The GreenCape Sector Development Agency

**DEVELOPMENT OF THE WASTE ECONOMY IN THE WESTERN CAPE**

Case Study Report

Decision Making for Integrated Waste Management:   
Developing and Evaluating Waste Management Scenarios for Stellenbosch Municipality

2014-2015



Report Prepared for:

Green Economy

Department of Economic Development and Tourism

Western Cape Government



**Prepared by:**

Tawanda Sango

10 December 2014

**Contact Person:**

Gracia Munganga

44A Bloem St, 2nd floor

Cape Town, 8001

Tel no. 021 811 0250

Email: gracia@green-cape.co.za

DEVELOPMENT OF THE WASTE ECONOMY IN THE WESTERN CAPE

Signature Page

For The GreenCape Sector Development Agency:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Signature

Chief Executive Officer Evan Rice\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date

# Executive summary

Municipalities in the Western Cape are under pressure to implement alternative waste management as a result of, among others, rapidly diminishing landfill airspace, and to meet the goals of the National Waste Management Strategy. To this end, GreenCape is tailoring and developing a municipal integrated waste management decision support tool (IWM DST) in order to assist Western Cape municipalities adopt a systems-based approach, addressing the full waste life cycle.

Stellenbosch Municipality was selected as the first case study municipality. The richness of Stellenbosch Municipality’s waste information, coupled with the pressing need for waste diversion (less than 4 years available landfill airspace in early 2014) allowed for the scope of the case study to cover both the tailoring and development of the IWM DST, as well as to support the development of Stellenbosch Municipality’s Integrated Waste Management Plan (IWMP) for 2015-2019.

The specific objectives of this work were to:

* establish Stellenbosch Municipality’s vision and goals for integrated waste management
* develop a baseline of the current waste management system
* identify key decision criteria
* generate waste management scenarios aligned with the vision and goals
* evaluate the waste management scenarios against the selected criteria
* compare and contrast the alternatives in a manner that highlights their benefits and drawbacks for municipal decision makers.

This report summarises the work done to meet these objectives. Key findings of note for Stellenbosch’s IWMP include a financial cost for the municipal waste management system under a business-as-usual scenario of R51m per annum (or R440/tonne waste treated) and a global warming potential (GWP) of 41,790 tonnes CO2,eq per annum. The biggest contributor to GWP occurs as a consequence of the high organic content of the municipal waste, and a predominantly landfill-based waste management system. A scenario diverting builders’ rubble and garden waste, results in an increase of the cost to the municipality to R54m (R470/tonne). By diverting garden waste to composting, there is significant environmental gains as the resulting CO2 generation from composting as opposed to methane (CH4) from landfill (to be quantified in the next phase of the work).

The case study has demonstrated the value of the IWM DST to explore alternative waste management scenarios and quantify their financial and environmental benefits. Stellenbosch Municipality’s 3rd generation IWMP, which is due to be drafted by the 31st of March 2015 will draw on these IWM DST results and associated analysis.

Table of Contents

[Executive summary i](#_Toc405972461)

[List of Tables………………………………………………………………………………........…iv](#_Toc405972462)

[List of Figures …………………………………………………………………………… iv](#_Toc405972463)

[1 Introduction 1](#_Toc405972464)

[1.1 Goal and outline 1](#_Toc405972465)

[2 Municipal decision support: Project Background 1](#_Toc405972466)

[2.1 Integrated Waste Management: Consideration of the Full Waste Management System on a life Cycle basis. 2](#_Toc405972467)

[2.2 Tailoring Integrated Waste management Models to the South African Context via Case Study Municipalities 3](#_Toc405972468)

[2.3 Rationale for Selection of Stellenbosch as a Case Study 4](#_Toc405972469)

[3 Stellenbosch Case Study Background 5](#_Toc405972470)

[3.1 Goal of Case Study 5](#_Toc405972471)

[3.2 Stellenbosch Municipality: Background 5](#_Toc405972472)

[3.3 Current Stellenbosch Municipal Waste Management 10](#_Toc405972473)

[3.3.1 Waste Treatment 10](#_Toc405972474)

[3.3.2 Stellenbosch Municipality Initiatives and Plans 10](#_Toc405972475)

[4 Stellenbosch Case Study Methodology 11](#_Toc405972476)

[4.1 Important Decision Making Criteria for Municipal Solid Waste Management 11](#_Toc405972477)

[4.2 Determination of Plausible Scenarios for Modelling 11](#_Toc405972478)

[4.2.1 Scenario 1: Builders’rubble (BR) crushing and brick making, garden waste composting (0-1yrs) 12](#_Toc405972479)

[4.2.2 Scenario 2: Increased source separation with local Material Recovery Facility (MRF), 1-5yrs 12](#_Toc405972480)

[4.2.3 Scenario 3: Increased source separation with local organic waste treatment (1-5yrs) 13](#_Toc405972481)

[4.2.4 Scenario 4: Regional collaboration (2-5yrs) 14](#_Toc405972482)

[4.3 Modelling of Scenarios – Financial and Environmental Costs 14](#_Toc405972483)

[4.3.1 Case study assumptions 14](#_Toc405972484)

[5 Stellenbosch case study results 17](#_Toc405972485)

[5.1 Waste Projection 17](#_Toc405972486)

