Monitoring report form for CDM project activity
(Version 07.0)

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

MONITORING REPORT		
Title of the project activity	EnviroServ Chloorkop Landfill Gas Recovery Project	
UNFCCC reference number of the project activity	0925	
Version number of the PDD applicable to this monitoring report	10	
Version number of this monitoring report	05	
Completion date of this monitoring report	29/10/2020	
Monitoring period number	07	
Duration of this monitoring period	19/01/2015 to 31/01/2020 both days inclusive	
Monitoring report number for this monitoring period	01	
Project participants	EnviroServ Waste Management (Pty) Ltd	
Host Party	South Africa	
Applied methodologies and standardized baselines	ACM0001: Large-scale Consolidated Methodology: Flaring or use of landfill gas, Version 15.0. ASB0001: Standardized baseline: Grid emission factor for the Southern African Power Pool (Version 01.0)	
Sectoral scopes	Sectoral scope(s):13 Conditional sectoral scope(s): 1	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	0	281,350
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	368,511	

SECTION A. Description of project activity

A.1. General description of project activity

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(a) Purpose of the project activity and the measures taken for GHG emission reductions or net anthropogenic GHG removals by sinks:

The purpose of the project is to extract landfill gas at the EnviroServ Chloorkop Landfill Site and to combust the landfill gas by flaring. Landfill gas consists of approximately 50% methane, which has a global warming potential 25 times greater than CO2. Through the destruction of methane, the emissions of greenhouse gas are reduced.

(b) Brief description of the installed technology and equipment:

The installed technology consists of wells in the landfill, a gas collection system connecting the wells and two flare installations connected to the gas collection system. Each flare installation consists of a blower that draws the gas from the wells and the gas collection system, and the flare itself.

(c) Relevant dates for the project activity

The EnviroServ Chloorkop Landfill Site consists of six waste disposal cells. Construction of the wellfield was done in a phased manner. The first vertical wells were installed in cells 1, 2 and 3 in 2005 as a pilot trial. These were followed by additional vertical wells in cells 1, 2 and 3, and horizontal collectors in cell 4, and the first flare in 2007. Commissioning of this initial phase took place in late 2007 with the first gas being flared on 19/01/2008 (the start date of the project activity). Additional vertical wells were installed in 2008 with additional horizontal collectors being installed in cells 5 and 6 from 2008. Installation of the second flare was completed in December 2008 and started operation in January 2009. However, since 8 June 2018, Flare 2 on the site was shut down and only one flare has remained operational to date due to low gas volumes. The LFG that was previously sent to Flare 2 has been redirected to Flare 1. The design capacity of the flare is 2000 Nm_3/h.

The second flare was subsequently decommissioned when the flare compound facility was moved to another location on the site. The flare compound was originally located on the north-eastern corner of the Chloorkop facility. The flare compound was subsequently moved to the south-western corner of the facility and was recommissioned on 09/12/2019 with only one flare. Cell 7 of the landfill site has been constructed and was only granted permission to fill the cell with waste on the 29 October 2020 which was only approved after the end of this monitoring period.

A.2. Location of project activity

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(a) Host Party(ies)

The host party is South Africa

(b) Region/ State/ Province

The project activity is located at the EnviroServ Chloorkop landfill site, Ekurhuleni Metropolitan Municipality, Gauteng Province, South Africa.

(c) City/ Town / Community

Ekurhuleni Metropolitan Municipality

(d) Physical/ Geographical location

The GPS coordinates are: 26° 02’ 30.35” S, 28° 10’ 04.58” E or latitude -26.0417, longitude 28.1679

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
South Africa (host)	EnviroServ Waste Management (Pty) Ltd – Private	No

A.4. References to applied methodologies and standardized baselines

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ACM0001
Large-scale Consolidated Methodology: Flaring or use of landfill gas Version 15.0
Sectoral scope(s): 13

Link: https://cdm.unfccc.int/methodologies/DB/JPYB4DYQUXQPZLBDVPHA87479EMY9M

Hereinafter referred to as “the applied methodology”.

The other methodological tools referred to in the applied methodology and used are:

- Emissions from solid waste disposal sites (Tool 04Version 06.0.1)
https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v8.0.pdf

- Project emissions from flaring (Version 02.0.0)
https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v3.0.pdf

- Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Version 02.0.0)
https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-v3.0.pdf

- 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)
https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-11-v3.0.1.pdf

- Tool to calculate project or leakage CO2 emissions from fossil fuel combustion (Version 02.0)
https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v3.pdf

- Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (Version 03.0)
https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v3.0.pdf

- ASB0001: Standardized baseline: Grid emission factor for the Southern African Power Pool (Version 01.0)
https://cdm.unfccc.int/filestorage/e/x/t/extfile-20150727172903093-EB73_repan03_ASB0001_-_Grid_emission_factor_for_the_SAPP.pdf/EB73_repan03_ASB0001%20-%20Grid%20emission%20factor%20for%20the%20SAPP.pdf?t=TGV8cWwwczBxfDAcCvbI7efrs3nEeKH6H9Kn

As per paragraph 48 of the CDM modalities and procedures, when choosing a baseline methodology, the approach “Existing actual or historical emissions, as applicable” has been selected as deemed being the most appropriate for the project activity.

A.5. Crediting period type and duration

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The second renewable crediting period from 19/01/2015 to 18/01/2022.

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

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Status of the project activity during this monitoring period.

During the initial part of this monitoring period, both flares were in operation, with flare 1 operating at 66% of its design capacity and flare 2 at 58% of its design capacity. The design capacity of each flare is 2,000 Nm3/h. The throughput of the flares was dictated by the amount of landfill gas available from the wellfield. The move of the flare compound and decommissioning of one of the flares was undertaken during this monitoring period.

Description of the installed technology, technical process and equipment

Landfill site

The EnviroServ Chloorkop Landfill Site has been used for the disposal of municipal solid waste since 1997, receiving 396,000 to 448,000 tons of waste per annum. The waste accepted includes general (or domestic) waste, garden waste, soil and builder's rubble. To date, 5 cells have been constructed and are now full. Cell 6 started receiving waste in May 2010 and is still in operation with cell 7 now in construction.

