Monitoring report form
(Version 05.1)

Complete this form in accordance with the Attachment "Instructions for filling out the monitoring report form" at the end of this form.

MONITORING REPORT	
Title of the project activity	Durban Landfill-gas-to-electricity project – Mariannhill and La Mercy Landfills
UNFCCC reference number of the project activity	0545
Version number of the monitoring report	4
Completion date of the monitoring report	06/07/2016
Monitoring period number and duration of this monitoring period	6th Monitoring Period 15/12/2013 – 30/09/2014 (both days included)
Project participant(s)	South Africa: Durban Solid Waste (DSW) - eThekwini municipality; Netherlands: Netherlands' Ministry of Infrastructure and the Environment (IenM); Electrabel, N.V.; Netherlands' Ministry of Economic Affairs, Agriculture and Innovation (EL&I); Finland: Government of Finland - Ministry of Foreign Affairs of Finland; Fortum Corporation; Germany: RWE Power AG Japan: Chubu Electric Power Co., Inc; The Chugoku Electric Power Co., Inc.; Kyushu Electric Power Co., Inc.; Mitsubishi Corporation; Tohoku Electric Power Co., Inc.; The Tokyo Electric Power Co., Inc.; Shikoku Electric Power Co., Inc.; Japan International Cooperation Agency (JICA); Mitsui & Co. Ltd. Norway: Government of Norway - Ministry of Foreign Affairs; Norsk Hydro ASA; Statoil ASA United Kingdom of Great Britain and Northern Ireland: Deutsche Bank AG; BP Alternative Energy International Ltd France: GDF SUEZ Sweden: Government of Sweden - Swedish Energy Agency; Bilateral and Multilateral Funds: Prototype Carbon Fund – Managing Company: International Bank for Reconstruction and Development (IBRD) as Trustee of the Prototype Carbon Fund (PCF)
Host Party	South Africa
Sectoral scope(s)	Sectoral Scope: 13 (Waste Handling and Disposal)

Selected methodology(ies)	ACM0001: “Large-scale Consolidated Methodology: Flaring or use of landfill gas”, (Version 15.0)	
Selected standardized baseline(s)	ASB0001 “Standardized baseline: Grid Emission Factor for the Southern African power pool”, (Version 01.0)	
Estimated amount of GHG emission reductions or net GHG removals by sinks for this monitoring period in the registered PDD	49,018 tCO_2e* **The PDD value been calculated by prorating the PDD yearly values by the number of days to match this monitored period (15/12/2013 to 30/09/2014).*	
Total amount of GHG emission reductions or net GHG removals by sinks achieved in this monitoring period	GHG emission reductions or net GHG removals by sinks reported up to 31 December 2012	GHG emission reductions or net GHG removals by sinks reported from 1 January 2013 onwards
	0	22,134 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>>

The project, when originally registered, consisted of an enhanced collection of landfill gas at two landfill sites of the municipality of Durban, the use of the recovered gas to produce electricity and flaring of the excess gas. The electricity produced is fed into the South African grid system. In its first crediting period, the project was implemented on the Mariannhill and La Mercy landfill sites.

The Mariannhill landfill is an active landfill site where waste will be deposited until 2020. It extends over 49 ha and receives 550 to 850 tonnes of waste per day. To date, the site has received approximately 2,000,000 tonnes. The Mariannhill landfill was officially designated a Nature Conservancy site in late 2002. It is the only landfill in South Africa granted such a status. The second landfill site, La Mercy, was an old landfill, already closed and far away from residential areas. It was receiving around 350 tonnes of waste per day and it closed with about 1 million tonnes of waste in place.

During the first crediting period, the project implemented a landfill gas recovery system at La Mercy and substantially upgraded the collection system at Mariannhill where 6 wells were installed as a pilot activity prior to the implementation of the project activity. A low height enclosed flare with maximum capacity of 1,000 Nm^3/h and a 1MW electricity generation unit were installed at Mariannhill. Depending on gas availability, electricity generation may be subsequently augmented to up to 2MW of combined capacity.

Meanwhile at the La Mercy site, due to the operational difficulties in extracting the landfill gas, the project activity did not continue extracting gas and was decommissioned on June 2009. A Notification of Changes (NoC) to the PDD was submitted and approved by CDM EB on its 65th meeting on 25/11/2011. Therefore, the project for the second and third crediting periods will focus on the gas extraction at the Mariannhill landfill.

The scenario existing prior to the implementation of the project activity was that neither landfill had an active landfill gas collection and utilization system in place. Landfill gas was vented to ensure that the concentration of methane in any particular area of the landfill stayed below hazardous levels. In the past, 6 collection wells were installed on the Mariannhill landfill as a pilot to investigate the feasibility of landfill gas recovery for electricity generation. The baseline scenario is the continuation of the practice prior to the implementation of the project, with limited collection and flaring of methane from the landfills in compliance with applicable regulations and the municipal electric company buying electricity from other suppliers. Therefore, the baseline scenario for the second crediting period is the same as the scenario existing prior to the implementation of the project activity.

The project activity contributes to sustainable development by improving the local environment with positive effects on air and groundwater quality. By displacing electricity from the grid, the project reduces emissions related to coal-fired power production which include sulphur oxides, nitrogen oxides, and particulates. It also reduces the adverse impacts related to transportation of coal and coal mining (dust and acid mine drainage). Near the landfill sites, the project improves the air quality by further reducing the amount of landfill gas released into the atmosphere and thus reducing the risk of exposure of neighbouring residents to odour. With regard to local employment, the project results in a small increase in the area of skilled jobs for operation and maintenance of the equipment.

Construction of the landfill gas management system began on 01/02/2006. The gas combustion equipment was commissioned in November 2006 and the first monitoring period commenced on 15/12/2006. Since then the project has been continuously operating achieving successful verifications for the complete first crediting period. The renewal of the crediting period was

approved by the CMD EB on 29/04/2014 and this is the first verification for the second crediting period.

The purpose of the project activity is thus to collect landfill gas and use it to generate renewable energy to avoid methane emissions going into the atmosphere. The total GHG emission reductions achieved in this monitoring period are 22,134 tCO_2e.

A.2. Location of project activity

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Mariannhill Landfill is located in the Municipality of eThekwini (formerly known as Durban) in KwaZulu Natal Province, South Africa. The site is located around 20 km to the west of Durban, in the Metro area formerly called the Inner West City Council (IWCC).

Durban is geographically located in the southeast region of South Africa on the Indian Ocean coast. Mariannhill landfill site is located at Latitude: -29.846389, Longitude: 30.837778. The following figure provides details of the physical/geographical location of the project activity:

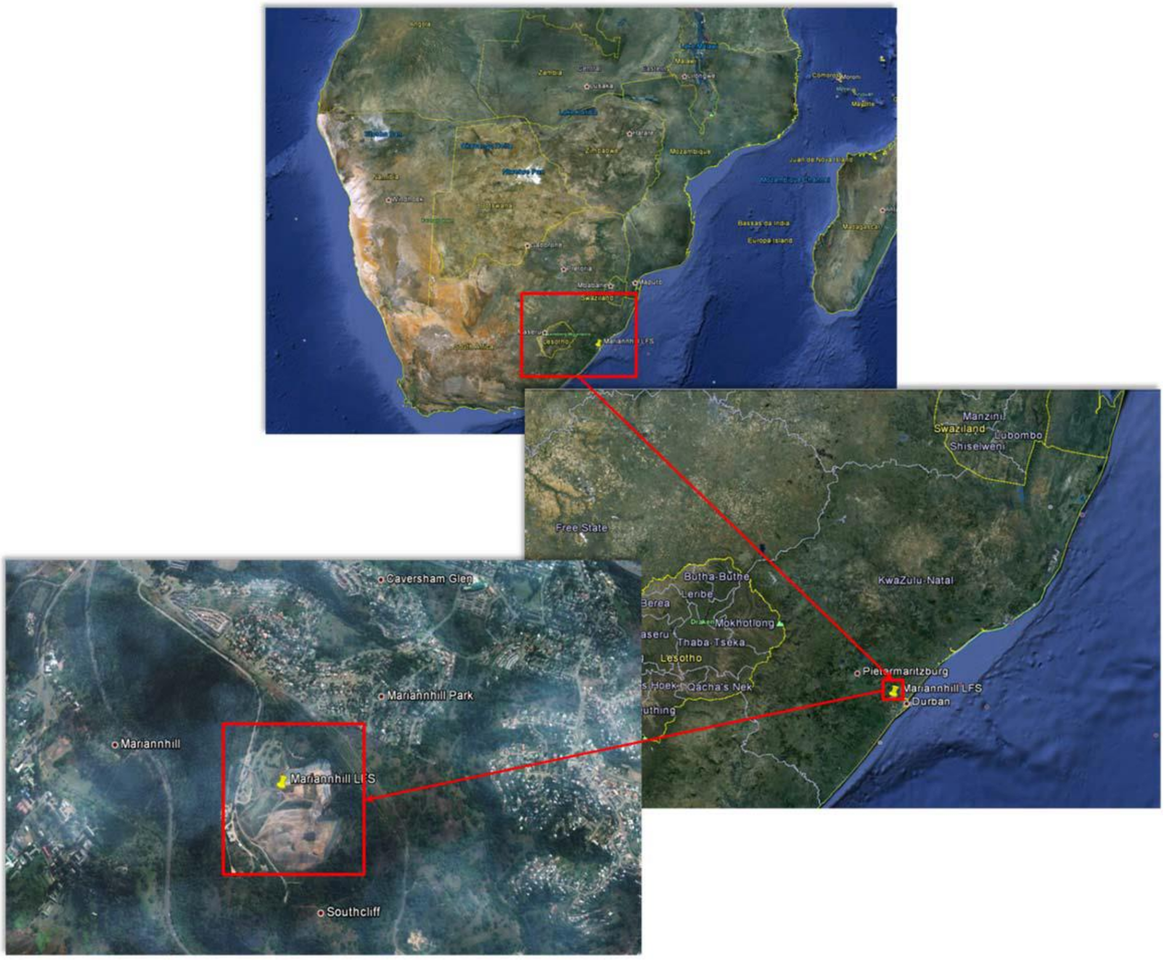

Figure 1 - Physical/geographical location of the project activity

A.3. Parties and project participant(s)

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate whether the Party involved wishes to be considered as project participant (yes/no)

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate whether the Party involved wishes to be considered as project participant (yes/no)
South Africa (host)	Durban Solid Waste (DSW) – eThekwini Municipality	No
Netherlands	Netherlands' Ministry of Infrastructure and the Environment (IenM); Electrabel N.V.; Netherlands' Ministry of Economic Affairs, Agriculture and Innovation (EL&I);	Yes
Finland	Government of Finland - Ministry of Foreign Affairs of Finland; Fortum Corporation;	Yes
Germany	RWE Power AG	No
Japan	Chubu Electric Power Co. Inc; The Chugoku Electric Power Co. Inc; Kyushu Electric Power Co. Inc.; Mitsubishi Corporation; Tohoku Electric Power Co. Inc.; The Tokyo Electric Power Co. Inc.; Shikoku Electric Power Co. Inc; Japan International Cooperation Agency (JICA); Mitsui & Co. Ltd.	No
Norway	Government of Norway – Ministry of Foreign Affairs; Norsk Hydro ASA; Statoil ASA	Yes
United Kingdom of Great Britain and Northern Ireland	Deutsche Bank AG; BP Alternative Energy International Ltd	No
France	GDF SUEZ	No
Sweden	Government of Sweden - Swedish Energy Agency	Yes
Bilateral and Multilateral Funds	Prototype Carbon Fund Managing Company: International Bank for Reconstruction and Development (IBRD) as Trustee of the Prototype Carbon Fund (PCF)	-

A.4. Reference of applied methodology and standardized baseline

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The methodology, standardized baseline and tools applied to this project are:

- 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);
- "Emissions from solid waste disposal sites" (version 06.0.1);
- "Project emissions from flaring" (version 02.0.0);
- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 1);
- "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 02.0.0); and

- "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).