[5.2 Base Case Study 20](#_Toc405972487)

[5.3 Modelling of Scenarios 22](#_Toc405972488)

[5.3.1 Scenario 1: Builders rubble crushing and garden waste composting 22](#_Toc405972489)

[6 Stellenbosch case study conclusions and way forward 24](#_Toc405972490)

[6.1 Key Insights 24](#_Toc405972491)

[6.2 Further Work 25](#_Toc405972492)

[6.2.1 Modelling of environmental and cost performance of scenarios 25](#_Toc405972493)

[6.2.2 stellenbosch municipality Sensitivity analyses 25](#_Toc405972494)

[6.3 Concluding Remarks 25](#_Toc405972495)

[7 References 26](#_Toc405972496)

[8 Appendices 27](#_Toc405972497)

[APPENDIX 1a: Waste Management officers’ survey – 14 March 2014 27](#_Toc405972498)

[Appendix 1b: Waste Management officers’ survey results – 14 MArch 2014 ………………………………………………………………………………………27](#_Toc405972499)

[Appendix 2: Stellenbosch Background information](#_Toc405972500) 32

[Appendix 3a: Stellenbosch waste characterisation study – data](#_Toc405972501) 33

[Appendix 3b: Stellenbosch Waste Characterisation Study – Geographical coverage](#_Toc405972502) 34

[Appendix 4: Minutes for brainstorming Stellenbosch IWMP process and scoping scenarios for modelling](#_Toc405972503) 35

[Appendix 5: Data input into the Environmental performance](#_Toc405972504) 42

[Appendix 6: Data input into financial model](#_Toc405972505) 44

# List of Tables

[Table 1: Stellenbosch Municipality demographics and waste disposal summary 6](#_Toc405972689)

[Table 2: Global warming potential of the different activities 21](#_Toc405972690)

[Table 3: Financial cost for Stellenbosch domestic waste collection and disposal 22](#_Toc405972691)

[Table 4: Financial cost analysis for scenario one 23](#_Toc405972692)

# List of Figures

[Figure 1: Systems-based approach for integrated waste management (Gentil *et al*, 2010) 3](#_Toc405972695)

[Figure 2: Overview of Stellenbosch Municipality Wards 7](#_Toc405972696)

[Figure 3: Stellenbosch Municipality waste flow diagram (prepared as part of this project to establish the waste management system baseline) 9](#_Toc405972697)

[Figure 4: Waste generation in Stellenbosch Municipality 18](#_Toc405972698)

[Figure 5: Projected landfill airspace depletion at Stellenbosch Municipality 19](#_Toc405972699)

# Introduction

## Goal and outline

GreenCape is developing a decision support process, supported by an integrated waste management model, in order to assist municipalities to consider a range of alternative options for waste management on an integrated basis both in terms of the scope of activities considered (all steps from collection to disposal) and according to a range of criteria, including financial and environmental criteria. The process and the associated models are referred to as the Integrated Waste Management Decision Support Tool (IWM DST).

This document presents a case study of the application of this tool to support Stellenbosch Municipality with integrated waste management. The case study serves as a vehicle for the tailoring of the models supporting the IWM DST to the South African context, whilst at the same time assisting in the development of Stellenbosch Municipality’s Integrated Waste Management Plan (IWMP) for the period of 2015 – 2019.

This report begins with a brief overview of the IWM DST project goals and provides an overview of the approach being taken for the development and tailoring of the IWM DST, including the role of case studies. It then introduces the Stellenbosch Municipality case study and an overview of the methodology being taken for this particular case study. Finally, a summary of the key findings from the case study and recommendations are presented. The technical details of the modelling work are provided in the appendices.

# Municipal decision support: Project Background

The majority of Western Cape municipalities have limited landfill airspace remaining and would like to improve their waste management practices. Municipalities are required to develop an Integrated Waste Management Plan (IWMP) every five years, with annual review and revision.

Integrated Waste Management is the consideration of the Waste Management system from collection to disposal, including all intermediate steps. In the past, most IWMPs have been done without necessarily setting clear goals and targets (e.g. for recycling rates), and without having a firm foundation for the alternatives being considered and the cost or associated environmental impact of these alternatives.

Development of IWM DST is part of the GreenCape project aimed at developing the waste economy in the Western Cape. The project specifically looks at addressing municipal waste management by taking into account the impact of waste management on a full life cycle basis.

## Integrated Waste Management: Consideration of the full Waste Management System on a life Cycle basis.

The IWM DST being developed by GreenCape aims to assist municipalities in the adoption of a systems-based approach to integrated waste management on a full life cycle basis. Such an approach can be geared to provide a set of guiding principles for the choice and scale of waste management technologies with an understanding of the financial, economic, social and environmental implications of different municipal solid waste management system configurations and technology choices on a life cycle basis. This entails the evaluation of the complete waste management system - from generation, to collection, transport, treatment and/or final disposal in an integrated manner, considering both the waste management system as a whole, as well as the inputs to it and the emissions from it. This is illustrated in Figure 1.

