private party
- Operating risks rest with the private party
- Increased flexibility for procurement
- Clear allocation of risk to the party best able to manage it
- Ability to benefit from the private party’s experience and expertise
- Asset is owned by the Metros at the end of the concession period

- Facilitates the development, rollout and participation of BBBEE initiatives.

Disadvantages

The following are disadvantages of a PPP structure:

- Perceived lack of control by the Metros
- Contracts are more complex and tendering process can take very long.

14.5 Financial analysis conclusion

- Affordability is likely but still needs to be affirmed at Full Feasibility stage.
- Significant Risk Transfer has been established (65%).
- The project provides VfM, but this too needs to be reaffirmed at Full Feasibility Stage.
- In terms of project funding, the Project can be developed on a “user-pay” basis, based on harnessing the service charges that customers pay to the Metros for Waste Management Services.
- As for the optimal financing model, the above discussions make it clear that a Public-Private Partnership arrangement is the most likely model that can be developed and optimised for the delivery of this project. It demonstrates more advantages than the other two models and has very little downside potential.

We, therefore, recommend that GDARDE take the Project to the Full Feasibility stage and explore the possibility of procuring Ecopark as a PPP.

15.CONCLUSIONS AND RECOMMENDATIONS

In a CSIR publication titled *South African Municipal Waste Management Systems: Challenges and Solutions* (May 2020), the following were listed as 'other operational challenges':

In addition to the above challenges, DEA (2019) and DEA (2012) have listed among others 1) low participation rates in source separation initiatives, 2) lack of infrastructure for recycling, 3) lack of recycling culture and willingness to recycle in communities and 4) waste collection backlogs. These findings concur with DEA (2011) which stated that about 87% of the municipalities does not have the means or proper infrastructure to initiate waste minimization and diversion which may include separation at source and resource recovery. DEA (2012) stated that municipalities find them opting for landfilling as a preferred disposal method because other available alternatives are more expensive than landfill costs. Most of the municipalities in South Africa do not have source separation programs. In some municipalities source separation programmes are run by private operators through provision of separate containers for source separation of recyclables and drop-off points (DEA and GIZ, 2018a; DEA and GIZ, 2018b; DEA and GIZ, 2018c; DEA and GIZ, 2018d).

Other important statements in the CSIR report having a direct impact on the current waste management situation at the three metros in Gauteng are the following:

Most of South African municipalities experience similar waste management challenges including i) financial constrai/nts i.e. limited budget allocated to waste management services, ii) operational problems i.e. fleet challenges such as break downs, not being able to collect all the generated waste, dysfunctional weighbridges and lack of adequate manpower, iii) legislation challenges i.e. mostly lack of law enforcement and the long waiting periods when applying for a waste licence, and iv) planning and management challenges i.e. not being able to manage the landfill sites well, inability to render an effective waste management services.

From the detailed investigations undertaken as part of the Pre-Feasibility Study for the proposed Regional Integrated Waste Facility "Ecopark" in Gauteng, the following Conclusions and Recommendations are put forward from the Technical Options and the Financial Analysis of this Pre-Feasiblity study:

Technical

- Licencing, development, and commissioning of the proposed regional Ecopark will be time consuming, and even more so when PPP processes are to be implemented. With the aforesaid likely to take between 5 and 10 years, it is not envisaged that the proposed Ecopark will address the short-term effects that landfill airspace shortages in Gauteng will have on environmentally sound, financially viable and sustainable waste management service delivery in Gauteng.
- As reported by the CSIR in 2020, compliance with the NWMS will require implementation of *Integrated Waste Management Systems*[10] by the three metros. Waste in its current

[10] Also refer to Appendix A and Appendix B.

form disposed of at metro / private landfills, ***cannot*** simply be rerouted to the proposed Ecopark. Failure of various donor funded waste minimisation projects in Gauteng provides evidence of this. It is further important that any financial model used for such facilities should ensure its financial viability and long-term sustainability, without the need for external funding of operations (e.g. donor funding).

