Long Term Waste Management Master Planning for the Ekurhuleni Metropolitan Municipality

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ABSTRACT
The Ekurhuleni Metropolitan Municipality (EMM) forms part of the Gauteng Province with a total population of 3 178 470 in 2011. The EMM owns five licensed waste disposal facilities that are all operated by waste contractors under contract to the EMM. Private landfill facilities are also in operation within the EMM. EMM landfilled 1 151 537 tons of waste between July 2014 and June 2015. In order to help address the waste management challenges of EMM, this study included short (0 – 5 years), medium (6 – 15 years) and long (16 – 25 years) term scenario planning and focussed on a number of recommendations in the short, medium and long term.

The paper also includes a look into the Feasibility Study on alternative waste treatment technologies which is undertaken as part of a Municipal PPP process looking at the development of infrastructure and associated strategies geared towards the reduction of waste to landfill.

1. INTRODUCTION

The Ekurhuleni Metropolitan Municipality (EMM) forms part of the Gauteng Province in South Africa and has a total area of 1,975 km^2 (15.6% of Gauteng's land mass). EMM houses 6% of the country's population, 26% of Gauteng's population and South Africa's largest airport, OR Tambo International Airport, is located in EMM. In 2011 EMM had a total population of 3 178 470 of which 71.7% were in the working age group (16 - 64 years). This Municipality thus has a large amount of waste that it is responsible for. The EMM owns five (5) municipal waste disposal facilities and they have Waste Licenses from the provincial environmental authority. The five EMM landfills are Rietfontein, Weltevreden, Rooikraal, Platkop and Simmer & Jack. Professional waste contractors under contract to the EMM operate these landfills. Some private landfill facilities are also in operation within the EMM and the Interwaste FG Landfill in Olifantsfontein currently receives municipal waste from the EMM. According to the weighbridge information provided a total of 1 151 537 tons of waste was landfilled at the EMM's landfill facilities between July 2014 and June 2015. According to Interwaste, 271 898 ton domestic waste from EMM was disposed of at their FG Landfill site from January 2012 to July 2015. This amounts to an average of 75 878 ton/year.

EMM's disposal facilities are situated in Boksburg (Rooikraal), 30 km from Germiston (Platkop), Springs (Rietfontein), Germiston (Simmer & Jack) and Brakpan (Weltevreden). All five the landfill sites have operational weighbridges with historic waste records from 2009.

Short (0 – 5 years), medium (6 – 15 years) and long (16 – 25 years) term scenario planning was undertaken to ascertain the effects of landfills reaching capacity on the state of waste disposal across the metro. To develop the disposal models for the landfill facility's an annual waste disposal growth rate of 1.5% was assumed. Advents and eventual implementation of waste minimisation strategies, separation at source programs and alternative waste treatment technologies will have an impact on long term waste disposal planning in the metro. When compared to the neighbouring metros, the EMM are in a relatively good position regarding available landfill airspace but this position needs to be well managed to ensure long term sustainable waste disposal in the EMM. In order to address the waste management challenges the EMM is facing, this study focussed on a number of recommendations in the short, medium and long term.

The paper also includes a look into the Feasibility Study on alternative waste treatment technologies which is undertaken as part of a Municipal PPP process looking at the development of infrastructure and associated strategies geared towards the reduction of waste to landfill.

1.1 Landfill Classification and the new Regulations

The landfill sites, with the exception of Rietfontein, were licenced as G:L:B- landfill sites, which implies it's a large facility receiving more than 500 tons of general waste per day and has a negative water balance. The negative water balance aimed to indicate that the site did not generate significant amounts of leachate and thus a leachate collection system was not required and most of the landfill sites did thus not have a leachate collection system installed in the first cell. All the sites however, with the exception of Simmer and Jack, have leachate collection systems installed in the most recent waste cells, as well as leachate ponds or sumps. Platkop landfill is licensed to accept asbestos waste. Rietfontein landfill was classified as a G:L:B+ facility, has a positive water balance and the waste cells thus had to include leachate collection systems. Rietfontein landfill is licensed to accept delisted wastes.