It is important to consider the full waste management system to understand the full system’s wide implications of any technology choice (i.e. what collection systems might be needed, what sorting systems etc.) for the successful application of these technologies and to estimate their full cost implications. Considering of the full waste management system on a life cycle basis is also important as it would be important not to shift “environmental burdens” and to aim for a net environmental benefit e.g. it would not be good if the new waste management system were so energy intensive that it caused significant carbon emissions upstream due to electricity and fuel production or improved the environment in the municipality at the cost of environmental degradation elsewhere.



Figure : Systems-based approach for integrated waste management (Gentil *et al*, 2010)

## Tailoring Integrated Waste management models to the South African context via case study municipalities

Many decision support tools for municipal waste management already exist (Gentil *et al,* 2010). However, many of these models make provision for larger scale, more centralised waste management solutions having had their origin in countries that are densely populated and have waste compositions that reflect there on average more affluent populations (e.g. US and EU). The municipal decision support component of the waste economy project at GreenCape therefore aims to:

* incorporate decision criteria relevant to South African municipal decision makers
* for environmental criteria: develop and tailor of one IWM tool (EASETECH[[1]](#footnote-1)) to the South African context
* for other: develop an external excel model to evaluate criteria such as cost and job creation potential, if necessary, and
* test the above (referred to as the “decision support tool”) via municipal case studies.

The case studies were initially anticipated to follow a two-phased approach. In the first phase, the selected case studies would assist in the development and tailoring of EASETECH to the local context. This would involve working with municipalities that are more advanced in terms of their alternative waste management planning, and preferably those that have already collected substantial plausible waste information.

The second phase would then involve working with municipalities that are in the initial phase of the 3rd generation of their integrated waste management planning, and effectively use the decision support tool to inform their IWMP and assist them in working towards their waste management targets.

Most of the available decision support tools evaluate different waste management systems based on environmental criteria. Therefore a tool such as EASETECH is not adequate on its own for decision support in the South African municipal context. The tailoring process of the tool being undertaken via GreenCape is thus also required to take into consideration and output information on criteria important to decision makers – such as cost (CAPEX and OPEX), job creation, landfill diversion potential etc. Appendices 1a and 1b show a questionnaire and a summary of the results respectively indicating important decision criteria obtained from Western Cape waste management officers.

## Rationale for selection of Stellenbosch as a case study

Stellenbosch Municipality was initially selected as a case study for the tailoring and development phase. However, due to their critical need to divert waste from landfill, as well as the need to develop their third generation Integrated Waste Management Plan (IWMP) within the current financial year (2014/15), the case study was modified to achieve both development and tailoring, as well as assist in the development of the Stellenbosch Municipality 3rd generation IWMP. This document details the results for Stellenbosch Municipality as a case study for the development and tailoring of the decision support tool. This work also feeds directly into the development of the IWMP which Stellenbosch Municipality aims to complete by 31 March 2015.

# Stellenbosch Case Study Background

## Goal of Case Study

The goal of this case study was then to develop and evaluate different scenarios for alternative waste management to form a foundation for Stellenbosch municipal decision makers for the selection of the most suitable waste management system for that would be incorporated into Stellenbosch’s Integrated Waste Management Plan (IWMP) for 2015-2019.

The specific objectives of this work were to:

1. establish Stellenbosch Municipality’s vision and goals for integrated waste management
2. develop a baseline of the current waste management system
3. identify key decision criteria
4. generate waste management scenarios aligned with the vision and goals
5. evaluate the waste management scenarios against the selected criteria
6. compare and contrast the alternatives in a manner that highlights their benefits and drawbacks for municipal decision makers.

The next section provides an overview of Stellenbosch’s waste production and current management and the manner in which this has been structured to allow for analysis, before presenting the details of the work done to achieve the above objectives.

## Stellenbosch Municipality: background

Stellenbosch Municipality has a population of 155,729, covering an area of 812km2. The total waste sent to the Devon Valley landfill site is approximately 115,000 tonnes per annum (tpa). Table 1 highlights some of the key figures with regards to waste management in Stellenbosch Municipality.

Table : Stellenbosch Municipality demographics and waste disposal summary

|  |  |
| --- | --- |
| Total population | 155,729 |
| Area (km2) | 812 |
| Number of wards | 22 |
| Total households | 43,427 |
| Formal households | 71% |
| Informal Households | 22% |
| Shack in backyard | 7% |
| Total waste landfilled (tpa) | 115,000 |
| Domestic waste landfilled (tpa) | 45,300 |
| Builders’ rubble | 35,600 |
| Mixed rubble | 3,220 |
| Garden waste | 3,530 |
| Commercial and industrial waste | 3,668 |
| Recyclables recovered (municipal) | 775 |
| Recyclables recovered (private) | 2,409 |
| Refuse removal |  |
| Weekly | 89% |
| Less Frequent | 3% |
| Own dump | 5% |
| None | 1% |
| Expected landfill closure | 2018 |

Stellenbosch municipality has a total of 22 wards, and some of the solid waste information –namely socio-economic information such as household types (formal, informal etc) and level of service delivery (waste collection) has been provided by the municipality. For the purpose of this case study, the waste generation information has been extrapolated to ward level. The detailed background information by ward is attached as Appendix 2.

For the purpose of this analysis, the wards were further grouped into five key geographical areas:

* Central area – accounting for approximately 89% of the population
* East – Franschhoek
* North – Devon Valley
* South – Lyndoch
* North-West – Devon Valley

This is illustrated in Figure 2 , showing the municipality as a whole, as well as the grouped areas.