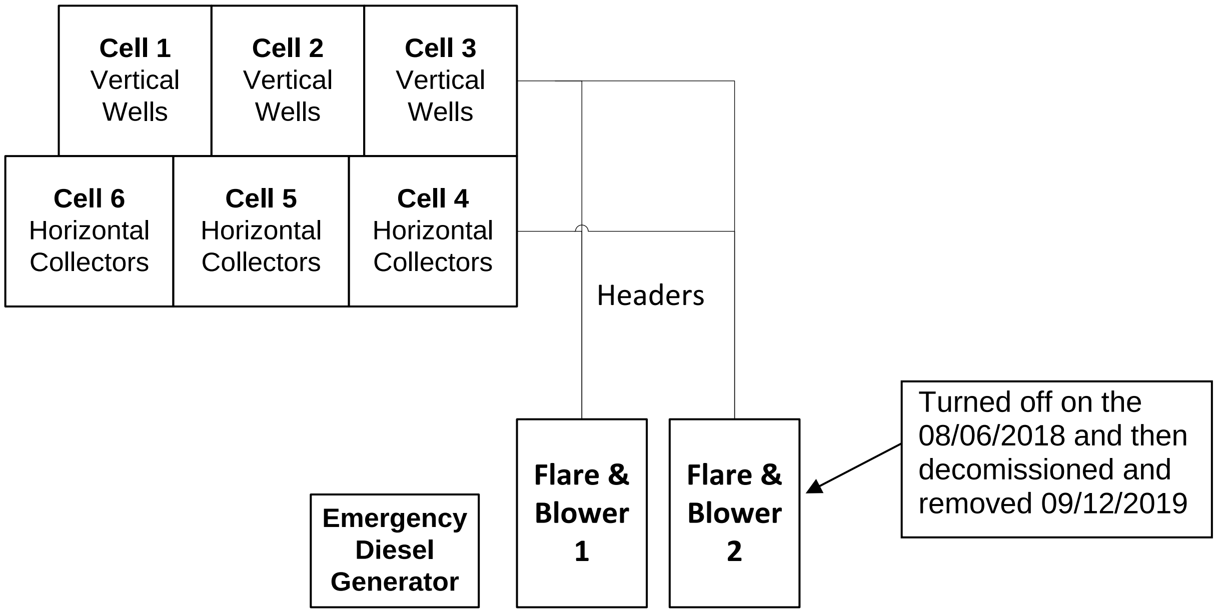
Landfill Gas Collection System

Vertical wells were installed in cells 1 to 3 by auguring into the existing waste body once the cell reached final grade. Horizontal collectors were installed in cells 4, 5 and 6 and involved the excavation of trenches into the waste at intermediate intervals before a cell reached final grade. The vertical wells and the horizontal collectors were connected to a number headers leading to the flare installations.

Flare System

There are two flare installations at the start of this monitoring period. The flares used are high temperature enclosed flares.
The two flare installations are situated alongside each other. An emergency diesel fuelled electricity generator supplies emergency power to the flare installations in the event of a failure of the power from the electricity grid.

A diagram of the landfill cells, flare installations and diesel generator are given below:



It is worth noting that in the few week leading up to the 09/12/2019 the flare compound was relocated to the other side of the landfill site due to operational requirements and as a result of the steady decline in gas volumes from the site only one flare was installed at the new location and commissioned on the 09/12/2019.

B.2. Post-registration changes

B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies, standardized baselines or other methodological regulatory documents

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There were no temporary deviations from the registered monitoring plan or applied methodology during this monitoring period.

B.2.2. Corrections

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Post Registration Change reference PRC-0925-001 processed on the 11/06/2020 for corrections to the to the project design

B.2.3. Changes to the start date of the crediting period

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No changes to the start date of the crediting period.

B.2.4. Inclusion of monitoring plan

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None for this monitoring period.

B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other methodological regulatory documents

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Post Registration Change reference PRC-0925-001 processed on the 11/06/2020 for permanent changes to the registered monitoring plan.

B.2.6. Changes to project design

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Post Registration Change reference PRC-0925-001 processed on the 11/06/2020 for changes to the project design.

B.2.7. Changes specific to afforestation or reforestation project activity

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Not applicable.

SECTION C. Description of monitoring system

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Data collection, recording, aggregation and reporting

To ensure the integrity of all the monitoring information generated by the project, two independent streams of data are received for the flares; telemetry data (primary) and check sheet data (secondary).

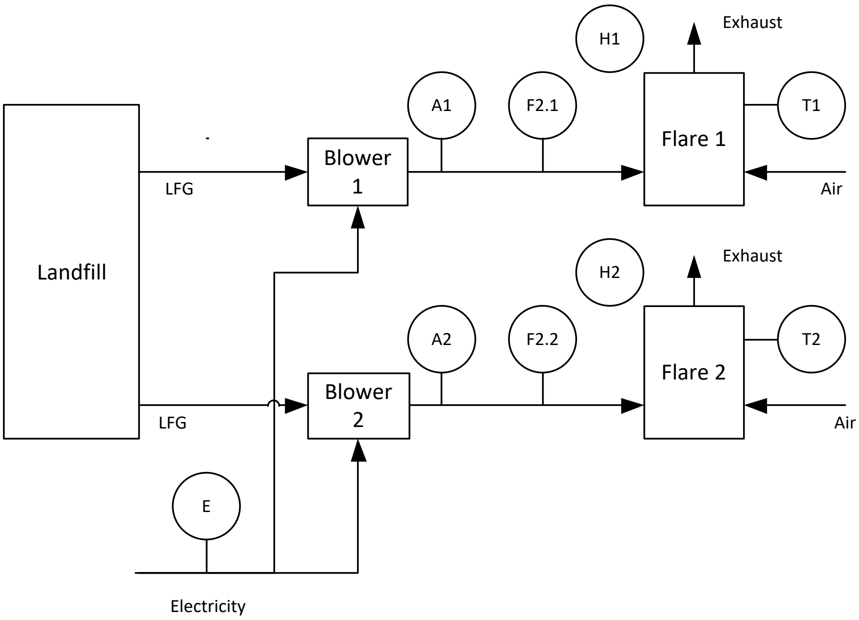
Primary data is defined as the data representing the main variables for the calculation of the emission reductions. This data is captured from the various sensors by a data acquisition system and is then stored on site in a data storage programme logic controller (PLC). The data is downloaded once a month for work book calculations.

Secondary data is defined as variables measured visually on site and includes the primary data variables. These variables are recorded daily during day-shift. This data is recorded on the daily check sheet and filed at the ENERGY Systems offices.

The primary data for the month is saved in comma separated value (CSV) format and pasted into an Excel spreadsheet workbook. This workbook calculates the number of emission reductions, transfers the results to an operations report and produces a graph and a data table. The primary data is the only data used in the calculation of emission reductions. This information is then used to create monthly report on the emission reductions. There is a separate monthly workbook for each flare.

The monthly information is copied into the summary workbook which gives the total values for the monitoring period.

A line diagram showing the relevant measuring points is given below.



	Parameter	Description	Instrument tag number
F2.1	$LFG_{flared,y}$	Total amount of landfill gas flared in flare 1	3092-FM-118
F2.2		Total amount of landfill gas flared in flare 2	3449-FM-118
A1	W_{CH4}	Methane fraction of landfill gas to flare 1	3092-E-172
A2		Methane fraction of landfill gas to flare 2	3449-E-172
H1	Flare hours	Working hours for flare 1	N/A
H2		Working hours for flare 2	N/A
T1	Flare temperature	Flare temperature flare 1	3092-E-151
T2		Flare temperature flare 2	3449-E-151
E	EL_{IMP}	Electricity consumed by project	-

Data security and archiving

All data and information obtained over the crediting period of the project is stored and archived in a secure filing system and kept for the life of the project, plus a further 2 years.
The data system uses 128 bit SSL encryption for security. The system is further protected by user names and passwords to restrict access.

Data is generated from the monitoring equipment and saved to the PLC in an electronic format, which can't be tampered with. Once the information is downloaded, it is backed up by ENERGY Systems. Access to the gathered data is only possible via a username and password, which is controlled by ENERGY Systems.

All the data is transferred via email and CD from ENERGY to EnviroServ on a monthly basis. The data and minutes of meeting is received and archived in a folder on the EnviroServ access controlled server. The CD's are archived in a secure locked cupboard. Access to the server is controlled by the EnviroServ IT department using the following process:

- The user needs to fill in a user application form requesting access to this folder.
- The Process Operations Manager has to approve access to this group by signing off the application form.
- The signed form is either scanned and e-mailed or faxed to the IT department.
- A call is logged with the service desk to request access to this group.
- One of the System Administrators then grants access to this group.
- For the access to take affect the user needs to log off and log back onto the system.

