Project design document form
(Version 11.0)

Complete this form in accordance with the instructions attached at the end of this form.

BASIC INFORMATION	
Title of the project activity	Joburg Landfill Gas to Energy Project
Scale of the project activity	☒ Large-scale ☐ Small-scale
Version number of the PDD	12
Completion date of the PDD	26/09/2020
Project participants	ENER-G Systems Joburg (PTY) Ltd.
Host Party	Republic of South Africa
Applied methodologies and standardized baselines	ACM0001: Flaring or use of landfill gas - Version 19.0. ASB0040-2018 Standardized baseline: Grid emission factor for Southern African Power Pool, version 1.
Sectoral scopes	Sectoral Scope 13 - Waste Handling and Disposal Conditional sectoral scope 1 - Energy industries (renewable - / non-renewable sources)
Estimated amount of annual average GHG emission reductions	480,155 t CO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

The Joburg Landfill Gas to Energy Project (hereafter referred to as the “Project”) developed by Ener-G Systems Joburg (Pty) Ltd. (hereafter, the “Project developer”) is a landfill gas (hereafter, “LFG”) collection and utilisation project at the Johannesburg landfill sites located in Johannesburg, South Africa (hereafter, the “Host Country”). The landfill site addresses and coordinates are detailed in Section A.2.

The objective of the project is to collect and destroy/utilise the LFG generated at five Johannesburg landfill sites. The project activity will consist of two distinct stages:

1. LFG will be captured and destroyed by using a LFG flare. The purpose of LFG flaring is to dispose of the flammable constituents, particularly methane, safely, and to control odour nuisance, health risks, and adverse environmental impacts. Hence, investment will be made in a highly efficient gas collection system and flaring equipment.
2. Once generation of LFG is proven to be steady, the captured LFG will be fed to the LFG flare and modular electricity generation plants. The generators will combust the LFG methane to produce electricity for internal use and/or export to a local power purchaser. Excess LFG and all gas collected during periods when electricity is not produced, will be flared.

Prior to implementation of the project activity, the LFG was being freely emitted into the atmosphere resulting in GHG emissions. The Project involves the destruction/utilisation of methane emissions as well as the displacement of electricity from the South African coal-based grid, resulting in a consequent reduction in CO_2 emissions. In the baseline scenario, the LFG would have been released into the atmosphere resulting in GHG (CH_4) emissions to the atmosphere. The electricity would have been produced in the fossil fuel based Southern African Power Pool grid, resulting in CO_2 emissions.

Emission reductions will be constituted by:

- the capture and destruction/utilisation of LFG; and
- the displacement of coal-based electricity from the grid by the generation of electricity from captured LFG.

The estimated annual average and total GHG emission reductions for the second crediting period are 480,155 tCO_2e and 3,361,087 tCO_2e respectively.

The project boundary includes five sites. The Robinson Deep flare was commissioned on 30 July 2011 and electricity generation was commissioned on 26 November 2016. The Marie Louise landfill site flare was commissioned on 04 May 2012 and electricity generation was commissioned on 25 January 2018. The Goudkoppies flare was commissioned on 3 June 2016 and electricity generation was commissioned on 25 April 2017. The last two sites, namely Linbro Park and Ennerdale sites, are currently not constructed and will remain within the basket of projects, subject to economic drivers required to commit to build these sites. It is estimated that the Linbro Park flare be commissioned between June 2021 and August 2021 and the Ennerdale flare will be commissioned between August 2021 and December 2021. The project boundary also includes the Southern African Power Pool’s electricity system – which comprises the power plants that are physically connected through transmission and distribution lines to supply electricity to the interconnected electricity system of the Southern African Power Pool.

The Project is assisting the Host Country in fulfilling its goal of promoting sustainable development, and will have several positive social and environmental impacts, namely:

- The integration of infrastructure which will improve environmental conditions. The installed LFG collection and flaring system will prevent potentially explosive situations

associated with subsurface gas migration, as it represents an effective control system minimising off-site gas migration.

- Several LFG constituents are hazardous and pose a potentially significant risk to human health. The objective of LFG flaring is to dispose of these perilous constituents, particularly methane, safely, and to control and reduce odour nuisance and health risks.
- Minimisation of environmental damage through reduced methane emissions.
- Provision of a model for LFG management, which is a key element in improving landfill management practices throughout the Host Country.
- Optimising the use of natural resources by acting as a clean technology demonstration project, encouraging less dependency on grid-supplied electricity. Development in this area has been discouraged by the extremely low cost of electricity in South Africa (by international comparison)[1]. By promoting the use of this technology, sustainable and diverse energy systems are promoted.
- Finally, the Project will attempt to increase employment opportunities in the areas where the Project is located, by providing short- and long-term employment opportunities for local people. Local contractors and labourers will be required for construction, and long-term staff will be contracted to operate and maintain the system.

A.2. Location of project activity

The project activity sites are located in Johannesburg, in the Gauteng Province of South Africa.

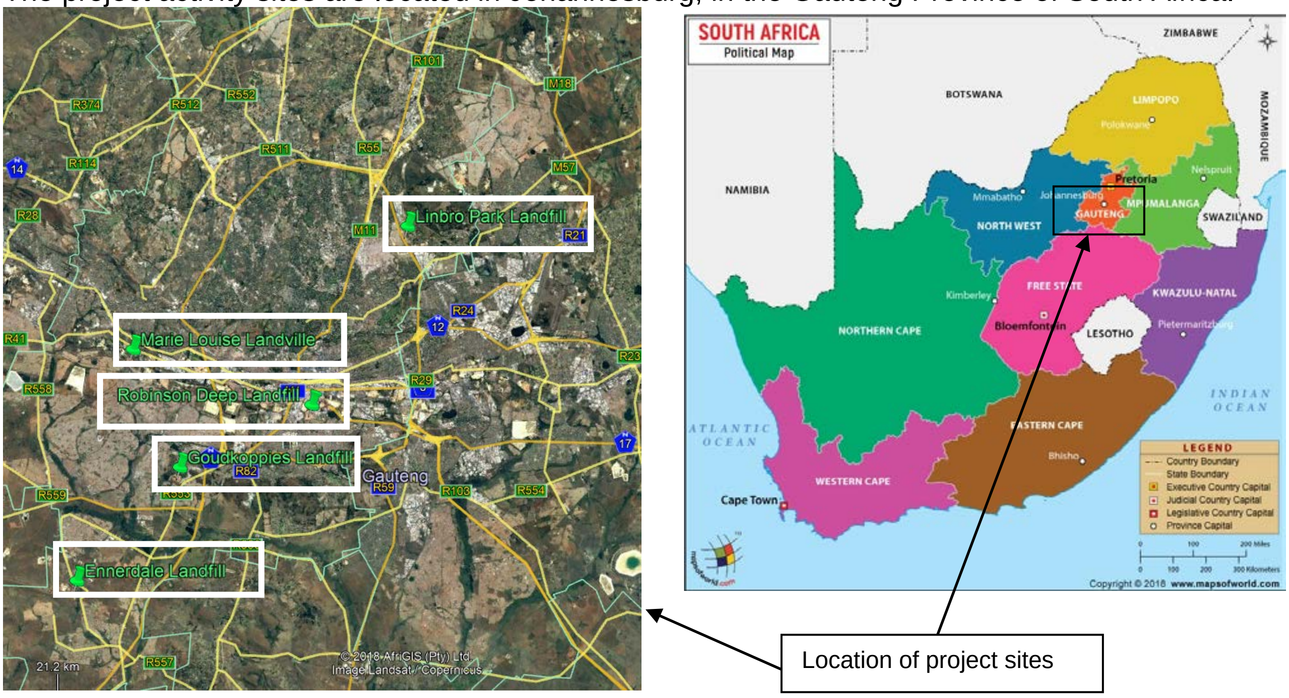


Figure: Locations of the project activity sites

The project activity sites are located at the following addresses and co-ordinates:

i. Linbro Park Landfill - Marlboro Drive, Sandton: 26° 05' 41.85" S & 28° 07' 13.43" E;
ii. Marie Louise Landfill - Dobsonville Drive, Roodepoort: 26° 11' 23.89" S & 27° 53' 00.13" E;
iii. Robinson Deep Landfill – Turffontein Road, Turffontein: 26° 13' 59.03" S & 28° 02' 14.77" E;

[1] Eskom Annual Report 2008, p. vi, extract from NUS Consulting Group International Electricity Supply and Cost Comparison, April 2008.

iv. Goudkoppies – Houthammer Road, Devland, Lenasia: 26° 16’ 52.31” S & 27° 55’ 24.93” E; and
v. Ennerdale Landfill – Old Lawley Road, Lawley: 26° 22’ 07.78” S & 27° 50’ 02.80” E.

A.3. Technologies/measures

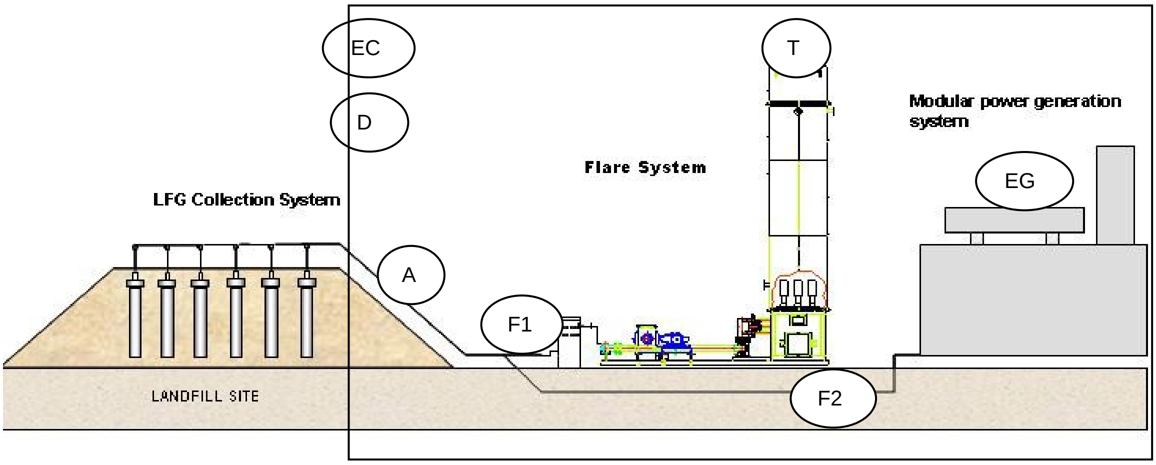
Table A.2.1: Joburg Landfill sites[2]

Site	Start year	Expected closure	Status
Linbro Park	1969	09/2006	Closed
Marie Louise	1991	02/2021	Active
Robinson	1936	08/2023	Active
Goudkoppie	1989	01/2030	Active
Ennerdale	1988	06/2026	Active

The baseline scenario at the 5 sites prior to the start of the implementation of the project activity was simple landfills without any gas collection, flaring, or electricity generation.

The project activity involves the installation of active LFG collection systems, enclosed flare systems, and subsequently modular electricity generation systems.

The following diagram illustrates the main components involved in the project activity (the general set-up is the same for all sites):



This is a proven technology for LFG combustion, and has been widely proven as reliable and environmentally safe.

The monitoring points are depicted on the diagram above, as per the following key:

Key	Description
A	Gas analyser measuring raw landfill gas
EC	Electricity meter measuring consumed electricity
EG	Electricity meter measuring generated electricity
D	Diesel meter (back-up generator)
F1	Flow meter measuring gas flow to flare/s
F2	Flow meter measuring gas flow to electrical engine/s
T	Thermocouple measuring temperature of flare exhaust gas

[2] Pikitup. 2019. Survey Report.

Technology transfer is involved in the project through the introduction and demonstration of a new and modern technology for capture, destruction/utilisation of LFG, and implementation of a detailed training program for maintenance and operation of the project equipment. The technology used in the project activity to collect, flare and utilise the LFG is designed in the UK.

Landfill Gas Collection System
The project activity involves the installation of active LFG collection systems using vertical and/or horizontal gas wells drilled into the landfill to extract the LFG. The gas collection pipe network consists of pipes that connect groups of gas wells to manifolds. These manifolds are connected to the main pipes and then to main header pipes, which deliver the LFG to the extraction plants and flares. The system operates at pressure slightly lower than atmospheric, as blowers will draw the gas from the wells through the collection system and deliver it to the flare or the LFG power generation system.

Flare System
The project activity involves the installation of modular enclosed gas flares at each landfill site consisting of pipe-work, valves, blower, stack with proprietary burners, instrumentation, and control panel. For safety purposes, flare units are fitted with flame arresters protecting the blower and the field pipe work - from burner flame flashback. At nominal flare temperatures (i.e. between 1,000°C and 1,150°C), methane destruction efficiency is 99.9%[3] (i.e. full destruction of combustible constituents found in LFG), in accordance with the stringent UK Environment Agency guidelines[4].

There are currently three flares installed in the project activity on three of the project sites, Robinson Deep, Goudkoppies and Marie Louise. All three flares have a capacity of 2000 m^3/h and are high temperature environmental ground mounted flares. The Robinson Deep facility has space for future expansions to include an additional 2000 m^3/h flare. It is estimated that the Linbro Park flare be commissioned between June 2021 and August 2021 and the Ennerdale flare will be commissioned between August 2021 and December 2021.

Electricity Generation Technology
When the Project secures Power Purchase Agreements (hereafter, “PPA”s) enabling the sale of generated electricity, modular reciprocating engine facilities will be installed at the sites. Small modular reciprocating engine generator units make it possible to adapt the equipment to the site-specific gas volumes. These generators are designed by the Ener-G Group in Manchester, UK, and will be supplied to the Project developer. The design capacity for this project activity is a maximum of 21 MW across the five sites, comprising of gensets ranging in capacity from 0.3 to 1.2 MWe (all with manufacturer’s expected efficiency of over 30%, with the ability to run at full load pending LFG availability).

The current capacity of the electricity generation installed in the project activity includes:

- Robinson Deep: 3.42MW of electricity generation.
- Goudkoppies: 2.28MW of electricity generation.
- Marie Louise: 2.28MW of electricity generation.

Additional electricity generation capacity across the landfill sites in the project activity is being considered. The additional electricity generation capacity will not exceed the 21 MW threshold.

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3 Please refer to "Biogas Technical Manual", p. 7-5, a soft copy of which was e-mailed (on 18/10/2010) to the validating DOE following the validation site visit.

4 UK Environment Agency, 2002: Guidance on Landfill Gas Flaring. Biogas Technology Limited, Low Emission Ground Flare Systems Brochure.

The LFG generators have an anticipated life of 10-15 years depending on operational conditions, fuel quality (in the form of LFG), and the maintenance regime adopted. The main mechanical-wearing components are limited to the generator (internal spark ignition engine), cooling fans, and blower.

The monitoring technology and protocol to be employed at the sites is standard, tested, and proven for LFG collection, flaring, and power generation systems worldwide. LFG flow will be continuously monitored via normalised flow-meters (which correct the quantity for fluctuations in temperature and pressure, thereby removing the need for separate temperature and pressure monitoring). Flaring conditions are closely monitored for safety and efficiency, and electricity measurement is accomplished via standard, regularly calibrated electricity meters.

Electricity generated by the project (at all the sites) will be transmitted to the Grid via electrical sub- stations (1 per site) that will each contain all suitable switching and metering equipment to facilitate such connection.

A.4. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of South Africa (host)	ENER-G Systems Joburg (PTY) Ltd. (private entity)	No

A.5. Public funding of project activity

The project will not receive any public funding from Parties included in Annex I of the UNFCCC.

A.6. History of project activity

The CDM project activity is neither registered as a different CDM project activity nor included as a component project activity (CPA) in a registered CDM programme of activities (PoA). The proposed CDM project activity is not a project activity that has been deregistered.

The CDM project activity is not a CPA that has been excluded from a registered CDM PoA nor a registered CDM project activity or a CPA under a registered CDM PoA whose crediting period has or has not expired, which exists in the same geographical location as the registered CDM project activity.

A.7. Debundling

Not applicable as the project is a large-scale project activity.

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines

As per the paragraph 279 (a) of the CDM project standard for project activities, Version 02.0, the PDD references valid version of the methodologies and methodological tools applied in the registered PDD, that is, the latest version at the time of the submission of the request for renewal of crediting period.

The large scale methodology ACM0001 Version 19, “Consolidated baseline and monitoring methodology for landfill gas project activities” has been employed in the project activity.

Furthermore, the project makes use of the following tools, which are referred to in ACM0001, Ver. 19:

- TOOL02 “Combined tool to identify the baseline scenario and demonstrate additionality” (Version 07.0) (hereafter also referred to as “Additionality tool”).
- TOOL03 “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion” (Version 03.0).
- TOOL04 “Emissions from solid waste disposal sites” (Version 08.0).
- TOOL05 “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (Version 03.0).
- TOOL06 “Project emissions from flaring” (Version 03.0).
- TOOL08 “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 03.0):
- TOOL11 “Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period” (Version 03.0.1).
- Standardized Baseline: Grid emission factor for the Southern Africa power pool (ASB0040-2018, Version 01.0).