Figure : Overview of Stellenbosch Municipality Wards

Figure 3 goes on to show the waste flow diagram that was developed for Stellenbosch Municipality. This shows the full chain from waste generation through to treatment and disposal. Landfill disposal remains the main method of dealing with solid waste-which remains unsustainable in the long run. Garden waste and builders’ rubble are currently collected separately as well. Stellenbosch University – with a student population of 30,000 – is also an area that can be looked at individually from a waste generation perspective.

Although Stellenbosch municipality has initiated a separation at source program, the bulk of the waste generated within the municipality is still currently being landfilled.

As of early 2014, the available landfill airspace at the only landfill site – Devon Valley - was ca. 480,000m3. At current disposal rates, the landfill is expected to last no more than four years. Once the current cell reaches capacity, Stellenbosch Municipality will have no option but to dispose of waste at a regional site, or go into an agreement with one of the neighbouring municipalities (City of Cape Town or Drakenstein) for landfill capacity.

Discussions with Saliem Haider, the Municipal Solid Waste Manager, revealed that subsequent of the closure of the Devon Valley site, no landfill site would be available within a 50 km radius of the municipality. Disposal of solid waste would therefore become extremely costly due to the high operation costs to cover transport of the waste in the future. Stellenbosch Municipality is therefore under immense pressure to divert large quantities of solid waste from landfill disposal to extend the lifespan of their landfills and buy time to plan the future. It is thus imperative that the municipality:

* Implement aggressive waste minimisation
* Implement alternative waste management technologies
* Identify an alternative waste disposal site, possibly via collaboration with other municipalities.

.



Figure : Stellenbosch Municipality waste flow diagram (prepared as part of this project to establish the waste management system baseline)

## Current Stellenbosch municipal waste management

### Waste treatment

Domestic waste is predominantly handled by the municipality, with 240*l* bins provided for formal households and communal skips for the informal settlements. All of the waste in these receptacles is currently being transported to the Devon Valley landfill for disposal. Currently, garden refuse is also being landfilled while builders’ rubble is stockpiled on-site. Additional key information:

* A separation at source programme has been rolled out in some areas, with a diversion rate of 720-840 tpa, or 1.6-1.9% of domestic waste.
* The bulk of the source separated, commingled recyclables is taken to the City of Cape Town’s Kraaifontein material recycling facility (MRF)
* Disposal cost (gate fee) for solid (general) waste is R430/tonne, with clean builders’ rubble and green waste accepted at no charge.

### Stellenbosch Municipality initiatives and plans

The municipality’s solid waste management department, under the leadership of Saliem Haider, the Municipal Solid Waste Manager, has undertaken initiatives to improve their waste information system. Critical to the planning and implementation of any alternative waste management systems is the need to have waste generation information. The information available includes:

* Waste quantities achieved via the installation of a weighbridge at the Devon Valley landfill site (December 2013);
* A waste characterisation study covering different areas across the municipality (2012)
* Lift-logger information identifying waste pick-up frequency across different areas

In terms of planning, the municipality is looking at:

* Developing their 3rd generation IWMP (final draft deadline: 31 March 2015)
* Doing the legislated Section 78(1, 2, 3 and 4) of the Municipal Systems Act (MSA, Act 32 of 2000) process to determine what mechanism is needed to implement alternative waste management in the municipality (tender to be re-advertised in early 2015).

The underlying aim of this case study is therefore to develop and assess a number of different scenarios targeted at extending the life of the Devon Valley landfill, support the IWMP process and ultimately support the building of long‑term, sustainable waste management systems and practices.

# Stellenbosch Case Study Methodology

This section details the methodology for assessing the base case impacts of the current waste management strategy, and comparison of the results with the performance of selected alternative waste management scenarios.

## Important decision making Criteria for municipal solid waste management

From interaction with municipal waste managers (discussed earlier and summarised in Appendix 1b), key criteria identified as crucial for decision making included financial cost, landfill airspace saving, job creation and environmental cost. The criteria for this case study will be limited to environmental and financial performance, with the environmental criteria being modelled via EASETECH and financial criteria using an MS Excel model. Additional criteria may be added to the excel model at a later stage of the project.

## Determination of plausible scenarios for modelling

The scenarios to be modelled were determined after a number of discussions to determine plausible scenarios the municipality could consider. These included a meeting between Stellenbosch Municipality, Herman Huisman and Marco Kraakman (from the Agentschap NL, Netherlands), Stellenbosch University [through the Infrastructure and innovation Committee (IIC)], with the Stellenbosch Deputy Mayor also in attendance. The key areas that needed to be determined where:

* The vision and strategic drivers for Stellenbosch Municipality, and understanding how these would shape/affect the waste management planning
* Heuristic process for determining what alternative waste management technologies would be relevant in the Stellenbosch Municipality context
* The way forward, as GreenCape would provide modelling support and ensuring that the work done is aligned with the municipality as well as with the IIC.

The solid waste department in Stellenbosch municipality, through the IIC, has given a **3-7-30** year planning breakdown:

* 3 year financial planning model
* 7 year planning and implementation phase
* 30 year strategic vision.

