Monitoring report form for CDM project activity
(Version 06.0)

MONITORING REPORT		
Title of the project activity	Embralixo/Araúna – Bragança Landfill Gas Project	
UNFCCC reference number of the project activity	1179	
Version number of the PDD applicable to this monitoring report	8.0	
Version number of this monitoring report	3.0	
Completion date of this monitoring report	21/11/2018	
Monitoring period number	#5	
Duration of this monitoring period	19/06/2017 – 31/03/2018	
Monitoring report number for this monitoring report	Not applicable.	
Project participants	Embralixo – Empresa Bragantina de Varrição e Coleta de Lixo Ltda. Araúna Participações e Investimentos Ltda. First Climate (Switzerland) AG	
Host Party	Brazil	
Sectoral scopes	13 - Waste handling and disposal	
Applied methodologies and standardized baselines	ACM0001, version 18.0 - Flaring or use of landfill gas	
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
	-	11,184 tCO_2e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	27,442 tCO_2e	

SECTION A. Description of project activity

A.1. General description of project activity

>>
The CDM project activity "Embralixo/Araúna – Bragança Landfill Gas Project" is implemented at the Bragança landfill. During the considered monitoring period, the project activity promoted real, measurable and permanent abatement of greenhouse gas (GHG) emissions through collection and destruction (through combustion in a high temperature enclosed flare) of landfill gas (LFG) that is generated at this landfill.

The Bragança landfill is operated by the solid waste management company and host-country project participant Embralixo – Empresa Bragantina de Varrição e Coleta de Lixo Ltda. The Bragança landfill was inaugurated in 1990 and has employed *state-of-the-art* waste landfilling technics and operation management. In the absence of the CDM project activity (that was commissioned in 2007), no efficient management of LFG would occur.

LFG (which is rich in methane) is generated at the Bragança landfill as a result of anaerobic decomposition of municipal solid waste (MSW) historically disposed at the landfill. During the monitoring period from 19/06/2017 to 31/03/2018, the project activity encompassed the following components/infrastructure:

(i) Capturing of LFG through a set of LFG collecting wells that are interconnected through a LFG collection pipeline network
(ii) Destruction of all collected LFG (which is collected by the LFG collecting wells and transported through the LFG collection pipeline network) by controlled combustion (in a high temperature enclosed flare installed in a LFG destruction facility).

As indicated in the registered PDD valid for the 2nd 7-year renewable crediting period of the project activity (hereafter denominated as "PDD"), the project design does not encompass any utilization of LFG. The project activity was implemented and has operated without having any share of collected LFG being sold as gaseous fuel to a local industry (in order to be combusted in boilers) or being utilized as fuel to power a thermal desorption unit or an electricity generation facility. During the monitoring period from 19/06/2017 to 31/03/2018, no collected LFG was thus utilized as gaseous fuel for electricity generation, as gaseous fuel in boilers or for any purpose other than being destroyed through combustion in the installed high temperature enclosed flare.

The amount and quality of collected LFG which is sent to the flare have been continuously measured, recorded and reported along the considered monitoring period. As also established in the project's monitoring procedure valid for the 2nd 7-year crediting period as per the PDD, the status/conditions of the high temperature enclosed flare and its compliance with operational requirements (as established by the flare equipment manufacturer) are also monitored.

A.2. Location of project activity

>>
The landfill where the project activity is implemented serves as a Municipal Solid Waste (MSW) disposal site for the city of Bragança Paulista and other cities in the region and it is named Bragança landfill. This landfill is located in the Estrada Municipal do Campo Novo / no number – Bragança Paulista – São Paulo, Brazil.

The exact geographic coordinates of the project site (in decimal and in Degree, Minute, Second (DMS) formats) are as follows:

Format	Latitude	Longitude
DMS	22° 56' 43" S	46° 34' 25" W

Decimal	-22.9453	-46.5736

The following images show the location of the project activity.