All tools and the methodology referenced throughout the PDD refer to the corresponding version number stated in this section of the PDD for each tool and methodology.

B.2. Applicability of methodologies and standardized baselines

The project meets the applicability conditions of the selected methodologies, standardized baseline and tools as demonstrated in the following table:

	Applicability Criteria	Applicability to Project
1.	As per paragraph 3.a of ACM0001: Install a new LFG capture system in an existing or new (Greenfield) SWDS where no LFG capture system was or would have been installed prior to the implementation of the project activity instance.	The project design consists of the development of new LFG capture systems. The baseline scenario at all five sites is the atmospheric release of LFG. The project therefore complies with this criterion.
2.	As per paragraph 3.b of ACM0001: Make an investment into an existing LFG capture system to increase the recovery rate or change the use of the captured LFG, provided that: (i) The captured LFG was vented or flared and not used prior to the implementation of the project activity instance; and (ii) In the case of an existing active LFG capture system for which the amount of LFG cannot be collected separately from the project system after the implementation of the project activity instance and its efficiency is not impacted on by the project system: historical data on the amount of LFG capture and flared is available.	The baseline scenario is the atmospheric release of LFG at all five sites, i.e. all the LFG was vented and not used prior to the implementation of the project activity. The project design consists of the installation of new extraction infrastructure to recover LFG at all five sites. The project therefore complies with criterion (i). Criterion (ii) does not apply because there was no existing active LFG capture system prior to the implementation of the project activity.
3.	As per paragraph 3.c of ACM0001: Flare LFG and/or use the captured LFG in	The project design consists of LFG flaring and electricity generation only.

	any (combination) of the following ways: (i) Generating electricity; (ii) Generating heat in a boiler, air heater or kiln (brick firing only) or glass melting furnace; and/or (iii) Supplying the LFG to consumers through a natural gas distribution network; (iv) Supplying compressed/liquefied LFG to consumers using trucks (v) Supplying the LFG to consumers through a dedicated pipeline.	The project therefore complies with these criteria, specifically (i).
4.	As per paragraph 3.d of ACM0001: Do not reduce the amount of organic waste that would be recycled in the absence of the project activity instance.	The project does not reduce the amount of organic waste that would be recycled in the absence of the project activity. Prior to the project being implemented, the organic waste that was brought to the site was sent to landfill and was not used for any purpose. As such there was no diversion of organic waste prior to project implementation. Furthermore, no diversion of organic waste has occurred during the project implementation. According to the Gauteng Province Outlook Report 2017, organic wastes are mostly tapped for landfill gas recovery at municipal landfills. Based on the report there are therefore no major organic waste recycling practices within the province. The project therefore complies with this criterion.
5.	As per paragraph 4.a of ACM0001: Atmospheric release of the LFG or capture of LFG and destruction through flaring to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons.	In this project the baseline scenario is the total atmospheric release of the gas (see further explanation below) and the in the current project activities, the captured gas is being flared and used to produce electricity. Therefore, the project complies with this criterion.
6.	As per paragraph 4.b of ACM0001: In the case that the LFG is used in the project activity instance for generating electricity and/or generating heat in a boiler, air heater, glass melting furnace or kiln: (i) For electricity generation: that electricity would be generated in the grid or in captive fossil fuel fired power plants; and/or	The electricity generated from the project activity is supplied to the grid. The generated electricity displaces electricity generated by the fossil fuel fired power plants in the grid. The project therefore complies with these criterion (i). Criterion (ii) does not apply because the project does not generate heat.

	(ii) For heat generation: that heat would be generated using fossil fuels in equipment located within the project boundary;	
7.	As per paragraph 4.c of ACM0001: In the case of LFG supplied to the end-user(s) through natural gas distribution network, trucks or the dedicated pipeline, the baseline scenario is assumed to be displacement of natural gas.	This criterion is not applicable. The project does not supply LFG to the end-user(s) through a natural gas distribution network, trucks or dedicated pipeline.
8.	As per paragraph 4.d of ACM0001: In the case of LFG from a Greenfield SWDS, the identified baseline scenario is atmospheric release of the LFG or capture of LFG in a managed SWDS and destruction through flaring to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons.	This applicability criterion does not apply to the project activity instance because the LFG arises from existing SWDSs. Furthermore, there are no requirements to capture LFG or destroy LFG through flaring in order to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons.
9.	As per paragraph 4 of TOOL02 “Combined tool to identify the baseline scenario and demonstrate additionality” (Version 07.0): The tool is applicable to all types of proposed project activities. However, in some cases, methodologies referring to this tool may require adjustments or additional explanations as per the guidance in the respective methodologies. This could include, inter alia, a listing of relevant alternative scenarios that should be considered in Step 1, any relevant types of barriers other than those presented in this tool and guidance on how common practice should be established.	The project activity complies with this criterion. Additionality was proven at the registration of the project. For the second project crediting period, the baseline scenarios (LFG venting and grid electricity) are addressed using TOOL11 “Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period” version 03.0.1, discussed below.
10.	As per paragraph 5 of ACM0001, this methodology is not applicable: a) In combination with other approved methodologies. b) If the management of the SWDS in the project activity instance is deliberately changed during the crediting in order to increase methane generation compared to the situation prior to the implementation of the project activity instance.	a) The project only utilises one methodology which is ACM0001 version 19. b) The project retains the same waste disposal practices for waste and the management of the landfill remains unchanged. The project therefore complies with these criteria.
11.	As per paragraph 2 of TOOL03 “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion” (Version 03.0): This tool provides procedures to calculate project and/or leakage CO2 emissions from the combustion of fossil fuels. It can be used in cases where CO2 emissions from fossil fuel combustion are calculated based on the quantity of fuel combusted	The project activity complies with this criterion. The tool is applicable to the project as diesel may be used in generators for on-site power backup for the flares. This tool is used to calculate project and/or leakage CO2 emissions from the combustion of diesel in backup generations. It is used in cases where

	and its properties. Methodologies using this tool should specify to which combustion process *j* this tool is being applied.	CO2 emissions from fossil fuel combustion are calculated based on the quantity of diesel combusted.
12.	As per paragraphs 3.a and 3.b of TOOL04 “Emissions from solid waste disposal sites” (Version 08.0), the tool can be used to determine emissions for the following types of applications: 3 (a) Application A: The project mitigates methane emissions from a specific existing SWDS. Methane emissions are mitigated by capturing and flaring or combusting the methane (e.g. “ACM0001: Flaring or use of landfill gas” version 19). The methane is generated from waste disposed in the past, including prior to the start of the CDM project activity. In these cases, the tool is only applied for an ex ante estimation of emissions in the project design document (CDM-PDD). The emissions will then be monitored during the crediting period using the applicable approaches in the relevant methodologies (e.g. measuring the amount of methane captured from the SWDS); 3 (b) Application B: The project avoids or involves the disposal of waste at a SWDS. An example of this application of the tool is ACM0022, in which municipal solid waste (MSW) is treated with an alternative option, such as composting or anaerobic digestion, and is then prevented from being disposed of in a SWDS. The methane is generated from waste disposed or avoided from disposal during the crediting period. In these cases, the tool can be applied for both ex ante and ex post estimation of emissions. These project activities may apply the simplified approach detailed in 0 when calculating baseline emissions.	The project activity complies with paragraph 3 (a) Application A because the project mitigates methane emissions from specific existing SWDSs. The tool is applied for the ex-ante estimation of emissions in the project description. Emissions will be monitored during the crediting period using the appropriate approaches referenced in the methodology ACM0001 Version 19.0. The project therefore complies with this criterion. Application B is not applicable because the project mitigates emissions from an existing SWDS, not the avoidance of waste at a SWDS.
13.	As per paragraph 4 of TOOL04 “Emissions from solid waste disposal sites” (Version 08.0): These two types of applications are referred to in the tool for determining parameters.	The project activity meets the applicability criterion Application A, as described above.
14.	As per paragraph 5 of the tool TOOL04 “Emissions from solid waste disposal sites” (Version 08.0): In the case that: (a) different types of residual waste are disposed or prevented from disposal; or that (b) both MSW and residual waste(s) are prevented from disposal, then the tool should be applied	Not applicable because the existing SWDSs are classified as general waste sites, meaning that they comprise of MSW and do not accept residual waste. Therefore the tool is applied only to the MSW in the absence of residual waste.

	separately to each residual waste and to the MSW.	
15.	As per paragraph 5 of TOOL05 "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (Version 03.0): The tool is only applicable if one out of the following three scenarios applies to the sources of electricity consumption: (a) Scenario A: Electricity consumption from the grid. The electricity is purchased from the grid only, and either no captive power plant(s) is/are installed at the site of electricity consumption or, if any captive power plant exists on site, it is either not operating or it is not physically able to provide electricity to the electricity consumer; (b) Scenario B: Electricity consumption from (an) off-grid fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants are installed at the site of the electricity consumer and supply the consumer with electricity. The captive power plant(s) is/are not connected to the electricity grid; or (c) Scenario C: Electricity consumption from the grid and (a) fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants operate at the site of the electricity consumer. The captive power plant(s) can provide electricity to the electricity consumer. The captive power plant(s) is/are also connected to the electricity grid. Hence, the electricity consumer can be provided with electricity from the captive power plant(s) and the grid.	The tool is applicable to the project since the tool is used to estimate project CO_2 emissions associated with the consumption of electricity. Scenario C applies to the project. The landfills may use standby diesel generators (captive power plants) for on-site power backup for the flares. The diesel generators. Hence, the project can be provided with electricity from the captive power plant(s) and the grid. The project therefore complies with this criterion.
16.	As per paragraph 6 of TOOL05 "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (Version 03.0): This tool can be referred to in methodologies to provide procedures to monitor amount of electricity generated in the project scenario, only if one out of the following three project scenarios applies to the recipient of the electricity generated: (a) Scenario I: Electricity is supplied to the	The project complies with Scenario 1: all generated electricity is supplied to the grid.

	grid; (b) Scenario II: Electricity is supplied to consumers/electricity consuming facilities; or (c) Scenario III: Electricity is supplied to the grid and consumers/electricity consuming facilities.	
17.	As per paragraph 7 of TOOL05 "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (Version 03.0): This tool is not applicable in cases where captive renewable power generation technologies are installed to provide electricity in the project activity, in the baseline scenario or to sources of leakage. The tool only accounts for CO2 emissions.	The project complies with this criterion: There are no captive renewable power generation technologies installed to provide electricity in the project activity in the baseline scenario or to sources of leakage. Only CO2 emissions are accounted for.
18.	As per paragraph 2 of TOOL06 "Project emissions from flaring" (Version 03.0.0): This tool provides procedures to calculate project emissions from flaring of a residual gas. The tool is applicable to enclosed or open flares and project participants should document in the CDM-PDD the type of flare used in the project activity.	The project complies with this criterion: project emissions are calculated in relation to the flaring of residual gas (LFG). All the flares in the project activity are enclosed flares, as documented in this PDD (see section B.6.1).
19.	As per paragraph 3 of TOOL06 "Project emissions from flaring" (Version 03.0.0): This tool is applicable to the flaring of flammable greenhouse gases where: a) Methane is the component with the highest concentration in the flammable residual gas; and b) The source of the residual gas is coal mine methane or a gas from a biogenic source (e.g. biogas, landfill gas or wastewater treatment gas).	The project complies with paragraph 3 (a): methane is the highest component of the residual gas (LFG). 3(b) does not apply.
20.	As per paragraph 4 of TOOL06 "Project emissions from flaring" (Version 03.0.0): The tool is not applicable to the use of auxiliary fuels and therefore the residual gas must have sufficient flammable gas present to sustain combustion. For the case of an enclosed flare, there shall be operating specifications provided by the manufacturer of the flare.	The project complies with this criterion: no auxiliary fuels are used to sustain flare combustion. All the enclosed flares are operated in accordance with the specifications provided by the manufacturer of the flares.
21.	As per paragraph 5 of TOOL08 "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 03.0): Typical applications of this tool are methodologies where the flow and composition of residual or flared gases or exhaust gases are measured for the	The methodological tool ACM0001 Version 19.0 refers to this tool for measurement of flow and composition of the residual or flared gases to determine baseline and project emissions.

	determination of baseline or project emissions.	The tool is applicable to the project as the flow and composition of residual or flared gases will be measured for the determination of baseline or project emissions. The gaseous stream that the tool will be applied to is the LFG delivery pipeline to each item of equipment at each site. The greenhouse gas for which the mass flow will be determined is methane.
22.	As per TOOL08 “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 03.0): Methodologies where CO_2 is the particular and only gas of interest should continue to adopt material balances as the means of flow determination and may not adopt this tool as material balances are the cost effective way of monitoring flow of CO_2.	This criterion is not applicable as CO_2 is not the only gas of interest in the project activity.
23.	As per TOOL08 “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 03.0): The underlying methodology should specify: (a) The gaseous stream the tool should be applied to; (b) For which greenhouse gases the mass flow should be determined; (c) In which time intervals the flow of the gaseous stream should be measured; and Situations where the simplification offered for calculating the molecular mass of the gaseous stream (equations (3) or (17)) is not valid (such as the gaseous stream is predominantly composed of a gas other than N_2).	The project complies with these criteria: (a) The tool is applied to the residual gas stream in the respective landfill. The option F of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 03.0) is used to calculate the mass flow of the gaseous stream. (b) The mass flow is determined for methane. (c) Monitoring is continuous.
24.	As per section I of TOOL11 “Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period”, version 03.0.1: This tool provides a stepwise procedure to assess the continued validity of the baseline and to update the baseline at the renewal of a crediting period, as required by paragraph 49 (a) of the modalities and procedures of the clean development mechanism. The tool consists of two steps. The first step provides an approach to evaluate whether the current baseline is still valid for the next crediting period. The second step provides an approach to update the baseline in case that the current baseline	The project activity complies with the applicability criteria of this tool. The steps to assess the continued validity of the baseline and to update the baseline at the renewal of a crediting period have been undertaken in section B.4 of this PDD.

	is not valid anymore for the next crediting period.	
25.	As per paragraph 3 of ASB0040-2018, Version 01.0: Clean development mechanism (CDM) project activities and programmes of activities (hereinafter referred as project activities) can apply this standardized baseline under the following conditions: (a) The project activity is implemented in any one of following countries, which are the SAPP member countries, and is connected to the SAPP; (i) Republic of Botswana; (ii) Democratic Republic of Congo; (iii) Kingdom of Lesotho; (iv) Republic of Mozambique; (v) Republic of Namibia; (vi) Republic of South Africa; (vii) Kingdom of Swaziland; (viii) Republic of Zambia, and (ix) Republic of Zimbabwe. (b) The CDM approved methodology that is applied to the project activity requires the determination of CO2 emission factor(s) through the application of the grid tool; (c) The project activity uses the ex-ante options for both the operating margin and build margin grid emissions factors, as described in the grid tool, and therefore no monitoring or recalculation of the emission factor during the crediting period is required.	The project complies with these criteria: (a) The project activity is located in South Africa. (b) The project activity requires the determination of CO2 emission factor(s) through the application of the grid tool. (c) The project activity uses the ex-ante options for both the operating margin and build margin grid emissions factors, as described in the grid tool, and therefore no monitoring or recalculation of the emission factor during the crediting period is required.
26.	As per paragraph 4 of ASB0040-2018, Version 01.0: The latest approved and valid values of this standardized baseline are the only values of the CO2 emission factor(s) that shall be applied for the project electricity system in the SAPP member countries listed under sub-para 3(a) above.	The project complies with this criterion. The valid values of ASB0040 version 0.10 are the only values of the CO2 emission factor that shall be applied for the project electricity system in the listed SAPP member countries.

B.3. Project boundary, sources and greenhouse gases (GHGs)

The project boundary includes five landfill sites, flares and electricity generation equipment:

- Robinson Deep landfill: installed flare and electricity generation equipment
- Marie Louise landfill: installed flare and electricity generation equipment
- Goudkoppies landfill: installed flare and electricity generation equipment
- Linbro Park landfill: flare and electricity generation equipment once installed
- Ennerdale sites landfill: flare and electricity generation equipment once installed

The project boundary also includes the Southern African Power Pool's electricity system – which comprises the power plants that are physically connected through transmission and

distribution lines to supply electricity to the interconnected electricity system of the Southern African Power Pool.

The emission sources and greenhouse gases included in the project boundary (in accordance with the applied methodologies and the applied standardized baseline) are described in the following table.