The methodology and methodological tools listed above are available online at the UNFCCC website, at the following link:
http://cdm.unfccc.int/methodologies/DB/D44X8FH8SFCXREE6037AXJSBGGFVDO

A.5. Crediting period of project activity

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The second crediting period of the project activity, to which this monitored period applies, started on 15/12/2013, running for 7 years to 14/12/2020 when it can be renewed.

A.6. Contact information of responsible persons/entities

>>
This CDM-MR-FORM has been completed by:

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They are not project participants listed in Appendix 1 below.

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

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Durban Solid Waste (DSW) is the municipal agency responsible for management and operation of multiple landfills in the Durban metropolitan area. Under the project, DSW has commissioned the installation of landfill gas extraction wells, flare units and landfill gas generator for the Mariannhill landfill site. DSW functions as the technical advisor and operator of the project.

Specifically, the following technology has been installed:

- Extraction wells: Over time some 33 gas wells will be constructed during phased restoration of the site to extract the landfill gas as it is produced;
- Gas collection pipework: Pipes collect and transport the gas from the wells to the extraction plant from where the gas is used for electricity generation, with any surplus gas being flared;
- Gas extraction plant (blower): A centrifugal blower is required to extract landfill gas from the wells and supply this to either the generation engine or the flare unit. The blower creates lower pressure inside the wells than in the landfill, thereby sucking the gas from the landfill into the wells and from there to the extraction plant;
- Flare unit: A landfill gas flare with maximum capacity of 1,000Nm^3/hr has been installed at the site;
- Landfill gas generator: A single 1MW unit has been installed at Mariannhill, which can be turned down to as low as 50% capacity (Jenbacher type 320 engine); and
- Switch gears, transformers and cabling: have been installed as needed for interconnection with the eThekwini Electricity grid.

The system is also equipped with condensate knockout pots in order to keep pipework clear of liquids which form due to changes in temperature. All engine and flaring equipment is housed in a purpose built compound to ensure no unauthorised access and maintain high standards of health and safety. The engine is installed within acoustic housing to minimise noise nuisance. All equipment is manufactured to established European standards and instrument maintenance and calibration procedures are implemented in accordance with the recommendations of the respective manufacturer.

Switch gear, transformers and cabling have been supplied to provide interconnection to the electricity grid system. In addition, the site is equipped with the necessary monitoring and data capture instrumentation to ensure that the requirements of the PDD are addressed.

A regular program of operation and maintenance of gas extraction and combustion equipment has been implemented, based on suppliers' recommendations. Specialist contractors are employed to carry out environmental monitoring, in addition to maintenance and servicing of the landfill gas flare and engine.

Status of Implementation

The project has involved the installation of a network of gas collection wells and pipework to which suction pressure is applied in order to draw landfill gas from the waste to undergo controlled combustion in order to generate electricity.

Construction of the landfill gas management system began on 01/02/2006. The gas combustion equipment was commissioned in November 2006 and the first monitoring period commenced on 15/12/2006.

The project implemented a substantial upgrade of a previously existing, small collection system at Mariannhill which comprised six gas collection wells installed as a pilot activity.

The gas utilisation system at Mariannhill currently comprises a single 1MW Jenbacher 320 engine and flare. The network of gas collection wells has been expanded on a phased basis as the site continues to develop, as summarised in the following table.

During this monitoring period 4 new wells – HW14 – HW17 were added.

MARIANNHILL LANDFILL : GAS WELLS AS AT 30 SEPTEMBER 2014

Base line wells - Cell 1	Vertical wells installed under Contract WS 5607 (1N0. in Cell 1; 6No. In Cell 3	Gas Riser Pipe (GRP) wells connected under Contract WS 5607 (Cell 4)	Vertical wells installed by Envitech (Cell 4)	Horizontal wells & riser connections installed under Contract WS 5920 and O&M contract (Cell 4 & 5) Installed after 2009 and before 1 October 2012					Horizontal wells & riser connections installed between 2-10-2012 and 14-12-2013 (Monitoring Period 5)					Horizontal wells & riser connections installed between 15-12-2013 and 30-09-2014				
				Header Station No.	Valve No. in Header Station	Well No.	Level	Approx. Length	Header Station No.	Valve No. in Header Station	Well No.	Level	Approx. Length	Header Station No.	Valve No. in Header Station	Well No.	Level	Approx. Length
BASELINE GW 1	GW 1	GRP 1	GW 8	HS 1	V8	HW 6	LC	130	HS 1	V15	HW 10	LC	140	HS 1	V7	HW 14	LD	120
BASELINE GW 2	GW 2	GRP 2	GW 9	HS 1	V9	HW 4	LB	120	HSC 3	V1	HW 11	LD	120	HS 1	V6	HW 15	LD	120
BASELINE GW 3	GW 3	GRP 3	GW 10	HS 1	V10	HW 1	LA	140	~~HSC 3~~	~~V2~~	~~HW 12~~	~~LD~~	~~120~~	HS 1	V13	HW 16	LD	120
BASELINE GW 4	GW 4	GRP 4	GW 11	HS 1	V16	HW 7	LC	102	~~HSC 3~~	~~V3~~	~~HW 13~~	~~LD~~	~~120~~	HS 1	V14	HW 17	LD	120
BASELINE GW 5	GW 5	GRP 5		HS 1	V17	RISERS	(LB)	varies										
BASELINE GW 6	GW 6	GRP 6		HS 1	V18	HW 2	LA	150										
	GW 7	GRP 7		HS 1	V19	HW 3	LA	145										
		GRP 8		HS 1	V20	HW 5	LB	125										
		GRP 9		~~HS 1~~	~~V16~~	~~HW 7~~	~~LC~~	~~130~~										
				~~HSC 3~~	~~V2~~	~~HW 8~~	~~LC~~	~~140~~										
				~~HSC 3~~	~~V3~~	~~HW 9~~	~~LC~~	~~140~~										

NOTE: HW 8 & HW 9 were damaged and abandoned.

HW 12 & HW 13 have been linked into the piping previously serving HW 8 & HW 9

HW 12 & HW 13 have been abandoned but linked into HW 14.

The volume of gas from the baseline wells (GW1 – GW6) has been decreasing with time until it was negligible and below the accurate measurement range of the flow meter used. In addition, from March 2012 well heads and seals were failing due to settlement and allowing oxygen ingress. Trials elsewhere with re-constructing the seals did not produce any significant improvement in gas production or quality. No more gas could be extracted from the baseline wells, therefore it was monitored to the point that no gas could be extracted from them, this being November 2012.

Further wells will be added at Mariannhill when new areas of landfilling are completed.

Operation of the Activity

During the monitoring period, the following data loss events have been identified:

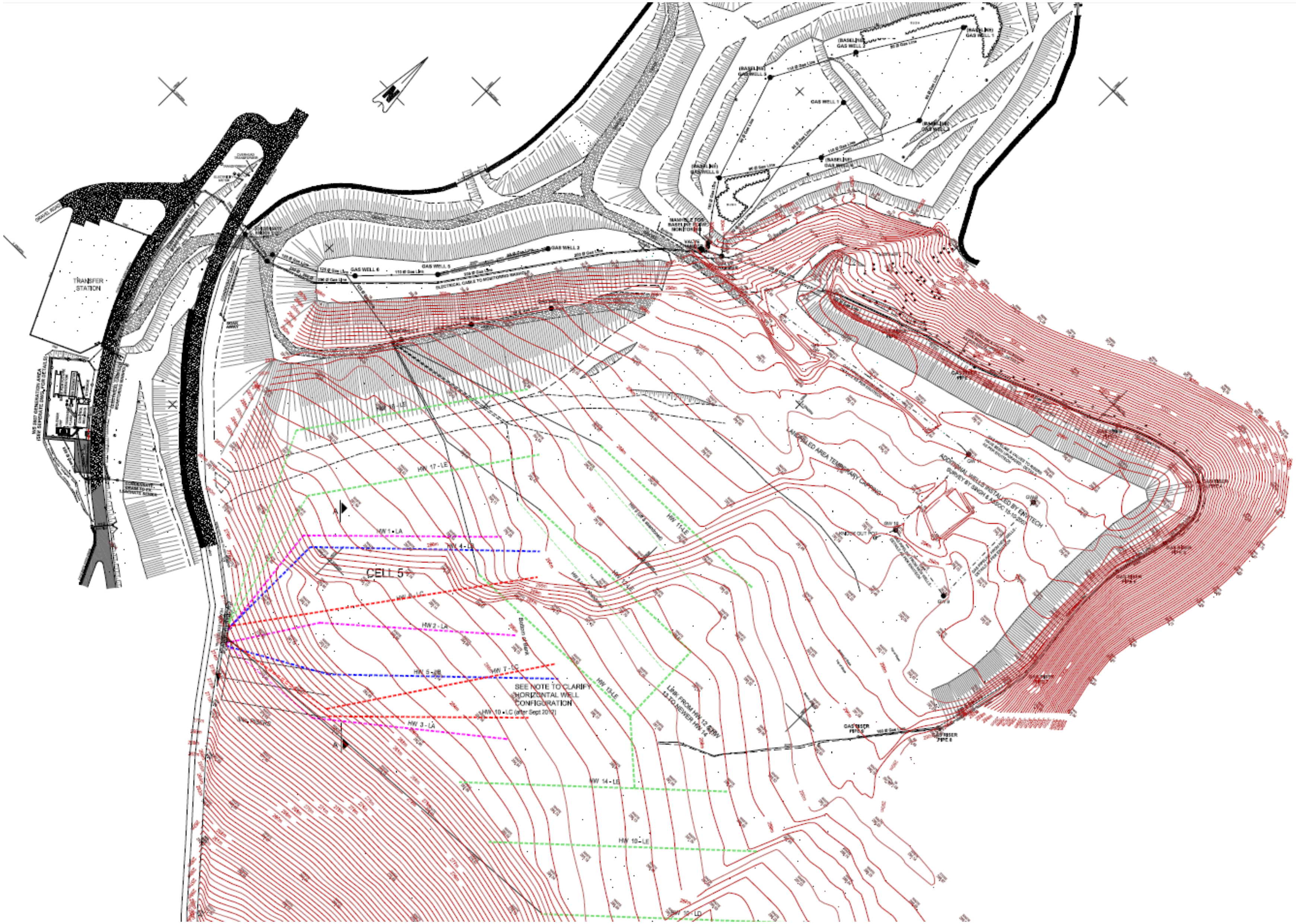
Parameter:	All raw data	
Data Incident:	Stabilization of monitoring equipment due to update of the new monitoring system.	
Data Handling Action:	Emission reductions from destroyed methane were not claimed until the new monitoring system was operational.	
Period(s):	From	To
	15/12/2013 at 00:00	19/12/2013 at 18:28