Figure 1 - Project's location within Brazil
(as visible in March 2017 by using Google Earth PC application)

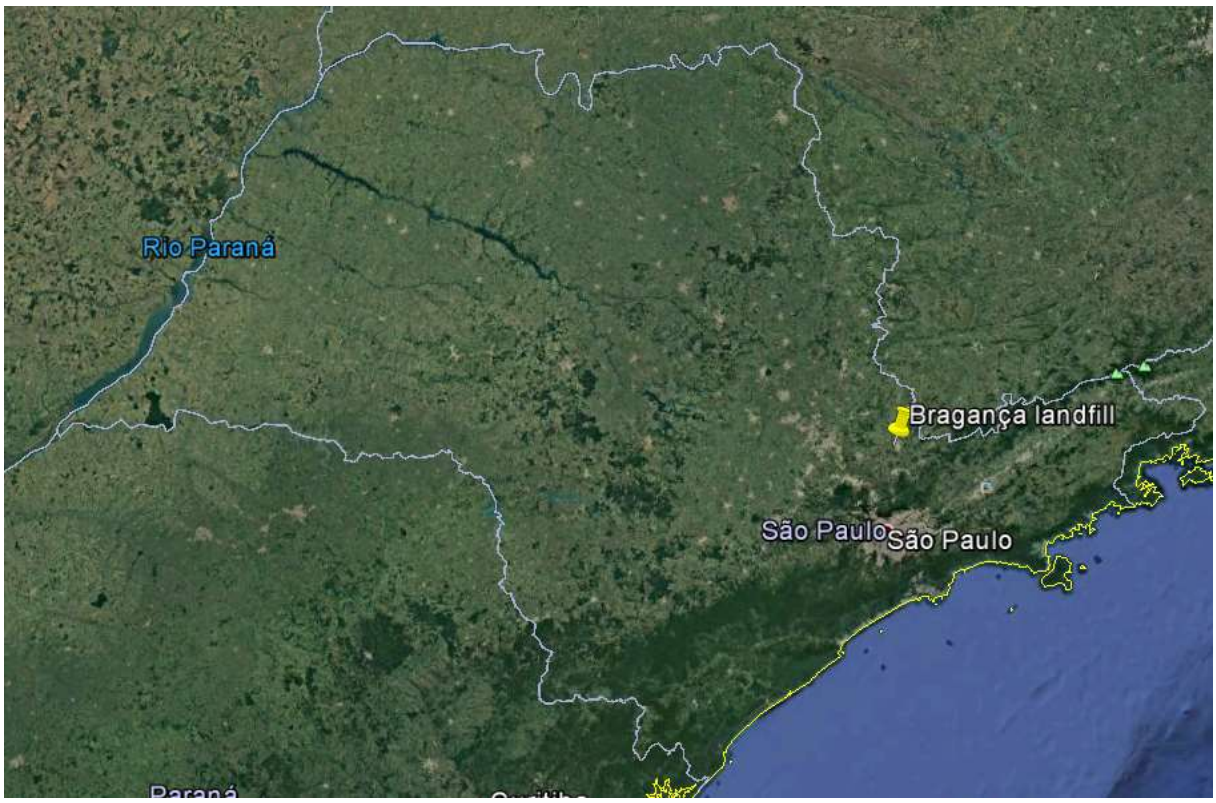


Figure 2 - Project's location within São Paulo State
(as visible in March 2017 by using Google Earth PC application)

Figure 3 - Project's location within the city of Bragança Paulista
(as visible in March 2017 by using Google Earth PC application)

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Brazil (host)	Embralixo – Empresa Bragantina de Varrição e Coleta de Lixo Ltda (Private Entity)	No
Brazil (host)	Arauna Participações e Investimentos Ltda (Private Entity)	No
Switzerland	First Climate (Switzerland) AG	No

A.4. Reference to applied methodologies and standardized baselines

>>
The project activity applies the following large-scale CDM baseline and monitoring methodology:

- ACM0001 – "*Flaring or use of landfill gas*" (version 18.0) (https://cdm.unfccc.int/filestorage/0/X/2/0X2IE6B1PJDLKMWN89AZGTFUHR3VYS/EB94_repan04_ACM0001.pdf?t=TGx8b3J0NmdrfDAsr0FIlp4m3kJdaDUB-j3F)

For the considered monitoring period, as also established in the PDD, the following methodological tools are also applied[1]:

- "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 02.0, EB 87) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v2.0.pdf)
- "Project emissions from flaring" (version 02.0.0, EB 68) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v2.0.pdf)
- "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0, EB 87) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-v3.0.pdf)
- "Tool to calculate the emission factor for an electricity system" (version 05.0, EB 87) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v5.0.pdf)

A.5. Crediting period type and duration

>>
2nd 7-year renewable crediting period from 01/01/2015 to 31/12/2021.

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

>>
During the considered monitoring period, the project activity encompassed the operation of the following equipment:

[1] The registered PDD also refer to the methodological tool "Emissions from solid waste disposal sites" (version 08.0, EB94). However, it is crucial to note that, as outlined in the PDD, applicable guidance of this methodological tools is only applied in the context of ex-ante estimation of emission reductions to be achieved by the project activity during the 2nd 7-year crediting period. This methodological tool is thus not applied for the ex-post determination of emission reductions achieved by the project activity.

- LFG gas extraction system composed of 27 vertical extraction wells, of which 22 were under regular operation and connected by HDPE pipes at the end of the considered monitoring period.

- 1 centrifugal blower with a 1,500 Nm^3/h capacity,

- 1 LFG condensation traps (for separating undesirable liquids in the collected LFG (leachate and condensate))

- LFG monitoring equipment/instruments:
    - 1 LFG flow meter,
    - 1 LFG temperature sensor,
    - 1 LFG pressure sensor,
    - 1 CH_4 content gas analyzer,
    - 1 thermocouple (to measure temperature in the exhaust gases of the flare)),
    - 1 UV flame detector (to monitor the operational and flame status of the installed flare)

- One high temperature enclosed flare (designed and supplied by Brasmetano Ind. e Com. Ltda.). The installed flare has a declared maximum LFG flow operational capacity of 1,500 Nm^3/h.

Further details about monitoring instruments/equipment under operation during the considered monitoring period are included in Section D.2.

In general, during the considered monitoring period, the project activity was implemented and has operated under full conformance with the previously conceived project design (as described in the PDD).

During the considered monitoring period, the project activity faced events when it became temporarily out of operation due to different reasons (occurred temporarily interruption in the supply of grid-sourced electricity, occurred previously planned and unplanned equipment maintenance/repair events, occurred performance of regular calibration events, events of drainage of condensate from the project's LFG pipeline, identification of unexpected problems in the PLC panel, data communication problems, etc.).

It is relevant to note that, during the 3.5-year period from January 2014 until August 2017, the project activity operated with a very reduced activity level. Moreover, during this particular period, no data from the LFG related monitoring instruments were recorded/reported by the project's data acquisition system. Due to that, no emission reductions are thus claimed during such period in which the project operated under very reduced activity level. As a result of made efforts to have the project activity again under normal operation, the project's monitoring system finally resumed its regular operations (in terms of data gathering and recording) on 04/08/2017. From 04/08/2017 onwards the project's LFG collection and destruction infrastructure also resumed to its normal conditions (in terms of quantitative and qualitative aspects for the collection and destruction of LFG).

Since the project's operation start in January 2008 until the end of the considered monitoring period, no backup captive off-grid electricity generator was ever used to meet the project's electricity demand during eventual interruptions of the supply of grid-sourced electricity to the project activity.

B.2. Post-registration changes

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

>>

Not applicable for the considered monitoring period. There are no temporary deviation from the registered monitoring plan or applied methodology encompassed by the considered monitoring period and/or previously approved by the CDM-EB.