According to the Waste Classification and Management Regulations (WCMR) as published in Government Gazette no 36784, all EMM's landfill sites must now be classified as Class B landfill sites.

Platkop landfill site could accept asbestos waste before the WCMR came into effect. The WCMR classifies asbestos waste as a Type 1 waste, which must be disposed of at a Class A landfill site. According to the Implementations and Transitional Provisions of the WCMR, if an alternative decision has been made by the Department of Water Affairs of the Department of Environmental Affairs, the waste does not require reclassification in terms of the WCMR for a period of three years after the WCMR came into effect. Therefor from August 2016, asbestos waste may no longer be accepted at Platkop, except if a Class A landfill cell is constructed.

Rietfontein landfill site could accept delisted wastes before WCMR came into effect. According to the WCMR, delisted wastes must be reclassified according to the WCMR and disposed of in lined cell in accordance with the WCMR classification.

2. LANDFILL LONG TERM MASTER PLANNING

Long Term (25 year, up to 2040) Master Planning was done for each of the landfill sites. The development of the Master Plans involved analysing the historic waste stream, determining the remaining airspace, estimation of rehabilitation requirements, assessing the water management on site and a cover material balance analysis.

Available information for all the five landfill sites, including previous designs, construction and planning reports, were consulted to get a clear understanding about the previous developments, existing infrastructure and problems experienced on the sites. Detailed site visits were undertaken to each of the landfill sites.

2.1 Waste Disposal Growth Rate

The historic weighbridge data was analysed in order to find an appropriate waste disposal growth rate for the landfill sites. The data did, however, not show a trend and most of the sites showed a negative waste disposal growth rate during the past three years. It was decided that it would not be realistic to use a negative waste disposal growth rate due to the fact that waste disposal would then ultimately become zero in the future. Although this has been proven to be true in other countries, it is the opinion of the author that the required technologies to achieve zero waste to landfill are largely unproven in South Africa. EMM has a population growth rate of 2.47% per annum according to the latest Census (2011) data provided by Statistics South Africa (Stats SA). Although waste generation volumes should theoretically increase as the population increases, it would not be a realistic assumption to use the population growth rate as the waste disposal growth rate. The reasons for this argument being:

- The development of private landfill facilities. More private companies are realising the value of waste and the need for well managed landfill sites. These sites could offer the Municipalities a more economically feasible alternative than developing their own landfill sites. The transport distances to landfill sites plays a big role in the economy of waste disposal and a private landfill might in some cases be closer than a municipal owned landfill site. If waste is disposed at the provided landfills instead of at EMM's landfills, it will decrease the waste disposal growth rate at EMM's landfills;

- Recycling initiatives reduce the amount of waste disposed at the landfill sites. The difference between the waste generation per capita and the landfilled waste per capita is becoming more significant as recycling initiatives increase;

- Changes in legislation towards waste minimisation. The National Environmental Management Waste Act of 2008 (Act No. 59 of 2008) (NEMWA) addresses waste minimisation specifically. NEMWA required the establishment of a National Waste Management Strategy (NWMS) One of the objectives of the NWMS is to divert 20% of all recyclables from landfill by 2016; and,

- Environmental propaganda was changing the mind-sets of the population to move towards a greener and more environmentally friendly way of living. This included waste minimisation and recycling. The population is becoming more aware of their responsibility towards the environment and the benefits of recycling.

Goal 1 of EMM's Draft Integrated Waste Management Plan (IWMP, 2015) is to reduce the amount of waste disposed at landfill sites with 10% in 2016, 2017 and 2018. The Gauteng Waste Minimisation Plan (GWMP, 2009) aimed to reduce waste going to landfill by 1% per annum from 2009 to 2015. The 1% reduction in waste per annum (as per the GEMP) was applied to EMM's waste disposal for reference purposes. The estimates for waste disposal for one of EMM's landfills can be seen in Figure 1.