	Source	GHG	Included?	Justification/Explanation
Baseline	Emission from decomposition of waste at the SWDS site	CO_2	No	CO_2 emissions from decomposition of organic waste are not accounted for.
		CH_4	Yes	The major source of emissions in the baseline.
		N_2O	No	N_2O emissions are small compared to CH_4 emissions from landfills. Exclusion of this gas is *conservative*.
	Emissions from electricity generation	CO_2	Yes	Major emission source as power generation is included in the project activity.
		CH_4	No	Excluded for simplification. This is *conservative*.
		N_2O	No	Excluded for simplification. This is *conservative*.
	Emission from heat generation	CO_2	No	No thermal energy generation is planned in the project activity.
		CH_4	No	Excluded for simplification. This is *conservative*.
		N_2O	No	Excluded for simplification. This is *conservative*.
	Emissions from the use of natural gas	CO_2	No	Natural gas use is not included in the project activity.
		CH_4	No	No LFG will be supplied through natural gas distribution networks, dedicated pipelines or trucks in the project activity.
		N_2O	No	Excluded for simplification. This is *conservative*.
Project activity	Emissions from fossil fuel consumption for purposes other than electricity generation or transportation due to the project activity	CO_2	Yes	Only in case of back-up electricity generation.
		CH_4	No	Excluded for simplification. This emission source is negligible.
		N_2O	No	Excluded for simplification. This emission source is negligible.
	Emissions from electricity consumption due to the project activity.	CO_2	Yes	This is applicable for on-site electricity use, if and when the project activity does not generate electricity from the captured LFG.
		CH_4	No	Excluded for simplification. This emission source is negligible.
		N_2O	No	Excluded for simplification. This emission source is negligible.
	Emissions from flaring	CO_2	No	Emissions are considered negligible.
		CH_4	Yes	The project emissions from flaring are based on a default flare efficiency of 80%. CH4 emissions that are not combusted (due to the efficiency factor of 80%) are therefore accounted for.
		N_2O	No	Emissions are considered negligible.
	Emissions from distribution of LFG using trucks and dedicated pipelines	CO_2	No	Not applicable as the project activity does not include distribution of LFG using trucks or dedicated pipelines.
		CH_4	No	Not applicable as the project activity does not include distribution of LFG using trucks or dedicated pipelines.
		N_2O	No	Not applicable as the project activity does not include distribution of LFG using trucks or dedicated pipelines.

A full flow diagram of the project set-up is presented in the following figure. The flow diagram comprises all possible elements of the LFG collection systems and the equipment for electricity generation. The Project boundary is indicated by the broken red line. If and when the project activity includes electricity generation, the project boundary

will be extended to include a power purchaser - the South African national grid or a local power purchaser.

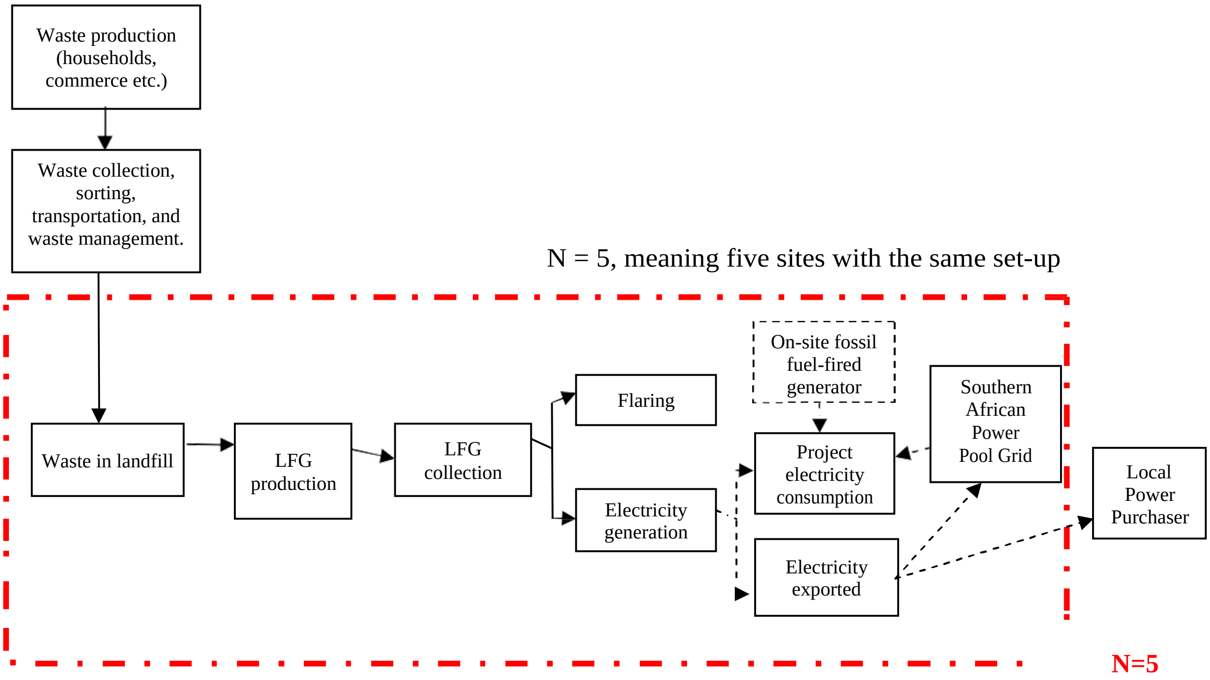

Figure: Flow diagram of Project set-up

B.4. Establishment and description of baseline scenario

As the project is in its second crediting period, the following steps of methodological tool, "*Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period*" version 03.0.1, are applied to evaluate whether the baseline at project registration is still valid and to update the baseline in case that the current baseline is not valid anymore.

- Step 1: Assess the validity of the current baseline for the next crediting period

The validity of the current baseline is assessed using the sub-steps 1.1 – 1.4:

- Sub-step 1.1: Assess compliance of the current baseline with the relevant mandatory national and/or sectoral policies

As per paragraph 284 of the CDM Project Standard for project activities version 02.0:

"The project participants shall assess and incorporate the impact of national and/or sectoral policies and circumstances, existing at the time of requesting the renewal of the crediting period, on the current baseline GHG emissions, without reassessing the baseline scenario."

The baseline scenario, as per the PDD at registration, is the atmospheric release of the landfill gas and the generation of electricity in existing grid-connected power plants.

Regulations relating to the atmospheric release of landfill gas
The national legislation applicable to the project activity at the time of registration was the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008). The objectives of the Act are to provide guidance on norms and standards related to waste disposal activities in South Africa. Relevant to these norms and standards are the

classifications of waste and the listed waste management activities. The project activity complied with Act at the time of registration and continues to do so at the time of requesting the renewal of the crediting period.

During the first crediting period, the South African government amended the Waste Act of 2008 by publishing the National Environmental Management: Waste Amendment Act, 2014. The revisions in the Waste Amendment Act of 2014 pertain largely to the administration of waste in South Africa (as summarised in preamble to the Act). The Waste Amendment Act of 2014 provides for actions that various levels of government may or may not undertake. Therefore, the Waste Amendment Act of 2014 does not impact the project activity.

During the first crediting period, the South African government also published the Waste Classification and Management Regulations on 23 August 2013. These regulations aim to provide for the national norms and standards for the disposal of waste to landfill in South Africa. In particular, these regulations contain waste disposal restrictions and timeframes for compliance (see regulation 5.(1)). The only restrictions applicable to this project activity are those regarding the disposal of garden waste on landfill sites. General landfills are required to reduce the volumes of garden waste accepted by 50% by 2023.

The landfills are owned by Pikitup, a state-owned enterprise. As such, Pikitup is required to comply with all applicable laws and regulations and thus the expected garden waste volumes have been reduced so that they are aligned with the requirements of the regulations.

As per the regulatory environment at the registration of the project, there is no legislative requirement in South Africa to capture, destroy or use landfill gas. The baseline scenario still complies with all relevant mandatory national and/or sectoral policies which have come into effect after the submission of the project activity for validation.

<u>Regulations pertaining to electricity generation</u>
Additionally, there was no project power generation in the baseline which requires the continued use of existing and/or new grid-connected power plants for all municipal power supply. **This is effectively the continuation of the status quo**.

Therefore step 1.2 is applied as follows.

- Step 1.2: Assess the impact of circumstances

The step entails an assessment of the impact of circumstances existing at the time of requesting renewal of the crediting period on the current baseline emissions, without reassessing the baseline scenario. The baseline scenario identified at the validation of the project activity was the continuation of the current practice without any investment. Therefore, an assessment of the changes in market characteristics is undertaken. This assessment evaluates whether the conditions used to determine the baseline emissions in the previous crediting period are still valid.

<u>The atmospheric release of the LFG, which represents the business as usual scenario, was identified as the most plausible baseline scenario in the absence of the project activity. T</u>he conditions used to determine the baseline emissions in the previous crediting period are emissions arising from the release of methane during the decomposition of waste and the displacement of emissions intensive, grid-based electricity. These conditions have been updated in the second crediting period.

Baseline emissions from waste: two conditions have changed. The first condition is the waste volumes have been updated to reflect the latest actual waste volume figures disposed of at the respective landfill sites. Additionally, the waste volume projections for future year are based on the estimated population growth of Gauteng[5] which is the province in which the projects are located. The projected waste volumes have also been amended to reflect the regulatory requirements of the 2013 Waste Classification and Management Regulations to reduce the volumes of garden waste accepted on general landfill sites by 50% by 2023. The second condition is the updated GWP for methane.

Baseline emissions relating to displacement of grid electricity: one condition has changed, which is the use of the mandatory grid emission factor (ASB0040-2018).

- Step 1.3: Assess whether the continuation of use of current baseline equipment or an investment is the most likely scenario for the crediting period for which renewal is requested.

Not applicable, no equipment was used in the current baseline as it is the atmospheric release of landfill gas.

- Step 1.4 Assessment of the validity of the data and parameters

As determined in Step 1.2 above, the following conditions used to calculate the baseline emissions have changed:

1. The project waste volumes for four sites (the Ennerdale; Robinson Deep; Marie Louise and Goudkoppies landfills) were updated with actual waste volumes[6] for the years 2014-2018. Linbro Park Landfill was closed in 2006 and therefore did not require updating of waste volumes. The 2019 waste volumes were calculated based on monthly average volumes[7] provided for the four sites. The projected future waste deposit values were also updated for these landfill sites, based on an estimated growth rate in the Gauteng province of 1.84%/year (using the 2019 waste volumes as a baseline). Where necessary, the future waste volumes were projected until the expected closure dates of the respective sites. The projected waste volumes have also been amended to reflect the regulatory requirements of the 2013 Waste Classification and Management Regulations to reduce the volumes of garden waste accepted on general landfill sites by 50% by 2023.
2. The grid emission factor applied in the previous crediting period was the calculated figure of 0.977 tCO_2/MWh. In the second crediting period, the mandatory grid emission factor of 0.9091 tCO_2/MWh prescribed by ASB0040-2018, version 1, has been applied.
3. The GWP for methane has been updated from 21 to 25. The change of the methane GWP (a fixed ex ante parameter) is undertaken as per the CDM project standard for project activities Version 2 (section 6.3) which allows for the use of the GWP of 25 for methane in the second Kyoto commitment period which started on 1 January 2013.

The outcome of Step 1.4 indicates that the current baseline needs to be updated with the conditions that have changed since the registration of the project. Step 2 of the methodological tool, "*Assessment of the validity of the original/current baseline and*

[5] Population.City. 2015. Gauteng · Population. Available at: http://population.city/south-africa/adm/gauteng/. Accessed 13 February 2020.

[6] Reference document: Landfill Tonnage.

[7] Pikitup. 2019. Survey Report.

update of the baseline at the renewal of the crediting period" version 03.0.1, is therefore applied.

- Step 2.1: Update the current baseline

The current baseline emissions for the second crediting period have been updated, as reflected in the following section B.6.

- Step 2.2: Update the data and parameters

The parameters relating to waste volumes, the grid emission factor and the GWP for methane have been updated accordingly in the following section B.6.

B.5. Demonstration of additionality

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Determination of the project scenario additionality is undertaken according to ACM0001, Version 11 (which refers to the CDM consolidated "Tool for the demonstration and assessment of additionality", hereafter referred to as "Additionality Tool"), which follows the subsequent steps:

Step 1. Identification of alternatives scenarios

Step 1 of the Additionality Tool is used, together with additional guidance from ACM0001.

Sub-step 1a. Define alternatives to the project activity:

- **LFG 1:** The project activity (i.e. capture of LFG and its flaring and/or its use) undertaken without being registered as a CDM project activity; and

- **LFG 2:** Atmospheric release of the LFG, which represents the business as usual scenario.

LFG1 cannot be the most plausible baseline scenario, as it is not a feasible course of action in the absence of the project activity (as explained in the investment analysis below).

As the Project may include electricity generation in the future, realistic and credible alternatives may include, inter alia:

- **P1.** Power generated from LFG undertaken without being registered as a CDM project activity;
- **P2.** Existing or construction of a new on-site or off-site fossil fuel fired cogeneration plant;
- **P3.** Existing or construction of a new on-site or off-site renewable based cogeneration plant;
- **P4.** Existing or construction of a new on-site or off-site fossil fuel fired captive power plant;
- **P5.** Existing or construction of a new on-site or off-site renewable based captive power plant; and
- **P6.** Existing and/or new grid-connected power plants.

Renewable sources other than LFG are not economically feasible for the project sites since there are no other renewable energy options available at the sites, and these would be less plausible than purchasing electricity from the National Grid. Therefore options P3 and P5 are discarded. Similarly, since heat is not considered as part of the proposed project activity, cogeneration plants are not a viable alternative, and alternatives P2 and P3 are discarded.

As a Grid connection already exists at the landfill sites, construction of a new on-site fossil fuel fired captive power plant is not as plausible as purchasing power from the grid, so that P4 and P5 are also discarded.

The remaining alternatives for power generation are therefore P1 and P6.

The remaining options for plausible baseline alternatives for the Project activity are:

- **LFG 2:** Atmospheric release of the LFG, which represents the business as usual scenario;
- **P1**: Power generated from LFG undertaken without being registered as CDM project activity, which represents the project activity. **P1** also corresponds to **LFG 1**; and
- **P6**: Power plants connected to the grid.

Heat generation is not considered in the absence of the project activity; given the lack of local off-takers. The costs associated with developing a pipeline to supply off-takers from the project sites would be too high to justify an investment in thermal energy production. Therefore, alternatives for heat generation are not considered.

Sub-step 1b. Enforcement of applicable laws and regulations:

LFG 2: Atmospheric release of the LFG represents the business as usual scenario, and complies with South Africa's local and national laws. While there exists a draft 'Minimum Requirements for Waste Disposal by Landfill' (published in 2005 and constituting the most recent legislation on landfill site management available in South Africa) it does not categorically specify that it is a mandatory requirement to actively capture, flare, or destroy LFG at every landfill in South Africa. The draft requirements provide guidelines to ensure safety on site (i.e. reducing the risk of explosions) by limiting LFG accumulation via passive ventilation. The prevailing practice in South Africa is either venting the LFG to ensure that the concentration of methane in any particular area of the landfill stays below hazardous levels, or to not install any kind of capturing system[8].

P1: Power generation without registration as a CDM project activity, complies with all the applicable laws and regulations.

P6: Power plants connected to the grid complies with all the applicable laws and regulations as they have to be licensed by the National Energy Regulator of South Africa in order to generate, transmit, or distribute electricity[9].

In summary, all possible scenarios described above comply with national and local regulations. There are no laws/regulations which specify that it is mandatory to destroy LFG at all landfills in the Host Country.

Step 2. Investment Analysis

Sub-step 2a: Determine appropriate analysis method

According to the "Tool for the demonstration and assessment of additionality", if the alternatives to the CDM project activity do not include investments of comparable scale to the project, then Option III must be used. In this case, the most likely alternative to the

[8] Department of Water Affairs and Forestry, 2005: Minimum requirements for waste disposal by landfill, draft 3rd edition, Chapter 8.4.6 Gas management systems, p. 99, available at: http://www.dwaf.gov.za/Documents/Other/WQM/RequirementsWasteDisposalLandfillSep05Part4.pdf

[9] Electricity Regulation Act, 2006: Government Gazette, Republic of South Africa, Vol. 493 No. 28992, Clause 8 (l) (a), available at: http://www.info.gov.za/view/DownloadFileAction?id=67855

project is not to install flaring and generation equipment at the sites. Therefore, since no investments of a similar scale to the Project are involved, benchmark analysis is applied.

Sub-step 2b: Option III - Apply benchmark analysis
The likelihood of development of the Project without being registered as a CDM (P1 or LFG 1), as opposed to the continuation of current activities (atmospheric release of LFG) will be determined by comparing the pre-tax Project IRR with a suitable benchmark rate of return available to investors in the Host Country.