As the 30 year vision had not been finalised, the general underlying guidelines were based on the National Development Plan (NDP, 2010). As such, the figure reflected in the National Waste Management Strategy (2010) would then form the basis for the minimum waste diversion to be achieved by any of the scenarios. Currently the figure was reduced from 25%, to 20% diversion by 2019. The planning and implementation phase would be largely based on the IWMP and Integrated Development Plan (IDP) of the municipality. The measures needed to achieve these would then be reflected in the IWMP, and these are described below.

In addition to the base case/status quo, four other scenarios were generated for consideration: details of these are provided below.

### Scenario 1: Builders’rubble (BR) crushing and brick making, garden waste composting (0-1yrs)**[[2]](#footnote-2)**

The first scenario takes into account municipal plans already under consideration. Stellenbosch Municipality is currently working on getting the following projects underway:

* Crushing of BR and mixing with clay to make bricks
* Garden waste composting at Franschhoek and Devon Valley/Klapmuts.

### Scenario 2: Increased source separation with local Material Recovery Facility (MRF), 1-5yrs[[3]](#footnote-3)

The average weight composition of the different fractions in domestic waste was taken to be the average of the compositions obtained from the characterisation study. Based on this, the maximum (potential) recyclable content in the domestic waste stream is approximately 46%.

Current waste diversion at the municipality is approximately 2.8% of the total waste stream (including municipal driven recycling, known private sector recycling and organic waste composting). Municipal recycling (via household source separation) is approximately 900tpa, or 2% of the total domestic waste stream. The 2nd scenario is aimed at increasing recycling to meet the legislated target (20%) by 2019. This scenario is summarised by the following:

* Construction of local MRF and local recycling
* Increased rollout of source separation of dry recyclables (to achieve 20% recycling)
* Residual waste to landfill
* Crushing of BR and mixing with clay to make bricks
* Garden waste composting at Franschhoek and Devon Valley/Klapmuts

### Scenario 3: Increased source separation with local organic waste treatment (1-5yrs)[[4]](#footnote-4)

The third scenario is modelled on achieving the 20% legislated recovery of recyclables, but by increasing the rollout of source separation as with scenario 2, including continuing the status quo practice of transporting commingled recyclables to Kraaifontein. In addition, the key difference for this scenario is the targeted recovery of organic waste, and treatment of this organic waste via composting and anaerobic digestion at Klapmuts. This scenario is characterised by:

* Local treatment of organic waste – bokashi and composting for informal, local AD for formal (Klapmuts)
* Increased rollout of source separation of dry recyclables (to achieve 20% recycling)
* Commingled recyclables sent to Kraaifontein
* Residual waste to landfill
* Crushing of BR and mixing with clay to make bricks
* Garden waste composting at Franschhoek and Devon Valley/Klapmuts

### Scenario 4: Regional collaboration (2-5yrs)

This scenario is based on the need for large waste quantities for some of the alternative waste management scenarios to operate successfully. This therefore investigates a collaboration between Stellenbosch, Drakenstein and City of Cape Town Municipalities. The City of Cape Town already has a MRF, hence recyclables can be channelled via Kraaifontein. Drakenstein is planning on the implementation of incineration with energy recovery for residual waste, as well as an Anaerobic Digestion (AD) process for organic waste. However, the Klapmuts site provides an ideal site (geographically between the three municipalities), and therefore a possible site for organic waste treatment. This scenario will therefore be characterised by:

* Local treatment of regional (possibility of importing organics from Drakenstein and City of Cape Town) organic waste – bokashi and composting for informal, local AD for formal (Klapmuts)
* Increased rollout of source separation (to achieve 15% recycling)
* Commingled recyclables sent to Kraaifontein
* Crushing of BR and mixing with clay to make bricks
* Garden waste composting at Franschhoek and Devon Valley/Klapmuts
* Residual waste to Drakenstein (for separation and treatment via AD and incineration)

## Modelling of scenarios – Financial and environmental Costs

Following the brainstorming session, the base case and the different scenarios were to be modeled so as to determine the impact of the different waste management strategies. Currently, the analysis considers financial and environmental criteria only. Financial and environmental life cycle costing was used to determine the cost and environmental performance of the various alternative waste management scenarios using the excel spreadsheet and EASTECH model.

### Case study assumptions

It is important to note that it was necessary to strike a balance between developing a functional model, and ensuring the assumptions made are an accurate reflection of the reality in Stellenbosch. Due to time constraints, it was decided to prioritise developing a functional model, and stakeholder engagements would then be carried out to check validity of the assumptions. There will be the opportunity to refine/modify the model results and assumptions during the last quarter of 2014/2015.

This section is organised in three main parts (i) general assumptions around the waste and Stellenbosch data, (ii) more specific assumption around the environmental modelling in EASETECH and (iii) around the financial modelling.