The folder is backed up as described in the process below:

- Currently the folder resides on a server's RAID5 Array drive which is located on a fibre attached SAN which provides additional redundancy.
- This drive is backed up using Backup Exec 12.5 using the following schedules
- Daily backup starts at 5:00pm in the afternoons
  - Backup Media is LTO4
  - Retention is 5 weeks off-site at MetroFile
  - Backup Schedule is Monday to Friday unless the daily backup falls within a monthly or yearly schedule
- Monthly backup 5:00pm in the afternoons
  - Backup Media is LTO4
  - Retention is 1 Year off-site at MetroFile
  - Backup Schedule is the last day of the month unless this day falls on a weekend or public holiday in which case it is the day before the start of that weekend or public holiday. Monthly schedule do not apply if it falls within a yearly backup schedule
- Yearly backup 5:00pm in the afternoons
  - Backup Media is LTO 4
  - Retention is Infinite off-site at MetroFile and is only recalled on request.
  - Backup Schedule is last day of the year unless this day falls on a weekend or public holiday in which case it is the day before the start of that weekend or public holiday.

Emergency procedures for the monitoring system

The calculation carried out by ENERGY Systems includes a validation check on the methane concentration, combustion temperature and flow of gas to the flare (see step 2 in the data calculation description in Section E1 below). If any of these parameters are outside the defined limits, the emission reduction value is set to zero i.e. no emission reductions are claimed for the period in which any of these parameters are outside the defined limits.

Roles and responsibilities

The responsibilities and authorities of those in the various positions are as follows:

Position	Responsibilities	Authorities
EnviroServ Waste to Energy General Manager	Overall responsibility for the landfill gas system. Overall responsibility for the Quality Management System for the landfill gas system. Reviews performance data on landfill gas system and submits comments to ENERGY Chairs monthly review meetings between EnviroServ and ENERGY on the operation of the landfill gas system Stores and archives data received from ENERGY on the EnviroServ Chloorkop CDM folder on the server.	Provides and manages resources for operation of the landfill gas system
EnviroServ Depot Manager	Liaison between ENERGY and rest of landfill site. Advises ENERGY of aspects of landfill operation that may impact on operation of the landfill gas system.	
EnviroServ IT Manager	Manages the IT system in EnviroServ.	Provides resources for data storage and backup.

Position	Responsibilities	Authorities
	Provides data storage and archiving (backup) of data for the landfill gas system.	
EnviroServ Procurement Manager	Manages procurement in EnviroServ. Manages the procurement of spares and services for the landfill gas system.	Manages resources and systems for procurement.
ENERGY General Manager	Overall responsibility for managing the landfill gas system.	Manages resources for the landfill gas system.
ENERGY Production Manager	Operation of the landfill gas system. Reviews workbook data from site and comments if necessary. Advises of any comments on the workbook data. Approves monthly report	Controls the landfill gas system
ENERGY Site Technician	Day-to-day operation of the landfill gas system	Controls the landfill gas system
Jones & Wagener Civil Consultant	Reviews data on well field and flare performance. Submits comments to ENERGY General Manager & EnviroServ Waste to Energy General Manager Provides technical support to ENERGY and EnviroServ	Recommends changes to operation of landfill gas system to ENERGY and EnviroServ. .

Regulatory Framework

The regulatory framework is monitored on an annual basis. In case upcoming regulations in South Africa mandate methane capture and destruction during the crediting period, the baseline scenario and emissions shall be adapted accordingly.

There were no changes to the regulatory framework during this monitoring period.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

Data/Parameter	OX_{top_layer}
Data unit	Not applicable
Description	Fraction of methane that would be oxidized in the top layer of the SWDS in the baseline.
Source of data	ACM0001 (Version 15.0)
Value(s) applied	0.1
Choice of data or measurement methods and procedures	According to the applied methodology, this value is consistent with how oxidation is accounted for in the methodological tool ‘Emissions from Solid Waste Disposal Sites’.
Purpose of data	Baseline emissions calculations
Additional comment	Not applicable

Data/Parameter	GWP_{CH4}
Data unit	tCO_2e/tCH_4
Description	Global warming potential of CH_4
Source of data	ACM0001 (Version 15.0)
Value(s) applied	25
Choice of data or measurement methods and procedures	As per IPCC: 21 for the first commitment period and in accordance with the latest COP/MOP decision. The latest COP/MOP decision (Decision 24/CP.19, paragraph 2) stipulates that “from 2015 until a further decision is adopted by the Conference of the Parties, the global warming potential values used by Parties included in Annex I to the Convention (Annex I Parties) ... shall be those listed in the column entitled “Global warming potential for given time horizon” in table 2.14 of the errata to the contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, based on the effects of greenhouse gases over a 100-year time horizon, as contained in annex III”; This means that from 2015 the value 25 shall be used for the GWP of methane.
Purpose of data	Baseline emissions calculations
Additional comment	Not applicable

Data/Parameter	η_{PJ}
Data unit	Not applicable
Description	Efficiency of the LFG capture system that will be installed in the project activity.
Source of data	ACM0001 (Version 15.0)
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	Baseline emissions calculations
Additional comment	Not applicable

Data/Parameter	φ_y
Data unit	Not applicable
Description	Default value for the model correction factor to account for model uncertainties.
Source of data	Version 06.0.1 of the ‘Emissions from solid waste disposal sites’.
Value(s) applied	0.75
Choice of data or measurement methods and procedures	Application A is applied as the project activity mitigates methane emissions from a specific existing SWDS. The project site is located within dry conditions9.
Purpose of data	Baseline emissions calculations
Additional comment	Not applicable

Data/Parameter	OX
Data unit	Not applicable
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	Based on an extensive review of published literature on this subject, including the IPCC Guidelines for National Greenhouse Gas Inventories, as per Version 06.0.1 of the ‘Emissions from solid waste disposal sites’.
Value(s) applied	0.1
Choice of data or measurement methods and procedures	Default value
Purpose of data	Baseline emissions calculations
Additional comment	When methane passes through the top-layer, part of it is oxidised by methanotrophic bacteria to produce CO_2. The oxidation factor represents the proportion of methane that is oxidised to CO_2. This should be distinguished from the methane correction factor (MCF) which is to account for the situation that ambient air might intrude into the SWDS and prevent methane from being formed in the upper layer of SWDS.

Data/Parameter	F
Data unit	Not applicable
Description	Fraction of methane in the SWDS gas (volume fraction).
Source of data	Version 06.0.1 of the ‘Emissions from solid waste disposal sites’.
Value(s) applied	0.5
Choice of data or measurement methods and procedures	Default value
Purpose of data	Baseline emissions calculations
Additional comment	Upon biodegradation, organic material is covered to a mixture of methane and carbon dioxide.

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 as per Version 06.0.1 of the ‘Emissions from solid waste disposal sites’.
Value(s) applied	0.5
Choice of data or measurement methods and procedures	Default value applied since the project activity mitigates methane emissions from a specific existing SWDS.
Purpose of data	Baseline emissions calculations
Additional comment	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, in the SWDS. This default value can only be used for

Data/Parameter	$MCF_{default}$
Data unit	Not applicable
Description	Methane correction factor
Source of data	Version 06.0.1 of the ‘Emissions from solid waste disposal sites’.
Value(s) applied	1.0
Choice of data or measurement methods and procedures	The project site 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.
Purpose of data	Baseline emissions calculations
Additional comment	Not applicable