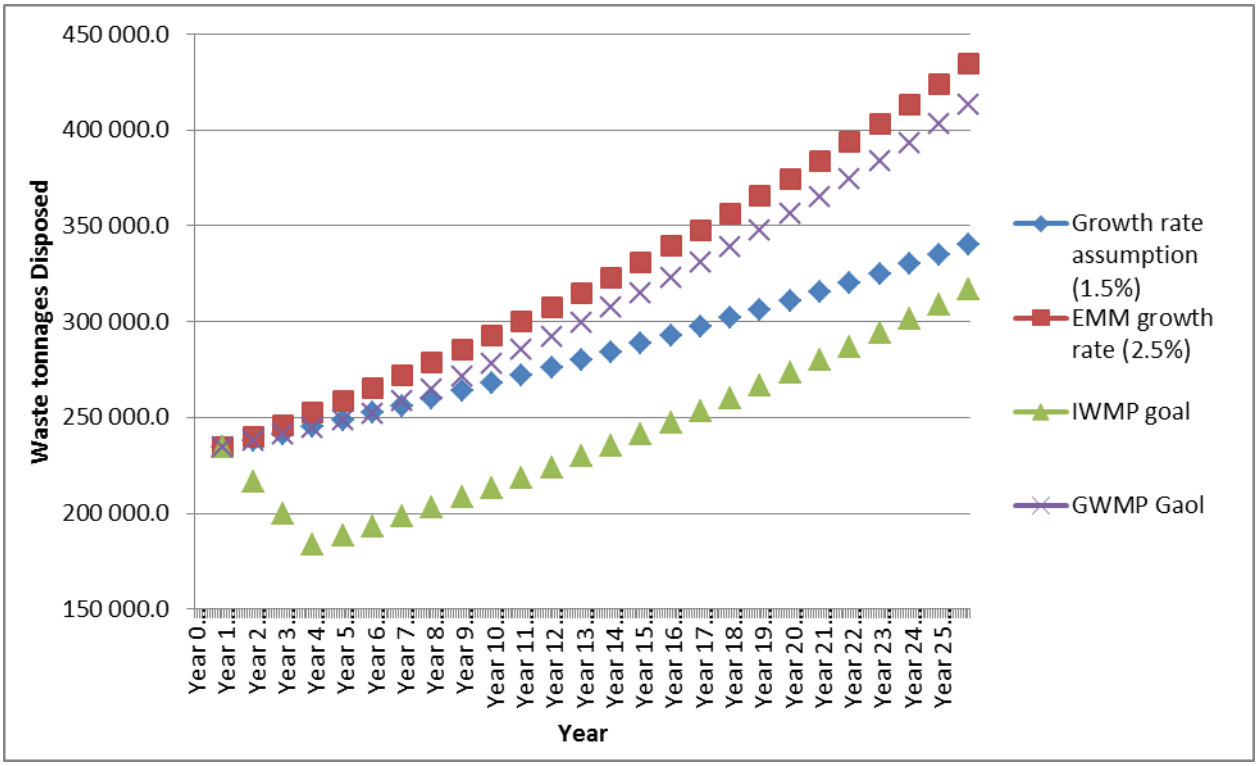

Figure 1: Waste disposal estimations (Rietfontein disposal facility)

With the above-mentioned factors in mind, a waste disposal growth rate of 1.5% was used for EMM's landfill sites over the next 25 years (up to 2040).

2.2 Long Term Planning

A Stage Development Plan was developed for each landfill site, indicating the landfill cell layout for the 25 year planning period. The Stage Development Plan took into consideration current and planned infrastructures, buffer zone requirements and other site specific constraints (e.g. dolomite) on site.

The average monthly tonnage for the last reporting year (2014/2015 financial year) was used as the starting disposal rate in the airspace modelling. A compaction density of 1 000km/m^3 and a waste to cover ratio of 1:4 (as per the Minimum Requirements) was assumed to calculate the available and required airspace (for the next 25 years). The cover material requirements for each landfill were also determined. For each landfill site the average monthly tonnage from the last reporting year was taken as the current scenario. A high and low scenario was also modelled (Figure 2). The waste disposal rates of the high and low scenarios were site dependant and was typically 5 000 ton/month higher or lower than the current scenario.