#### General assumptions

In the absence of additional information, the following are the general assumptions that were made:

* Waste distribution per ward was directly proportional to number of households per ward
* Municipal average for waste composition was used where characterisation data for a ward was absent (available characterisation data was predominantly for central areas and exclude wards: 2,3,4,5,8,9,12,14,17,18,19,20 – see Appendices 3a and 3b)
* Road transport distance from each collection area to the landfill site was determined using Google maps
* All wards -except for wards 2, 12, 14 and 15 receive weekly, door-to-door refuse collection
* Wards 2, 12, 14 and 15, due to their high percentage of informal households receive waste service via communal skips (wards 2, 12, 14 and 15 have 77%, 74%, 50% and 72% informal households and 20, 16, 29, and 17% formal households respectively)
* Skips from Franschhoek and Klapmuts are for garden waste only
* Compactor trucks are assumed to be ca. 80% full on average
* Stellenbosch recyclables to Kraaifontein are assumed to have same profile as the recyclables handled at Huis Horison – a NGO that handles 15% of Stellenbosch Municipality’s source-separated recyclables.

#### Assumptions for modelling in EASETECH (environmental‑specific assumptions)

Part of the purpose of this case study is tailoring EASETECH to the South African context. However, some assumptions were necessary as discussed below. These were based on discussion with municipal staff and other waste experts in the Western Cape. Sensitivity analysis will be done to determine the effect of these assumptions. The specific assumptions made are as follows:

* Where there was a discrepancy between the definition for fractions in EASETECH and the Stellenbosch data, the Stellenbosch data was assumed to split evenly across the fractions defined in EASETECH e.g. Stellenbosch municipality classifies all paper under one category, without giving specifics on the different types and grades, and EASETECH has 10 different paper fractions.
* For recycling, it is assumed that 90% of recyclables are recovered/recycled, with the remaining 10% going to landfill (Sensitivity analysis will be done to examine the effect of different levels of recycling effectiveness).
* Destination for recyclables:
  + Plastic to Gauteng (1,400km distance)
  + Steel to local plants, e.g. Atlantis (50km distance)
  + Aluminium to Port Elizabeth (700km)
  + Paper to Durban (1600km)
  + Glass to Bellville (40km)

#### Assumptions for financial modelling

* 10 year depreciation period for capital equipment (5-8 yrs for European Union countries, Eunomia Consulting, 2001)
* Maintenance costs estimated at 5-6% of CAPEX (Brennan, 1998). This figure can be higher when the equipment is used poorly, and lower if the equipment is used more efficiently
* Cost figures were obtained from a number of sources, presented here (in order of hierarchy):
  + Stellenbosch 2nd generation IWMP (2010)
  + Eden (2013), Drakenstein (2013) and City of Cape Town (2009) Municipality Feasibility studies for alternative waste management
  + Department of Environmental Affair’s (DEA’s) Knowledge Product 2 (2014)
  + European Commission’s report on Costs for Municipal Waste Management (2001)

The basis adopted for development of the financial modelling (i.e. the equations and principles used) is primarily the United States Environmental Protection Agency’s (EPA’s) handbook on full cost accounting for solid waste (USEPA, 1997), which is considered one of the key reference texts for waste management system costing internationally, and has been used for the feasibility studies done by consulting firms for, among others, City of Cape Town and Stellenbosch Municipalities.

# stellenbosch case study Results

## Waste projection

Based on the landfill data obtained from the municipal Waste Management Officer (Saliem Haider), waste disposal was projected over 30 years. As mentioned earlier, this was calculated based on population growth as determined from the 2011 census. This in essence pegs the waste disposal per capita per annum at current rates. Correction for this and other aspects hence may be necessary to get more accurate projections and will be considered as part of a sensitivity analysis in future..

The waste projection for the municipality was determined. Total amount of waste, as well as total amount of domestic waste landfilled per year are shown in Figure 4. Plotting the total projected waste landfilled against the landfill airspace remaining results in Figure 5.

Figure : Waste generation in Stellenbosch Municipality

At the start of 2014, the Devon Valley landfill site had 480,000m3 of landfill airspace available. Based on this figure, as well as the waste projection above, landfill airspace availability was calculated to determine the remaining life of the landfill site. The results are shown in Figure 5, which presents the remaining landfill airspace at the end of each year. In addition, a number of simulated scenarios are plotted and compared so as to determine the impact different levels of intervention will have on the life span of the site.

Although these are not the formal scenarios for modelling, but rather ones that would rely on infrastructure in place with some extension of existing planned programmes, these scenarios serve to illustrate the pressure on the landfill site. The simulated scenarios include:

* Business as Usual (BAU)
* Diverting all the builders’ rubble from landfill disposal
* Diverting builders’ rubble and garden waste from landfill disposal
* Diverting builders’ rubble, garden waste and 10% of the MSW that reports to landfill
* Diverting builders’ rubble, garden waste and 20% of the MSW that reports to landfill
* Diverting builders’ rubble, garden waste and 50% of the MSW that reports to landfill

A key highlight was that even with significant diversion, the landfill site will have to be closed in the next few years, and a new site would need to be identified.

Figure : Projected landfill airspace depletion at Stellenbosch Municipality

## Base case study

Appendix 5 shows a screenshot of the base case model in EASETECH that was used to calculate the environmental impact, as well as the tables of data that was input into EASETECH, including:

* Waste distribution and composition by ward
* Waste distribution by treatment
* Door-to-door mixed waste collection and transport and disposal to landfill
* Communal skip collection from informal households, transport and disposal to landfill
* Commingled recyclable collection from households, and transport to Kraaifontein (85%) and Huis Horison (15%)
* Stellenbosch University organic waste collection, and transport to University farm for composting
* Skip collection from Klapmuts and Franschhoek, transport and disposal to landfill

The base case environmental results indicate that the activities associated with collection, transport and disposal of domestic waste have a global warming potential (GWP) of 38,993t CO2,eq, out of a system total of 41,790t CO2,eq. As a consequence of the high organic content of the municipal waste, and a predominantly landfill-based system, this is expected as it leads to a significant potential for methane production potential.