- Implementation of integrated waste management systems by metros should also include a network of strategically located waste transfer stations that will allow for waste to be transported more cost effectively to any (remote) regional waste management facilities. Due to its high density, construction and demolition waste (C&DW) should not be transported over long distances for processing but should be crushed and screened as close to the source as possible, with the offtake subsequently used in the same area.
- The current poor state of waste transfer station- and landfill operations at the three metros in Gauteng (irrespective of whether the services are rendered inhouse or outsourced), is a reason for concern if Advanced Waste Treatment Technologies (AWTT) like municipal incinerators or anaerobic digestors are to be developed, commissioned, and operated under the leadership of the metros.
- The three metro's poor track record on waste management operations over the past decade will make it difficult for them to licence new waste management facilities – irrespective of it being local or regional facilities. With public participation being an important component of the licencing process, opposition by Interested and Affected Parties may prevent any such licencing processes from being successful. The CoJ's failed attempt to licence the proposed Northern Works landfill is an example of this. It is also to be recognised that poor standard of operations and lack of legal compliance by some metros already resulted in early closure of municipal waste management facilities.
- According to information received from CoJ/Pikitup officials, the city is in the process of implementing mitigating measures that will address the impact of imminent closure of its four landfills. Detailed investigation of Pikitup's capital budget for the next ten years however failed to provide evidence that adequate financial allowance was made for this, which is likely to result in municipal waste having to be transported over long distances to private landfills. The is not only expected to have a significant impact on waste management logistics, but it will also have significant financial impacts for CoJ ratepayers.
- Due to 'financial issues', several CoE landfills were not operational for extended periods of time like more than a year – subsequently having a significant impact on waste collection logistics, costs, and the extent of illegal dumping in the metro. To overcome the aforesaid problems, the CoE is proposing implementation of Advanced Waste Treatment Technologies - including but not limited to an incinerator, anaerobic digester, material recovery facilities, composting facilities, and transfer stations. Information received from CoE is that the tipping fee for the proposed new AWTT facility is expected to be in the order of R 1 000-00 per tonne on current levels of waste separation at source. This is almost 3 times as much as the CoE's current disposal fee of around R 350-00 per tonne at its municipal landfills. In addition to the fact that it is questionable whether such high tipping fees can be afforded by residents of the CoE, it is also creating the risk of

significantly increased illegal dumping in the metro. Illegal dumping is subsequently to be collected at high cost by the metro for disposal at R 1 000-00 per tonne.

- No information was received from the CoT’s landfill division regarding its strategy to address the landfill airspace shortage in the metro.

Considering the high number of constraints associated with waste management in Gauteng (poor separation at source, financial constraints, disruption to power supply, limited skilled operators, etc.), coupled with a need for increased job creation, the options viable for implementation at the proposed regional integrated waste management facility is limited.

During the Full Feasibility Study, a ranking matrix should be used that is based on weighted criteria that is agreed to by the major stakeholders. In addition to that, ongoing fluctuations in the ZAR/US$ exchange rate is also causing instability in the CAPEX and OPEX requirements for imported plant and equipment. Linked this is the market for the expected offtake, with the market value thereof constantly changing. It is thus recommended that the Full Feasibility Study also include market research to determine the long-term demand for offtake despite the increased supply after implementation of the Ecopark. A sensitivity analysis to determine the potential impact of the various risks identified, e.g. fluctuations in the ZAR/US$ exchange rate as well as interest rates, should also be undertaken.

As the only viable options for implementations as the ***first phase*** of the Ecopark is limited to recycling with source-separated materials, in combination with windrow composting and chipping of building rubble at source, the need for a landfill remains. The detailed feasibility study should, however, identify and investigate potential mitigating measures that can be implemented to address some of the constraints currently considered to be of significance.

However, the following actions are recommended even before the Full Feasibility Study for the proposed project is undertaken:

- ***Short term:*** Address problems with operation of existing services and infrastructure at metros. Determine availability of private landfill airspace as well as the cost for medium-term (up to five years) disposal at such landfills. Select the most viable combination of transport, transfer and disposal options and enter short term to medium term contracts for the use of such landfills (until long term measures can be put in place).
- ***Medium term:*** Implement waste minimisation and diversion systems, together with strategically located transfer stations, throughout the metros. Tailings from such processes is subsequently to be disposed of at remaining public and private landfills.
- ***Long term:*** Implement (and sustainable operate) Regional Integrated Waste Management Facility / Facilities. Continue with planning and implementation of more advanced systems once the systems for the first phase of the project were successfully implemented.

Financial

In summary:

- Affordability is likely but still needs to be affirmed at Full Feasibility stage.

- Significant Risk Transfer has been established (65%).
- The project provides VfM, but this too needs to be reaffirmed at Full Feasibility Stage.
- In terms of project funding, the Project can be developed on a “user-pay” basis, based on harnessing the service charges that customers pay to the Metros for Waste Management Services.
- With respect to the optimal financing model, the above discussions make it clear that a Public-Private Partnership arrangement is the most likely model that can be developed and optimised for the delivery of this project. It demonstrates more advantages than the other two models and has very little downside potential.

We, therefore, recommend that GDARD take the Project to the Full Feasibility stage and explore the possibility of procuring the IRWTF as a PPP.

16.REFERENCES

Ref. No.	Document
[1]	Constitution of the Republic of South Africa (Act 108 of 1996)
[2]	National Environmental Management: Waste Act (Act 59 of 2008)
[3]	Draft Terms of Reference for the Project Steering Committee on the Regional Integrated Waste Facility Project in Gauteng (10 Feb 2023)
[4]	Revised Concept Note for the Proposed Regional Integrated Waste Management Facility “Ecopark” June 2022. Prepared by GDARDE
[5]	Updated Project Schedule for the Integrated Regional Waste Facility 10.02.2023
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