<table>
<tr><td>Data/Parameter</td><td>$DOCj$</td></tr>
<tr><td>Data unit</td><td>Not applicable</td></tr>
<tr><td>Description</td><td>Fraction of degradable organic carbon in the waste type j.</td></tr>
<tr><td>Source of data</td><td>Version 06.0.1 of the ‘Emissions from solid waste disposal sites’.</td></tr>
<tr><td>Value(s) applied</td><td><table>
<tr><td>Wood and wood products</td><td>43</td></tr>
<tr><td>Pulp, paper and cardboard (other than sludge)</td><td>40</td></tr>
<tr><td>Food, food waste, beverages and tobacco (other than sludge)</td><td>15</td></tr>
<tr><td>Textiles</td><td>24</td></tr>
<tr><td>Garden, yard and park waste</td><td>20</td></tr>
<tr><td>Glass, plastic, metal, other inert waste</td><td>0</td></tr>
</table></td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>The most appropriate fraction(s) based on the options provided on page 11 of version 06.0.1 of the ‘Emissions from solid waste disposal sites’ were selected.</td></tr>
<tr><td>Purpose of data</td><td>Baseline emissions calculations</td></tr>
<tr><td>Additional comment</td><td>Not applicable</td></tr>
</table>

Data/Parameter	k_j
Data unit	l/yr
Description	Decay rate for the waste type j.
Source of data	Version 06.0.1 of the ‘Emissions from solid waste disposal sites’.
Value(s) applied	Pulp, paper, cardboard (other than sludge), textiles: 0.04 Wood, wood products and straw: 0.02 Other (nonfood) organic putrescible garden and park waste: 0.05 Food, food waste, sewage sludge, beverages and tobacco: 0.06
Choice of data or measurement methods and procedures	The most appropriate decay rate(s) based on the options provided on page 12 of version 06.0.1 of the ‘Emissions from solid waste disposal sites’.
Purpose of data	Baseline emissions calculations
Additional comment	In the case of this project activity, the landfill site is boreal and temperate, and dry.

Data/Parameter	EF_{EF}
Data unit	tCO_2/MWh
Description	Emission factor for electricity generation
Source of data	Standardized baseline: ASB0001 Grid emission factor for the Southern African Power Pool (Version 01.0).
Value(s) applied	0.9488
Choice of data or measurement methods and procedures	Combined margin CO_2 emission factor for the project electricity system applicable to all project activities other than wind and solar for the second or third crediting period.
Purpose of data	Calculations of baseline and project emissions
Additional comment	Not applicable

Data/Parameter	$W_{j.x}$
Data unit	Tonnes
Description	Amount of solid waste type *j* disposed in the SWDS in year *x* – Domestic Waste
Source of data	Measured by the project participant
Value(s) applied	430,536 tonnes annually
Choice of data or measurement methods and procedures	Data taken from historical records of landfill operation, aggregated into annual figures and provided by EnviroServ.
Purpose of data	Baseline emission calculations
Additional comment	The amount of waste in tonnes has been obtained from the project participant. However, assumptions have been applied when differentiating the waste as required for the calculations using the First Order Decay Model.

Data/Parameter	P_n
Data unit	Pa
Description	Total pressure at normal conditions
Source of data	Version 02.0.0 of the ‘Tool to determine the mass flow of a greenhouse gas in a gaseous stream’.
Value(s) applied	101,325
Choice of data or measurement methods and procedures	Not applicable
Purpose of data	Calculation of baseline emissions
Additional comment	Not applicable

Data/Parameter	$\mathbf{T_n}$
Data unit	K
Description	Temperature at normal conditions
Source of data	Version 02.0.0 of the ‘Tool to determine the mass flow of a greenhouse gas in a gaseous stream’.
Value(s) applied	273.15
Choice of data or measurement methods and procedures	Not applicable
Purpose of data	Calculation of baseline emissions
Additional comment	Not applicable

Data/Parameter	R_u
Data unit	$Pa.m^3/kmol.K$
Description	Universal ideal gases constant
Source of data	Version 02.0.0 of the ‘Tool to determine the mass flow of a greenhouse gas in a gaseous stream’.
Value(s) applied	8,314
Choice of data or measurement methods and procedures	Not applicable
Purpose of data	Calculation of baseline emissions
Additional comment	Not applicable

Data/Parameter	MM_i
Data unit	kg/kmol
Description	Molecular mass of greenhouse gas i
Source of data	Version 02.0.0 of the ‘Tool to determine the mass flow of a greenhouse gas in a gaseous stream’.
Values	(see table below)
Choice of data or measurement methods and procedures	Not applicable
Purpose of data	Calculation of baseline emissions
Additional comment	Not applicable

Values:

Compound	**Structure**	**Molecular mass (kg / kmol)**
Carbon dioxide	CO_2	44.01
Methane	CH_4	16.04
Nitrous oxide	N_2O	44.02
Sulfur hexafluoride	SF_6	146.06
Perfluoromethane	CF_4	88.00
Perfluoroethane	C_2F_6	138.01
Perfluoropropane	C_3F_8	188.02
Perfluorobutane	C_4F_{10}	238.03
Perfluorocyclobutane	$c\text{-}C_4F_8$	200.03
Perfluoropentane	C_5F_{12}	288.03
Perfluorohexane	C_6F_{14}	338.04

Data/Parameter	MM_k
Data unit	kg/kmol
Description	Molecular mass of gas k
Source of data	Version 02.0.0 of the ‘Tool to determine the mass flow of a greenhouse gas in a gaseous stream’.
Value(s) applied	For gases *k* that are greenhouse gases apply values for MM_i. (see table below)
Choice of data or measurement methods and procedures	Not applicable
Purpose of data	Calculation of baseline emissions
Additional comment	Not applicable

Value(s) applied:

Compound	Structure	Molecular mass (kg/kmol)
Nitrogen	N_2	28.01
Oxygen	O_2	32.00
Carbon monoxide	CO	28.01
Hydrogen	H_2	2.02
Nitric oxide	NO	30.01
Nitrogen dioxide	NO_2	46.01
Sulfur dioxide	SO_2	64.06

Data/Parameter	$SPEC_{flare}$
Data unit	Temperature - °C Flow rate kg/h or m^3/h Maintenance schedule – number of days
Description	Manufacturer’s flare specifications for temperature, flow rate and maintenance schedule
Source of data	Flare manufacturer
Value(s) applied	Document in the CDM-PDD the flare specifications set by the manufacturer for the correct operation of the flare for the following parameters: (a) Minimum and maximum inlet flow rate, if necessary converted to flow rate at reference conditions or heat flux; (b) Minimum and maximum operating temperature; and (c) Maximum duration in days between maintenance events The flare specifications set by the manufacturer for the correct operation of the flare are the following: a) The minimum and maximum inlet flow rate is 400 – 2000 Nm^3/h b) The minimum and maximum operating temperature is 350 - 1150°C The maximum duration between maintenance events is provided by the manufacturer by means of an overview of maintenance tasks and frequency and is provided in the technical manual to the installed flares. Different tasks have different maintenance frequencies. Some maintenance tasks have to be performed daily (maximum duration in days between maintenance events is 1), e.g. condensate drain valves; whereas only every six months (maximum duration in days between maintenance events is 182) e.g. the condition of all cables and connectors needs to be checked and replaced in case of any defective items. The technical manual to the installed flares is available upon request.
Choice of data or measurement methods and procedures	Not applicable
Purpose of data	Determination of flare efficiency
Additional comment	Only applicable in case of enclosed flares. The maintenance schedule is not required if Option A is selected to determine flare efficiency of an enclosed flare.

D.2. Data and parameters monitored

Data/Parameter	*Management of SWDS*
Data unit	Not applicable
Description	Management of SWDS
Measured/calculated/ Default	N/A
Source of data	Different sources of data: • Original design of the landfill; • Technical specifications for the management of the SWDS; National regulations.
Value(s) applied	Waste management licence: number 16/2/7/A230/D17/Z1/P280.
Monitoring equipment	N/A
Measuring/reading/recording frequency	Annual
Calculation method (if applicable)	The waste management licence is granted by a governmental department (third party).