Parameter:	All raw data	
Data Incident:	Power failures	
Data Handling Action:	Emission reductions from destroyed methane were not claimed until power was restored and system was operational.	
Period(s):	From	To
	20/01/2014 at 11:23	20/01/2014 at 13:26
	16/01/2014 at 12:31	16/01/2014 at 17:05
	03/02/2014 at 12:17	04/02/2014 at 11:21
	04/02/2014 at 19:47	05/02/2014 at 07:46
	06/03/2014 at 14:03	06/03/2014 at 16:10
	12/04/2014 at 12:39	14/04/2014 at 08:01
	03/05/2014 at 09:09	03/05/2014 at 12:49
	12/06/2014 at 17:40	12/06/2014 at 19:37
	18/06/2014 at 12:47	19/06/2014 at 14:07
	25/06/2014 at 16:32	26/06/2014 at 16:55
	27/06/2014 at 12:51	27/06/2014 at 14:20
	14/07/2014 at 09:42	14/07/2014 at 11:39

	21/07/2014 at 04:10	21/07/2014 at 06:06
	19/08/2014 at 07:26	21/08/2014 at 09:39
	29/08/2014 at 01:23	29/08/2014 at 09:43
	01/09/2014 at 00:00	02/09/2014 at 11:07
	26/09/2014 at 13:26	27/09/2014 at 09:40
	30/09/2014 at 14:30	30/09/2014 at 23:59

Parameter:	All raw data	
Data Incident:	System Maintenance	
Data Handling Action:	Emission reductions from destroyed methane were not claimed until power was restored and system was operational.	
Period(s):	From	To
	10/01/2014 at 18:21	11/01/2014 at 10:51
	20/02/2014 at 15:17	20/02/2014 at 16:11
	27/02/2014 at 10:06	27/02/2014 at 15:31
	17/03/2014 at 08:48	17/03/2014 at 17:23
	28/03/2014 at 09:15	28/03/2014 at 12:10
	04/04/2014 at 09:19	04/04/2014 at 16:23
	09/07/2014 at 11:52	09/07/2014 at 16:47
	07/08/2014 at 07:51	07/08/2014 at 16:00

Parameter:	Flare Operation	
Data Incident:	Flare operating below specification (i.e. below 500dC)	
Data Handling Action:	Emission reductions from destroyed methane were not claimed until flare exhaust gas temperature was greater than 500dC	
Period(s):	From	To
	Due to multiple data points were the flare was running below specification for each month during the verification period, for exact reference to specific date and times for these occurrences refer to monthly data calculation sheets referenced: CDM Data 2013_12a CDM Data 2014_01a CDM Data 2014_02a CDM Data 2014_03a CDM Data 2014_04a CDM Data 2014_05a CDM Data 2014_06a CDM Data 2014_07a CDM Data 2014_08a CDM Data 2014_09a	


TRANSFER STATION
CELL 5
SEE NOTE TO CLARIFY HORIZONTAL WELL CONFIGURATION
HW 1 - LA
HW 2 - LA
HW 3 - LA
HW 14 - LE
HW 10 - LE
GAS WELL 6
GAS WELL 5
GAS WELL 2
GAS WELL 1

B.2. Post-registration changes

B.2.1. Temporary deviations from registered monitoring plan, applied methodology or applied standardized baseline

>>
No temporary deviations have been applied during this monitoring period

B.2.2. Corrections

>>
For this crediting period, several monitoring parameters were corrected in accordance with ACM0001 version 15 and relevant tools. The flow diagram and information for parties' involvement was corrected among other editorial changes. The corrections did not require prior approval but were submitted together with the request for permanent changes from the registered monitoring plan (see summary in section B.2.3 below) and approved on 12/10/2015. For details, please refer to the approved revised PDD dated 30/06/2015 (reference No.: PRC-0545-002) (available here).

For the previous crediting period, PRC reference No.: PRC-0545-001 had also been approved on 30/08/2013; however it is no longer relevant to this crediting period as the methodology has been updated since the projects renewal of the crediting period.

B.2.3. Changes to start date of crediting period

>>
No changes to the start of the crediting period have been approved or submitted with this monitoring report.

B.2.4. Inclusion of a monitoring plan to the registered PDD that was not included at registration

>>
N/A

B.2.5. Not applicable as the monitoring plan was included at registration. Permanent changes from registered monitoring plan, applied methodology or applied standardized baseline

>>
A request for permanent changes from the registered monitoring plan was submitted on 15/07/2015 and approved on 12/10/2015 (reference No.: PRC-0545-002). The permanent changes are summarized below:

1. Removal of the following parameters for LFG volume on wet basis: $V_{LFG,total,y,wb}$, $V_{LFG,sent\_flare,y,wb}$ and $V_{LFG,EL,y,wb}$;
2. Revision of QA/QC procedures for parameters $V_{LFG,total,y,db}$, $V_{LFG,sent\_flare,y,db}$ and $V_{LFG,EL,y,db}$;
3. Update of the flow diagram;
4. Incorporate parameter $SPEC_{flare}$ in section B.6.2 as per the tool "Project emissions from flaring" version 2;
5. Incorporate parameter $p_{H2O,t,Sat}$ as per the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 02.0.0);
6. Update QA/QC and monitoring frequency for parameters T_t and P_t;
7. Update of parameter $EG_{PJ,y}$.
8. Parameter $Op_{flare,h}$: To clarify that only flame detection is used for determination of the flare operation.
9. Ex-ante fixed parameter OX has been deleted as parameter OX_{top_layer} is already in line with methodology ACM0001.

For more details, please refer to the revised PDD dated 30/06/2015 (available here)

B.2.6. Changes to project design of registered project activity

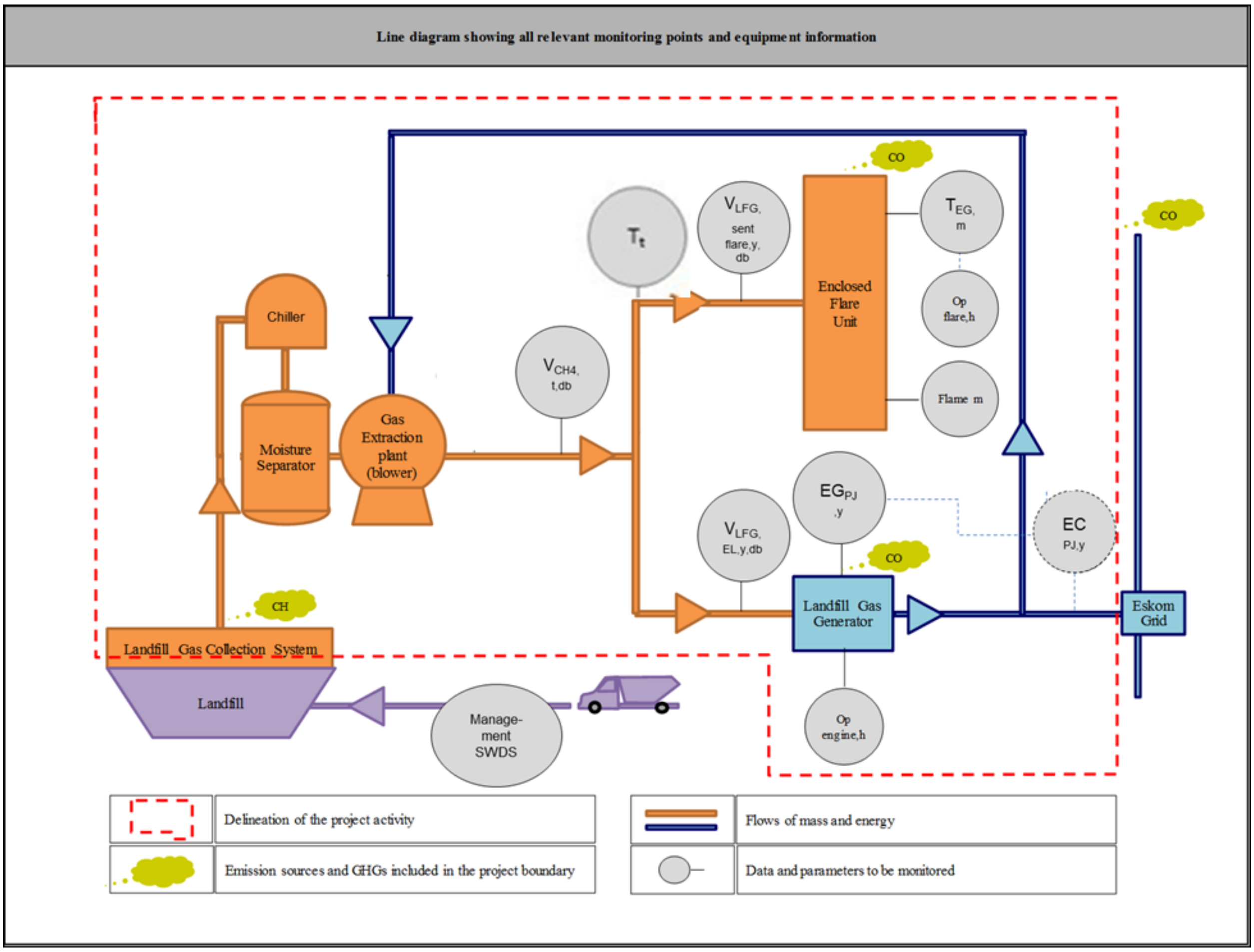
>>
No changes to the project design of the registered project activity have been approved or submitted with this monitoring report.

B.2.7. Types of changes specific to afforestation or reforestation project activity

>>
Not applicable.

SECTION C. Description of monitoring system

>>
The flow diagram below presents the equipment, systems and flows of mass and energy for the project. In particular, it includes the data and parameters to be monitored taking into account the project boundary as per methodology ACM0001 "Flaring or use of landfill gas" (version 15.0), as follows:



The following describes the operational and management structure that the project operator implements in order to monitor emission reductions achieved by the project activity.

Data Collection:

The data is mainly collected automatically through a data logger. The data gathered automatically includes gas flow ($V_{LFG,total,y}$, $V_{LFG,sent\_flare,y}$ and $V_{LFG,EL,y}$)), volumetric fraction of methane ($V_{CH4,t}$), temperature in the exhaust gas of the flare ($T_{EG,m}$), operation of the flare station ($Op_{flare,h}$), operation of the electrical plant ($Op_{engine,h}$), net electricity generated ($EL_{LFG,y}$).