Using the most recent topographical surveys and the final landfill surface the airspace available in each cell was determined and compared to the waste disposal model. An estimation of each cell's life span could be made, enabling EMM to plan for progressive rehabilitation and liner requirements.

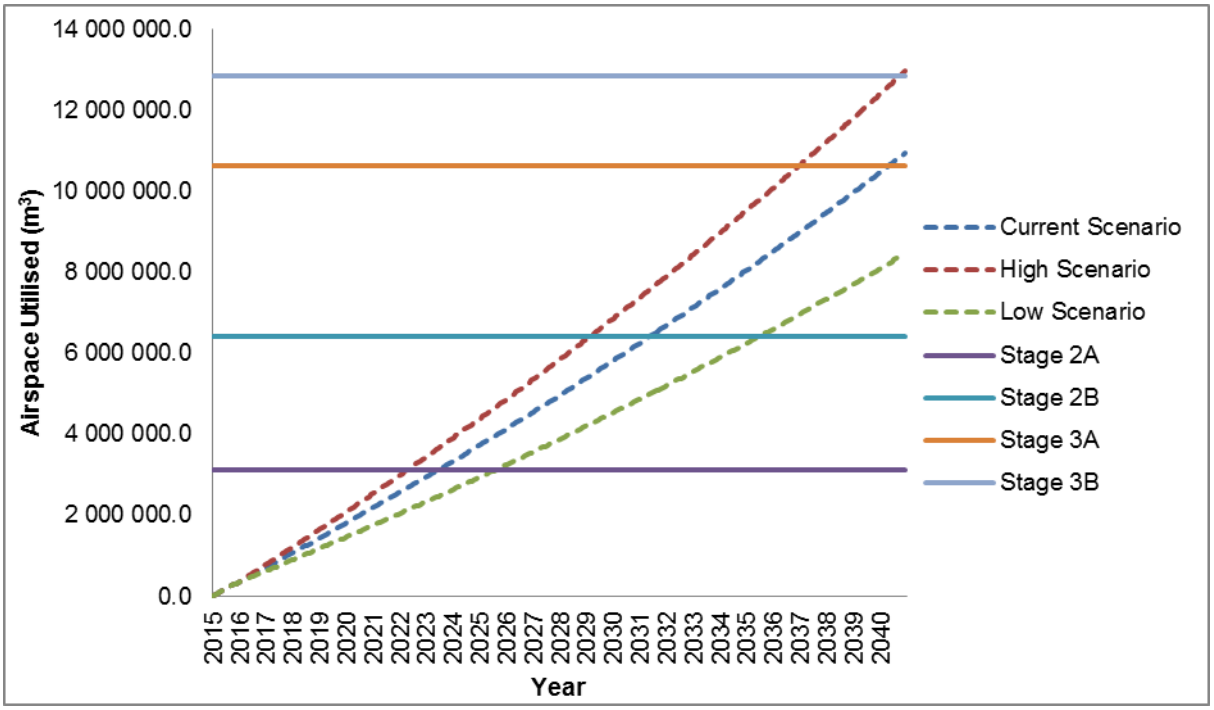

Figure 2: Waste Disposal Scenarios (Rooikraal disposal facility)

A material balance was done for each site, taking into consideration the current stockpile on site, the estimated excavation depths as per previous geotechnical studies and liner and capping area requirements.

2.3 Water Management

It is important to keep the contaminated and uncontaminated water on site separate. The clean stormwater should be diverted around the landfill site by means of berms and channels.

In order to size the leachate retention pond, a monthly time-series dam balance model was developed using Microsoft Excel. The model explicitly simulates the volume of water in the dam before and after a rainfall event on a monthly basis and hence the probability of the leachate retention pond spilling in a given month. Long term historic rainfall data was used in the model. The model makes a number of assumptions regarding the leachate collection pipe diameter, slope and the water level in the pipes. The leachate dam size for each site were used and as the pump capacities were unknown, five different pump capacities were assumed. It was assumed that the leachate can be pumped from the dam for 18 hours per day for a 30 day month. In order to model the required pump capacity and leachate dam size, scenarios using different active cell areas and leachate dam capacities were analysed. The result was a graph for the different scenarios indicating the pump capacity, probability of spilling and percentage of time pumping required. Thus EMM can use the graph to decide on a leachate dam size, pump and pumping time.