According to the "Tool for the demonstration and assessment of additionality", a relevant benchmark for a project's equity IRR can be derived from government bond rates increased by a suitable risk premium (to reflect private investment and/or project type). The benchmark derived is a pre-tax WACC (Weighted Average Cost of Capital) and is comparable with pre-tax Project IRR. The benchmark has been derived from the following parameters:

- **Risk Free Rate**: According to Bloomberg, an acknowledged specialist in providing financial data and investment information, the risk free rate for South Africa (equivalent to long term government bond yields) is taken as the average yield from 1999 to 05/2009 (start date of the project activity) at 9.07%.
- **Risk Premium (Market Return - Risk Free Rate):** In order to estimate the standard market return in the Host Country, the average equity market return has been analyzed. The FTSE/JSE index consists of all stocks traded on the South African Stock Exchange. During the most recent ten years prior to the investment decision (i.e. 1999 - 2008), the FTSE/JSE index has achieved a compounded annual return of 14.28%. The Risk premium/country premium can be determined as the difference between the average market return and the average risk free rate, or 14.28% - 9.07% = 5.21%.
- A Beta (hereafter, "β") coefficient of 1.00 (market average) has been applied which is conservative for LFG to energy projects in the developing world (since they have a high probability of underperforming)[10].
- Income Tax Rates (28%)[11]: the tax rate applicable in South Africa is used to derive the pre-tax Equity IRR from the post-tax Equity IRR.

  With the effective tax rate of 28% the pre-tax WACC Benchmark is calculated as follows:

  - equity return (post-tax) = risk free rate + (β * equity country premium)
    = 9.07% + (1 * 5.21%)
    = 14.28%
    equity return (pre-tax) = equity return (post tax) / (1 – income tax rate)
    = 14.28 / (1-28%)
    = 19.83%

10 A study performed for the world bank in 2007, "Landfill Gas Capture Design vs. Actual Performance and the Future for CDM Projects", http://siteresources.worldbank.org/INTLACREGTOPURBDEV/Resources/840343-1178120035287/EditedLFGWorkshopReportAugust14.pdf

11 http://kpmghu.lcc.ch/dbfetch/52616e646f6d495638d5fe192b00c8fdb1e872a3c31c6c4c34e2b269ef7e38a8/kpmg_indirecttaxratesurvey_accessible1.pdfhttp://www.google.co.in/#hl=en&source=hp&q=tax+adjusted+cost+of+equity&aq=f&aqi=&aql=&oq=&gs_rfai=&fp=f0bb1200aec65a16

- WACC (pre-tax) = (debt part * Cost of Debt) + (equity part * Cost of Equity (pre tax))
  = (69% * 11.15%[12]) + (31% * 19.83%)
  = 13.82%

Sub-step 2c: Calculation and comparison of financial indicators

Table 5.1 below illustrates the result of the financial analysis for the project activity, considering a twenty-one year period. As shown, the project IRR (without CDM revenue) is lower than the chosen benchmark.

Table B.5.1: Financial results of the project (LFG 1 or P1) with and without carbon finance

	Without CDM	**With CDM**
IRR	7.31 %	23.54 %
Pre-tax WACC (the chosen benchmark)	13.82%	

Table B.5.2: Assumption for financial analysis

Input / Assumpt	**Unit**	**Value**	**Comments**
Electricit y price	ZAR/M Wh	1050 in the first year (i.e.	Tariff used is as per the Maximum Programme Price of Eskom's 2010-2018 MTPPP (Medium Term Power Purchase Programme). After 2018, an inflation corrected electricity
Kyoto CER	ZAR/to nne CO2 e	170	http://www.globeinternational.org/docs/content/may_09_cms.pdf,
Post-Kyoto		34	Post-Kyoto CER price assumed to be 20% of
CAPEX	ZAR	211,296,906	Total for actual power installed 17 MW See attached Financial Calculation.
	ZAR/MW	12,590,687	Per actual MW installed See attached Financial Calculation.

12 As per indicative term sheets related to the bank loan.

OPEX	ZAR/MWh	373 in the first year (i.e. 2012).	2012 1st year full operation (inflation corrected for later years). See attached Financial Calculation.

The underlying calculation and detailed information on the financial analysis carried out can be found in the spreadsheet made available to the DOE.

Sub-step 2d: Sensitivity analysis
A sensitivity analysis was undertaken using assumptions that move the IRR to the benchmark value. The sensitivity analysis shows that a considerable variation of major parameters would have to transpire in order to improve the Project IRR to the benchmark value.

Table B.5.3 – Sensitivity analysis

Sensitivity	Variation	IRR [%]	Benchmar
Increase in	13.98	13.82	13.82
Decrease in	27.93	13.82	13.82
Decrease in	21.87	13.82	13.82

<u>Increase in revenue:</u>
The increase in revenue is composed of the following parameters:

- *<u>Power generation from the gas</u>*: Power generation is based on the gas model and the highest Power Load Factor (hereafter "PLF") was assumed by the Project developer, so an increase in gas consumption or electricity generation is highly unlikely.
- *<u>Electricity tariff</u>*: In 04/2007, when the Project developer sent a proposal to the Johannesburg Council for LFG collection and electricity generation at the five sites, the expected tariff was 0.37 Rand/kWh, which was based on actual prices at that time. The tariffs available to the Project developer in 2009 were taken from Eskom's Medium Term Power Purchase Programme (MTPPP)[13]. Therein, a pricing pyramid was developed with a lower threshold of the Eskom Ceiling Price below which Eskom would accept all bids (starting at 0.65 Rand/kWh in 2009, and ending the contractual period in 2018 at 0.35 Rand/kWh). Eskom also developed a Maximum Programme Price for which they would not review any bids higher than the Maximum Programme Price (starting at 1.05 Rand/kWh in 2009, and ending the contractual period in 2018 at 0.35 Rand/kWh). This schedule was designed to encourage power producers online as soon as possible by providing an incentive for early start-up (when the value of additional capacity is greatest). To be conservative, the calculated project IRR is based on the Maximum Programme Price of Eskom's MTPPP (i.e. the price at which Eskom would not review any bids that are higher than this price). To date there has not been any contract signed under the MTPPP. For the period after 2018, the rate of 2018 corrected for inflation was employed. Since the project already applies the Maximum Programme Price of the MTPPP tariff, a further increase by 13.98% is highly unlikely to occur in the future.

[13] Schedule of the Eskom Medium Term Power Purchase Program base tariff, Appendix H, May 2008, available at: http://www.eskom.co.za/content/MTPPP%20RFT%20rev%201%2013%20May%202008%5B1%5D.doc

Decrease in CAPEX:
A reduction of 27.93% in the investment cost would be necessary for the IRR to reach the benchmark, and such a reduction in investment cost by such a significant percentage is highly unlikely. These costs are based on the cost of equipment required for the Project, the major part of which concerns the generators for which a purchase order (with a defined purchase amount) has already been made.

Decrease in OPEX:
A decrease of 21.87% in the OPEX is required for the IRR to reach the benchmark. The primary components of OPEX are material and manpower costs, both of which are exposed to inflation and will therefore increase in the future. A reduction in operation and maintenance costs by any amount is highly unlikely. These costs are not likely to decrease as it is known what maintenance is required, and the Project developer has a good idea (from extensive prior experience in South Africa) what salaries and material costs are expected to be.

In conclusion, the Project IRR is not sufficient to warrant investment in this project even with an increase in electricity revenue or production, or a decrease in investment or operation and maintenance costs. The installation of a LFG to energy project is therefore not viable without carbon finance.

Method:
EB41 Annex 45 requires the consideration of sufficient variation in the input parameters to ensure that the additionality of a project is robust. This guidance suggests that variation of at least 10% in either direction should be considered where appropriate. The Project's additionality was tested by increasing revenues (+) and decreasing (-) costs, both capital and operational, and as a stopping point we used the values that rendered the project IRR equal to the benchmark. Decreasing revenues and increasing costs would not be reasonable as this would further decrease the financial attractiveness of the project i.e. would make the project even more additional. An explanation was then given regarding the probability of obtaining such additional revenue or reduction in expenditure to such a degree. The range tested was in fact far larger than +/-10%, and as such the EB41 Annex 45 guidance was adhered to.

Step 3. Barrier Analysis

Barrier Analysis is not used for the demonstration of additionality for the project as the CDM project activity is unlikely to be financially/economically attractive (as per Step 2c Para 11b).

Step 4. Common Practice Analysis for South Africa

Sub-step 4a: Analyse other activities similar to the proposed project activity
Although LFG has been recognised as a source of odour and as a potential explosion hazard, few LFG management systems have been constructed in Southern Africa, and those that have make use of CDM[14]. Further, LFG management in South Africa is currently limited to passive venting of gas[15]. Passive venting involves construction of impervious migration barriers adjacent to the landfill and passive venting from boreholes and perforated pipes within the landfill – the result is GHG emissions. Therefore, prevailing practice in South Africa is to either vent LFG to ensure that the concentration of

[14] Department of Water Affairs and Forestry, 1998: Minimum requirements for waste disposal by landfill, chapter 8.4.6 Gas Management Systems, pp. 8-11, available at: http://www.dwaf.gov.za/Dir_WQM/docs/Pol_Landfill.PDF

[15] Department of Water Affairs and Forestry, 2005: Minimum requirements for waste disposal by landfill, draft 3rd edition, Chapter 8.4.6 Gas management systems, p. 99, available at: http://www.dwaf.gov.za/Documents/Other/WQM/RequirementsWasteDisposalLandfillSep05Part4.pdf

methane in any particular area of the landfill remains below hazardous levels, or to not install any kind of management and capturing system.

The Department of Minerals and Energy, South Africa, had conducted a detailed study for assessment of potential landfill gas capture and utilization sites in South Africa as part of their Capacity Building in Energy efficiency and renewable energy initiative. The study "Landfill Gas Resources for Power Generation in South Africa[16]" identified 453 landfill sites under operation or in the process of being given a permit in South Africa out of which only 57 had sufficient waste input to justify investigation as potential landfill gas-to-power projects. Further, although 57 sites have potential for power generation project, the majority of air space and thus, power generation opportunities are associated with 20 larger landfill sites located in metropolitan or municipal areas contributing to 70% of the probable energy yield from landfills. These 20 largest landfill sites included Joburg landfill sites therefore these 20 landfill sites are identified as similar to the project activity in terms of size/scale.

The following table depicts the status of LFG extraction implementation for the similar landfill sites in South Africa. Projects that have submitted a Project Idea Note to South Africa DNA[17] for approval or registered CDM projects are considered as securing carbon revenues for landfill gas capture and utilization projects.

Sl. No.	Landfill site	Province	Landfill Gas status	Carbon Revenue Status	Reference
1	Linbro Park	Gauteng	Landfill Gas utilization / Flaring	Under registration with UNFCCC	**Joburg Landfill Gas to Energy CDM Project - the proposed project**
2	Vissershok CMC	Western Cape	Atmospheric release	considering carbon revenues for gas capture and utilization / flaring	Database of South Africa's DNA
3	Valhalla Tshwane	Gauteng	Atmospheric release	considering carbon revenues for gas capture and utilization / flaring	Database of South Africa's DNA - The Tshwane Lilanda Methane Gas project involves 9 sites in Pretoria region including
4	Biasar Road	Kwa-zulu Natal	Landfill Gas utilization / Flaring	Registered CDM project - 1921	Durban Landfill gas to Electricity Project – Bisasar Road Landfill
5	Marie Louise	Gauteng	Landfill Gas utilization / Flaring	Under registration with UNFCCC	Joburg Landfill Gas to Energy CDM Project - the proposed project activity

[16] Capacity Building in Energy Efficiency and Renewable Energy: Landfill Gas Resources for Power Generation in South Africa, Department of Minerals and Energy Pretoria

[17] http://www.energy.gov.za/files/esources/kyoto/2012/CDM_Projects_Portfolio_19_June%202012.pdf

6	Robinson Deep	Gauteng	Landfill Gas utilization	Under registration with UNFCCC	Joburg Landfill Gas to Energy CDM Project - the
7	Deerdepoort Tshwane	Gauteng	Atmospheric release	considering carbon revenues for gas capture and utilization / flaring	Database of South Africa's DNA - The Tshwane Lilanda Methane Gas project involves 9 sites in Pretoria region including Valhalla and Deerdepoort landfill sites
8	Rooikraal EMM	Gauteng	Landfill Gas utilization	Registered CDM project - 3677	Ekurhuleni Landfill gas Recovery Project
9	Belville South	Western Cape	Atmospheric release	considering carbon revenues for gas capture and utilization / flaring	Database of South Africa's DNA
10	Kwaggasrand Tshwane	Gauteng	Atmospheric release	considering carbon revenues for gas capture and utilization / flaring	Database of South Africa's DNA
11	Onderstepoort Tshwane	Gauteng	Atmospheric release	considering carbon revenues for gas capture and utilization / flaring	Database of South Africa's DNA
12	Goudkoppies	Gauteng	Landfill Gas utilization / Flaring	Under registration with UNFCCC	Joburg Landfill Gas to Energy CDM Project - the proposed project activity
13	Weltervreden EMM	Gauteng	Landfill Gas utilization / Flaring	Registered CDM project - 3677	Ekurhuleni Landfill gas Recovery Project
14	Garstkloof Tshwane	Gauteng	Atmospheric release	considering carbon revenues for gas capture and utilization / flaring	Database of South Africa's DNA
15	Coastal Park	Western Cape	Atmospheric release	considering carbon revenues for gas capture and utilization / flaring	Database of South Africa's DNA

16	Koedoeskloof	Eastern Cape	Landfill Gas utilization / Flaring	Registered CDM project - 5692	Nelson Mandela Bay Metropolitan's Landfill Gas Project
17	Simmer and Jack EMM	Gauteng	Landfill Gas utilization / Flaring	Registered CDM project - 3677	Ekurhuleni Landfill gas Recovery Project
18	Boitshepi Emfuleni	Gauteng	Atmosph eric release	considering carbon revenues for gas capture and utilization / flaring	Database of South Africa's DNA
19	Southern Bloem	Free State	Atmosph eric release	Atmospheric release (no gas wells on site for LFG capture)	Atmospheric release (no gas wells on site for LFG capture)
20	Ga-Rankuwa Tshwane	Gauteng	Atmosph eric release	considering carbon revenues for gas capture and utilization / flaring	Database of South Africa's DNA

"All projects similar to the proposed project activity are developed under the CDM, and are therefore excluded from the discussion on prevailing practice.

Sub-step 4b: Discuss any similar options that are occurring
Since the only landfills which have active LFG capture and flaring are CDM projects (or in the process of applying for CDM), the project does not have any similar options which do not consider CDM.

Additional step: CDM consideration

Project timeline and consideration
CDM was considered early on in the process. In fact upon the decision of the Project developer to prepare a proposal (dated 23/04/2007), in response to a tender from the Municipality of Johannesburg. The Project developer was awarded the project, and an agreement was signed with the Municipality on 27/05/2009. On 29/05/2009, a purchase order was made for the generators with a value of ZAR 137,130,053. This is the "point of no return" and therefore the "project start date".

A notification of CDM consideration was sent to and received by the UNFCCC before 27/11/2009, which is within 6 months after the signing date of the Agreement with the Municipality.

Table B.5.6: Major Milestones achieved throughout CDM Project

Milestone	Date achieved	Comments
Tender Notice published by City of Johannesburg Metropolitan Municipality to develop five sites under the CDM.	23/04/2007	The tender notice clearly mentions that the Johannesburg municipality, owner of the sites, is interested in developing the

ERPA signed between the Project developer and EcoSecurities	10/07/2008	The signing of ERPA before the start date of the project activity further substantiates the seriousness of CDM consideration by
Final Lease & Gas Rights Agreement Signed by the Project developer and the Municipality of Johannesburg to develop the proposed project under CDM	27/05/2009	The Agreement mentions that PD will enter into ERPA for the sale and purchase of CERs related to the project with EcoSecurities.
Purchase order for Generators	29/05/2009	**Start date CDM Project**
Submittal EIA and EMP reports	09/2009	The EIA also included a stakeholder consultation in line with CDM requirements.
Notification of CDM consideration sent to UNFCCC and DNA	20/11/2009	Within 6 months after signing Agreement with the Municipality.
Validation Work Order Signed	11/08/2010	-
Signing Power Purchase Agreements (PPAs) with Eskom	Q2 2011	-
Start Date of Construction	10/2010	-
Operation Start Date	Q3 2011	-

As can be seen from the timeline, at the point of submitting the PDD for validation the Project developer has not agreed on a final PPA and has therefore not agreed on a tariff for the electricity to be produced as a result of utilisation of LFG at the sites. Besides this, the tariff known at the point in time when the investment was made (purchase order for generators dated 29/05/2009, i.e. the start date of the project, has been set for the definition of baseline and for the financial additionality test.