A regular visual inspection is carried out by a designated / trained landfill employee. During this inspection, the employee will check the instrumentation and monitoring data such as gas quality, gas flow, vacuum, and flare temperature. The employee will also analyze the data and adjust the applied vacuum within the landfill to maintain a steady gas quality and flow. Gas quality and vacuum levels will also be periodically checked directly at each gas well, using a portable meter. This routine monitoring allows the identification of underperforming gas wells and the application of necessary corrective actions. The combination of these two inspections optimises the landfill gas collection efficiency.

Data Storage:

Raw data from the monitoring instrumentation are automatically logged at minute intervals and stored on the computer system hard drive.

Data are recorded on a secure database on the Proficy Historian Software that is being used to log the data. The data on the secured database cannot be altered or changed.

The data are then extracted monthly onto Microsoft Excel for use in compiling the CER calculations.

Raw data from the monitoring instrumentation are automatically logged at minute intervals and stored on the computer system hard drive. The data are stored on a secured database within the monitoring instrumentation software with a file containing data for each month. On a monthly basis the data are exported from these files to an Excel electronic workbook. The workbook includes capacity for the operator to record any occurrences which are relevant to the calculation of emission reductions and how such occurrences have been addressed. The calculation of emission reductions is checked by use of a bespoke manual ‘Methodology for the Calculation of CERs for the Durban/World Bank CDM Landfill Gas to Electricity Project’.

On a monthly basis the electronic data from the Data Acquisition (DA) facility, including the monthly calculated ERs, are downloaded to a portable memory device (memory stick and/or an external hard drive) and transferred to the CDM Contractor’s (Envitech Solutions) file server where it is archived under the Project. The CDM Contractor’s file server is backed up to an external hard drive on a weekly basis. The monthly calculated ERs are then forwarded electronically to the CDM Project Manager for review and kept in the CDM Project Manager’s office as an additional backup copy.

Envitech has provided a CDM Data Processing: Step by Step Methodology manual, for DSW staff to closely follow.

Data are then stored and archived, being kept for at least two years after the end of the crediting period

Project Management Responsibility:

The project implementation and operation is under the direct supervision of the CDM Project Manager. The following table summarizes the key tasks of the project manager with regard to the monitoring system for the project:

Task	
Monitoring	• Develop and establish management and operations system

Task	
system	• Establish and maintain monitoring and reporting system and implement MP
Data Collection	• Establish and maintain data measurement, collection and record keeping systems for landfill gas collection and power supply • Check data quality, collection and record keeping procedures regularly
Data Computation	• Complete MP workbook • Or develop and use equivalent recording, calculation and reporting tool for ERs
Data Storage systems	• Implement record maintenance system • Store and maintain records (paper trail) • Implement sign-off system for records and completed worksheets
Performance monitoring and reporting	• Analyze data and compare project performance with project targets • Analyze system problems and implement improvements (performance management) • Prepare and forward annual report and worksheets to WB CFU
Quality assurance and verification	• Establish and maintain quality assurance system with a view to ensuring transparency and allowing for audits and verification • Prepare for, facilitate and co-ordinate audits and verification process

The key participants in the organisational structure for the project are:

CDM Project Manager – Durban Solid Waste (DSW)
CDM Manager – Jon Pass (Wilson & Pass Engineers)
CDM Monitoring Contractor – Envitech Solutions
CDM Engine Maintenance Contractor – Peters Plant Services
CDM Flare Maintenance Contractor – Envitech Solutions / Organics
Quality Assurance – SLR Consulting Limited

Training of Monitoring Personnel:

The monitoring personnel are trained internally or externally as per requirements identified. Training has included:

- Landfill gas collection system balancing;
- Calibration of monitoring equipment; and
- Impact of the monitoring on the CDM activity.

Procedure in Case of Failure:

If there is an equipment (flow meter, gas analyser, gauge, etc.) failure, the corresponding entity/person (Landfill Manager, equipment supplier etc) is immediately notified. When possible, repairs are carried out on site.

If the damaged equipment cannot be repaired, it is replaced by the same or an equivalent unit as soon as possible. In some cases, fully calibrated portable instruments are used in order to carry out daily monitoring of the missing parameter(s). These data are recorded on paper and manually included in the CER calculations.

If the engine and flare are not operational, landfill gas will not be combusted and therefore no credits are claimed during such periods.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante or at renewal of crediting period

Data/parameter:	**OX_{top_layer}**
Unit	Dimensionless
Description	Fraction of methane that would be oxidized in the top layer of the SWDS in the baseline
Source of data	Methodology ACM0001 "Flaring or use of landfill gas", version 15.0
Value(s) applied)	0.1
Choice of data or measurement methods and procedures	Applicable to Step A (Section 5.4.1 ACM0001, version 15.0)
Purpose of data	Calculation of baseline emissions
Additional comments	-

xc

Data/parameter:	**GWP_{CH4}**
Unit	tCO_2e/tCH_4
Description	Global warming potential of CH4
Source of data	IPCC
Value(s) applied)	25
Choice of data or measurement methods and procedures	As per Table 2.14 of the Fourth Assessment Report of the IPCCC which can be found at: http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html#table-2-4
Purpose of data	Calculation of baseline emissions
Additional comments	-

Data/parameter:	**D_{CH4}**
Unit	tCH_4/m^3CH_4
Description	Methane density
Source of data	Tool “Project emissions from flaring”, version 2.0
Value(s) applied)	0.000716
Choice of data or measurement methods and procedures	N/A
Purpose of data	Calculation of baseline emissions
Additional comments	-

Data/parameter:	φ
Unit	-
Description	Model correction factor to account for model uncertainties
Source of data	As per the tool “Emissions from solid waste disposal sites” – Version 6
Value(s) applied)	0.75
Choice of data or measurement methods and procedures	N/A
Purpose of data	Calculation of baseline emissions
Additional comments	-

Data/parameter:	**F**
Unit	-
Description	Fraction of methane in the SWDS gas (volume fraction)
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied)	0.5
Choice of data or measurement methods and procedures	A default value of 0.5 is recommended by IPCC.
Purpose of data	Calculation of baseline emissions
Additional comments	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic conditions in the SWDS.

Data/parameter:	**f_y**
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	As per the tool “Emissions from solid waste disposal sites” – Version 6
Value(s) applied)	0
Choice of data or measurement methods and procedures	N/A
Purpose of data	Calculation of baseline emissions
Additional comments	-

Data/parameter:	**η_{PJ}**
Unit	-
Description	Efficiency of the LFG capture system that will be installed in the project activity
Source of data	As per footnote 4 on page 10/23 of ACM0001 / Version 15.0 "Flaring or use of landfill gas"
Value(s) applied)	50%
Choice of data or measurement methods and procedures	As per footnote 4 on page 10/23 of ACM0001 / Version 15.0 "Flaring or use of landfill gas"
Purpose of data	Calculation of baseline emissions
Additional comments	The efficiency of the planned LFG collection, flaring, and utilization system is taken into account for the ex-ante estimation of emission reductions.

Data/parameter:	**MCF**
Unit	-
Description	Methane Correction Factor
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied)	1
Choice of data or measurement methods and procedures	IPCC default value

Purpose of data	Calculation of baseline emissions
Additional comments	N/A

Data/parameter:	**DOC_j**
Unit	-
Description	Fraction of degradable organic carbon (by weight) in the waste type *j*.
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)
Value(s) applied)	see table below
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of baseline emissions
Additional comments	The values applied are for wet waste.

Waste type j	**DOC_j (%wet waste)**
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

Data/parameter:	**DOC_f**
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	IPCC default value
Purpose of data	Calculation of baseline emissions
Additional comments	N/A

Data/parameter:	**kj**
Unit	-
Description	Decay rate for the waste type *j*.
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)

<table>
<tr><td>Value(s) applied)</td><td>
<table>
<tr><th colspan="2" rowspan="2">Waste type j</th><th colspan="2">Boreal and Temperate (MAT≤20°C)</th><th colspan="2">Tropical (MAT>20°C)</th></tr>
<tr><th>Dry (MAP/PET <1)</th><th>Wet (MAP/PET >1)</th><th>Dry (MAP< 1000mm)</th><th>Wet (MAP> 1000mm)</th></tr>
<tr><td rowspan="2">Slowly degrading</td><td>Pulp, paper, cardboard (other than sludge), textiles</td><td>0.04</td><td>0.06</td><td>0.045</td><td>0.07</td></tr>
<tr><td>Wood, wood products and straw</td><td>0.02</td><td>0.03</td><td>0.025</td><td>0.035</td></tr>
<tr><td>Moderately degrading</td><td>Other (non-food) organic putrescible garden and park waste</td><td>0.05</td><td>0.10</td><td>0.065</td><td>0.17</td></tr>
<tr><td>Rapidly degrading</td><td>Food, food waste, beverages and tobacco (other than sludge)</td><td>0.06</td><td>0.185</td><td>0.085</td><td>0.40</td></tr>
</table>
</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>IPCC default value</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comments</td><td>http://www.worldweather.org/035/c00137.htm</td></tr>
</table>

Data/parameter:	$\mathbf{EF_{EL,k,y}}$ (equivalent to $EF_{grid,CM,y}$ from the Standardized Baseline)
Unit	tCO_2/MWh
Description	CO_2 emissions intensity of the electricity displaced
Source of data	Standardized baseline “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	Based on the standardized baseline for Southern African power pool
Purpose of data	Calculation of baseline emissions and calculation of project emissions
Additional comments	The value will be kept fixed for the entire crediting period.

Data/parameter:	$\eta_{flare,m}$
Unit	%
Description	Flare Efficiency in the minute m
Source of data	As per “Project emissions from flaring” (Version 02.0.0)
Value(s) applied)	0, 0.5 or 0.8
Choice of data or measurement methods and procedures	As per “Project emissions from flaring” (Version 02.0.0)

Purpose of data	The default value flare efficiency will be used to calculate the amount of methane destroyed by flaring ex post as per Option A (1) of "Project emissions from flaring" version 02.0.0. The flare height installed in the project activity is less than 10 times the diameter. This makes it a low height flare. As per the tool "Project emissions from flaring" version 02.0.0, a low height flare is an enclosed flare for which the flame enclosure has a height between 10 and two times the diameter of the enclosure. Given that the project is using a low height flare, the flare efficiency in the minute m shall be adjusted, as a conservative approach, by subtracting 0.1 from the default value of 90% for the efficiency of the flare. Therefore, a value of 80% will be used for the project activity. In case the monitoring equipment for the (1) flare temperature or (2) flare manufacturer specifications is unavailable for maintenance, or failure, the following methods will be used for ηflare,m: • 0% if the temperature of the flare (T_{EGm}) and the flow rate of the residual gas to the flare ($F_{RG,m}$) are not within the manufacturer's specification for the flare ($SPEC_{flare}$) in minute m, and the flame is not detected in minute m ($Flame_m$). • 50% if the flame is detected in minute m ($Flame_m$), but the temperature of the flare ($T_{EG,m}$) and the flow rate of the residual gas to the flare ($F_{RG,m}$) are not within the manufacturer's specification for the flare ($SPEC_{flare}$) in minute m. This is applicable for those cases in which the system is unavailable for maintenance or failure.
Additional comments	According to the tool "Project emissions from flaring" version 02.0.0, for enclosed flares that are defined as low height flares, the flare efficiency in the minute m shall be adjusted, as a conservative approach, by subtracting 0.1 from the efficiency as determined in Options A or B. For example, the default value applied should be 80%, rather than 90%. For the current monitoring period, either 0% or 80% has been applied in order to be conservative.