QA/QC procedures	Check that the SWDS still has a valid Waste Management license.
Purpose of data	To ensure that the SWDS waste management licence is still valid.
Additional comment	Not applicable

Data/Parameter	$Opj_{j,h}$
Unit	Not applicable
Description	Operation of the equipment that consumes the LFG.
Measured/calculated/ Default	N/A
Source of data	Project Participants
Value(s) of monitored parameter	Not Applicable
Monitoring equipment	Programme Logic Controller (PLC) and UV sensor and thermocouples
Measuring/reading/recording frequency	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: (a) Temperature. Determine the location for temperature measurements and minimum operational temperature based on manufacturer's specifications of the burning equipment. Document and justify the location and minimum threshold in the PDD; (b) Flame. Flame detection system is used to ensure that the equipment is in operation; (c) Products generated. Monitor the generation Opj,h = 0 when: (a) One of more temperature measurements are missing below the minimum threshold in hour h (instantaneous measurements are made at least every minute); (b) Flame is not detected continuously in hour h (instantaneous measurements are made at least every minute) Otherwise, Opj,h = 1
Calculation method (if applicable)	Not Applicable
QA/QC procedures	Equipment shall be maintained and calibrated in accordance with manufacturer's recommendations.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Not applicable

Data/Parameter	$EC_{PJ,j,y}$
Unit	MWh
Description	Quantity of electricity consumed by the project electricity consumption source j in year y
Measured/calculated/ default	Measured
Source of data	Electricity Meter
Value(s) of monitored parameter	1,366,226 MWh from 19 January 2015 to 31 January 2020

Monitoring equipment	Electricity Power Meter Merlin Gerin - Serial number - 38001212
Measuring/reading/recording frequency	Continuous measuring and recorded monthly
Calculation method (if applicable)	Calculation of project emissions
QA/QC procedures	The meters are solid state sealed meters and are not serviceable items. Please refer to the technical specification sheet for the meters that are installed on site.
Purpose of data/parameter	This parameter is required for calculating project emissions from electricity consumption due to an alternative waste treatment process t PEEC,y) using the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".EGEC,y
Additional comments	The meters are solid state meters and are not serviceable items.

Data/Parameter	CAPEX and OPEX
Unit	Currency – ZAR
Description	Total investment to implement the project and total cost to operate the project.
Measured/calculated/ Default	Measured and calculated
Source of data	Project Participant
Value(s) of monitored parameter	CAPEX total R 26,866,785 and OPEX R1,793,450 for 2019
Monitoring equipment	N/A
Measuring/reading/recording frequency	At the first issuance request after each phase of the project is fully implemented.
Calculation method (if applicable)	N/A
QA/QC procedures	Audited by professional, independent financial auditors. The DOE should only verify that the data provided corresponds to the data from independent financial auditors.
Purpose of data/parameter	In order to collect the information that is required for the update of the provisions in section 5.3.1 of ACM0001 (version 15). Project activities that are registered using these simplified procedures are required to report cost and revenue information at the first issuance request after each phase of the project is fully implemented.
Additional comments	None

Data/Parameter	*Tariff of electricity exported*
Unit	Currency- ZAR
Description	Tariff of electricity exported
Measured/calculated/ Default	Default
Source of data	- Power purchase agreement
Value(s) of monitored parameter	-N/A no electricity generation or exported during this monitoring period.
Monitoring equipment	Electricity export meters
Measuring/reading/recording frequency	Measured continuously

Calculation method (if applicable)	N/A
QA/QC procedures	N/A
Purpose of data/parameter	Tariff of electricity exported
Additional comments	Not applicable as no electricity generation has been installed to date.

Data/Parameter	*TDLy*
Unit	Not applicable
Description	Average technical transmission and distribution losses for providing electricity.
Measured/calculated/ Default	N/A value taken from annual report issued by Eskom
Source of data	Data obtained from grid operator.
Value(s) of monitored parameter	Insert TDL values from Eskom annual reports 2015 8.78% 2016 8.59% 2017 8.85% 2018 9.1% 2019 9.7% 2020 9.7% Same value as 2019 as the 2020 report is not available to the public.
Monitoring equipment	N/A
Measuring/reading/recording frequency	Annually
Calculation method (if applicable)	N/A
QA/QC procedures	Not applicable
Purpose of data/parameter	Calculation of project emissions
Additional comments	Not applicable

Data/Parameter	$EC_{BL,k,t}$
Unit	MWh/yr
Description	Quantity of electricity that would be consumed by the baseline electricity consumption source k in year y
Measured/calculated/ Default	Use electricity meters installed at the electricity consumption sources.
Source of data	Direct measurement or calculated based on measurements from more than one electricity meters
Value(s) of monitored parameter	0 as no power was produced and supplied
Monitoring equipment	N/A
Measuring/reading/recording frequency	N/A
Calculation method (if applicable)	N/A
QA/QC procedures	Not applicable
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Not applicable as no electrical power was produced and exported

<table>
<tr><td>Data/Parameter</td><td>$Flame_m$</td></tr>
<tr><td>Unit</td><td>Flame on or Flame off</td></tr>
<tr><td>Description</td><td>Flame detection of flare in the minute m</td></tr>
<tr><td>Measured/calculated/
default</td><td>Measured using a fixed installation optical flame detector: Ultra Violet detector
.</td></tr>
<tr><td>Source of data</td><td>Measurements by the project participant.</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>n/a as only used in ex-post calculations</td></tr>
<tr><td>Monitoring equipment</td><td>Flare PLC
Flare Krom Schroder UVS 6 Sensor – Serial Number – 84315100
Flare Thermocouples – Part Number – T1TECNSX60 Wika</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Continuously measured of the flare temperature and monitoring that the UV sensor detects a flame</td></tr>
<tr><td>Calculation method
(if applicable)</td><td>N/A</td></tr>
<tr><td>QA/QC procedures</td><td>Equipment shall be maintained and calibrated in accordance with manufacturer’s recommendations.
<table>
<tr><td colspan="2">Flare Thermocouple Functionality Test</td></tr>
<tr><td>Flare 1</td><td>Flare 2</td></tr>
<tr><td>10/04/2015</td><td>19/03/2015</td></tr>
<tr><td>08/07/2015</td><td>13/06/2015</td></tr>
<tr><td>12/10/2015</td><td>14/09/2015</td></tr>
<tr><td>15/01/2016</td><td>12/01/2016</td></tr>
<tr><td>06/04/2016</td><td>06/04/2016</td></tr>
<tr><td>04/07/2016</td><td>01/08/2016</td></tr>
<tr><td>10/10/2016</td><td>02/11/2016</td></tr>
<tr><td>24/01/2017</td><td>02/02/2017</td></tr>
<tr><td>24/04/2017</td><td>02/05/2017</td></tr>
<tr><td>24/07/2017</td><td>02/08/2017</td></tr>
<tr><td>24/10/2017</td><td>02/11/2017</td></tr>
<tr><td>22/12/2017</td><td>02/02/2018</td></tr>
<tr><td>22/03/2018</td><td>16/05/2018</td></tr>
<tr><td>16/05/2018</td><td></td></tr>
<tr><td>22/06/2018</td><td></td></tr>
<tr><td>26/09/2018</td><td></td></tr>
<tr><td>20/12/2018</td><td></td></tr>
<tr><td>25/03/2019</td><td></td></tr>
<tr><td>25/06/2019</td><td></td></tr>
<tr><td>25/09/2019</td><td></td></tr>
<tr><td>18/12/2019</td><td></td></tr>
<tr><td></td><td></td></tr>
</table>
<table>
<tr><td colspan="2">Thermocouple Replaced – T Comb.</td><td></td></tr>
<tr><td>Flare 1</td><td>Flare 2</td><td></td></tr>
<tr><td>02/10/2015</td><td>None replaced</td><td></td></tr>
<tr><td>24/07/2017</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comments</td><td>The flare PLC is setup to trip if the UV sensor does not see a flame for more than 3 second.The flare also trips if the combustion temperature of the flame drops below the set-point at any point so both parameters need to be healthy in order for the flare to run.</td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>$V_{i,t,wb}$</td></tr>
<tr><td>Unit</td><td>m3 gas i/m3 wet gas</td></tr>
<tr><td>Description</td><td>Volumetric fraction of greenhouse gas i in a time interval t on a wet basis.</td></tr>
<tr><td>Measured/calculated/ default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>Project Participant</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>Annual Average CH4
Flare 1 47.05%
Flare 2 47.85%</td></tr>
<tr><td>Monitoring equipment</td><td>Continuous in-situ gas analysers Include details of analyser
Serial number:
GIR 5000: Serial Number – I-02177 Tag no:3449-E-172