B.2.2. Corrections

>>

Not applicable for the considered monitoring period. There are no Corrections (in information that do not affect the project design) encompassed by the considered monitoring period and/or previously approved by the CDM-EB.

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

>>

Not applicable for the considered and/or previous monitoring periods. There are no changes to start date of the crediting period encompassed by the considered monitoring period and/or previously approved by the CDM-EB that would be applicable for the considered monitoring period and/or previous monitoring periods.

B.2.4. Inclusion of monitoring plan

>>

Not applicable for the considered and/or previous monitoring periods. There is no inclusion of monitoring plan (and/or applicable methodological tools) encompassed by the considered monitoring period and/or previously approved by the CDM-EB that would be applicable for the considered monitoring period and/or previous monitoring periods.

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

>>

Not applicable for the considered monitoring period. There are no permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied CDM baseline and monitoring methodology and/or applicable methodological tools encompassed by the considered monitoring period and/or previously approved by the CDM-EB that would be applicable for the considered monitoring period and/or previous monitoring periods.

B.2.6. Changes to project design

>>

Not applicable for the considered monitoring period. There are no permanent changes to the design of the project activity encompassed by the considered monitoring period and/or previously approved by the CDM-EB that would be applicable for the considered monitoring period and/or previous monitoring periods.

SECTION C. Description of monitoring system

>>

C.1. INSTRUMENTATION

Figure shows a schematic instrumentation diagram of the project's monitoring system as per the configuration available during the monitoring period.