Start date of the project

The primary milestones achieved for the CDM project are presented in Table B.5.6 (above). The start date is in line with EB clarification from EB 41, paragraph 67, and refers to the definition of start date as per the Glossary of CDM terms, Version 04. The start date shall be considered to be the date on which the project participant has committed to expenditures related to the implementation or related to the construction of the project activity. This, for example, can be the date on which contracts have been signed for equipment or construction/operation services required for the project activity. Minor pre- project expenses such as the contracting of services/payment of fees for feasibility studies or preliminary surveys, should not be considered in the determination of the start date as they do not necessarily indicate the commencement of implementation of the project.

The project construction commenced in 10/2010, and the purchase order for generators has already been made. Thus the start date for the project activity is the date on which the purchase order was made, since this represents the point where the Project developer committed to major expenditures related to the implementation of the project and is the earlier of construction/implementation for the project activity.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

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Baseline emissions

Baseline emissions are determined according to equation (1) of the methodology ACM0001, version 19 and comprise the following sources:

a) Methane emissions from the SWDS in the absence of the project activity;

b) Electricity generation using fossil fuels or supplied by the grid in the absence of the project activity;

c) Heat generation using fossil fuels in the absence of the project activity; and

d) Natural gas used from the natural gas network in the absence of the project activity.

$$BE_y = BE_{CH,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y}$$

(Equation 1 of ACM0001, v19)

Where:

BE_y	=	Baseline emissions in year *y* (t CO_2e/yr)
$BE_{CH4,y}$	=	Baseline emissions of methane from the SWDS in year *y* (t CO_2e/yr)
$BE_{EC,y}$	=	Baseline emissions associated with electricity generation in year *y* (t CO_2/yr)
$BE_{HG,y}$	=	Baseline emissions associated with heat generation in year *y* (t CO_2/yr)
$BE_{NG,y}$	=	Baseline emissions associated with natural gas use in year *y* (t CO_2/yr)

For the project activity described in this document, the baseline emissions are derived from methane from the SWDS and electricity generation. There is no heat generation or natural gas use in the baseline.

Baseline emissions of methane from the SWDS ($BE_{CH4,y}$)

Baseline emissions of methane from the SWDS are determined as follows, based on the amount of methane that is captured under the project activity and the amount that would be captured and destroyed in the baseline (such as due to regulations). In addition, the effect of methane oxidation that is present in the baseline and absent in the project is taken into account:[18]

[18] $OX_{top\text{-}layer}$ is the fraction of the methane in the LFG that would oxidize in the top layer of the SWDS in the absence of the project activity. Under the project activity, this effect is reduced as a part of the LFG is captured and does not pass through the top layer of the SWDS. This oxidation effect is also accounted for in the methodological tool “Emissions from solid waste disposal sites”.

$$BE_{CH4} = \left(\left(1 - OX_{top_{layer}}\right) \times F_{CH4,PJ,y} - F_{CH,BL,y}\right) \times GWP_{CH4}$$

(Equation 2 of ACM0001, v19)

Where:

$BE_{CH4,y}$	=	Baseline emissions of methane from the SWDS in year *y* ($t\ CO_2e/yr$)
OX_{top_layer}	=	Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (dimensionless)
$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* ($t\ CH_4/yr$)
$F_{CH4,BL,y}$	=	Amount of methane in the LFG that would be flared in the baseline in year *y* ($t\ CH_4/yr$)
GWP_{CH4}	=	Global warming potential of CH_4 ($t\ CO_2e/t\ CH_4$)

For the purposes of these calculations, and in accordance with ACM0001 Version 19.0, the following values are applied:

- OX_{top_layer} = 0.1 (default value for baseline calculations stipulated in ACM0001 Version 19);
- $F_{CH4,BL,y}$ = 0 (there is no capture, flaring or use of landfill gas in the baseline scenario and therefore Case 1 of ACM0001 Version 19 applies); and
- GWP_{CH4} = 25 (as per the CDM project standard for programmes of activities Version 2 (section 6.3) which allows for the use of the GWP of 25 for CH4 in the second Kyoto commitment period which started on 1 January 2013. In addition, this is supported by ACM0001 which states that the “Default value of 25 from IPCC Fourth Assessment Report (AR4) shall be updated according to any future COP/MOP decisions”.).

Ex post determination of $F_{CH4,PJ,y}$

During the crediting period, $F_{CH4,PJ,y}$ is determined as the sum of the quantities of methane flared and used in power plant(s), boiler(s), air heater(s), glass melting furnace(s), kiln(s) and natural gas distribution, as follows:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y} + F_{CH4,HG,Y} + F_{CH4,NG,y}$$

(Equation 3 of ACM0001, v19)

Where:

$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* ($t\ CH_4/yr$)
$F_{CH4,flared,y}$	=	Amount of methane in the LFG which is destroyed by flaring in year *y* ($t\ CH_4/yr$)
$F_{CH4,EL,y}$	=	Amount of methane in the LFG which is used for electricity generation in year *y* ($t\ CH_4/yr$)
$F_{CH4,HG,y}$	=	Amount of methane in the LFG which is used for heat generation in year *y* ($t\ CH_4/yr$)
$F_{CH4,NG,y}$	=	Amount of methane in the LFG which is sent to the natural gas distribution network and/or dedicated pipeline and/or to the trucks in year *y* ($t\ CH_4/yr$)

For the project activity described in this document, the baseline emissions are derived from methane from the SWDS and electricity generation. There is no heat generation or natural gas use in the baseline. The equation can therefore be reduced to:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$$

$F_{CH4,EL,y}$ is determined using the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" and monitoring the working hours of the power plants, so that no emission reductions are claimed for methane destruction during non-working hours. This is taken into account by monitoring the hours that the equipment utilizing the LFG is operating in year *y* ($Op_{j,h,y}$).

The following requirements apply:

(a) As per the gaseous stream tool, if the LFG is used for multiple purposes (e.g. flaring or energy generation), and all methane destruction devices are verified to be operational (e.g. by means of flame detectors records, energy generated), a single flow meter may be used to record the flow into multiple destruction devices. The destruction efficiency of the least efficient among the destruction devices shall be used as the destruction efficiency for all destruction devices monitored by this flow meter. If there are any periods for which one or more destruction devices are not operational, paragraph 5 (a) and (b) of the Appendix of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" tool shall be followed. This is currently not anticipated in the current project design as a flow meter is anticipated for each methane destruction devices;

(b) CH_4 is the greenhouse gas for which the mass flow should be determined;

(c) The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations (3) or (17) in the tool);

(d) The mass flow should be calculated on an hourly basis for each hour *h* in year *y*;

(e) The mass flow calculated for hour *h* is 0 if the equipment is not working in hour *h* ($Op_{j,h}$=not working), the hourly values are then summed to a yearly unit basis.

$F_{CH4,flared,y}$ is determined as the difference between the amount of methane supplied to the flare(s) and any methane emissions from the flare(s), as follows:

$$F_{CH4,flared,y} = F_{CH4,sent_{flare},y} - \frac{PE_{flare,y}}{GWP_{CH4}}$$

(Equation 4 of ACM0001, v19)

Where:

$F_{CH4,flared,y}$	=	Amount of methane in the LFG which is destroyed by flaring in year *y* (t CH_4/yr)
$F_{CH4,sent\_flare,y}$	=	Amount of methane in the LFG which is sent to the flare in year *y* (t CH_4/yr)
$PE_{flare,y}$	=	Project emissions from flaring of the residual gas stream in year *y* (t CO_2e/yr)
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2e/t CH_4)

$F_{CH4,sent\_flare,y}$ is determined directly using the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" Version 03.0, applying the requirements described above where the gaseous stream tool shall be applied to is the LFG delivery pipeline to the flare(s).

The mass flow of a greenhouse gas i in a gaseous stream ($F_{i,t}$) is determined through measurement of the flow and volumetric fraction of the gaseous stream. Table 2 of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" Version 03.0 shows the different ways to make these measurements and the corresponding calculation option for $F_{i,t}$.

Table 2. Measurement options

Option	Flow of gaseous stream	Volumetric fraction
A	Volume flow – dry basis	dry or wet basis[3]
B	Volume flow – wet basis	dry basis
C	Volume flow – wet basis	wet basis
D	Mass flow – dry basis	dry or wet basis
E	Mass flow – wet basis	dry basis
F	Mass flow – wet basis	wet basis

Since the gaseous stream flow will be measured on mass wet basis and the volumetric fraction of methane will be measured in wet basis, option F will be used in the respective sites in the project activity:

Option F of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 03.0.0)

The mass flow of greenhouse gas *i* ($F_{I,t}$) is determined using the equations below as stipulated in the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0):

$$F_{i,t} = V_{t,wb,n} \times v_{i,t,wb} \times \rho_{i,n}$$ Mass Flow Tool Equation (9)

$$\rho_{i,n} = \frac{P_n * MM_i}{R_u * T_n}$$ Mass Flow Tool Equation (10)

$$V_{t,wb,n} = M_{t,wb} / \rho_{t,wb,n}$$ Mass Flow Tool Equation (15)

$$\rho_{t,wb,n} = \frac{P_n \times MM_{t,wb}}{R_u \times T_n}$$ Mass Flow Tool Equation (16)

Where:

$F_{i,t}$ Mass flow of greenhouse gas i in the gaseous stream in time interval t (kg gas/h)
$V_{t,wb,n}$ Volumetric flow of the gaseous stream in the time interval t at normal conditions on a wet basis (m^3 wet gas/h)
$v_{i,t,wb}$ Volumetric fraction of greenhouse gas *i* in the gaseous stream in a time interval *t* on a wet basis (m^3 gas *i*/m^3 wet gas)
$\rho_{i,n}$ Density of greenhouse gas *i* in the gaseous stream normal conditions (kg gas/m^3 wet gas i)
P_n Absolute pressure of the gaseous stream in time interval *t* at normal conditions (Pa)
MM_i Molecular mass of greenhouse gas *i* (kg/kmol)
R_u Universal ideal gases constant (Pa.m^3/kmol.K)
T_n Temperature of the gaseous stream at normal conditions (K)

$M_{t,wb}$ Mass flow of the gaseous stream in time interval *t* on wet basis (kg/h)
$\rho_{t,wb,n}$ Density of greenhouse gas *i* in the gaseous stream in interval *t* on a wet basis at normal conditions (kg wet gas/m^3 wet gas)
$MM_{t,wb}$ Molecular mass of greenhouse gas *i* in time in time interval *t* on a wet basis (kg/kmol wet)

The molecular mass of the gaseous stream ($MM_{t,wb}$) is determined according to equation (17) below, as stipulated in the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0):

$$MM_{t,wb} = \sum_k (V_{k,t,wb} \times MM_k)$$ Mass Flow Tool Equation (17)

Where:

$MM_{t,wb}$	Molecular mass of gaseous stream in time interval *t* on a wet basis (kg wet gas/kmol wet gas)
$V_{k,t,wb}$	Volumetric fraction of gas *k* in the gaseous stream in time interval *t* on a wet basis (m^3 gas *k*/ m^3 wet gas)
MM_k	Molecular mass of gas *k* (kg/kmol)
k	All gases contained in the gaseous stream (e.g. N_2, CO_2, O_2, CO, H_2, CH_4, N_2O, NO, NO_2, SO_2, SF_6 and PFCs and H_2O in vapor phase).

The determination of the molecular mass of the gaseous stream ($MM_{t,wb}$) requires measuring the volumetric fraction of all gases (k) in the gaseous stream. However, as a simplification, the volumetric fraction of only the gases k that are greenhouse gases and are considered in the emission reduction calculation in the underlying methodology must be monitored and the difference to 100% may be considered as pure nitrogen. As per ACM0001 the only GHG to be considered is methane, therefore only the volumetric fraction of the methane will be monitored.

The project emissions PEflare, *y*, emissions due to flaring, are accounted for as below:

$$PE_{flare,y} = GWP_{CH4} \times \sum_{m=1}^{525600} F_{CH4,RG,m} \times (1 - \eta_{flare,m}) \times 10^{-3}$$

(Project emissions from flaring Equation 15)

Where:

$PE_{flare,y}$	= Project emissions from flaring of the residual gas stream in year *y* (t CO_2e/yr)
GWP_{CH4}	= Global warming potential of methane valid for the commitment period (tCO_2e/tCH_4)
$F_{CH4,RG,m}$	= Mass flow of methane in the residual gas in the minute *m* (kg)
$\eta_{flare,m}$	= Flare efficiency in minute *m*

Project emissions from flaring

Project emissions from flaring will be calculated and monitored according to the procedures described in the *Tool06 "Project emissions from flaring, version 3*". As the Project uses enclosed flares, Option A of the tool "Project emissions from flaring" Version 03.0 will be used for determining the flare efficiency. The project emissions are calculated as follows:

Option A – Default Value

The flare efficiency for minute *m* is 90% when the following two conditions are met to demonstrate that the flare is operating:

(1) The temperature of the flare ($T_{EG,m}$) and the flow rate of the residual gas to the flare ($F_{RG,m}$) is within the manufacturers specification for the flare ($SPEC_{flare}$) in minute *m*; and
(2) The flame is detected in minute *m* ($FLAME_m$).

Otherwise the flare efficiency is 0%.

For enclosed flares that are defined as low height flares, the flare efficiency shall be adjusted, as a conservative approach, by subtracting 10 percentile points. For example, the default value applied shall be 80%, rather than 90%. For the purposes of this project, 80% is used.

Ex ante estimation of $F_{CH4,PJ,y}$

An ex ante estimate of $F_{CH4,PJ,y}$ is required to estimate baseline emission of methane from the SWDS in order to estimate the emission reductions of the proposed project activity. It is determined according to equation (5) of the applied methodology:

$$F_{CH4,PJ,y} = n_{PJ} \times BE_{CH4,SWDS,y} / GWP_{CH4}$$

(Equation 5 of ACM0001, v19)

$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year y (t CH4/yr)
$BE_{CH4,SWDS,y}$	=	Amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year y (t CO2e/yr)
n_{PJ}	=	Efficiency of the LFG capture system that will be installed in the project activity
GWP_{CH4}	=	Global warming potential of CH4 (t CO2e/t CH4)

Determination of $BE_{CH4,SWDS,y}$

$BE_{CH4,SWDS,y}$ is determined using the methodological tool “Emissions from solid waste disposal sites”, version 08.0. The following guidance should be taken into account when applying the tool:

(a) f_y in the tool shall be assigned a value of 0 because the amount of LFG that would have been captured and destroyed is already accounted for in equation (2) of this methodology;

(b) In the tool, *x* begins with the year that the SWDS started receiving wastes (e.g. the first year of SWDS operation); and

(c) Sampling to determine the fractions of different waste types is not necessary because the waste composition can be obtained from previous studies.

The methane generation from the landfill in the absence of the project activity at year *y* ($BE_{CH4,SWDS,y}$), is calculated as per the “Emissions from solid waste disposal sites” version 08.0 as follows:

$$BE_{CH4,SWDS,y} = \varphi_y . (1 - f_y) . GWP_{CH4} . (1 - OX) . \frac{16}{12} . F . DOC_{f,y} . MCF_y . \sum_{x=1}^{y} \sum_{j,x} W_{j,x} . DOC_j . e^{-k_j (y-x)} . (1 - e^{-k_j})$$

(Equation 1 of SWDS Tool, v8)

Where:

φ_y	=	Model correction factor to account for model uncertainties for year y
f_y	=	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in the year y
GWP_{CH4}	=	Global warming potential of CH4 (tCO_2e/t CH4)
OX	=	Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste)
F	=	Fraction of methane in the SWDS gas (volume fraction)
$DOC_{f,y}$	=	Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring at the SWDS for year y (weight fraction)
MCF_y	=	Methane correction factor for the year y
$W_{j,x}$	=	Amount of solid waste type j disposed or prevented from disposal in the SWDS in the year x (tons)
DOC_j	=	Fraction of degradable organic carbon in the waste type j (weight fraction)
k_j	=	Decay rate for the waste type j (l/yr)
j	=	Type of residual waste or types of waste in the MSW
x	=	Years in the time period in which waste is disposed at the SWDS, extending from the first year in the time period (x = 1) to year y (x = y) (x = 1) to the year y for which avoided emissions are calculated (x = y)
y	=	Year of the crediting period for which methane emissions are calculated (y is a consecutive period of 12 months)

The table below summarises the parameters used in this calculation.

Parameter	Application A	Value Applied	Units	Explanation
φ_y	Default value	0.75	-	The values applied are for Boreal & temperate (MAT < 20°C) and dry (MAP < 1,000mm) conditions.
OX	Default value	0.1	-	In accordance with the SWDS tool.
F	Default value	0.5	-	In accordance with the SWDS tool.
$DOC_{f,y}$	Default value	0.5	-	In accordance with the SWDS tool.