Guardian NG: Serial Number – CH4 – 13983 Tag No: 3092-E-172
The analysers are calibrated on a weekly basis using the below listed certified span gas.</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Continuous and recorded every 30 minutes.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>Ex post determination of the amount of methane in the LFG which is flared in the project activity in the year y</td></tr>
<tr><td>QA/QC procedures</td><td>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.

Span Gas Traceability Certificate details:
<table>
<tr><td>Site</td><td>Serial Number</td><td>Validity</td></tr>
<tr><td>Chloorkop</td><td>11307-01</td><td>01/05/2014 – 30/05/2015</td></tr>
<tr><td></td><td>112076-03</td><td>01/06/2016 – 30/06/2017</td></tr>
<tr><td></td><td>112405-01</td><td>30/06/2017 – 30/06/2018</td></tr>
<tr><td></td><td>112739-01</td><td>01/07/2018 – 31/07/2019</td></tr>
<tr><td></td><td>CAN-4682</td><td>10/09/2019 – 30/09/2021</td></tr>
<tr><td></td><td></td><td></td></tr>
</table>
The Analysers are calibrated using the above span gas on a weekly basis. A delayed calibration for the period from 31/07/2019 to 10/09/2019 has been applied in the workbook reducing the CH4 value by 2% due there being a delay in the supply of a replacement snap gas cylinder over this period. The instrument was over-reading by 1.6% and the accuracy of the span gas is 2% so the higher value is applied in order to be conservative.</td></tr>
<tr><td>Purpose of data/parameter</td><td>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 02.0.0).</td></tr>
<tr><td>Additional comments</td><td></td></tr>
</table>

Data/Parameter	$M_{t,wb}$
Unit	kg/h
Description	Mass flow of the gaseous stream in time interval t on a wet basis
Measured/calculated/ default	Measured and calculated
Source of data	Flow meter

Value(s) of monitored parameter	<table><tr><td>Flare 1 total</td><td>Flare 2 total</td><td>Total</td></tr><tr><td>28 624 626</td><td>8 403 176</td><td>37 027 802</td></tr></table>

<table>
<tr><td rowspan="2">Monitoring equipment</td><td>Thermal mass flowmeter.
The typical accuracy of the thermal mass flowmeters is ±1.5% of reading, ±0.5 % of full scale.
Calibration frequency is 3 years. Validity of calibration is 3 years from time the flowmeter is taken into service after calibration.</td></tr>
<tr><td>
<table>
<tr><th></th><th>Flare 1</th><th>Flare 2</th></tr>
<tr><td>Instrument tag number</td><td>3092-FM-118</td><td>3449-FM-118</td></tr>
<tr><td>Change in monitoring equipment</td><td>YES</td><td>YES</td></tr>
<tr><td>Serial number</td><td>A309FA02000</td><td>A604B902000</td></tr>
<tr><td>1st Calibration date</td><td>26/07/2012</td><td>09/05/2014</td></tr>
<tr><td>Taken into service</td><td>22/11/2012</td><td>03/10/2014</td></tr>
<tr><td>Replaced on</td><td>Replaced on 21/11/2015
Thermal Mass flow meters
Type: E&H Proline T mass 65I
Acccuracy: is ±1.5% of reading, ±0.5 % of full scale.
Calibration frequency: every three years as per manufacturer’s specifications
Serial No: A309F902000
1st calibration date 20/07/2015
Valid from 20/11/2015 to 19/11/2018 as per manufacturer’s specifications</td><td>Replaced on 02/10/2017
Thermal Mass flow meters
Type: E&H Proline T mass 65I
Acccuracy: is ±1.5% of reading, ±0.5 % of full scale.
Calibration frequency: every three years as per manufacturer’s specifications
Serial No: 99047602000
1st calibration date 16/05/2017
Valid from 02/10/2017 to 01/10/2020 as per manufacturer’s specifications</td></tr>
<tr><td>Replaced on</td><td>Replaced on 21/11/2018
Thermal Mass flow meters
Type: E&H Proline T mass 65I
Acccuracy: is ±1.5% of reading, ±0.5 % of full scale.
Calibration frequency: every three years as per manufacturer’s specifications
Serial No: 99047702000
1st calibration date 31/07/2018
Valid from 21/11/2018 to 20/11/2021 as per manufacturer’s specifications</td><td></td></tr>
</table>
</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Continuous monitoring and recording data every 30 minutes</td></tr>
<tr><td>Calculation method
(if applicable)</td><td>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 02.0.0).</td></tr>
<tr><td>QA/QC procedures</td><td>Calibration and frequency of calibration is according to manufacturer’s specifications.</td></tr>
</table>

Purpose of data/parameter	Ex post determination of the amount of methane in the LFG which used in the project activity in the year y.
Additional comments	For the above Flare 1 flow meter with Tag number 3092-FM-118 there was a delay in the replacement of the unit by two days between the 19/11/2018 and the 21/11/2018. The error was 0.19% for this meter when it came back from calibration and was lower than the 1.5% tolerance in the OEM specification sheet. As a result we have adjusted the values for these two days down by the 1.5% value in line with the rules delayed calibration. This has been done in Column C of the ER Calculation sheet where an amended formula reduces the input value by 1.5%

Data/Parameter	FCi,j,y
Unit	Mass or volume unit per year (e.g. ton/yr or m3 /yr)
Description	Quantity of fuel type i combusted in process j during the year y
Measured/calculated/ default	Onsite Measurements
Source of data	Project Participant
Value(s) of monitored parameter	Insert values for Diesel 2015 3112 lt 2016 1207 lt 2017 820 lt 2018 781 lt 2019 310 lt 2020 150 lt Adjustment of 4.55% applied to above values
Monitoring equipment	A ruler gauge must be part of the daily tank and calibrated on the 12/08/2020 Delayed calibration applies
Measuring/reading/recording frequency	The consistency of metered fuel consumption quantities have been cross-checked with the bulk purchases that is based on purchased quantities from the sites bulk tank.
Calculation method (if applicable)	N/A
QA/QC procedures	The Ruler is calibrated annually and the fuel consumption quantities are cross-checked with the diesel register on site for the bulk tank. The Ruler was calibrated on the 12/08/2020 and with a confidence level of 95.45% as this was a delayed calibration and the ruler is a custom made rule for the fuel tank we have adjusted the values up by 4.55% which is the difference in the confidence level in order to be conservative.
Purpose of data/parameter	To determine the amount of diesel (fuel type i) combusted in the project activity in the year y.
Additional comments	Not applicable

Data/Parameter	$NCV_{diesel,y}$
Unit	GJ/ L diesel
Description	Weighted average net calorific value of diesel in year y
Measured/calculated/ default	Default
Source of data	IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Volume 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.