Table 2 below shows a full breakdown of GWP by activity. The overall system as illustrated in Figure 3 earlier shows that the biggest contributors to global warming are (i) domestic waste collection and disposal and (ii) the composting (Stellenbosch University). Composting organic waste naturally results in the formation of CO2, with a global warming potential (GWP) approximately 21 times less than the methane (CH4) that would have been generated from landfill anaerobic processes. However the large GWP for waste collection and disposal is also associated with the relative volume of waste going to landfill – 47% of domestic waste is organic waste on average, and domestic waste is roughly 15 times the amount of recycled waste in Stellenbosch (Appendix 5).

The negative numbers for recycling (both municipal and private) indicate that there is a net reduction in CO2 in the aggregated recycling value chains, despite some of the large distances travelled. Although the processes for conversion of e.g. paper to cardboard still result in an increase CO2 emissions, the results below show that the net savings associated with avoiding the production of the substituted product is much bigger than the CO2 emissions from recycling.

Table : Global warming potential of the different activities

|  |  |
| --- | --- |
| Activity | GWP - tonnes CO2,eq |
|  |  |
| Domestic waste collection and disposal | 38,993 |
| Stellenbosch University organic waste composting | 3,112 |
| Municipal recycling | -157 |
| Private recycling | -158 |
|  |  |
| Total | **41,790** |

The financial cost for the base case was calculated based on the data collected from Stellenbosch Municipality (Appendix 6 shows the information that was entered into the financial model in more detail), and the assumptions described earlier (Section 4.3.1.3). The total operating cost for the status quo is approximately R51m a year (including depreciation and amortised cost for landfill closure and rehabilitation). Based on landfill volumes of 115,000tpa, the cost of waste management is approximately R440/tonne.

Table : Financial cost for Stellenbosch domestic waste collection and disposal

|  |  |
| --- | --- |
| Activity | Cost |
|  |  |
| Wages, salaries, benefits | R 16 610 000 |
| Maintenance | R 2 252 000 |
| Fuels and lubricants | R 1 576 000 |
| Miscellaneous - Illegal dumping | R 597 600 |
| Misc - Bad debt | R 2 722 000 |
| Misc - Insurance reserve | R 346 400 |
| Other (printing, stationery, materials, etc) | R 9 064 |
| Skips - Franschoek - Devon Valley | R 288 800 |
| Skips - Klapmuts - Devon Valley | R 265 200 |
| Insurance, Licenses, Taxes | R 656 500 |
| Oversight and support services | R 7 541 000 |
| Depreciation (Vehicles/Equipment) | R 4 504 000 |
| Amortised Closure and Post-Closure Care | R 13 300 000 |
|  |  |
| Total cost | **R 50 670 000** |

## Modelling of scenarios

### Scenario 1: Builders rubble crushing and garden waste composting

Table 4 below summarises the results obtained for the case where Stellenbosch Municipality composts organic waste at the landfill, and also produces compressed earth bricks from builders’ rubble and clay. Based on the DEA KP2, a composting facility for the amount of waste to be treated would cost approximately R7,75m. For the builders’ rubble, the Municipality would outsource the operation and the overall scenario would cost the Municipality approximately R2m for the scale of operation envisaged.

Table : Financial cost analysis for scenario one

|  |  |
| --- | --- |
| Activity | Cost |
|  |  |
| Wages, salaries, benefits | R 16 608 857 |
| Maintenance | R 3 209 541 |
| Fuels and lubricants | R 1 576 161 |
| Miscellaneous - Illegal dumping | R 597 686 |
| Misc - Bad debt | R 2 722 041 |
| Misc - Insurance reserve | R 346 406 |
| Other (printing, stationery, materials, etc) | R 9 064 |
| Skips - Franschoek - Devon Valley | R 288 800 |
| Skips - Klapmuts - Devon Valley | R 265 200 |
| Builders' rubble contract | R 2 000 000 |
| Insurance, Licenses, Taxes | R 656 516 |
| Oversight and support services | R 7 541 127 |
| Depreciation (Vehicles/Equipment/Buildings/Landfills) | R 6 299 082 |
| Amortised Closure and Post-Closure Care | R 12 727 604,17 |
|  |  |
| Total | **54 400 000** |

The normalised cost for this scenario comes to approximately R470/tonne – a 7% increase. Although this scenario costs more than the base case, the following points must also be considered:

* Landfill airspace saving from diverting builders’ rubble (at a current official municipal cost of R430/t, that in itself is equivalent to a saving of R7,3m/year)
* Depending on the contractual agreement, sale of the CEBs can generate income to offset some of the municipal costs. Alternatively, the municipality can use the bricks in some of their projects to offset cost.
* By diverting garden waste to composting, there is significant environmental gains as the resulting CO2 generation from composting as opposed to methane (CH4) from landfill. The environmental benefits are to be quantified in the next phase of the work.