Data/parameter:	**R_u**
Unit	Pa.m^3/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 02.0.0
Value(s) applied)	8,314
Choice of data or measurement methods and procedures	Constant
Purpose of data	Calculation of baseline emissions
Additional comments	N/A

Data/parameter:	**MM_i**
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 02.0.0
Value(s) applied)	(see table below)

Compound	Structure	Molecular mass (kg/kmol)
Methane	CH_4	16.04

Choice of data or measurement methods and procedures	Constant
Purpose of data	Calculation of baseline emissions
Additional comments	N/A

Data/parameter:	**Pn**
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 02.0.0
Value(s) applied)	101,325 Pa
Choice of data or measurement methods and procedures	Constant
Purpose of data	Calculation of baseline emissions
Additional comments	N/A

Data/parameter:	**Tn**
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 02.0.0
Value(s) applied)	273.15
Choice of data or measurement methods and procedures	Constant
Purpose of data	Calculation of baseline emissions
Additional comments	N/A

Data/parameter:	$SPEC_{flare}$
Unit	Temperature: °C Flow rate: Nm^3/h
Description	Manufacturer's flare specifications for temperature, flow rate and maintenance schedule: Minimum Temperature: 500°C Minimum Flow rate: 100 Nm^3/h
Source of data	Flare manufacturer
Value(s) applied)	N/A
Choice of data or measurement methods and procedures	As per Flare manufacturer
Purpose of data	Calculation of baseline emissions
Additional comments	N/A

D.2. Data and parameters monitored

Data / Parameter:	$\mathbf{V_{LFG,total,y,db}}$
Unit:	m^3 dry gas/h

Description:	Volumetric flow of total landfill gas which is sent to flare and used for electricity generation in year y on a dry basis
Measured/ Calculated / Default:	Calculated
Source of data:	Flow Meter
Value(s) of monitored parameter:	Values are provided in monthly spreadsheets: CDM Data 2013_12a.xls CDM Data 2014_01a.xls CDM Data 2014_02a.xls CDM Data 2014_03a.xls CDM Data 2014_04a.xls CDM Data 2014_05a.xls CDM Data 2014_06a.xls CDM Data 2014_07a.xls CDM Data 2014_08a.xls CDM Data 2014_09a.xls
Monitoring equipment:	Type: Kurz Instruments (Flare flow) Accuracy Class: +/- 2% Serial Number: FD20272A Calibration Frequency: Periodic calibration/verification against a primary device provided by an independent accredited entity such as the manufacturer. Calibration and frequency of calibration is according to manufacturer's specifications, but at least every 2 years. Date of Last Calibration: 30/10/2013 Validity: 30/10/2013 to 29/10/2014 Type: Kurz Instruments (Engine flow) Accuracy Class: +/- 2% Serial Number: FD20273A Calibration Frequency Periodic calibration/verification against a primary device provided by an independent accredited entity such as the manufacturer. Calibration and frequency of calibration is according to manufacturer's specifications, but at least every 2 years. Date of Last Calibration: 30/10/2013 Validity: 30/10/2013 to 29/10/2014
Measuring/ Reading/ Recording frequency:	Continuous / Every minute
Calculation method (if applicable):	Measured readings from each meter are added together to derive the total volume of landfill gas.
QA/QC procedures:	Periodic calibration / verification against a primary device provided by an independent accredited entity such as the manufacturer. For the current monitored period SGS reported an error of 4.1% identified to be within the allowable range for the engine flow meter. However, since no further action was taken by the project owner, and in order to conservatively account for this error, a 4.1% discount has been applied to all the values that were monitored by this meter.
Purpose of data:	Calculation of baseline emissions
Additional comment:	This parameter is monitored as per Option A of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", version 2.0.0. No separate monitoring of temperature and pressure is necessary Flow meters that automatically express LFG volumes in standardised cubic meters are used. These readings are then adjusted to normalised cubic meters within the SCADA spreadsheets.

Data / Parameter:	**$V_{LFG,sent\_flare,y,db}$**
Unit:	m³ dry gas/h
Description:	Volumetric flow of landfill gas which is sent to flare in year y on a dry basis
Measured/ Calculated / Default:	Measured
Source of data:	Flow Meter
Value(s) of monitored parameter:	Values are provided in monthly spreadsheets: CDM Data 2013_12a.xls CDM Data 2014_01a.xls CDM Data 2014_02a.xls CDM Data 2014_03a.xls CDM Data 2014_04a.xls CDM Data 2014_05a.xls CDM Data 2014_06a.xls CDM Data 2014_07a.xls CDM Data 2014_08a.xls CDM Data 2014_09a.xls
Monitoring equipment:	Type: Kurz Instruments (Flare flow) Accuracy Class: +/- 2% Serial Number: FD20272A Calibration Frequency: Periodic calibration/verification against a primary device provided by an independent accredited entity such as the manufacturer. Calibration and frequency of calibration is according to manufacturer’s specifications, but at least every 2 years. Date of Last Calibration: 30/10/2013 Validity: 30/10/2013 to 29/10/2014
Measuring/ Reading/ Recording frequency:	Continuous / Every minute
Calculation method (if applicable):	Not applicable
QA/QC procedures:	Periodic calibration / verification against a primary device provided by an independent accredited entity such as the manufacturer. Calibration and frequency of calibration is according to manufacturer’s specifications, but at least every 2 years.
Purpose of data:	Calculation of baseline emissions
Additional comment:	This parameter is monitored as per Option A of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, version 2.0.0. No separate monitoring of temperature and pressure is necessary. Flow meters that automatically express LFG volumes in standardised cubic meters are used. These readings are then adjusted to normalised cubic meters within the SCADA spreadsheets

Data / Parameter:	**$V_{LFG,EL,y,db}$**
Unit:	m³ dry gas/h
Description:	Volumetric flow of landfill gas which is used for electricity generation in year y on a dry basis
Measured/ Calculated / Default:	Measured
Source of data:	Flow Meter

Value(s) of monitored parameter:	Values are provided in monthly spreadsheets: CDM Data 2013_12a.xls CDM Data 2014_01a.xls CDM Data 2014_02a.xls CDM Data 2014_03a.xls CDM Data 2014_04a.xls CDM Data 2014_05a.xls CDM Data 2014_06a.xls CDM Data 2014_07a.xls CDM Data 2014_08a.xls CDM Data 2014_09a.xls
Monitoring equipment:	Type: Kurz Instruments (Engine flow) Accuracy Class: +/- 2% Serial Number: FD20273A Calibration Frequency: Periodic calibration/verification against a primary device provided by an independent accredited entity such as the manufacturer. Calibration and frequency of calibration is according to manufacturer's specifications, but at least every 2 years. Date of Last Calibration: 30/10/2013 Validity: 30/10/2013 to 29/10/2014
Measuring/ Reading/ Recording frequency:	Continuous / Every minute
Calculation method (if applicable):	Not applicable
QA/QC procedures:	Periodic calibration / verification against a primary device provided by an independent accredited entity such as the manufacturer. For the current monitored period SGS reported an error of 4.1% identified to be within the allowable range for the engine flow meter. However, since no further action was taken by the project owner, and in order to conservatively account for this error, a 4.1% discount has been applied to all the values that were monitored by this meter.
Purpose of data:	Calculation of baseline emissions
Additional comment:	This parameter is monitored as per Option A of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", version 2.0.0. No separate monitoring of temperature and pressure is necessary. Flow meters that automatically express LFG volumes in standardised cubic meters are used. These readings are then adjusted to normalised cubic meters within the SCADA spreadsheets

Data / Parameter:	**T_t**
Unit:	K
Description:	Temperature of the gaseous stream in time interval t
Measured/ Calculated / Default:	Measured
Source of data:	Temperature Transmitter
Value(s) of monitored parameter:	Values are provided in monthly spreadsheets: CDM Data 2013_12a.xls CDM Data 2014_01a.xls CDM Data 2014_02a.xls CDM Data 2014_03a.xls CDM Data 2014_04a.xls CDM Data 2014_05a.xls CDM Data 2014_06a.xls CDM Data 2014_07a.xls CDM Data 2014_08a.xls CDM Data 2014_09a.xls

Monitoring equipment:	Type: WIKA TR200 Accuracy Class: 0.75% of full scale Serial Number: 46002570
Measuring/ Reading/ Recording frequency:	Continuous
Calculation method (if applicable):	Not applicable
QA/QC procedures:	Temperature of the gaseous steam is measured by temperature transmitter. Calibration for the temperature transmitter is not required, as per manufacturer' specifications.
Purpose of data:	Calculation of baseline emissions
Additional comment:	As per the last version of the "Tool to determine the mass flow of a GHG in a gaseous stream" (Version 02.0.0), Option 2 (Simplified calculation without measurement of the moisture content) will be used to determine the absolute humidity by assuming the gaseous stream is dry or saturated depending on which is the conservative situation. This parameter must be monitored continuously to assure that monitored gas is on a dry basis, and for those instances when the temperature is above 60^{o}C make sure that the gas is conservatively converted to dry basis.

Data / Parameter:	**P_t**
Unit:	Pa
Description:	Pressure of the gaseous stream in time interval t
Measured/ Calculated / Default:	Measured
Source of data:	Pressure Transmitter
Value(s) of monitored parameter:	Values are provided in monthly spreadsheets: CDM Data 2013_12a.xls CDM Data 2014_01a.xls CDM Data 2014_02a.xls CDM Data 2014_03a.xls CDM Data 2014_04a.xls CDM Data 2014_05a.xls CDM Data 2014_06a.xls CDM Data 2014_07a.xls CDM Data 2014_08a.xls CDM Data 2014_09a.xls
Monitoring equipment:	Type: GE Sensing Druck PTX 7900-3399 Accuracy Class: +/- 0.25% of full scale Serial Number: 2345399 Calibration Frequency: Annual Date of last calibration: 13/05/2015 Validity:13/05/2015 – 12/05/2016 Given that a delayed calibration was conducted for the pressure transmitter, values reported by this piece of equipment during this complete monitored period have been corrected by the maximum error identified on the delayed calibration of 0.687%.
Measuring/ Reading/ Recording frequency:	Continuous
Calculation method (if applicable):	Not applicable
QA/QC procedures:	Calibration for the pressure transmitter is done annually as per manufacturer' specifications.