<table>
<tr><th>Parameter</th><th>Application A</th><th>Value Applied</th><th>Units</th><th>Explanation</th></tr>
<tr><td>MCF_y</td><td>Default value</td><td>1.0</td><td>-</td><td>The landfill is an anaerobic managed solid waste disposal site. This is because there is a controlled placement of waste at the landfill (waste is specifically deposited in designated cells, and mining waste is deposited in a separate cell) and cover material and compacting equipment is used.</td></tr>
<tr><td>k_j</td><td>Default value</td><td>
<table>
<tr><td colspan="2">Waste type j</td><td></td></tr>
<tr><td rowspan="2">Slowly degrading</td><td>Pulp, paper, cardboard (other than sludge textiles</td><td>0.04</td></tr>
<tr><td>Wood, wood products and straw</td><td>0.02</td></tr>
<tr><td>Moderately degrading</td><td>Other (non-food) organic putrescible garden and park waste</td><td>0.05</td></tr>
<tr><td>Rapidly degrading</td><td>Food, food waste, sewage sludge, beverages and tobacco</td><td>0.06</td></tr>
</table>
</td><td>l/yr</td><td>Landfill is:
- Boreal and temperate (MAT <20°C) and
- Dry (MAP/PET <1)
MAP is defined as the Mean Annual Precipitation and PET is defined as the Potential Evapotranspiration.
These two values have not changed since registration therefore the ratio between them remains the same.</td></tr>
</table>

Parameter	Application A	Value Applied	Units	Explanation
DOC_j	Default value	Wood and wood products: 43 Pulp, paper and cardboard: 40 Food, food waste: 15 Textiles: 24 Garden and park waste: 20 Inert: 0	-	In accordance with the SWDS tool.
f_y	Estimated once	0	-	No methane is captured and flared in the baseline.

Determination of $F_{CH4,BL,y}$

This section provides a procedure to determine the amount of methane that would have been captured and destroyed (by flaring) in the baseline due to regulatory or contractual requirements, to address safety and odour concerns, or for other reasons (collectively referred to as requirement in this section). The four cases in the following table are distinguished. The appropriate case are identified and the corresponding instructions followed.

Cases for determining methane captured and destroyed in the baseline

Situation at the start of the project activity	Requirement to destroy methane	Existing LFG capture and destruction system
Case 1	No	No
Case 2	Yes	No
Case 3	No	Yes
Case 4	Yes	Yes

Since there are no requirements to destroy methane, nor is there an existing LFG capture system at the project site, Case 1 applies. Therefore, $F_{CH4,BL,y} = 0$.

Baseline emissions associated with electricity generation ($BE_{EC,y}$)

The baseline emissions associated with electricity generation in year y ($BE_{EC,y}$) are calculated using TOOL05 “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (Version 03.0”.

$$BE_{EC,y} = \sum_{k} EC_{BL,k,y} \times EF_{EF,k,y} \times (1 + TDL_{k,y})$$

(Equation 2 of Electricity Consumption and Generation Tool, v3)

Where:

$BE_{EC,y}$	=	Baseline emissions from electricity consumption in year y (t CO2 / yr)
$EC_{BL,k,y}$	=	Quantity of electricity that would be consumed by the baseline electricity consumer k in year y (MWh/yr). $EC_{BL,k,y}$ is equivalent to $EG_{PJ,y}$.
$EF_{EF,k,y}$	=	Emission factor for electricity generation for source k in year y (t CO2/MWh)
$TDL_{k,y}$	=	Average technical transmission and distribution losses for providing electricity to source *j* in year *y*
k	=	Sources of electricity consumption in the baseline

This project applies the latest version of the mandatory Standardized Baseline for grid emission factor for the Southern African Power Pool (ASB0040-2018 version 01.0). The Standardized Baseline is applied in accordance with paragraph 50 of the CDM project standard for project activities (Version 02.0) and paragraph 4 of ASB0040 (Version 01.0). As per the Standardized Baseline, the combined margin CO2 emission factor ($EF_{grid,CM,y}$) for interconnected electricity system of the SAPP was used. The applicable value applied is 0.9091 tCO2/MWh which is the value that may be applied in the second crediting period of this project, and applies to all project activities except wind and solar power generation. ASB0040 is a mandatory Standardized Baseline and as such has been used in the calculations.

Therefore $EF_{EF,k,y} = EF_{grid,CM,y}$.

<u>Project Emissions</u>

The project emissions are calculated as follows:

$$PE_y = PE_{EC,y} + PE_{FC,y} + PE_{DY,y}$$

(Equation 22 of ACM0001, v19)

Where:

PE_y	=	Project emissions in year y (tCO_2/y)
$PE_{EC,y}$	=	Emissions from consumption of electricity due to the project activity in year y (tCO_2/y)
$PE_{FC,y}$	=	Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation, year y (tCO_2/y)
$PE_{DY,y}$	=	Emissions from distribution of compressed/liquefied LFG using trucks in year y (tCO_2/y)

PE_{DTy} is not applicable to this project.

Only emissions from consumption of electricity by the project activity ($PE_{EC,y}$), the consumption of diesel in back-up electricity generators (PE_{FCy}) and emissions from flaring shall be calculated.

Project emissions from electricity consumption

$PE_{EC,y}$ is calculated according to TOOL05 “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (Version 03.0)” using the following equation:

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EF,j,y} \times (1 + TDL_{j,y})$$

(Equation 1 of Tool05, v3)

This project applies the latest version of the mandatory Standardized Baseline for grid emission factor for the Southern African Power Pool (ASB0040-2018 version 01.0). As per the Standardized Baseline, the combined margin CO2 emission factor ($EF_{grid,CM,y}$) for interconnected electricity system of the SAPP was used. The applicable value applied is 0.9091 tCO2/MWh which is the value that may be applied in the second crediting period of this project, and applies to all project activities except wind and solar power generation. ASB0040 is a mandatory Standardized Baseline and as such has been used in the calculations.

Therefore $EF_{EF,j,y} = EF_{grid,CM,y}$.

Project emissions from fossil fuel consumption

The project may use a fossil fuel generator on-site to generate electricity in case there is a failure of grid electricity (though this is *highly* unlikely). If this occurs, emissions from fossil fuel combustion ($PE_{FC,j,y}$) will be calculated as per Option B of the TOOL05 "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (Version 03.0)".

As per option B of the aforementioned tool, the *"Tool to calculate project or leakage CO2 emissions from fossil fuel combustion, version 3"* shall be followed to determine the Project or leakage emissions, as per the following equation:

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y}$$

(Equation 1 of Fossil Fuel Combustion Tool, v3)

where:

$PE_{FC,j,y}$	=	Are the CO_2 emissions from fossil fuel combustion in process *j* during the year *y* (tCO_2/yr)
$FC_{i,j,y}$	=	Is the quantity of fuel type *i* combusted in process *j* during the year *y* (mass or volume unit/yr)
$COEF_{i,y}$	=	Is the CO_2 emission coefficient of fuel type *i* in year *y* (tCO_2/mass or volume unit)
i	=	Are the fuel types combusted in process *j* during the year *y*

The CO2 emission factor of the fuel type used is calculated using Option B according to the '*Tool to calculate project or leakage CO2 emissions from fossil fuel combustion' as per the following equation, version 3':* Option B is used as the chemical composition of the fuel type is not readily available for Option A.

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i,y}$$

(Equation 4 of Fossil Fuel Combustion Tool, v3)

Where:

$COEF_{i.y}$	=	CO2 emission coefficient of fuel type *i* in year *y* [tCO2/mass or volume unit];
$NCV_{j,y}$	=	Weighted average net calorific value of the fuel type *i* year *y* [GJ/mass or volume unit];
$EF_{,j,y}$	=	Weighted average CO2 emission factor of fuel type *i* in year *y* [tCO2/GJ];
I	=	Fuel types combusted in process *j* during year *y*

Leakage emissions:

No leakage effects need to be accounted for under this methodology.

Emission reductions:

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y$$

(Equation 26 of ACM0001, v19)

ER_y	=	Emission reductions in year y (t CO2e/yr)
BE_y	=	Baseline emissions in year y (t CO2e/yr)
PE_y	=	Project emissions in year y (t CO2/yr)

B.6.2. Data and parameters fixed ex ante

Data/Parameter	**GWP_{CH4}**
Data unit	tCO_2e/tCH_4
Description	Global Warming Potential of methane
Source of data	IPCC (Fourth Assessment Report)
Value(s) applied	25
Choice of data or measurement methods and procedures	Shall be updated according to any future COP/MOP decisions.
Purpose of data	Calculation of baseline emissions
Additional comment	This parameter is also referred to in the “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site”

<table>
<tr><th>Data/Parameter</th><th>EF_{EL} or $EF_{grid, CM, y}$</th></tr>
<tr><td>Data unit</td><td>tCO_2/MWh</td></tr>
<tr><td>Description</td><td>Combined margin emission factor for the grid in year y</td></tr>
<tr><td>Source of data</td><td>Standardized baseline “Grid emission factor for the Southern African power pool”, version 01.0.</td></tr>
<tr><td>Value(s) applied</td><td>0.9091</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>
<table>
<tr><th rowspan="2">Parameter</th><th rowspan="2">Unit</th><th rowspan="2">Description</th><th rowspan="2">Applicable project types</th><th colspan="3">Applicable values</th></tr>
<tr><th>First crediting period</th><th>Second crediting period</th><th>Third crediting period</th></tr>
<tr><td>$EF_{grid, CM, y}$</td><td>tCO_2/MWh</td><td>Combined margin CO_2 emission factor for interconnected electricity system of the SAPP</td><td>All project activities except wind and solar power generation</td><td>0.9481</td><td>0.9091</td><td>0.9091</td></tr>
</table>
</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

Data/Parameter	$\varphi_{default}$
Data unit	-
Description	Default value for the model correction factor to account for model uncertainties
Source of data	Methodological tool: Emissions from solid waste disposal sites, Version 08.0
Value(s) applied	0.75
Choice of data or measurement methods and procedures	Application A is as the project activity mitigates methane emissions from existing SWDSs in Gauteng. The sites are therefore dry sites.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	OX
Data unit	-
Description	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data	Methodological tool: Emissions from solid waste disposal sites, Version 08.0
Value(s) applied	0.1
Choice of data or measurement methods and procedures	Default value
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	F
Data unit	-
Description	Fraction of methane in the SWDS gas (volume fraction)
Source of data	Methodological tool: Emissions from solid waste disposal sites, Version 08.0
Value(s) applied	0.5
Choice of data or measurement methods and procedures	Default value from the “*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site”* Version 8.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	$DOC_{f,default}$
Data unit	Weight fraction
Description	Default value for the fraction of degradable organic carbon (DOC) in MSW that decomposes in the SWDS
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.5
Choice of data or measurement methods and procedures	Default value as defined in the “*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site”* Version 8.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	**$MCF_{default}$**
Data unit	-
Description	Methane Correction Factor
Source of data	Methodological tool: Emissions from solid waste disposal sites, Version 08.0
Value(s) applied	1.0
Choice of data or measurement methods and procedures	1.0 for **anaerobic managed solid waste disposal sites**. Default value as defined in the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site",* Version 8 (for a site with controlled placement of waste, cover material, and levelling of the waste) was used.
Purpose of data	Calculation of baseline emissions
Additional comment	The methane correction factor (MCF) accounts for the fact that unmanaged SWDSs produce less methane from a given amount of waste than managed SWDSs, since a larger fraction of waste decomposes aerobically in the top layers of unmanaged SWDSs.

Data/Parameter	**DOC_j**
Data unit	-
Description	Fraction of degradable organic carbon in the waste type *j*
Source of data	Methodological tool: Emissions from solid waste disposal sites, Version 08.0
Value(s) applied	Wood and wood products: 43 Pulp, paper and cardboard (other than sludge): 40 Food, food waste, beverages and tobacco (other than sludge): 15 Textiles: 24 Garden, yard and park waste: 20 Glass, plastic, metal, other inert waste: 0
Choice of data or measurement methods and procedures	In accordance with the *"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"*, Version 8.
Purpose of data	Calculation of baseline emissions
Additional comment	The values applied are for wet waste.

<table>
<tr><td>Data/Parameter</td><td>k_j</td></tr>
<tr><td>Data unit</td><td>-</td></tr>
<tr><td>Description</td><td>Decay rate for the waste type j</td></tr>
<tr><td>Source of data</td><td>Methodological tool: Emissions from solid waste disposal sites, Version 08.0</td></tr>
<tr><td>Value(s) applied</td><td>The following vales are applied for the parameter k_j:
<table>
<tr><td>Waste type j</td><td>Boreal and Temperate
Dry</td></tr>
<tr><td>Pulp, paper, cardboard (other than sludge), textiles</td><td>0.04</td></tr>
<tr><td>Wood, wood products and straw</td><td>0.02</td></tr>
<tr><td>Other (non-food) organic putrescible garden and park waste</td><td>0.05</td></tr>
<tr><td>Food, food waste, sewage sludge, beferages and tobacco</td><td>0.06</td></tr>
</table></td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>As per the “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site, version 8”.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>The values applied are for Boreal & temperate (MAT < 20°C) and dry (MAP < 1,000mm) conditions. Proof of the climate data for Johannesburg from the South African Weather Service will be provided to the DOE upon request.</td></tr>
</table>

Data/Parameter	**f_y**
Data unit	-
Description	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year *y*
Source of data	Methodological tool: Emissions from solid waste disposal sites, Version 08.0
Value(s) applied	0
Choice of data or measurement methods and procedures	In accordance with paragraph 38(a) of the applied methodology, ‘*f_y in the tool shall be assigned a value of 0 because the amount of LFG that would have been captured and destroyed is already accounted for in equation 2 of this methodology*’.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	**W_x**
Data unit	Tonnes
Description	Amount of solid waste type *j* disposed in the SWDS in year *x*
Source of data	Landfill Operator
Value(s) applied	Please refer to calculation spreadsheet
Choice of data or measurement methods and procedures	Data is taken from historical records of landfill operation and aggregated annually.
Purpose of data	Calculation of baseline emissions
Additional comment	This is determined once *ex-ante* for the purpose of estimating emission reductions.

Data/Parameter	**$NCV_{i,y}$**
Data unit	GJ per mass or volume unit (e.g. GJ/m³, GJ/ton)
Description	Weighted average net calorific value of fuel type *i* in the year *y*
Source of data	IPCC default values as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.
Value(s) applied	0.0433 TJ/t
Choice of data or measurement methods and procedures	Values are taken from IPCC (2006) for diesel[19]. Any future revision of IPCC guidelines will be taken into account at the renewal of the crediting period.
Purpose of data	Calculation of project emissions
Additional comment	This parameter will only be used if and when there is fossil fuel consumption. Fossil fuel consumption will be monitored as stated in Section B.7.1.

Data/Parameter	**$EF_{CO2,i,y}$**
Data unit	tCO_2/GJ
Description	Weighted average CO_2 emission factor of fuel type *i* in the year *y*
Source of data	IPCC default values as provided in Table 1.4 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.
Value(s) applied	74.8 tCO_2/TJ
Choice of data or measurement methods and procedures	Values are taken from IPCC (2006) for diesel[20]. Any future revision of IPCC guidelines will be taken into account at the renewal of the crediting period.
Purpose of data	Calculation of project emissions
Additional comment	This parameter will *only* be used if and when there is fossil fuel consumption. Fossil fuel consumption will be monitored as stated in Section B.7.1.

Data/Parameter	η_{PJ}
Data unit	-
Description	Efficiency of the LFG capture system that will be installed in the project activity
Source of data	ACM0001 version 19
Value(s) applied	0.5
Choice of data or measurement methods and procedures	Since the technical specifications are not available for the LFG capture system, a default value of 50% is applied for the purposes of ex-ante emissions estimation.
Purpose of data	Calculation of baseline emissions
Additional comment	-

[19] This is used for illustrative purposes for ex-ante estimations, as the fossil fuel used in the project activity may be subject to change. Thus the actual NCV of the fuel consumed shall be used for ex-post ER calculation.

[20] This is used for illustrative reasons for ex-ante estimations, as the fossil fuel used in the project activity may be subject to change. Thus the actual EFCO2,i,y from the fuel consumed shall be used for ex-post ER calculations.