Value(s) of monitored parameter	0.0381
Monitoring equipment	Not Applicable
Measuring/reading/recording frequency	Any future revision of the IPCC Guidelines should be taken into account
Calculation method (if applicable)	Project emissions determination of the amount of diesel (fuel type i) combusted in the project activity in the year y.
QA/QC procedures	N/A
Purpose of data/parameter	Project emission determination from diesel consumption
Additional comments	None

Data/Parameter	$EF_{CO2,diesel,y}$
Unit	tCO2/GJ
Description	Weighted average CO2 emission factor of diesel in year y
Measured/calculated/ default	Default
Source of data	IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Volume 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.
Value(s) of monitored parameter	0.0741
Monitoring equipment	Not Applicable
Measuring/reading/recording frequency	Any future revision of the IPCC Guidelines should be taken into account
Calculation method (if applicable)	Project emissions determination of the amount of diesel (fuel type i) combusted in the project activity in the year y.
QA/QC procedures	N/A
Purpose of data/parameter	Calculate project emissions form diesel consumption
Additional comments	None

Data/Parameter	$T_{EG, m}$		
Unit	°C		
Description	Temperature of the flare		
Measured/calculated/ default	Measured value		
Source of data	Thermocouple		
Value(s) of monitored parameter	Flare 1	Flare 2	Weighted Average
	944	836	899

<table>
<tr><td>Monitoring equipment</td><td>The thermocouple on flare 1 was replaced, as per table below, as it had failed. There were no replacements of thermocouples on flare 2.

<table>
<tr><td></td><td>Flare 1</td><td>Flare 2</td></tr>
<tr><td>Instrument tag number</td><td>3092-E-151 ($T_{Combust}$)</td><td>3449-E-151 ($T_{Combust}$)</td></tr>
<tr><td></td><td>02/10/2015</td><td>None replaced</td></tr>
<tr><td></td><td>24/07/2017</td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

Type: N type thermocouple
The typical accuracy of this type of thermocouple is ± 5 °C.
The thermocouples do not have serial numbers.
The thermocouples are calibrated by means of a check done every 3 months using a portable temperature probe and monitor.</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Data is monitored continuously.
Date is aggregated monthly and yearly</td></tr>
<tr><td>Calculation method (if applicable)</td><td>NA</td></tr>
<tr><td>QA/QC procedures</td><td>See monitoring equipment above</td></tr>
<tr><td>Purpose of data/parameter</td><td>Baseline emission calculations</td></tr>
<tr><td>Additional comments</td><td>The measured values were not used in the emission reduction calculations. The temperature is measured continuously and data logged every 30 minutes and emission reductions are not claimed when the temperature is below a threshold value of 700 °C.</td></tr>
</table>

D.3. Implementation of sampling plan

>>

Not applicable. None of the data and parameters monitored are to be determined by a sampling approach.

SECTION E. Calculation of emission reductions or net anthropogenic removals

E.1. Calculation of baseline emissions or baseline net removals

>>

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

$$BE_{CH4} = ((1 - OX_{top\ \mathrm{layer}}) \times F_{CH4,PJ,y} - F_{CH,BL,y}) \times GWP_{CH4}$$ ACM0001 Equation (2)

Where:

$BE_{CH_4,y}$	Baseline emissions of methane from the SWDS in year *y* (tCO_2e/y)
$OX_{top\ layer}$	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* (tCH_4/y)
$F_{CH4,BL,y}$	Amount of methane in the LFG that would be flared in the baseline in year *y* (tCH_4/y)
GWP_{CH4}	Global warming potential of CH_4 ($tCO_2e/t\ CH_4$)

Calculation of $F_{CH4,PJ,y}$:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y} + F_{CH4,HG,y} + F_{CH4,NG,y}$$ ACM0001 Equation (3)

Where:

$F_{CH4,PJ,y}$ Amount of methane in the LFG which is flared and/or used in the project activity in year y (tCH_4/yr)
$F_{CH4,flared,y}$ Amount of methane in the LFG which is destroyed by flaring in year y (tCH_4/yr)
$F_{CH4,EL,y}$ Amount of methane in the LFG which is used for electricity generation in year y (tCH_4/yr)
$F_{CH4,HG,y}$ Amount of methane in the LFG which is used for heat generation in year y (tCH_4/yr)
$F_{CH4,NG,y}$ Amount of methane in the LFG which is sent to the natural gas distribution network and/or to the trucks in year y (tCH_4/yr)

Values used for the above two formulas:

$F_{CH4,BL,y}$ = 0, since in the baseline no requirements to destroy methane were existing and neither was the LFG captured and destroyed prior to implementation of the project activity, as per the applied methodology, paragraph 39 and 40;
$F_{CH4,EL,y}$ = 0, as there was no use of LFG for electricity generation during this monitoring period
$F_{CH4,HG,y}$ = 0, as there was no use of LFG for heat generation.
$F_{CH4,NG,y}$ = 0, as there was no supply of LFG into the natural; gas network

Therefore:

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

Calculation of $F_{CH4,flared,y}$

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

Where:

$F_{CH4,flared,y}$ Amount of methane in the LFG which is destroyed by flaring in year y (tCH_4/yr)
$F_{CH4,sent\_flare,y}$ Amount of methane in the LFG which is sent to the flare in year y (tCH_4/yr)
$PE_{flare,y}$ Project emissions from flaring of the residual gas stream in year y (tCO_2e/yr)
GWP_{CH4} Global Warming Potential of CH_4 (tCO_2e/tCH_4)

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)

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

Where:

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

$F_{i,t}$ 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 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.

$PE_{flare,y}$ is determined using the methodological tool “Project emissions from flaring”. If LFG is flared through more than one flare, then $PE_{flare,y}$ is the sum of the emissions for each flare determined separately.

The project activity involves the installation of one enclosed flare. The calculation procedure in the applied tool “Project emissions from flaring” (Version 02.0.0) determines the project emissions from flaring the residual gas ($PE_{flare,y}$) based on the flare efficiency ($\eta_{flare,m}$) and the mass flow of methane to the flare ($F_{CH4,RG,m}$).

Step 1: Determination of the methane mass flow in the residual gas

The mass flow of methane in the residual gaseous stream has been determined in accordance with the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 02.0.0) as described above.

Step 2: Determination of flare efficiency

The flare efficiency depends on the efficiency of combustion in the flare and the time that the flare is operating. For determining the efficiency of combustion of enclosed flares there is the option to apply a default value or determine the efficiency based on monitored data.

Option A to make use of the default flare efficiency has been selected for the flare efficiency.

The flame enclosure has a height of 4.1 times the diameter of the enclosure and is therefore classified to be a low height flare.

For enclosed flares that are defined as low height flares, the flare efficiency has been adjusted, as a conservative approach, by subtracting 0.1 from the efficiency as determined in Options A or B. Accordingly, the Chloorkop flare is a low-height flare and therefore the default flare efficiency is therefore 80% (90% less 10%).

Option A: Default value
The flare efficiency used is 80% (90% less 10% as described in the paragraph above) 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 manufacturer's specification for the flare ($SPEC_{flare}$) in minute m; and
2. The flame is detected in minute m ($Flame_m$).

Otherwise $\eta_{flare,m}$ is 0%.