Purpose of data:	Calculation of baseline emissions
Additional comment:	Following the last version of the "Tool to determine the mass flow of a GHG in a gaseous stream" (Version 02.0.0), this parameter is only used in the event the temperature of the gaseous stream flow is above 60ºC, when Option 2 of the tool (Simplified calculation without measurement of the moisture content) needs to be applied to convert the measured volumetric flow from wet basis to dry basis. It will therefore only be reported when required.

Data / Parameter:	$p_{H20,t,Sat}$
Unit:	Pa
Description:	Saturation pressure of H2O at temperature Tt in time interval t
Measured/ Calculated / Default:	Calculated
Source of data:	[1] Fundamentals of Classical Thermodynamics; Gordon J. Van Wylen, Richard E. Sonntag and Borgnakke; 4º Edition 1994, John Wiley & Sons, Inc.
Value(s) of monitored parameter:	-
Monitoring equipment:	This parameter is solely a function of the gaseous stream temperature Tt and can be found at reference [1] for a total pressure equal to 101,325 Pa
Measuring/ Reading/ Recording frequency:	-
Calculation method (if applicable):	-
QA/QC procedures:	
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	$v_{CH4,t,db}$
Unit:	m³ CH_4/m³ dry gas
Description:	Volumetric fraction of CH_4 in a time interval t on a dry basis
Measured/ Calculated / Default:	Measured
Source of data:	Gas analyser
Value(s) of monitored parameter:	Values are provided in monthly spreadsheets: CDM Data 2013_12a.xls CDM Data 2014_01a.xls CDM Data 2014_02a.xls CDM Data 2014_03a.xls CDM Data 2014_04a.xls CDM Data 2014_05a.xls CDM Data 2014_06a.xls CDM Data 2014_07a.xls CDM Data 2014_08a.xls CDM Data 2014_09a.xls

Monitoring equipment:	Type: Edinburgh Instruments, Gascard NG Accuracy Class: +/- 2% Serial Number: 2309 Calibration Frequency: calibration check at least annually Date of Last Calibration: 22/08/2013 Validity: 22/08/2013-21/08/2014 In accordance with the recommendations of the manufacturer, the stationary analysers are checked at least annually by the manufacturer. However, given that it was not carried out as per the QA/QC procedures the analyser has been considered as out of calibration for the period from 22/08/2014 to 30/09/2014 (end of this monitoring period). During this time, and following the guidance for delayed calibration, a discount of 2% has been applied to the monitored values from the analyser for the months of August and September 2014. The PE has used a second piece of equipment, the Biogas 5000, to crosscheck data reported by the stationary gas analysers. The handheld Biogas 5000 gas analyser is serviced and calibrated annually by the manufacturer and also checked and adjusted periodically by the monitoring contractor using certified calibration gas. Handheld Instrument (Biogas 5000) Serial Number: G500625 Accuracy: +/-0.5% of methane content Calibration frequency: annual Date of last calibration: 30/08/2013, 15/01/2014 Validity of Calibration Certificates: 30/08/2013 – 29/08/2014 15/01/2014 – 14/01/2015
Measuring/ Reading/ Recording frequency:	Continuous
Calculation method (if applicable):	Not applicable
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:	This parameter will be monitored as per Options A and B of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", version 2.0.0. The analyser has been installed in the main line between the flare and the booster.

Data / Parameter:	**$EG_{PJ,y}$**
Unit:	MWh
Description:	Amount of net electricity generated using LFG
Measured/ Calculated / Default:	Measured
Source of data:	Electricity Meter

Value(s) of monitored parameter:	Values are provided in monthly spreadsheets: CDM Data 2013_12a.xls CDM Data 2014_01a.xls CDM Data 2014_02a.xls CDM Data 2014_03a.xls CDM Data 2014_04a.xls CDM Data 2014_05a.xls CDM Data 2014_06a.xls CDM Data 2014_07a.xls CDM Data 2014_08a.xls CDM Data 2014_09a.xls
Monitoring equipment:	Type: Landis +Gyr (Export) Accuracy Class: 0.50% Serial Number: 86342181 Calibration Frequency: 10 years Date of Last Calibration: 22/03/2006 Validity: valid through the current monitoring period, up to 21/03/2016 Type: Landis +Gyr (Back up) Accuracy Class: 0.50% Serial Number: 95680700 Calibration Frequency: 10 years Date of Last Calibration: 12/11/2008 Validity: valid through the current monitoring period, up to 11/11/2018
Measuring/ Reading/ Recording frequency:	Continuous
Calculation method (if applicable):	Not applicable
QA/QC procedures:	Electricity meter will be calibrated as per manufacturer's specifications, but at least once every 10 years. Electricity meter will be subject to maintenance as per Eskom procedures. Data will be recorded electronically, and kept during the crediting period and two years after.
Purpose of data:	Calculation of baseline emissions
Additional comment:	Required to estimate the emission reductions from electricity generation from LFG.

Data / Parameter:	$\mathbf{EC_{PJ,y}}$
Unit:	MWh
Description:	Amount of electricity consumed by the project activity during the year y
Measured/ Calculated / Default:	Measured
Source of data:	Electricity Meter
Value(s) of monitored parameter:	Values are provided in monthly spreadsheets: CDM Data 2013_12a.xls CDM Data 2014_01a.xls CDM Data 2014_02a.xls CDM Data 2014_03a.xls CDM Data 2014_04a.xls CDM Data 2014_05a.xls CDM Data 2014_06a.xls CDM Data 2014_07a.xls CDM Data 2014_08a.xls CDM Data 2014_09a.xls

Monitoring equipment:	Type: Landis +Gyr (Import) Accuracy Class: 0.50% Serial Number: 85066208 Calibration Frequency: 10 years Date of Last Calibration: 26/08/2005 Validity: valid through the current monitoring period, up to 25/08/2015
Measuring/ Reading/ Recording frequency:	Continuous
Calculation method (if applicable):	Not applicable
QA/QC procedures:	Electricity meter will be calibrated as per manufacturer's specifications, but at least once every 10 years. Electricity meters will be subject to maintenance as per Eskom procedures Data will be recorded electronically, and kept during the crediting period and two years after.
Purpose of data:	Calculations of baseline emissions
Additional comment:	This parameter refers to the electricity consumed from the grid by the project activity.

Data / Parameter:	**$Op_{engine,h}$**
Unit:	-
Description:	Operation of the engine that consumes the LFG
Measured/ Calculated / Default:	Measured
Source of data:	Electricity Meter and SCADA system
Value(s) of monitored parameter:	Values are provided in monthly spreadsheets: CDM Data 2013_12a.xls CDM Data 2014_01a.xls CDM Data 2014_02a.xls CDM Data 2014_03a.xls CDM Data 2014_04a.xls CDM Data 2014_05a.xls CDM Data 2014_06a.xls CDM Data 2014_07a.xls CDM Data 2014_08a.xls CDM Data 2014_09a.xls
Monitoring equipment:	Type: Landis +Gyr (Export) Accuracy Class: 0.50% Serial Number: 86342181 Calibration Frequency: 10 years Date of Last Calibration: 22/03/2006 Validity: valid through the current monitoring period, up to 21/03/2016 Type: Landis +Gyr (Back up) Accuracy Class: 0.50% Serial Number: 95680700 Calibration Frequency: 10 years Date of Last Calibration: 12/11/2008 Validity: valid through the current monitoring period, up to 11/11/2018
Measuring/ Reading/ Recording frequency:	Hourly

Calculation method (if applicable):	For the engine using the LFG monitor that the plant is operating in hour h by monitoring the following: • Products generated: Monitor the generation of electricity generated. $Op_{engine,h}$ = 0 when: • No products are generated in the hour h Otherwise, $Op_{engine,h}$ = 1
QA/QC procedures:	Operation of engine is confirmed by its own control box which sends a signal to the PLC to communicate whether it is running or off.
Purpose of data:	Calculation of baseline emissions
Additional comment:	Data will be kept for at least two years after the end of the crediting period.

Data / Parameter:	**$Op_{flare,h}$**
Unit:	-
Description:	Operation of the flare that consumes the LFG
Measured/ Calculated / Default:	Measured
Source of data:	Thermocouple and SCADA system Flame detector, please refer to parameter $Flame_m$ below for details
Value(s) of monitored parameter:	Values are provided in monthly spreadsheets: CDM Data 2013_12.xls CDM Data 2014_01.xls CDM Data 2014_02.xls CDM Data 2014_03.xls CDM Data 2014_04.xls CDM Data 2014_05.xls CDM Data 2014_06.xls CDM Data 2014_07.xls CDM Data 2014_08.xls CDM Data 2014_09.xls
Monitoring equipment:	Thermocouple that monitors flame temperature (see below) and SCADA system. Flame Thermocouple: Type: Type N Thermocouple Probe Accuracy Class: 0.75% Serial Number: 3397084 Calibration Frequency: Replace as required, at least annually Date of Last Calibration: 29/11/2013 Validity: 3 years *Initial calibrations of the thermocouples are performed in the manufacturer's factory before being installed at the project site. Function is routinely checked by the monitoring contractor and items are replaced when malfunctions are noted, usually every few months, and should be replaced at least annually. The site record sheets show that replacements took place on 17/12/2013 during the monitoring period, with the following thermocouples being used:* 1. *SN 7650 – 15/12/2013 – 17/12/2013* 2. *SN 3397084 – 17/12/2013 to present date*
Measuring/ Reading/ Recording frequency:	Hourly

Calculation method (if applicable):	For the enclosed flare using the LFG monitor that it is operating in hour h by monitoring the following: • Flame. Flame detection system is used to ensure that the equipment is in operation; Op_{flare},h = 0 when: • Flame is not detected continuously in hour h (instantaneous measurements are made at least every minute); Otherwise, $Op_{flare,h}$ = 1
QA/QC procedures:	Thermocouples shall be replaced on failure or at least annually
Purpose of data:	Calculation of baseline emissions
Additional comment:	Data will be kept for at least two years after the end of the crediting period.

Data / Parameter:	**$Flame_m$**
Unit:	Flame on or Flame off
Description:	Flame detection of flare in the minute m
Measured/ Calculated / Default:	Measured
Source of data:	Flame Detector
Value(s) of monitored parameter:	Values are provided in monthly spreadsheets: CDM Data 2013_12a.xls CDM Data 2014_01a.xls CDM Data 2014_02a.xls CDM Data 2014_03a.xls CDM Data 2014_04a.xls CDM Data 2014_05a.xls CDM Data 2014_06a.xls CDM Data 2014_07a.xls CDM Data 2014_08a.xls CDM Data 2014_09a.xls
Monitoring equipment:	Flame Detector
Measuring/ Reading/ Recording frequency:	Once per minute
Calculation method (if applicable):	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 baseline emissions
Additional comment:	Data will be kept for at least two years after the end of the crediting period.