<table>
<tr><th>Data/Parameter</th><th>$SPEC_{flare}$</th></tr>
<tr><td>Data unit</td><td>Temperature (°C)
Flow rate or heat flux (kg/h or m^3/h)
Maintenance schedule (N° of days)</td></tr>
<tr><td>Description</td><td>Manufacturer’s flare specifications for temperature, flow rate and maintenance schedule.</td></tr>
<tr><td>Source of data</td><td>Flare manufacturer</td></tr>
<tr><td>Value(s) applied</td><td>
<table>
<tr><th></th><th>Temperature (°C)</th><th>Flow rate m^3/h)</th><th>Maintenance schedule</th></tr>
<tr><td>Min</td><td>700°C</td><td>400m^3/h</td><td rowspan="2">Not applicable.
The maintenance schedule is not required if Option A (default flare efficiency option specified in the tool titled ‘Project emissions from flaring, v3’) is selected to determine flare efficiency of an enclosed flare</td></tr>
<tr><td>Max</td><td>1,200°C</td><td>2,000m^3/h</td></tr>
</table>
</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>The values were taken from the specifications provided by the flare manufacturer. These specifications stipulate the operating ranges for temperature and flow rate.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

Data/Parameter	**Ru**
Data unit	Pa.m3/kmol.k
Description	Universal ideal gases constant
Source of data	“Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, Version 03.0
Value(s) applied	8.314
Choice of data or measurement methods and procedures	“Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, Version 03.0
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	MM_i
Data unit	kg/kmol
Description	Molecular mass of greenhouse gas *i*
Source of data	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream", Version 03.0
Value(s) applied	Methane: 16.04 Nitrogen: 28.01
Choice of data or measurement methods and procedures	The molecular mass of Methane is 16.04 kg/kmol as per the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", Version 03.0
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	P_n
Data unit	Pa
Description	Total pressure at normal conditions
Source of data	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream", Version 03.0
Value(s) applied	101,325 Pa
Choice of data or measurement methods and procedures	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream", Version 03.0
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	T_n
Data unit	K
Description	Temperature at normal conditions
Source of data	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream", Version 03.0
Value(s) applied	273.15 K
Choice of data or measurement methods and procedures	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream", Version 03.0
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	$\eta_{flare,m}$
Data unit	-
Description	Flare efficiency for the minute *m*
Source of data	Methodological Tool "Project emissions from flaring" Version 02.0.0
Value(s) applied	0.8
Choice of data or measurement methods and procedures	The flare efficiency for the minute m is 80% when the following two conditions are met to demonstrate that the low-height flare is operating: 1. The temperature of the flare (TEG_m) and the flow rate of the residual gas to the flare (FRG_m) is within the manufacturer's specification for the flare (SPECflare) in minute m; and 2. The flame is detected in minute m ($Flame_m$). Otherwise $\eta_{flare,m}$ is 0%.

Purpose of data	Calculation of baseline emissions
Additional comment	In accordance with paragraph 23 of the tool “Project emissions from flaring” Version 02.0.0. The applied efficiency has been adjusted to 80% from the default of 90% as the flares are defined as low height flares.

B.6.3. Ex ante calculation of emission reductions

Baseline emissions

The baseline emissions are determined according to equation (1) of the applied methodology:

$$BE_{y} = BE_{CH,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y}$$

(Equation 1 of ACM0001, v19)

A sample calculation is provided as follows:

Year	BEy	$BE_{CH4,y}$	$BE_{EC,y}$	$BE_{HG,y}$	$BE_{NG,y}$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2019	78,263	555,613	15,709	-	-

Baseline emissions of methane from the SWDS ($BE_{CH4,y}$)

Baseline emissions of methane from the SWDS are determined according to equation (2) of the applied methodology:

$$BE_{CH4} = \left(\left(1 - OX_{to\,p_{layer}}\right) \times F_{CH4,PJ,y} - F_{CH,BL,y}\right) \times GWP_{CH4}$$

(Equation 2 of ACM0001, v19)

A sample calculation is provided as follows:

Year	$BE_{CH4,y}$	OX	$F_{CH4,PJ,y}$	$F_{CH4,BL,y}$	GWP_{CH4}
	tCO_2e	-	tCH_4	tCH_4	tCO_2e/tCH_4
2019	555,613	0.1	24,694	-	25

The baseline emissions of methane from the SWDS are determined according to equation (5) of the applied methodology:

$$F_{CH4,PJ,y} = n_{PJ} \times BE_{CH4,SWDS,y}/GWP_{CH4}$$

(Equation 5 of ACM0001, v19)

Year	$F_{CH4,PJ,y}$	η_{PJ}	$BE_{CH4,SWDS,y}$	GWP_{CH4}
	tCH_4	-	tCO_2e	tCO_2e/tCH_4
2019	24,694	0.5	1,234,695	25

The baseline emissions associated with electricity generation in year *y* ($BE_{EC,y}$) are calculated using the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation, Version 3”.

$$BE_{EC,y} = \sum_{k} EC_{BL,k,y} \times EF_{EF,k,y} \times \left(1 + TDL_{k,y}\right)$$

(Equation 2 of Electricity Consumption and Generation Tool, v3)

A sample calculation is provided as follows:

Year	$BE_{EC,y}$	$EC_{BL,k,y}$	$EF_{EF,k,y}$	$TDL_{,y}$
	tCO_2e	MWh	tCO_2e/MWh	-
2019	15,709	15,752	0.9091	9.70[21]

Project emissions

The project emissions are calculated in accordance with equation (22) of the applied methodology:

$$PE_y = PE_{EC,y} + PE_{FC,y} + PE_{DY,y}$$

(Equation 22 of ACM0001, v19)

Year	PE_y	$PE_{EC,y}$	$PE_{FC,y}$	$PE_{DT,y}$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2019	1,975	14,421	-	-

Project emissions from electricity consumption:
$PE_{EC,y}$ is calculated according to the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation, Version 3" using the following equation:

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EF,j,y} \times \left(1 + TDL_{j,y}\right)$$

(Equation 1 of Electricity Consumption Tool and Generation, v3)

Year	$PE_{EC,y}$	$EC_{PJ,y}$	$EF_{EL,y}$	$TDL_{,y}$
	tCO_2e	MWh	tCO_2e/MWh	-
2019	14,421	14,460	0.9091	9.70

Project emissions from fossil fuel consumption:
Since the backup diesel generators will only be used in the event of a failure in the grid electricity (which is highly unlikely), project emissions associated with fossil fuel consumption will be set as zero ex-ante, and monitored during the crediting period.

Emission reduction
The emission reductions of the project activity are calculated using equation (26) of the applied methodology:

$$ER_y = BE_y - PE_y$$

(Equation 26 of ACM0001, v19)

Year	ER_y	BE_y	PE_y
	tCO_2e	tCO_2e	tCO_2e
2019	76,288	78,263	1 975

[21] Eskom. 2019. Integrated Report 2019.

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions ($t\ CO_2e$)	Project emissions ($t\ CO_2e$)	Leakage ($t\ CO_2e$)	Emission reductions ($t\ CO_2e$)
2019	78,263	1,957	0	76,288
2020	575,530	14,421	0	561,109
2021	579,731	16,027	0	563,704
2022	575,795	24,035	0	551,760
2023	572,144	24,035	0	548,110
2024	560,321	24,035	0	536,287
2025	547,864	24,035	0	523,830
2026	462,819	24,035	0	438,784
Total	**3,489,649**	**128,562**	**0**	**3,361,087**
Total number of crediting years	7			
Annual average over the crediting period	498,521	18,366	0	480,155

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data/Parameter	**Management of SWDS**
Data unit	-
Description	Management of SWDS
Source of data	Use different sources of data: (a) Original design of the landfill; (b) Technical specifications for the management of the SWDS; (c) Local or national regulations.
Value(s) applied	Waste Management Licences: - Ennerdale Landfill: 12/9/11/L53/3 - Goudkoppies Landfill: 12/9/11/L283/3 - Linbro Park Landfill: 12/9/11/L282/3 - Marie Louise Landfill: 12/9/11/L280/3 - Robinson Deep Landfill: 12/9/11/L281/3
Measurement methods and procedures	Project participants should refer to the original design of the landfill to ensure that any practice to increase methane generation have been occurring prior to the implementation of the project activity. Any change in the management of the SWDS after the implementation of the project activity should be justified by referring to technical or regulatory specifications.
Monitoring frequency	Annual
QA/QC procedures	The waste management licence is granted by a governmental department (3rd party)
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	**$Op_{j,h}$**
Data unit	-
Description	Operation of the equipment that consumes the LFG

Source of data	Thermocouples, UV sensors, electricity meters
Value(s) applied	0 or 1
Measurement methods and procedures	For each equipment unit *j* using *the LFG* monitor that the plant is operating in hour *h* by the monitoring any one or more of the following three parameters: • The operating temperature of the flare will be measured using a thermocouple located within the combustion chamber of the flare. The minimum operating temperature is 700°C and the maximum operating temperature is 1200°C; • A UV sensor will be located in the combustion chamber and used to detect a flame; • Products generated: electricity generated. $Op_{j,h}$=0 when: • One of more temperature measurements are missing or below the minimum threshold in hour *h* (instantaneous measurements are made at least every minute); • Flame is not detected continuously in hour *h* (instantaneous measurements are made at least every minute); • No products are generated in the hour *h* Otherwise, $Op_{j,h}$=1 The thermocouples have an accuracy class of class 1 and should be tested for functionality every three months in accordance with the manufacturer's specifications. The UV sensor does not have an accuracy class as it either reads "ON" or "OFF" and should be replaced in accordance with the manufacturer's specifications. The electricity meters at the landfill sites have an accuracy class of Class 0.5. The accuracy of the meters at Ennerdale and Linbro Park will be determined once equipment has been finalised.
Monitoring frequency	Hourly
QA/QC procedures	The thermocouple should be tested for functionality every 3 months in accordance with the manufacturer's specifications. The UV sensor should be replaced every 10,000 hours or 1 year in accordance with the manufacturer's specifications The electricity meters measuring the electricity generated are guaranteed by the equipment manufacturer for 10 years, which is in line with the national standard, SANS 474:2009, which specifies a calibration frequency of 10 years.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	$EG_{PJ,y} = EC_{BL,k,y}$
Data unit	MWh
Description	Amount of electricity generated using LFG by the project activity in year y
Source of data	Electricity meter
Value(s) applied	36,536 (annual average, ex-ante estimate)

Measurement methods and procedures	Monitor net electricity generation by the project activity using LFG The electricity meters at Robinson Deep, Marie Louise and Goudkoppies landfill sites have an accuracy class of Class 0.5. The accuracy of the meters at Ennerdale and Linbro Park will be determined once equipment has been finalised.
Monitoring frequency	Continuous
QA/QC procedures	Electricity meter(s) will be subject to regular maintenance and testing in accordance with stipulation of the meter supplier, to ensure accuracy. In accordance with the equipment manufacturer specifications, the meters are guaranteed for 10 years which is in line with the national standard, SANS474: 2009, which specifies a calibration frequency of 10 years.
Purpose of data	Calculation of baseline emissions
Additional comment	Required to calculate the emission reductions from electricity generation from LFG. Will *only* be used if and when the project produces electricity. The equation to be used is in B.6.1. Therefore, $EG_{PJ,y}$ is equivalent to $EC_{BL,k,y}$.

Data/Parameter	**TDL_y**
Data unit	%
Description	Average technical transmission and distribution losses for providing electricity
Source of data	Eskom 2019 Annual Report
Value(s) applied	9.70
Measurement methods and procedures	Monitored annually. In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years.
Monitoring frequency	Annual
QA/QC procedures	N/A: Third party information source
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	**$T_{EG,m}$**
Data unit	˚C
Description	Temperature in the exhaust gas of the enclosed flare in minute *m*
Source of data	Project participants
Value(s) applied	>500°C[22]
Measurement methods and procedures	Continuous monitoring of the temperature in the exhaust gas with a type N thermocouple. Accuracy of applied thermocouples: +/-0.75% (for 333°C to 1,200°C).
Monitoring frequency	Once per minute
QA/QC procedures	The thermocouples are solid state instruments and do not require calibrating. A functionality test of the instruments is conducted every 3 months to ensure that they are functioning properly.
Purpose of data	Calculation of project emissions
Additional comment	-

Data/Parameter	**$EC_{PJ,j,y}$**
Data unit	MWh/y
Description	Quantity of electricity consumed by the project electricity consumption source in year *y*

[22] This is an illustrative value used for the purposes of estimating emission reductions. Actual values used for the calculation of emission reductions will be monitored *ex-post*.

Source of data	Electricity meter
Value(s) applied	4,820 (annual average, *ex-ante* estimate)
Measurement methods and procedures	Electricity will be measured using electricity meters and data will be aggregated at least annually. The electricity meter at Robinson Deep has an accuracy class of Class 1. The electricity meter at Marie Louise has an accuracy class of Class B. The electricity meter at Goudkoppies has an accuracy class of Class 0.2. The accuracy of the meters at Ennerdale and Linbro Park will be determined once equipment has been finalised.
Monitoring frequency	Annually
QA/QC procedures	Electricity meters will be subject to regular maintenance and calibration in accordance with stipulation of the meter supplier to ensure accuracy. The meters at Robinson Deep, Marie Louise and Goudkoppies do not require calibration as they are solid state instruments.
Purpose of data	Calculation of project emissions
Additional comment	-

Data/Parameter	**$FC_{i,j,y}$**
Data unit	Mass or volume unit per year (e.g. ton/yr or m^3/yr)
Description	Quantity of fuel type *i* combusted in process *j* during the year *y*
Source of data	Onsite measurements
Value(s) applied	0 (*ex-ante* estimate)
Measurement methods and procedures	Diesel will be supplied from tanks and ruler gauges will be used to determine volume of diesel consumed. The ruler gauges will be part of the tank and calibrated at least once a year. The measurements will be recorded in a book (on a daily basis or per shift). The volume is obtained by multiplying the tank level by the tank cross-sectional area. The mass is calculated by multiplying the resulting volume by the density value of 0.84 Kg/l from Oak Ridge National Laboratory, (http://bioenergy.ornl.gov/papers/misc/energy_conv.html). The ruler gauges have an accuracy of +/- 3lt.
Monitoring frequency	Annually
QA/QC procedures	The metered fuel consumption quantities may be cross-checked against purchase invoices (if available). The ruler gauges are calibrated once a year. A log sheet is kept of the diesel recordings.
Purpose of data	Calculation of project emissions
Additional comment	-

Data/Parameter	**$v_{i,t,wb} = v_{k,t,wb}$**
Data unit	m^3 gas i/m^3 wet gas
Description	Volumetric fraction of greenhouse gas i in a time interval t on a wet basis
Source of data	Measurement
Value(s) applied	N/A
Measurement methods and procedures	Continuous in-situ analyzers
Monitoring frequency	Continuous

QA/QC procedures	Calibration should include zero verification with an inert gas (e.g. N2) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases must have a certificate provided by the manufacturer and must be under their validity period.
Purpose of data	Calculation of Baseline Emissions
Additional comment	-

Data/Parameter	**$M_{t,wb}$**
Data unit	kg/h
Description	Mass flow of the gaseous stream in time interval *t* on a wet basis
Source of data	Flow meter
Value(s) applied	-
Measurement methods and procedures	Instruments with recordable electronic signal (analogical or digital) are used. The mass flow meters at all of the landfill sites have an accuracy of +/- 1.0% and are calibrated every 3 years in accordance with the manufacturer's specifications.
Monitoring frequency	Continuous
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited. The flow meters will be calibrated every 3 years in accordance with the manufacturer's specifications.
Purpose of data	Ex post determination of the amount of methane in the LFG which used in the project activity in the year *y*
Additional comment	This parameter will be monitored in Option F as per the applied "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 03.0.0).

Data/Parameter	**$Flame_m$**
Data unit	Flame on or Flame off
Description	Flame detection of flare in the minute m
Source of data	-
Value(s) applied	0 or 1
Measurement methods and procedures	Measure using a fixed installation optical flame detector: Ultra Violet detector or Infrared or both
Monitoring frequency	Once per minute. Detection of flame recorded as a minute that the flame was on, otherwise recorded as a minute that the flame was off
QA/QC procedures	Equipment shall be maintained and calibrated in accordance with manufacturer's recommendations
Purpose of data	Calculation of Project Emissions
Additional comment	-

B.7.2. Sampling plan

>>
Not applicable: no sampling takes place.

B.7.3. Other elements of monitoring plan

>>
The Monitoring Plan for this project has been developed to ensure that from the start, the project is well organised in terms of the collection and archiving of complete and reliable data.

Data collection and record keeping arrangements
Monitoring data will be collected and recorded as detailed in Section B.7.1. All data required for verification and issuance will be backed-up and retained for at least two years following the end of the crediting period or the last issuance of CERs of the Project, whichever occurs later.

Data collected on-site by ENER-G Systems Joburg will be compiled in an electronic format on a regular basis.

Data Quality Control and Quality Assurance
All data collected on-site will be checked internally before being stored to assure it is complete and of an appropriate quality.

ENER-G Systems Joburg will perform regular checks of the final data, and analyse project performance prior to any verification. Moreover, regular internal audits will be conducted to assure that the Project is in compliance with CDM requirements.

Procedures will be developed to deal with possible monitoring data adjustments and uncertainties as well as emergencies.

Maintenance and Calibration of monitoring equipment
The Project developer is responsible for general maintenance of all equipment, which will be maintained and calibrated in line with manufacturers' recommendations. This will assure that equipment operates at the accuracies stated by monitoring equipment provider(s).