To evaluate the size of the contaminated stormwater dam the same monthly dam model was used as for the leachate retention dam. The capacity of the stormwater dam was changed until the probability of spilling was less than or equal to 2%. Two site conditions were used, an ideal site area that will contribute to contaminated water and a worst case site area. Five different pump capacities were used in the analysis for each site condition. The results for the worst case site area indicated that a very large contaminated stormwater dam and pump would be required and is thus unpractical. It is therefore important to effective manage the landfill site to keep the area contributing to contaminated stormwater as small as possible.

2.4 Progressive Rehabilitation Plan

As an Annexure to the Long Term Plan, a Progressive Rehabilitation Plan was developed for each of the landfill sites. The Progressive Rehabilitation Plan would guide EMM in planning for capping and rehabilitation of the landfill as well as liner requirements. The required capping and liner areas were given for each year. Modelling software was used to give a representative image of the landfill in 5 year increments.

Figure 3: Weltevreden Landfill Facility Progressive Rehabilitation Plan

3. INTEGRATED WASTE DISPOSAL MASTER PLAN

The individual Long Term Plans for each landfill site was used to develop a metro wide Integrated Waste Disposal Master Plan (IWDMP) for EMM.

3.1 Waste Disposal

The current waste disposal rate across EMM was determined by adding up all the landfill sites' weighbridge tonnages, including EMM's waste disposed at Interwaste's FG landfill.

The major waste types disposed at EMM's landfill facilities can be divided into five major waste categories: general domestic refuse, industrial refuse, mixed rubble, clean building rubble and clean compost or garden refuse (Figure 4). Domestic waste accounts for 47.57% of the total waste disposed at EMM's landfill facilities.

For the purposes of estimating the total waste disposal across EMM, the municipality was divided into Northern and Southern areas. The Southern areas being where the waste is collected and disposed at EMM owned facilities and the Northern areas where the waste is disposed at FG landfill. Only the domestic waste tonnage disposed at FG landfill were available.

To estimate the total waste disposed in the Northern area, the same waste type distribution (Figure 4) as the Southern area were assumed. Using the domestic waste tonnage disposed at FG landfill, the other types of and total waste disposed in the Northern area could be estimated.

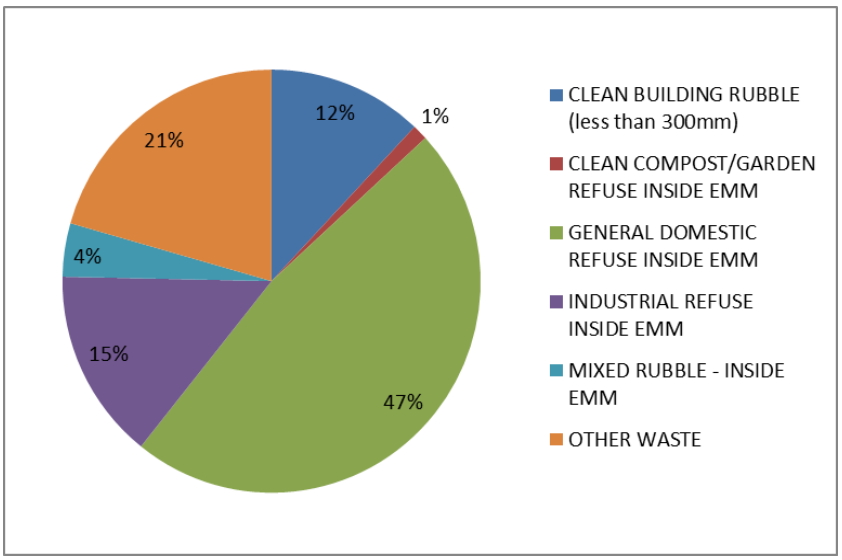

Figure 4: Major Waste Types Disposed at EMM Landfill Facilities

The waste disposal growth rate was taken as 1.5% per year, as per the Long Term Master Plans.