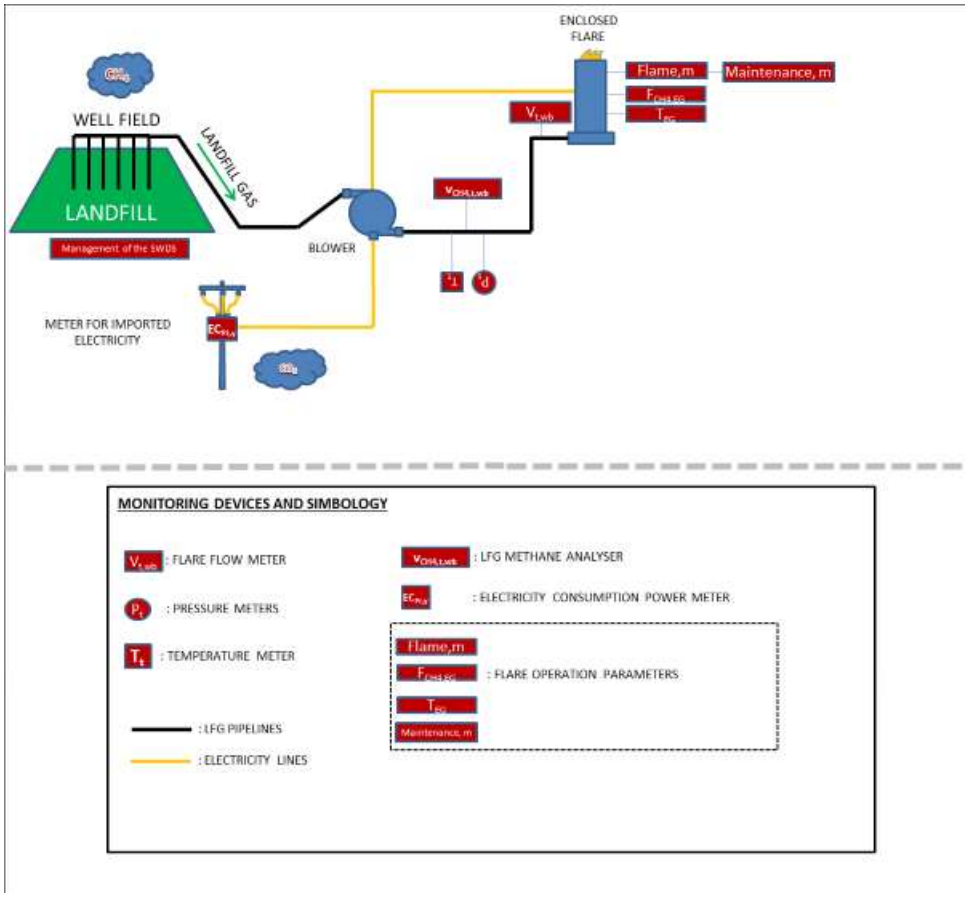


Figure 4: Schematic instrumentation diagram of the project's monitoring system valid for the considered monitoring period

As part of the project activity, the following monitoring instruments/equipment are installed along the main LFG distribution pipeline (in its final section) within the project's LFG destruction facility (between the installed centrifugal blowers and the enclosed flare):

- One LFG flow meter. This measurement unit measures the flow of LFG collected by the project activity which is sent to the installed flare for combustion.

- One LFG pressure sensor. This instrument measures LFG pressure in the section between the centrifugal blowers and the high temperature enclosed flare in the LFG collection pipeline.

- One LFG temperature sensor. This instrument measures the LFG temperature in the LFG collection pipeline in the section between the centrifugal blowers and the high temperature enclosed.

- One continuous CH_4 content gas analyzer unit. This equipment provides continuous measurement of methane fraction in collected LFG. While the project's LFG collection process ensures that most of the humidity of the collected LFG is removed by condensation (in available condensation removal traps) prior of having collected LFG passing through the installed LFG flow meters and the installed CH_4 content gas analyzer unit, flow of collected LFG being sent to the flare and CH_4 fraction of collected LFG can thus be regarded as measured under the same basis/conditions in terms of moisture.

- One thermocouple that measure the temperature in the exhaust gas of the flare ($T_{EG,m}$). Such measurements are considered in order to assure the operation of flare as per the operation conditions defined by the flare manufacturer. The thermocouple is located in the upper section of the installed flare and is only used to monitor the flare temperature from

an operational point of view and in order to ensure that high flare combustion efficiency is achieved.

- One UV flame detector. For every minute that flame is detected in the flare, its operational status is considered as “On” and emission reductions are thus accounted for such given minute.

The electricity demand of the project activity has been entirely met by imports of grid-sourced electricity. Consumption of grid-sourced electricity during the considered monitoring period was measured by an installed electricity meter.

C.2. DATA ACQUISITION, STORAGE AND MANAGEMENT SYSTEM

As part of the monitoring process for the project activity, all continuous measurements of LFG related monitoring parameters (including measurements of temperature of exhaust gas of the flare and status of the flare) were recorded/reported every minute during the considered monitoring period in an installed data acquisition unit and archiving solution (database) designed and configured by Araúna Participações e Investimentos Ltda.

As part of the operation of the project activity, monitoring data has been recorded by the utilized data acquisition and archiving infrastructure (database). Recorded LFG related monitoring data (+ measurement records for temperature of temperature of exhaust gas of the flare, status of the flare, and operational status of the installed engine-generator set consuming LFG) are regarded as “*raw data*” for processing emission reduction calculations valid for the considered monitoring period. As part of the implemented monitoring procedure for the project activity, such “*raw data*” is exported into MS-Excel spreadsheet format for generating the main emission reduction calculation spreadsheet which is enclosed to this Monitoring Report[2].

The project’s operational staff for the LFG destruction facility are trained for all related operation, maintenance and safety procedures. Related training certificates for operational staff were issued and are kept achieved. All relevant operational events (emergency, failures, maintenance, etc.) for the LFG destruction facility are registered in operation workbooks. All performed maintenance and/or repair events applicable for the critical pieces of equipment for both project components (flare, centrifugal blowers, CH_4 content gas analyzer unit, air compressor, engine-generator modular package sets, control systems, etc.) are also registered in the project’s operation workbooks.