Data / Parameter:	**$T_{EG,m}$**
Unit:	°C
Description:	Temperature in the exhaust gas of the enclosed flare in minute m
Measured/ Calculated / Default:	Measured
Source of data:	Thermocouple

Value(s) of monitored parameter:	Values are provided in monthly spreadsheets: CDM Data 2013_12a.xls CDM Data 2014_01a.xls CDM Data 2014_02a.xls CDM Data 2014_03a.xls CDM Data 2014_04a.xls CDM Data 2014_05a.xls CDM Data 2014_06a.xls CDM Data 2014_07a.xls CDM Data 2014_08a.xls CDM Data 2014_09a.xls
Monitoring equipment:	Equipment Type: Type N Thermocouple Probe Accuracy Class: 0.75% Serial Number: 3397084 Calibration Frequency: Replace as required, at least annually Date of Last Calibration: 29/11/2013 Validity: 3 years *Initial calibrations of the thermocouples are performed in the manufacturer's factory before being installed at the project site. Function is routinely checked by the monitoring contractor and items are replaced when malfunctions are noted, usually every few months, and should be replaced at least annually. The site record sheets show that replacements took place on 17/12/2013 during the monitoring period, with the following thermocouples being used:* *1. SN 7650 – 15/12/2013 – 17/12/2013* *2. SN 3397084 – 17/12/2013 to present date*
Measuring/ Reading/ Recording frequency:	Once per minute
Calculation method (if applicable):	Not applicable
QA/QC procedures:	Thermocouples shall be replaced on failure or at least annually
Purpose of data:	Calculation of baseline emissions
Additional comment:	Data will be kept for at least two years after the end of the crediting period.

Data / Parameter:	$BE_{CH4, SWDS,y}$
Unit:	tCO2e
Description:	Methane generation from the landfill in the absence of the project activity at year y
Measured/ Calculated / Default:	Calculated
Source of data:	Calculated as per the "*Emissions from solid waste disposal sites" –Version 6*

Value(s) of monitored parameter:	<table><tr><th colspan="2">Period</th><th rowspan="2">$BE_{CH4,SWDS,y}$ (tonnes of CO2)</th></tr><tr><th>Start Date</th><th>End Date</th></tr><tr><td>15/12/2013</td><td>14/12/2014</td><td>111,761</td></tr><tr><td>15/12/2014</td><td>14/12/2015</td><td>119,537</td></tr><tr><td>15/12/2015</td><td>14/12/2016</td><td>124,886</td></tr><tr><td>15/12/2016</td><td>14/12/2017</td><td>128,588</td></tr><tr><td>15/12/2017</td><td>14/12/2018</td><td>131,167</td></tr><tr><td>15/12/2018</td><td>14/12/2019</td><td>132,978</td></tr><tr><td>15/12/2019</td><td>14/12/2020</td><td>134,262</td></tr><tr><td colspan="2">Total</td><td>883,179</td></tr><tr><td colspan="2">Annual average</td><td>126,168</td></tr></table>
Monitoring equipment:	Not applicable
Measuring/ Reading/ Recording frequency:	Not applicable
Calculation method (if applicable):	Calculated ex-ante as per the “Emissions from solid waste disposal sites” – Version 6
QA/QC procedures:	Not applicable
Purpose of data:	Calculation of baseline emissions
Additional comment:	Used for ex-ante estimation of the amount of methane that would have been destroyed/combusted during the year.

Data / Parameter:	**TDL_y**
Unit:	%
Description:	Average technical transmission and distribution losses in the grid in year y for the voltage level at which electricity is obtained from the grid at the project site.
Measured/ Calculated / Default:	Default
Source of data:	Value of average transmission losses from the South African national electricity utility, Eskom Report 2013/2014, page 98, available at http://integratedreport.eskom.co.za/pdf/full-integrated.pdf
Value(s) of monitored parameter:	8.88%
Monitoring equipment:	Manual check
Measuring/ Reading/ Recording frequency:	Annual check
Calculation method (if applicable):	Not applicable
QA/QC procedures:	Eskom website will be checked annually.
Purpose of data:	Calculation of baseline emissions and Calculation of project emissions
Additional comment:	-

Data / Parameter:	**Management of SWDS**
Unit:	-
Description:	**Management of SWDS**

Measured/ Calculated / Default:	Measured
Source of data:	Site records
Value(s) of monitored parameter:	The Project Entity is in compliance with their operational manual and procedures.
Monitoring equipment:	Manual check
Measuring/ Reading/ Recording frequency:	Annually
Calculation method (if applicable):	Not applicable
QA/QC procedures:	Any change in the management of the landfill will be justified by referring to technical or regulatory specifications. Also, it will be documented and filed by the landfill operator.
Purpose of data:	-
Additional comment:	-

D.3. Implementation of sampling plan

>>
Not applicable.

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

>>
According to the baseline methodology ACM0001 – Version 15.0, baseline emissions are calculated as follows:

$$BE_y = BE_{CH4,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y} \qquad \text{Equation (1)}$$

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)

Heat is not generated and natural gas is not used in the project and therefore both $BE_{HG,y}$ and $BE_{NG,y}$ are assigned a value of zero. $BE_{CH4,y}$ and $BE_{EC,y}$ are calculated as follows:

Calculation of $BE_{CH4,y}$

Baseline emissions of methane from the SWDS are calculated as follows:

$$BE_{CH4} = \left(\left(1 - OX_{top\_layer}\right) \times F_{CH4,PJ,y} - F_{CH,BL,y}\right) \times GWP_{CH4} \qquad \text{Equation (2)}$$

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)

In the calculations of emission reductions, OX_{top_layer} is assigned a value of 0.1 and GWP_{CH4} is assigned a value of 25. No methane would be flared in the baseline scenario and therefore $F_{CH4,BL,y}$ is assigned a value of zero. $F_{CH4,PJ,y}$ is calculated as follows:

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

$F_{CH4,PJ,y}$ is determined as the sum of the quantities of methane flared and used in power plants, boilers, air heaters, glass melting furnaces, kilns and natural gas distribution network as follows:

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

Where:
$F_{CH4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used in the project activity in year y (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 to the trucks in year y (t CH_4/yr)

No methane in the project is either used for heat generation or sent to the natural gas distribution network and therefore both $F_{CH4,HG,y}$ and $F_{CH4,NG,y}$ are assigned a value of zero.

As an example using data from the month of January 2014, the aggregated value of $F_{CH4,PJ,y}$ for the month is 90.77 t CH_4.

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

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

$$F_{CH4,flared,y} = F_{CH4,sent\_flare,y} - \frac{PE_{flare,y}}{GWP_{CH4}} \quad \text{Equation (4)}$$

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)

For the second crediting period of the project, GWP_{CH4} is assigned a value of 25.

$F_{CH4,sent\_flare,y}$ is determined using the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream". The tool requires the calculation as follows (Option A is used as the gaseous stream has a temperature of less than 60°C):

$F_{i,t} = V_{t,db} * v_{i,t,db} * \rho_{i,t}$

With

$\rho_{i,t} = P_t * MM_i / R_u * T_t$

Where:

$F_{i,t}$ = Mass flow of greenhouse gas i in the gaseous stream in time interval t (kg gas/h)
$V_{t,db}$ = Volumetric flow of the gaseous stream in time interval t on a dry basis (m^3 dry gas/h)
$v_{i,t,db}$ = Volumetric fraction of greenhouse gas i in the gaseous stream in a time interval t on a dry basis (m^3 gas i/m^3 dry gas)
$\rho_{i,t}$ = Density of greenhouse gas i in the gaseous stream in time interval t (kg gas i/m^3 gas i)
P_t = Absolute pressure of the gaseous stream in time interval t (Pa)
MM_i = Molecular mass of greenhouse gas i (kg/kmol)
R_u = Universal ideal gases constant ($Pa.m^3/kmol.K$)
T_t = Temperature of the gaseous stream in time interval t (K)

The gas temperature and pressure are monitored to allow these calculations to be carried out.

As an example using data from the month of January 2014, the aggregated value of $F_{CH4,flared,y}$ for the month is 7.95 t CH_4.

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

The amount of methane in the LFG which is used for electricity generation in year y (FCH4,EL, y) is determined using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” version 2.0.0, applying the requirements described in the PDD where the gaseous stream is the LFG delivered to electricity generation. Option 2 of the mentioned “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” version 2.0.0 under the name “Simplified calculation without measurement of the moisture content” is applied as a simple and conservative approach to determine the absolute humidity of the gaseous stream of $F_{CH4,EL,y}$ by assuming the gaseous stream is dry or saturated depending on which is the conservative situation. Since the gaseous stream is measured on volume basis and the volumetric fraction of methane is measured in dry basis, two options are used in the project activity:

- Option A has been applied throughout this monitoring period, as temperature of the gaseous stream (T_t) is less than 60ºC (333.15 K) at the flow measurement point (way b of Option A), and
- Option B has not been used, as per the PDD is to be used in case of wet basis of the gas, demonstrating that the temperature of the gaseous stream (Tt) is more than 60ºC (333.15 K) at the flow measurement point and by converting the measured volumetric flow from wet basis to dry basis.

The following paragraphs show the formulae described in the PDD used to determine the absolute humidity of the gaseous streams applying the Option 2 “Simplified calculation without measurement of the moisture content” and to determine the flow and volumetric fraction of the gaseous stream applying Option A and Option B as per the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” version 2.0.0:

- **Option 2: Simplified calculation without measurement of the moisture content**

  This option provides a simple and conservative approach to determine the absolute humidity by assuming the gaseous stream is dry or saturated depending on which is the conservative situation. If it is conservative to assume that the gaseous stream is dry, then $m_{H2O,t,db}$ is assumed to equal 0. If it is conservative to assume that the gaseous stream is saturated, then $m_{H2O,t,db}$ is assumed to equal the saturation absolute humidity ($m_{H2O,t,db,sat}$) and calculated using equation (4) of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” version 2.0.0 as follows:.

$$m_{H2O,t,db,Sat} = \frac{p_{H2O,t,Sat} * MM_{H2O}}{(P_t - p_{H2O,t,Sat}) * MM_{t,db}}$$

(4) equation of “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” version 2.0.0

Where:

Variable		*Definition*
$m_{H2O,t,db,sat}$	=	Saturation absolute humidity in time interval *t* on a dry basis (kg H2O/kg dry gas)
$p_{H20,t,Sat}$	=	Saturation pressure of H_2O at temperature T_t in time interval t (Pa)
T_t	=	Temperature of the gaseous stream in time interval *t* (K)
P_t	=	Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_{H2O}		Molecular mass of H2O (kg H2O/kmol H2O)
$MM_{t,db}$		Molecular mass of the gaseous stream in a time interval *t* on a dry basis (kg dry gas/kmol dry gas)

Parameter $MM_{t,db}$ is estimated using equation (3) of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 2.0.0 as follows:

$$MM_{t,db} = \sum_{k} (v_{k,t,db} * MM_k)$$

(3) equation of "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 2.0.0

Where:

Variable		*Definition*
$MM_{t,db}$	=	Molecular mass of the gaseous stream in time interval *t* on a dry basis (kg dry gas/kmol dry gas)
$v_{k,t,db}$	=	Volumetric fraction of gas *k* in the gaseous stream in time interval *t* on a dry basis (m^3 gas k/m^3 dry gas)
MM_k	=	Molecular mass of gas *k* (kg/kmol)
K	=	All gases, except H2O, 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). See available simplification below

The determination of the molecular mass of the gaseous stream (MMt,db) 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. The simplification is not acceptable if it is differently specified in the underlying methodology.