3.2 Waste Generation

The estimated residential waste generation in EMM was calculated using waste generation rates published in the Department of Environmental Affairs, National Waste Information Baseline Report (2012), citing Fiehn and Ball (2005). The average waste generation rates for the different income levels are as shown in Table 1. The low income category was taken as R0 – R4 800 per month, the medium income as R4 801 to R19 600 and the high income category as R19 601 and above. The average for the very low and low income category was used for the low income category whilst the average for the high and very high income has been used for the high income category. It was assumed that the waste generation growth rate is equal to the population growth rate of 2.47%. Information regarding EMM's population and income groups was obtained from Stats SA.

Table 1: Residential waste generation rates by Income Level (source: DEAT, 2006; BPDM, 2009)

Income Level	Waste generation kg/capita/day					
	DEAT (2006)	DEAT (unpublished)	GDACEL	BPDM (2004)	NWDACE (2008)	Average
Very Low	-	-	0.2 - 0.4 (average: 0.3)	-	-	0.3
Low	0.41	0.2 - 0.7 (average: 0.45)	0.4 - 0.7 (average: 0.55)	1.45	0.45	0.46
Medium	0.74	0.7 - 1.9 (average: 1.3)	0.7 - 1.1 (average: 0.9)	1.1	1.1	1.03
High	1.29	1.5 - 1.3 (average: 2.25)	1.1 - 1.2 (average: 1.15)	1.85	1.85	1.68
Very High	-	-	1.2 - 2.5 (average: 1.85)	-	-	1.85

Comparing the estimated generated residential waste for the Southern area (serviced by EMM's five disposal sites) to the actual disposed domestic waste at the five sites indicated that 84% of the calculated generated waste gets disposed. The difference could be due to recycling activities, areas not receiving waste collection services, estates or complexes serviced by private waste management companies, etc.

Comparing the domestic waste disposed at the FG landfill facility and the calculated waste generation for the Northern area, 47% of the generated waste is being disposed at FG landfill facility. This could be due to

private waste management companies servicing certain areas (e.g. estates) or people making use of their own or communal refuse dumps, as many of the properties in the northern part of EMM are situated on smallholdings or farms.

Using the waste type distribution of the Southern area (Figure 4) for the Northern part, the total waste disposed in the Northern part could be estimated (assuming 84% of the generated waste gets disposed as for the Southern areas).

Thus for the scenario planning two different waste tonnages would be used for the northern region of EMM. A higher value where the calculated waste generation value was used to calculate the total waste and a lower value where the waste disposed at FG was used for the calculation of the total disposed waste. Figure 4 was used to calculate the total tonnage to be used in the scenario planning.

3.3 Scenario Planning

In order for EMM to plan ahead for the required waste management activities, short, medium and long term scenario planning was undertaken.

3.3.1 Short Term Planning

The short term planning was done for 0 to 5 years (up to 2020). The Simmer and Jack landfill was the only landfill that would reach capacity in the short term planning time frame, if no other development would take place. The graveyard or material stockpile areas could still be developed. The waste would thereafter have to be transferred from Simmer & Jack to another landfill, increasing waste management transportation costs and the waste disposal rate at the receiving landfill. The distances between the Simmer and Jack landfill and the other EMM landfills were used to decide which site to divert the waste to. Although Rooikraal is the closest to Simmer & Jack, it was proposed that the waste is transferred to Platkop. Rooikraal did not have any available cover material and diverting the waste to Rooikraal would add to amount of cover material that has to be imported in the short term.

Short term planning included locating a cover material source at Rooikraal, as this facility still has a lot of airspace available.