Records and documented evidences for performed calibration events in monitoring instruments/equipment are also registered in workbooks. The calibration certificates and registries for all performed calibration events are also kept in files. Calibration procedures are performed in accordance with applicable recommendation and requirements as established by equipment manufacturers and are also under conformance with applicable CDM requirements. The project’s maintenance manual also includes related calibration procedures, requirements and instructions.

[2] 3 (three) calculation spreadsheets are enclosed to this Monitoring Report:

- 1 spreadsheet in which every-minute monitoring records valid for the whole considered monitoring period are reported. This spreadsheet is used for the determination of baseline emissions and it is termed as “main emission reduction spreadsheet”

- 1 spreadsheet with calculations of the parameter Flare efficiency ($\eta_{flare,calc,m}$)

- 1 spreadsheet in which emissions reductions achieved by the project activity during the considered monitoring period are calculated and summarized. This spreadsheet is termed as “summarized emission reduction spreadsheet”

C.3. MANAGERIAL RESPONSIBILITIES

Ensuring operation of the whole project activity under compliance with all applicable CDM requirements is the responsibility of the CDM Operational Manager of Araúna Participações e Investimentos Ltda. The CDM Project Manager of Araúna Participações e Investimentos Ltda. (who directly reports to the vice-president of the organization), is in charge of all validation and verification related activities (including development of PDD, Monitoring Reports and supporting documentation). The CDM Operational Manager is assisted/supported by hired technical consultants from the hired CDM technical consultancy/advisory service company UniCarbo – Energia e Biogás Ltda. The CDM Project Manager is responsible for ensuring the correct application of the monitoring plan.

Under an operational perspective, the CDM operations manager and CDM supervisor are in charge of performing all field monitoring activities and ensuring appropriate monitoring data logging and recording (always with assistance/support from by hired technical consultants from UniCarbo – Energia e Biogás Ltda.). They are also responsible for the performance of related calibration events as well as all applicable planned or unplanned maintenance and repair events.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

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	Consistent with how oxidation is accounted for in the methodological tool "Emissions from solid waste disposal sites" (version 08.0)
Value(s) applied	0.1
Choice of data or measurement methods and procedures	Default value as per the applied CDM baseline and monitoring methodology ACM0001 - "Flaring or use of landfill gas" (version 18.0)
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	**$F_{CH4,BL,x-1}$**
Unit	tCH_4/yr
Description	Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity (2007).
Source of data	Measurements performed by Embralixo – Empresa Bragantina de Varrição e Coleta de Lixo Ltda. / Araúna Participações e Investimentos Ltda. (related to year 2007).

Value(s) applied	71.20
Choice of data or measurement methods and procedures	Selected value is as per historical measurements performed by Embralixo – Empresa Bragantina de Varrição e Coleta de Lixo Ltda. / Araúna Participações e Investimentos Ltda.
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	**GWP_{CH4}**
Unit	tCO_2e/tCH_4
Description	Global Warming Potential of CH_4
Source of data	"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. Available at: www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html#table-2-14 The applied value is also in accordance with the "Standard for application of the global warming potential to clean development mechanism project activities and programmes of activities for the second commitment period of the Kyoto Protocol".
Value(s) applied	25
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	The applied value shall be updated according to any future COP/MOP decisions and/or decision by the CDM-EB.