# stellenbosch case study Conclusions and way forward

This report represents the first pass at the case study for improved integrated waste management for Stellenbosch. The work is still to be expanded within the project year, both in terms of expanding the work via extensions to the Stellenbosch Municipal case study, as well as on tailoring the decision support tool. However, the work has already provided some valuable insights.

## Key Insights

Some key points already emerge from the preliminary modelling:

* Recycling of the recyclable fraction of municipal solid waste shows net positive benefits with regards to global warming potential, regardless of significant transport distances (e.g. for PET). This is linked to how carbon emissions from landfill are measured in a life cycle assessment. It remains critical however to ensure optimisation of logistics so as to realise the full benefits of the systems perspective on the waste management system.
* With the limited airspace left at the Devon Valley site, and the almost non-existence of any suitable site for a new landfill, the need for regional collaboration is even more critical. The financial and environmental implications of this will be examined as part of the extension of this work within the current project time frame.

## Further Work

### Modelling of environmental and cost performance of scenarios

The environmental performance and costing of the scenarios will be finalised during the reaming weeks of the current quarter. The purpose is to have these as detailed and accurate as possible so as to support the drafting of the Stellenbosch IWMP, which is being done internally (i.e. by the municipality as opposed to consultants) for the first time. This would give an indication of the key infrastructural commitments for the different alternative waste management options, including capital outlay and annual operating expenses for the municipality, as well as an indication of the key points of intervention to reduce emissions contributing to climate change.

### stellenbosch municipality Sensitivity analyses

Sensitivity analyses will be done in the next quarter as part of the tailoring process of the decision support tool. This is key especially to testing the assumptions made in both the financial and environmental models. Some of the assumptions may have significant impact, and may be of greater interest to the municipality (e.g. loading of compactor trucks, which would then impact number of trips to landfill, ultimately impacting on operational cost – wear and tear, fuel etc- and associated environmental impacts.

## Concluding Remarks

In conclusion, from a full life-cycle analysis, the preliminary results already indicate that net environmental benefits can be expected from the alternative waste management scenarios. Modelling these alternative scenarios using the integrated waste management decision support model is key to being able to demonstrate these benefits and stimulate discussion on the uptake of the correct combinations and configuration of alternatives waste treatment technologies. This modelling also assist in identifying opportunities for even further improvements (cost savings, improved environmental performance). For the selection of the preferred integrated waste management system, it is necessary to consider the trade-offs between cost and environmental benefits (and other criteria). Although cost is ultimately one of the higher ranked criteria for municipal decision making, these inputs are essential for opportunities for overall improvement in waste management practice to be realised and, very importantly, the tools being developed to be used as part of a structured decision making process.

As GreenCape will be assisting Stellenbosch both toward submission and approval of its IWMP in the 2015/2016 year, the work will further demonstrate the use of the decision support tool within a municipal decision making process to achieve the goal of sustainable integrated waste management at a municipal level.

# References

Department of Environmental Affairs (DEA). (2014). *Knowledge Product 2: Appropriate Technology for Advanced Waste Treatment.*

Eunomia Research and Consulting. (2001). *Costs for Municipal Waste Management in the European Union.*

Gentil, E. D. (2010). Models of waste life cycle assessment: Review of technical assumptions. *Waste Management*, 2636-2648.

Harrison, K. W., Dumas, R. D., Solano, E., Barlaz, M. A., Downer Brill Jr., E., & Ranjithan, S. R. (2001). Decision Support Tool for Life-Cycle-Based Solid Waste Management. *Journal of Computing in Civil Engineering, 15*, 44-58.

Ltd, E. R. (20...). *Costs for Municipal Waste Management in the EU.*

Sango, T. S., Kissoon, S., Basson, L., & Munganga, G. (2014). Development of the waste economy in the Western Cape: A decision support tool for integrated municipal waste management. *WasteCon 2014.*

StatsSA. (2014). *www.statssa.gov.za*. Retrieved from Statssa 2011 census data.

Stellenbosch Municipality. (2010). *Integrated Waste Management Plan.*

United States Environmental Protection Agency (USEPA). (1997). *Full Cost Accounting for Municipal Solid Waste Management: A handbook.*

# Appendices

# APPENDIX 1A: Waste Management officers’ survey – 14 March 2014

# Appendix 1b: Waste Management officers’ survey results – 14 MArch 2014

# Appendix 2: Stellenbosch Background information

# Appendix 3a: Stellenbosch waste characterisation study – data

# Appendix 3B: Stellenbosch Waste Characterisation Study – Geographical coverage

# Appendix 4: Minutes for Brainstorming STellenbosch IWMP process and scoping scenarios for modelling

# Appendix 5: Data input into the Environmental performance

# Appendix 6: Data input into financial model

# 

1. See the 2013/2014 report on the Waste Economy Project for the motivation for selecting the EASETECH integrated waste management model for the purposes of this work (Executive Summary available at: http://www.green-cape.co.za/assets/Uploads/13001-Waste-Economy-Executive-Summary-Final.pdf). [↑](#footnote-ref-1)
2. Probable implementation timeframe of 0-1 years [↑](#footnote-ref-2)
3. Probable implementation timeframe of 1-5 years [↑](#footnote-ref-3)
4. Probable implementation timeframe of 1-5 years [↑](#footnote-ref-4)