3.3.2 Medium Term Planning

The medium term scenario planning was for 6 to 15 years, up to 2030. During the medium term the Rietfontein and possibly FG landfill would reach capacity. Waste from Rietfontein could be diverted to either Weltevreden or Rooikraal landfill. Weltevreden landfill would be the closest landfill to divert the waste from the Northern region (FG) to. A graph showing the influence of the additional waste on the each of the receiving landfills was presented in the report (similar to Figure 5).

3.3.3 Long Term Planning

For the long term planning scenario (up to 25 years or 2040) the impact of the short term and medium term scenarios were taken into account and the impact was modelled on the other landfill sites. The long term planning included 12 possible long term scenarios for waste management across EMM.

Another investigation was done regarding possible locations of Material Recovery Facilities (MRFs) in EMM. The study advised that EMM should construct four clean MRFs across EMM. The MRFs were estimated to divert 1 600 ton/month waste from the landfill sites. During the scenario planning, it was assumed that the MRF's would be operational by end of 2020 (scenarios 7, 8, 11 and 12).

EMM considered applying to increase Weltevreden's maximum landfilled height above ground level from 10m to 40m. In order to demonstrate the impact of the height increase on the overall airspace of EMM, Weltevreden landfill's final height was taken as 10m and 40m in the scenario planning.

The waste disposal rate in the northern region of EMM was taken as calculated using the volume of waste currently disposed at FG landfill facility as well as the volume calculated using the waste generation rate and current waste types in EMM. The waste volumes between the actual disposed waste and the calculated disposed waste differs significantly, thus it was decided to model both volumes in the scenario planning (the waste generation rate calculated value being the highest one). EMM would have to determine the actual disposed waste volume in the Northern area in order to use the most appropriate scenario for future planning.

The scenarios indicated what the impact of one site reaching capacity would be on the other landfill sites. Scenario 5 and 6 took into account that waste from a closed site might be taken to more than one operating site, which might be a more economical option in terms of transportation costs. In total 12 different scenarios were considered.

The results of the scenario modelling were shown on a graph for each landfill site, indicating the influence of the different scenarios on the lifespan of the landfill site (Figure 5).