Since methodology ACM0001 version 15.0 states that the simplification offered for calculating the molecular mass of the gaseous stream is valid (equations 3 or 17 in the tool), only the volumetric fraction of methane (CH_4) contained in the gaseous stream ($v_{CH4,t,db}$) has been measured because it is the greenhouse gas considered in the emission reduction calculation. Therefore, the difference to 100% is considered as pure nitrogen.

- **Option A**

Flow measurement on a dry basis is not feasible for a wet gaseous stream. Therefore, to use option A it is necessary to demonstrate that the gaseous stream is dry to use this option. There are two ways to do this:

a) Measure the moisture content of the gaseous stream (CH_2O,t,db,n) and demonstrate that this is less or equal to 0.05 kg H_2O/m^3 dry gas; or

b) Demonstrate that the temperature of the gaseous stream (T_t) is less than 60ºC (333.15 K) at the flow measurement point.

For the project activity, the method b) from above has been used, demonstrating that the temperature of the gaseous stream (T_t) is less than 60ºC (333.15 K) at the flow measurement point.

The mass flow of greenhouse gas i ($F_{i,t}$) is determined as follows:

$$F_{i,t} = V_{t,db} * v_{i,t,db} * \rho_{i,t}$$

(5) equation of "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 2.0.0

With:

$$\rho_{i,t} = \frac{P_t * MM_i}{R_u * T_t}$$

(6) equation of "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 2.0.0

Where:

Variable		*Definition*
$F_{i,t}$	=	Mass flow of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas/h)
$V_{t,db}$	=	Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m³ dry gas/h)
$v_{i,t,db}$	=	Volumetric fraction of greenhouse gas *i* in the gaseous stream in a time interval *t* on a dry basis (m³ gas *i*/m³ dry gas)
$\rho_{i,t}$	=	Density of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas *i*/m³ gas *i*)
P_t	=	Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_i	=	Molecular mass of greenhouse gas *i* (kg/kmol)
R_u	=	Universal ideal gases constant (Pa.m^3/kmol.K)
T_t	=	Temperature of the gaseous stream in time interval *t* (K)

Calculation of $PE_{,flare,y}$

$PE_{,flare,y}$ is calculated in accordance with "Project emissions from flaring" (version 02.0.0)

$$PE_{flare,y} = GWP_{CH4} \times \sum_{m=1}^{525600} F_{CH4,RG,m} \times (1 - \eta_{flare,m}) \times 10^{-3} \quad (15)$$

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*

A default flare efficiency has been applied for the project. The default value used is 80% to reflect that the flare is an enclosed, low height variant. If the flame is detected in minute m but the temperature of the flare or flow rate of the residual gas are not within the manufacturers specification for the flare, or if the flare is not operating, the flare efficiency is 0% and no emissions are claimed.

The global warming potential of methane is given a default value of 25.

$F_{CH4,RG,m}$ is determined using the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", Option A as described above.

As an example using data from the month of January 2014, the aggregated value of $PE_{,flare,y}$ for the month is 218.96 t CO_2e.

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

$F_{CH4,EL,y}$ is also determined using the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" and the working hours of the power plant are monitored so that no emission reductions are claimed for methane destruction during non-working hours. The tool requires the calculation as follows (Option A is used as the gaseous stream has a temperature of less than 60°C):

$F_{i,t} = V_{t,db} * v_{i,t,db} * \rho_{i,t}$

With

$\rho_{i,t} = P_t * MM_i / R_u * T_t$

Where:

$F_{i,t}$ = Mass flow of greenhouse gas i in the gaseous stream in time interval t (kg gas/h)
$V_{t,db}$ = Volumetric flow of the gaseous stream in time interval t on a dry basis (m^3 dry gas/h)
$v_{i,t,db}$ = Volumetric fraction of greenhouse gas i in the gaseous stream in a time interval t on a dry basis (m^3 gas i/m^3 dry gas)
$\rho_{i,t}$ = Density of greenhouse gas i in the gaseous stream in time interval t (kg gas i/m^3 gas i)
P_t = Absolute pressure of the gaseous stream in time interval t (Pa)
MM_i = Molecular mass of greenhouse gas i (kg/kmol)
R_u = Universal ideal gases constant (Pa.m^3/kmol.K)
T_t = Temperature of the gaseous stream in time interval t (K)

The gas temperature and pressure are monitored to allow these calculations to be carried out.

As an example using data from the month of January 2014, the aggregated value of $F_{CH4,EL,y}$ for the month is 82.82 t CH_4.

Using the example figures from January 2014 as referenced above, the calculation of $BE_{CH4,y}$ produces a value of 2,042.28 t CO_2e for the month.

Calculation of $BE_{EC,y}$

Calculation of $BE_{EC,y}$ is determined using the "Tool to calculate baseline, project and/or leakage emissions from electricity" (version 1).

$$BE_{EC,y} = \sum_k EC_{BL,k,y} \times EF_{EL,k,y} \times (1 + TDL_{k,y}) \quad \textbf{(2)}$$

Where:

$BE_{EC,y}$ = the baseline emissions from electricity consumption by the project activity during the year (t CO_2/yr)
$EC_{BL,k,y}$ = the quantity of electricity that would be consumed by the baseline electricity consumption source k during the year y (MWh)
$EF_{EL,k,y}$ = the emission factor for the grid in year y (tCO_2/MWh)
$TDL_{k,y}$ = the average technical transmission and distribution losses in the grid in the year y for the voltage level at which electricity is obtained from the grid at the project site.

As an example using data from the month of January 2014:

- 448.19 MWh of electricity was produced by the project;
- the emission factor of the grid, as defined by the standardized baseline "Grid emission factor for the Southern African power tool", is 0.9488 tCO_2/MWh; and
- the average technical transmission and distribution losses, based on the most recently published data from Eskom[1], was 8.88%.

On the basis of the above, the baseline emissions from electricity production by the project for the month of January 2014 are therefore:

- 448.19 x 0.9488 x (1 + 0.0888) = 471.83 t CO_2e

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[1] *Integrated Results for the year ended 31 March 2014*. Eskom. 11th July 2014

For January 2014, the total baseline emissions (BE_y) are therefore the sum of $BE_{EC,y}$ and $BE_{CH4,y}$ which equates to 2,504.37 t CO_2e.

Electronic spreadsheets are attached as follows which present the full calculations referenced in this monitoring report:

CDM Data 2013_12a.xls
CDM Data 2014_01a.xls
CDM Data 2014_02a.xls
CDM Data 2014_03a.xls
CDM Data 2014_04a.xls
CDM Data 2014_05a.xls
CDM Data 2014_06a.xls
CDM Data 2014_07a.xls
CDM Data 2014_08a.xls
CDM Data 2014_09a.xls

E.2. Calculation of project emissions or actual net GHG removals by sinks

>>
Project emissions are calculated as:

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

Where:

PE_y = Project emissions in year *y* (t CO_2/yr)
$PE_{EC,y}$ = Emissions from consumption of electricity due to the project activity in year *y* (t CO_2/yr)
$PE_{FC,y}$ = Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation, in year *y* (t CO_2/yr)
$PE_{DT,y}$ = Emissions from the distribution of compressed/liquefied LFG using trucks, in year *y* (t CO_2/yr)

The project has not consumed fossil fuels or distributed compressed/liquefied LFG using trucks and therefore both $PE_{FC,y}$ and $PE_{DT,y}$ are not calculated and are assigned a value of zero.

The value of $PE_{EC,y}$ is calculated using the “Tool to calculate baseline, project and/or leakage emissions from electricity” (version 1).

Project emissions from consumption of electricity are calculated based on the quantity of electricity consumed, an emission factor for electricity generation and a factor to account for transmission losses, as follows:

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

Where:

$PE_{EC,y}$ = the project emissions from electricity consumption by the project activity during the year (t CO_2/yr)
$EC_{PJ,j,y}$ = the quantity of electricity consumed by the project activity during the year y (MWh)
$FE_{EL,j,,y}$ = the emission factor for the grid in year y (tCO_2/MWh)
$TDL_{j,y}$ = the average technical transmission and distribution losses in the grid in the year y for the voltage level at which electricity is obtained from the grid at the project site.

As an example using data from the month of January 2014:

- 20.71 MWh of electricity was consumed by the project;
- the emission factor of the grid, as defined by the standardized baseline “Grid emission factor for the Southern African power tool”, is 0.9488 tCO_2/MWh; and
- the average technical transmission and distribution losses, based on the most recently published data from Eskom[2], was 8.88%.

On the basis of the above, the project emissions from electricity consumption by the project for the month of January 2014 are therefore:

- 20.71 x 0.9488 x (1 + 0.0888) = 20.63 t CO_2

Electronic spreadsheets are attached as follows which present the full calculations referenced in this monitoring report:

CDM Data 2013_12a.xls
CDM Data 2014_01a.xls
CDM Data 2014_02a.xls
CDM Data 2014_03a.xls
CDM Data 2014_04a.xls
CDM Data 2014_05a.xls
CDM Data 2014_06a.xls
CDM Data 2014_07a.xls
CDM Data 2014_08a.xls
CDM Data 2014_09a.xls

E.3. Calculation of leakage

>>
Under methodology ACM0001 “Flaring or use of landfill gas” Version 15.0, no leakage effects need to be accounted for.

[2] *Integrated Results for the year ended 31 March 2014*. Eskom. 11th July 2014

E.4. Summary of calculation of emission reductions or net GHG removals by sinks

Item	Baseline emissions or baseline net GHG removals by sinks (t CO_2e)	Project emissions or actual net GHG removals by sinks (t CO_2e)	Leakage (t CO_2e)	GHG emission reductions or net GHG removals by sinks (t CO_2e) achieved in the monitoring period		
				Up to 31/12/2012	From 01/01/2013	Total amount
Total	22,334	200	0	0	22,134	22,134

E.5. Comparison of actual emission reductions or net GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO_2e)	49,018 tCO_2e	22,134 tCO_2e

E.6. Remarks on difference from estimated value in registered PDD

>>

The actual emission reductions achieved during the monitoring period were lower than predicted in the registered PDD. This is mainly due to frequent power outages impacting on the operation of equipment at the site.

Appendix 1. Contact information of project participants and responsible persons/entities

Project participant and/or responsible person/ entity	☐ Project participant ☒ Person/entity responsible for completing the CDM-MR-FORM
Organization name	SLR Consulting Limited
Street/P.O. Box	Holsworth Park
Building	2nd Floor, Hermes House
City	Shrewsbury
State/region	Shropshire
Postcode	SY3 5HJ
Country	United Kingdom
Telephone	+44 (0)1743 239250
Fax	
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Document information

Version	Date	Description
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.
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 (EB70, 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	28 May 2010	EB 54, Annex 34. Initial adoption.

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