All relevant monitoring equipment will be traceable with specific serial and/or tag numbers.

Staff training
Training is conducted on-site at regular intervals to ensure that staff are capable of performing their designated tasks at high standards. The parties will agree upon procedures and responsibilities for CDM- specific training to warrant that they understand the importance of complete and accurate data and records for CDM monitoring.

CDM monitoring organisation and management
Prior to the start of the crediting period, the organisation of the monitoring team will be finalised. Clear roles and responsibilities will be assigned to all staff involved in the CDM project. The Project developer will have a designated CDM Monitoring Manager who will be responsible for monitoring operations of the project activity. All staff involved in the collection of data and records will be coordinated by the Monitoring Manager.

Please refer to Annex 5 for details.

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

>>
29/05/2009 (Purchase Order of LFG to Energy Generator).

C.2. Expected operational lifetime of project activity

>>
Up to 20 years and 0 months[23].

[23] The agreement between Project developer and the Johannesburg Municipality (signed 27/05/2009) ends after 20 years (i.e. 27/05/2029).

C.3. Crediting period of project activity

C.3.1. Type of crediting period

>>
Renewable crediting period.
Second crediting period.

C.3.2. Start date of crediting period

>>
12/11/2019.

C.3.3. Duration of crediting period

>>
7 years and 0 months.

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>
The Project will actively collect and combust LFG, thereby improving overall LFG management and reducing adverse global and local environmental effects of uncontrolled releases of LFG. Whilst the main global environmental concern over gaseous emissions of methane is the fact that it is a potent greenhouse gas, thus contributing importantly to global warming, emissions of LFG can also have significant health and safety implications at the local level. For example:

- Risk of explosions and/or fires either within the landfill or outside its boundaries, although the majority of LFG emissions are quickly diluted in the atmosphere;

- Asphyxiation and/or toxic effects to humans from concentrated emissions of LFG; and

- Local and global environmental effects such as odour nuisances, stratospheric ozone layer depletion, and ground-level ozone creation due to over 150 trace component contained in LFG.

Through both the installation of a well-designed LFG collection and a destruction/utilisation system and its proper operation, LFG will be captured and combusted in a controlled manner, thereby removing safety risks from the surrounding community, reducing the risks of toxic effects on the local community and the local environment as well as reducing the emissions of a potent greenhouse gas.

It is worth noting that the Project developer will install flares and electricity generation units which minimise the environmental impact of LFG emissions, which is significantly less harmful than the continued uncontrolled release of LFG into the atmosphere. The Project will significantly reduce odour and greenhouse gas emissions.

Thus, the project activity can be referred as environmentally ameliorative, and the installation of the LFG collection and combustion system is part of a broader effort by the Project developer to continue to improve waste management practices.

In South Africa it is nevertheless a legal requirement that a professional body conducts the Environmental Impact Assessment (EIA) which needs to be submitted to the Gauteng Department of Agriculture, Conservation and Environment (DEAT). The EIA Scoping Report was submitted to DEAT in September 2009, and in parallel the CDM process is under way to

receive the Record of Decision from DEAT, necessary to be in compliance with South African Environmental legislation. The EIA Scoping Report is available for the DOE (on request), and the Record of Decision will be provided as soon as it is received, before the start of the crediting period.

The potential impacts of the Project have been divided into those that can be mitigated during the design phase, and those impacts that require management during the construction and operational phase of the Project:

- **Preconstruction (Design phase):**
  Surface and groundwater impacts

- **Construction phase:**
  Employment opportunities Dust
  Noise
  Waste disposal Safety

- **Operational Phase Solid Waste Management Vegetation**
  Noise Safety

Identified issues are addressed in Section D.2.

D.2. Environmental impact assessment

>>

Identified environmental impacts	**Measures undertaken**
	Pre-Construction (Design Phase)
Surface & Groundwater impacts	The potential negative impacts of the Project on surface and groundwater quality downstream will be insignificant provided that the storm-water and wash-water are managed.
Vegetation & Biodiversity	Vegetation at the site had been highly disturbed and invaded, and as such there are no significant environmental impacts.
	Construction Phase
Visual aspects	The following mitigation measures will be implemented: • All construction activities are to be undertaken from a designated contractor lay-down area, which must be clearly demarcated within the landfill site. • Ensure that contractors and staff are well managed and adhere to the mitigation and management measures stipulated in this report. • All infrastructures will be situated in such a way as to reduce the negative aesthetics associated with the LFG Utilisation Plant.
Dust	The following measures will be taken to control the dust nuisance generated during the construction phase: • Speed limits on dust roads will be implemented to prevent dust entrainment into the atmosphere. • All stockpiles must be restricted to designated areas and may not exceed a height of two metres.
Noise	The following measures must be implemented on-site to minimise potential noise impacts: • Ensure the flare is enclosed to retard noise generation. • All vehicle and equipment exhaust systems should be maintained to prevent excessive noise.

Soil erosion & compaction	The following mitigation measures will reduce the risk of any negative impacts on in situ soil: • Contractors will be limited to clearly defined access routes and areas to be constructed in order to ensure that undisturbed areas will not be disturbed.
Vegetation Damage	Most natural vegetation in the construction footprint is already degraded and the only plants to be maintained are situated along the fence line. Potential damage to vegetation and biodiversity impacts will be insignificant.
Waste Disposal	Waste such as builders' rubble, fill material, oils, general waste, and sewage will be generated during the construction phase. All waste must be disposed of in a legally acceptable manner, with no burning of refuse to take place on-site. Provided that these management recommendations are
Safety	All employees must be made aware of the dangers associated with LFG. No smoking is to be allowed on-site due to the risks associated with LFG.
Operational Phase	
Solid Waste Management	All solid waste must be disposed of at a permitted landfill site. The impacts of solid waste from this site will be insignificant.
Noise	The following measures must be implemented on site to minimise potential noise impacts: • Routine maintenance of the plant must be undertaken to ensure noise nuisance does not occur.
Storm water management	All storm water drains must be maintained on a regular basis and cleared of refuse and debris.

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

>>

WSP Environmental South Africa (Pty) Ltd. was appointed by Ener-G Systems Joburg (Pty) Ltd. to carry out the environmental scoping, Environmental Impact Assessment (EIA), and draft Environmental Management Plan (EMP), for the development of the Joburg Landfill Gas to Energy Project into a CDM Project. The scoping report and the stakeholder consultation clearly specify that the project is designed under the CDM. Scoping and EIA reports have been prepared and submitted to the Department of Environmental Affairs and Tourism (DEAT) as per the requirements of the National Environmental Management Act (No. 107 of 1998) (NEMA) that were promulgated on 03/07/2006.

The following authorities have been advised of the proposed development:

- Department of Environmental Affairs and Tourism (DEAT)
- City of Johannesburg Region E
- Ward Councillor 105
- Urban Management
- Environmental Health Department City of Johannesburg

Interested & Affected Parties (I&APs) were identified by placing official notices of the EIA process for the proposed development in the national newspaper, "The Citizen" on 19/02/2009. In addition advertisements were placed in "The Citizen" and "The Sowetan" newspapers on the

07/08/2009. The reports went on public review for a period of four weeks from 07/08/2009 to 04/09/2009 at appropriate public venues in the areas of the landfills.

The EIA and EMP reports were updated with public comments and submitted to DEAT. Furthermore a “knock and drop” of Project Background Information Documents was conducted to residents surrounding the sites. Copies of the adverts and Background Information Documents (as well as proof of distribution) are attached to the Environmental Impact Report as Appendix C[24].

Table E.1.1: Summary of Public and Authority Involvement to date

Date	Event/Activity	Comments
19/02/2009	Advertisement national news paper: “The Citizen”	
23/02/2009	Public meeting Linbro Park: 17:00-18:00 – Rembrandt Park Primary School	EIA Appendix F contains attendance register
25/02/2009	Public meeting Marie Louise – St. Angela’s Catholic	EIA Appendix F contains attendance register
26/02/2009	Public meeting Goudkoppies: 17:00-18:00 – Silver Oaks High School	EIA appendix F contains attendance register
26/02/2009	Public meeting Robinson Deep: 17:00-18:00	EIA Appendix F contains attendance register
27/02/2009	Authorities meeting: 09h30-11:30 – WSP Main	EIA appendix F contains attendance register
27/02/2009	Public meeting Ennerdale: 17:00- 18:00 – Ennerdale Civic	EIA appendix F contains attendance register
12/03/2009	Additional public meeting Linbro Park: 18:30-19:30 – Nation Farm in Linbro Park	EIA appendix F contains attendance register
30/03/2009	Submission EIA Application Authorisation - Ennerdale - Goudkoppies - Linbro Park - Marie Louise - Robinson Deep	- DEAT Reference Nr.: 12/12/20/1472 - DEAT Reference Nr.: 12/12/20/1476 - DEAT Reference Nr.: 12/12/20/1475 - DEAT Reference Nr.: 12/12/20/1473 - DEAT Reference Nr.: 12/12/20/1474
05/06/2009	Scoping Report sent to DEAT	
08/07/2009	Authorities’ site visit 08/07/2009 & 09/07/2009	On request of Mr. Ngidi, DEAT
07/08/2009	Advertisement: “The Citizen” and “The Sowetan”	

[24] A copy of the EIA report for *every* site is available to the DOE on request.

07/082009	Start Public Review Ennerdale -Main security office Ennerdale landfill site - Ennerdale Civic Centre Goudkoppies - Goudkoppies landfill site main entrance - Eldorado Park Thusong library centre Linbro Park - Linbro Park Public Library - Nelton Farm Marie Louise - Marie Louise Landfill Site - Dobsonville Thusong Service Centre Robinson Deep - Robinson Deep main entrance office - Rosettenville library	Review Period 07/08/2009 – 04/09/2009
09/2009	Submission EIA and EMP Reports	

E.2. Summary of comments received

>>

In general the following types of issues were raised by the Authorities and I&APs:

- Air quality – a few stakeholders asked questions pertaining to the Project's impact on local air quality, and these were answered to their satisfaction, with the Project developer explaining how the project will in fact improve air quality in the area of the landfills;
- Possibilities for office blocks and housing – questions were raised regarding the potential use of the rehabilitated landfills, and the Project developer explained that there is indeed a potential to utilise the areas for recreational purposes, but not for housing (considering the underlying ecology); and
- Employment – a few stakeholders asked questions regarding employment and training for locals at the landfills, and the Project developer stated that they would utilise local employment capacity and provide necessary training is.

The EIA reports include a comprehensive list of all issues raised by I&APs and Stakeholders during public and authorities meetings.

E.3. Consideration of comments received

>>

The main issues as mentioned in Section E.2 are addressed as follows:

Air quality

The proposed project will extract natural LFGes thereby improving the general air quality in the area. Although this project will have benefits to the physical and socio-economic environment, it will not impact on water resources in the area.

Possibilities for office blocks and housing

The landfill area cannot, in its current state, be used for an area of residential or commercial development. Due to the fact that the underlying geology of the site is not stable, due to dumping of domestic waste, no considerable buildings would be permitted to be constructed on-site. The site may be used as a recreational area *after* sufficient rehabilitation.

Employment
The project will generate minor employment during the Construction and Operational Phases.

Capping
During the stakeholder consultation, a query was raised regarding site management, and when dumping would cease, since there had been concerns regarding leachate and dust from the landfill. The response was that according to legislation, minimising the amount of waste dumped at the landfill site (Ennerdale) had begun. Capping and covering of the site were ongoing, and final rehabilitation would commence following site closure. All capping and rehabilitation work are undertaken according to legislation.

A query was raised regarding the lack of notification for people staying and working on-site. The response (from WSP) was that surrounding landowners were notified of the proposed project through Background Information Documents, Site Notices, and Media Advertisement which was placed in the Citizen Newspaper. Furthermore, the Ward Councillor was notified via fax, email and telephonically.

Groundwater
No additional water will be introduced to the sites from the proposed project. Mitigation measures will be implemented during the construction and operational phases, minimising surface or groundwater incidents. These measures contribute to a net improvement on the business as usual scenario.

Technical project details
During the stakeholder event, a technical operations description of the proposed project was presented to the attendees by the Project developer.

For specific details, the EIA reports include responses to all issues raised by I&APs and Stakeholders during the public and authorities meetings, and response to the public review. Moreover, they include an assessment of the impact on the Biophysical and Socio-economic Environments, and subsequent management and mitigation measures which have been identified.

It has been concluded by WSP Environmental South Africa (Pty) Ltd. that *there are no environmental fatal flaws and no significant negative impacts associated with the proposed project should mitigation and management measures be implemented.* It should be noted that positive impacts if the proposed project include carbon credits, the production of electricity as well as the reduction in LFG emissions from surrounding residential areas. Socio-economic impacts are perceived to be positive by providing employment opportunities and improving the ambient air quality.

SECTION F. Approval and authorization

>>
The South African letter of approval was available and provided at the time of submitting the PDD to the DOE for registration.

ENER-G Systems Joburg (project participant listed in the PDD) is authorized by South Africa in the respective letter of approval.

Appendix 1. Contact information of project participants

Organization name	Ener-G Systems Joburg (PTY) Ltd.
Country	South Africa
Address	205 Northway GES House Durban KZN 4051
Telephone	+27 31-5640222
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E-mail	dcornish@gessa.co.za
Website	
Contact person	Mr. David Cornish M: +27 83 385 0661 E: dcornish@gessa.co.za

Appendix 2. Affirmation regarding public funding

The project will not receive any public funding from an Annex 1 country.

Appendix 3. Applicability of methodologies and standardized baselines

N/a.

Appendix 4. Further background information on ex ante calculation of emission reductions

N/a.

Appendix 5. Further background information on monitoring plan

MONITORING INFORMATION

Table: CDM Monitoring System Procedures

Procedure	Description	Scope
CDM Staff training	This procedure outlines the steps to ensure that relevant staff receive adequate training to collect and archive complete and accurate data necessary for CDM monitoring.	This procedure will be adhered to by all staff on site prior to performing monitoring duties for the CDM project.
CDM data and record keeping arrangements / day-to-day records handling	This procedure provides details of the site data and record keeping arrangements. The arrangements ensure that complete and accurate records are retained. Data and records will be stored and archived according to this procedure.	All relevant data and records will be managed as per this procedure. Staff are responsible for ensuring that any data or records are dealt with as per this procedure.
CDM data quality control and quality assurance	Data and records will be checked prior to being stored and archived. Data from the project will be checked for possible errors or omissions, and for completeness on a regular basis.	Staff are responsible for ensuring the collection and archiving of complete and accurate data and records.
Internal audits	This procedure will outline the process of internal audits, where the performance of the project will be assessed. It will also provide details on the follow-up of forward actions arising from third party verification(s).	This procedure will be adhered by all CDM staff involved in internal audits.
Equipment failure	This procedure details the process of data collection in the unlikely event that a problem with relevant monitoring equipment occurs.	This procedure will be established by the Project developer.
Equipment calibration	This procedure details the process of organising and managing the calibration process as per manufacturer recommendations.	Meter calibration will be conducted according to manufacturers' recommendations. The Project developer is responsible for organising calibrations and ensuring that records are retained.

The above procedures will be documented as part of the monitoring support materials.

Appendix 6. Summary report of comments received from local stakeholders

Not applicable.

Appendix 7. Summary of post-registration changes

The following post-registration change is proposed in this version of the PDD.

Correction

Removal of name of former project participant in section B.7.3: The previously registered PDD referred to "EcoSecurities" as the entity responsible for collecting onsite data; performing regular checks of the final data and analysing project performance prior to any verification. EcoSecurities is no longer responsible for these activities and is no longer involved in the project. ENER-G Systems Joburg is now responsible for the activities in question.

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Document information

Version	*Date*	*Description*
11.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN); • Make editorial improvements.
10.1	28 June 2017	Revision to make editorial improvement.
10.0	7 June 2017	Revision to: • Improve consistency with the "CDM project standard for project activities" and with the PoA-DD and CPA-DD forms; • Make editorial improvement.
09.0	24 May 2017	Revision to: • Ensure consistency with the "CDM project standard for project activities" (CDM-EB93-A04-STAN) (version 01.0); • Incorporate the "Project design document form for small-scale CDM project activities" (CDM-SSC-PDD-FORM); • Make editorial improvement.
08.0	22 July 2016	EB 90, Annex 1 Revision to include provisions related to automatically additional project activities.

Version	*Date*	*Description*
07.0	15 April 2016	Revision to ensure consistency with the “Standard: Applicability of sectoral scopes” (CDM-EB88-A04-STAN) (version 01.0).
06.0	9 March 2015	Revision to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; • Make editorial improvement.
05.0	25 June 2014	Revision to: • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from F-CDM-PDD to CDM-PDD-FORM; • Make editorial improvement.
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	13 March 2012	Revision required to ensure consistency with the “Guidelines for completing the project design document form for CDM project activities” (EB 66, Annex 8).
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.

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