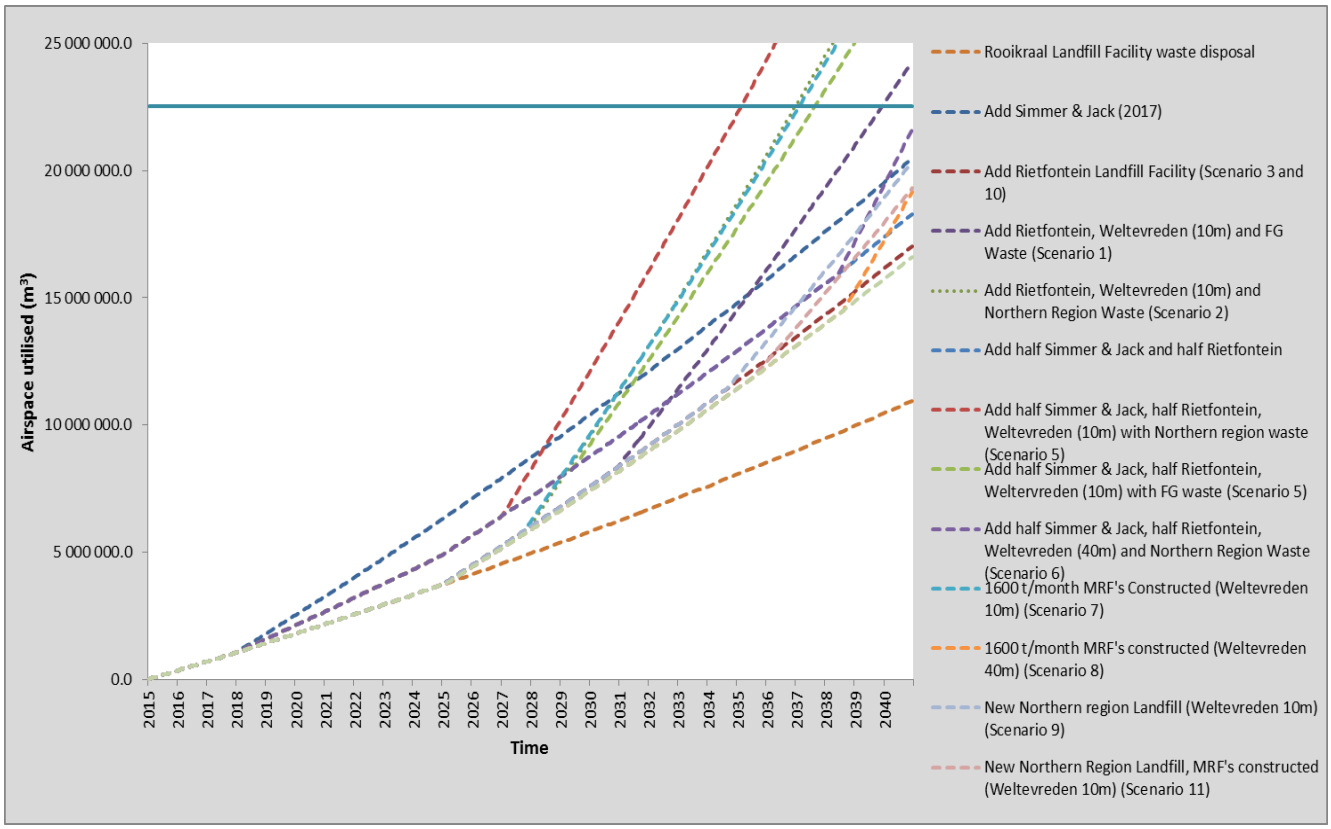

Figure 5: Long Term Scenario Planning (Platkop Disposal Facility)

3.3.4 Recommendations and mitigating actions

The short term recommendations proposed to EMM included:

- obtaining a decision on the possibility of developing the graveyard and stockpile areas at the Simmer & Jack landfill site;
- relocating excess cover material at Simmer & Jack to Rooikraal;
- initiate the process for a transfer station and MRF at Simmer & Jack;
- apply to increase the permitted height at Weltevreden; and
- identify sources for cover material at Rooikraal and Weltevreden.

The medium term recommendations proposed to EMM included:

- upgrading of the transfer stations, small, medium and large;
- develop and operate MRF's;
- development of a new landfill facility in the northern region of EMM;
- Review of landfill Master Plans

The long term recommendations proposed to EMM included:

- monitor the weighbridge data and the waste disposal growth rate to accurately plan for future waste disposal; and
- plan and budget for upcoming landfill closures and capping of landfill sites.

4. FEASIBILITY STUDY ON ALTERNATIVE WASTE TREATMENT TECHNOLOGIES

The Master Planning studies indicated that EMM could benefit from alternative waste treatment technologies to reduce the landfilling of waste. The feasibility study to investigate alternative waste treatment technologies was commenced to explore the feasibility of such as project in terms of the need, financial feasibility, site identification and preliminary concept design, legal and regulatory requirements etc.

This project will explore the feasibility of alternative waste treatment technologies in EMM in terms of the relevant National Treasury regulations to the Public Finance Management Act, 1999 (PFMA), Municipal Systems Act (MSA), as well as the Municipal Finance Management Act.

Different alternative waste treatment technologies will be considered, with the focus being reducing the amount of waste going to landfill. Job creation is a very important role player in any project in South Africa and the final proposed technology will take this into consideration.

The carbon footprint of EMM's waste management activities will be analysed. The current carbon footprint will be compared to that of the proposed technology's in order to ensure that waste management in EMM is done in the most environmental friendly manner. Currently EMM is reducing their carbon footprint from their landfill sites by extracting the landfill gas. The landfill gas is flared to change the composition of the gas into a less environmentally harmful gas.

A waste characterisation study will be completed to assess the waste streams available for alternative waste treatment technologies. The summer sampling of the study indicated that a very big portion of the domestic waste going to landfills is garden waste. There is no recycling at source initiatives in the residential areas of EMM, therefor there is an opportunity to recover recyclables of the municipal waste stream. Various industrial areas are however serviced by private waste management companies that separate and sell the recyclables.

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