Project emissions from flaring are calculated as the sum of emissions in year *y*, based on the methane mass flow in the residual gas ($F_{CH4,RG,m}$) and the flare efficiency ($\eta_{flare,m}$), as follows:

$$PE_{flare,y} = GWP_{CH4} \times \sum_{m=1}^{525600} F_{CH4,m} \times \left(1 - \eta_{flare,m}\right) \times 10^{-3}$$ Flaring Tool Eq. (15)

Where:

$PE_{flare,y}$	Project emissions from flaring of the residual gas in year *y* (tCO_2e)
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*

Flare Specifications

In accordance with the applied methodological tool "Project emissions from flaring", the flare specifications set by the manufacturer for the correct operation of the flare are documented in the CDM-PDD for the following parameters:

a) The minimum and maximum inlet flow rate is 400 – 2000 Nm^3/h
b) The minimum and maximum operating temperature is 350 - 1150°C
c) UV sensor one or off

All of the above conditions are monitored by the flare PLC which will trip the flare and shut it down if any one of the parameters is not within the specified operating range. In addition the calculations contained in the consolidated workbook summary also undertake this operational check to ensure that no data that comes through is used to calculate ERs if that above conditions are not in line with the manufacturers specifications. The consolidated workbook has separate worksheets for the monthly raw data received from each flare and then an emissions reduction calculation sheet which applies all the above and below calculations to the raw data and then a summary sheet which shows the results for the month in question. For the emission reduction workbook see the file: "Chloorkop Consolidated Report 19 Jan 2015- Jan 2020 – Final V3".

E.2. Calculation of project emissions or actual net removals

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

$$PE_y = PE_{EC,y} + PE_{FC,y} + PE_{DT,y}$$ ACM0001 equation (22)

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, in year y (tCO_2/y)
$PE_{DT,y}$	Emissions from distribution of compressed/liquefied LFG using trucks, in year y (tCO_2/y)

Project emissions from distribution of compressed/ liquefied LFG using trucks is not applicable as all the LFG captured will be flared on-site.

Project emissions associated with consumption of electricity ($PE_{EC,y}$)

Project emissions from consumption of electricity due to the project activity shall be calculated in accordance with equation (1) of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” (Version 01).

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

Where

$PE_{EC,}$	Project emissions from electricity consumption in year y (tCO_2 / yr)
$EC_{PJ,y}$	Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr)
$EF_{EF,y}$	Emission factor for electricity generation for source j in year y (tCO_2/MWh)
$TDL_{j,y}$	Average technical transmission and distribution losses for providing electricity to source j in year y

$EF_{EF,j/k/l,y}$ is determined according to the Standardised Baseline Methodology (ASB0001: Grid emission factor for Southern African Power Pool, Version 01.0), with the amount from electricity consumed ($EC_{PJ,j,y}$) from the grid being monitored.

Project emissions associated with fossil fuel combustion ($PE_{FC,y}$)

The use of diesel in the onsite generator contributes towards project emissions in accordance with the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” (Version 02).

The CO_2 emissions from fossil fuel combustion in process j are calculated based on the quantity of fuels combusted and the CO_2 emission coefficient of those fuels, as per Equation (1) of the tool, as follows:

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y}$$ Fossil Fuel Tool Equation (1)

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

The CO_2 coefficient will be calculated using Option B of the “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”, which makes use of the net calorific value and CO_2 emission factor of the fuel type, as follows:

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i,y}$$ Fossil Fuel Tool Equation (4)

Where:

$COEF_{i,y}$	CO_2 emission coefficient of the fuel type I in year y (tCO_2/ mass or volume unit)

$NCV_{i,y}$	Weighted average net calorific value of the fuel type i in year y (GJ/mass or volume unit)
$EF_{CO2,i,y}$	Weighted average CO_2 emission factor of the fuel type i in year y (tCO_2/GJ)

All of the above calculations are contained in the consolidated workbook titled "Chloorkop Consolidated Report 19 Jan 2015 - Jan 2020 – Final V3".

Therefore:

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

$PE_{EC,}$ = 1 428
$PE_{FC,}$ = 717
$PE_{DT,}$ = 0 no natural gas was distributed

$$PE_y = 1\,428 + 717 + 0$$

$$PE_y = 2\,145$$

All of the above calculations are contained in the consolidated workbook titled "Chloorkop Consolidated Report 19 Jan 2015- Jan 2020 – Final V3".

E.3. Calculation of leakage emissions

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The methodology assumes no leakages from the project activity.

E.4. Calculation of emission reductions or net anthropogenic removals

	Baseline GHG emissions or baseline net GHG removals (t CO_2e)	Project GHG emissions or actual net GHG removals (t CO_2e)	Leakage GHG emissions (t CO_2e)	GHG emission reductions or net anthropogenic GHG removals (t CO_2e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	283,495	2,145	0	0	281,350	281,350

E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period (t CO_2e)	Amount estimated ex ante for this monitoring period in the PDD (t CO_2e)
281,350	368,511

E.5.1. Explanation of calculation of "amount estimated ex ante for this monitoring period in the PDD"

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From the below extract from the current PDD we have calculate the Ex ante volumes for the monitoring report period.

Extracted from the New PDD for the period beyond 19 January 2015

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
Year 2015	70,548	464	0	70,084
Year 2016	71,883	464	0	71,418
Year 2017	72,990	464	0	72,526
Year 2018	73,890	464	0	73,425
Year 2019	74,597	464	0	74,133
Year 2020	81,998	466	0	81,532
Year 2021	82,369	466	0	81,903
Total	528,274	3 253	0	525,021
Total number of crediting years	7			

19 January 2015 to 31 December 2015	= 70,084 (based on PPD period)
Year 1 January 2016 to 31 December 2019	= 71,418 + 72,526 + 73,425 + 74,133 = 291,502
Year 1 January 2020 to 31 January 2020	= 81,532 / 365 * 31 = 6,925
Total for this monitoring period	= 70,084 + 291,502 + 6,925 = 368,511

The actual emission reductions achieved were significantly less than those estimated ex-ante values. The reasons were are follows:

- Downtime as a result of load shedding and a reduction in waste volumes to the site for short period of time.
- The ex-ante estimates of the landfill gas production were calculated using a multicomponent first order kinetic model based on the amount of biodegradable organic carbon in the landfill and the various waste fractions put to the landfill. This, in turn, was determined from the amount of domestic waste put to the landfill, and the fraction of this that was organic carbon. In the PDD, the volume of domestic waste for the years 2006 to 2012 was taken to be the same as that in 2005. The volume of domestic waste actually put to the landfill was considerably less than this, particularly in the years from 2007 onwards because of the reduced economic activity in South Africa as well as other business reasons. Also, the actual fraction of the total waste that was domestic waste was believed to be less than that assumed in the model. These factors would have reduced the quantity of landfill gas generated in this monitoring period compared to that estimated in the PDD.
- In addition as a result of the significant reduction in market value of emission reductions there was a matching reduction in capital expansion of the gas collection system which decreased the collection efficiency for the project.

E.6. Remarks on increase in achieved emission reductions

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There has not been an increase in the emission reductions but rather a decrease which is in line with the waste input reductions and an aging waste mass that yields less gas per year.

E.7. Remarks on scale of small-scale project activity

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Not applicable

Document information

Version	*Date*	*Description*
07.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Add a section on remarks on the observance of the scale limit of small-scale project activity during the crediting period; • Add "changes specific to afforestation or reforestation project activity" as a possible post-registration changes; • Clarify the reporting of net anthropogenic GHG removals for A/R project activities between two commitment periods; • Make editorial improvements.
06.0	7 June 2017	Revision to: • Ensure consistency with version 01.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Make editorial improvements.
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.

Version	*Date*	*Description*
04.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from *F-CDM-MR* to *CDM-MR-FORM*; • Editorial improvement.
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB 70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.

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