Data/Parameter	**R_u**
Unit	$Pa.m^3/kmol.K$
Description	Universal ideal gases constant
Source of data	Default value as per the "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	-

Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	**MM_k**
Unit	kg/kmol
Description	Molecular mass of gas *k*
Source of data	Default values as per the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 02.0.0)
Value(s) applied	For considered gases *k* that are greenhouse gases (GHGs), the values below are applied for MMi. The following is defined by the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream": *"The determination of the molecular mass of the gaseous stream ($MM_{t,db}$) requires measuring the volumetric fraction of all gases (k) in the considered gaseous stream. However as a simplification, only the volumetric fraction of 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."* ACM0001 (version 18.0) does not include any restriction to such simplification. Thus, only the volumetric fraction of gases that are greenhouse gases and are considered in related calculations (CH_4 in the particular case of the project activity) and the difference to 100% is just considered as pure nitrogen.
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Compound	Structure	Molecular mass (kg/kmol)
Nitrogen	N_2	28.01

Data/Parameter	**MM_i**
Unit	kg/kmol
Description	Molecular mass of greenhouse gas *I*
Source of data	Default values as per the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 02.0.0)

Value(s) applied	The following values of molecular mass are applicable for CH_4 (the only GHG which is considered): Compound | Structure | Molecular mass (kg/kmol) Methane | CH_4 | 16.04
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	**P_n**
Unit	Pa
Description	Total pressure at normal conditions
Source of data	Default value as per the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0)
Value(s) applied	101,325
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	**T_n**
Unit	K
Description	Temperature at normal conditions
Source of data	Default value as per the "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	-
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	MM_{H2O}
Unit	kg/kmol
Description	Molecular mass of water
Source of data	Default value as per the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 02.0.0)
Value(s) applied	18.0152
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	$TDL_{grid,y}$
Unit	-
Description	Average technical transmission and distribution losses for providing electricity to the grid and for grid sourced electricity consumed by the project activity.
Source of data	Applicable default value as per the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation".
Value(s) applied	20%
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of project emissions (due to the consumption of grid-sourced electricity by the project activity).
Additional comments	-

Data/Parameter	w_{BM}
Unit	%
Description	Weighting of build margin emissions factor

Source of data	Applicable default value as per the "Tool to calculate the emission factor for an electricity system" (version 05.0)
Value(s) applied	0.75 (75%) during the 2nd 7-year crediting period
Choice of data or measurement methods and procedures	The applicable value valid for 2nd crediting period as per the "Tool to calculate the emission factor for an electricity system" (version 5.0) is selected.
Purpose of data/parameter	Calculation of project emissions (due to the consumption of grid-sourced electricity by the project activity).
Additional comments	-

Data/Parameter	**w_{OM}**
Unit	%
Description	Weighting of operating margin emissions factor
Source of data	Applicable default value as per the "Tool to calculate the emission factor for an electricity system" (version 05.0)
Value(s) applied	0.25 (25%) during the 2nd 7-year crediting period
Choice of data or measurement methods and procedures	The applicable value for the 2nd crediting period as per the "Tool to calculate the emission factor for an electricity system" (version 4.0) is selected.
Purpose of data/parameter	Calculation of project emissions (due to the consumption of grid-sourced electricity by the project activity).
Additional comments	-

Data/Parameter	**$EF_{grid,BM,y}$**
Unit	tCO_2/MWh
Description	Build margin CO_2 emission factor in year *y*
Source of data	Data is ex-ante determined as per applicable guidance of the "Tool to calculate the emission factor for an electricity system" valid for 2nd crediting period. The selected value valid for all years encompassed by the 2nd 7-year crediting period is the value calculated by the DNA of Brazil and valid for year 2016 ($EF_{grid,BM,2016}$).
Value(s) applied	0.1581

Choice of data or measurement methods and procedures	Official value is determined/calculated by the DNA of Brazil. Values are made available online: http://www.mct.gov.br/index.php/content/view/74689.html
Purpose of data/parameter	Calculation of project emissions (due to the consumption of grid-sourced electricity by the project activity).
Additional comments	-

Data/Parameter	**$EF_{grid,OM-adj,y} = EF_{grid,OM,y}$**
Unit	tCO_2/MWh
Description	Operating margin CO_2 emission factor in year *y*
Source of data	Data is ex-ante determined as per applicable guidance of the "Tool to calculate the emission factor for an electricity system" valid for 2nd crediting period. The selected value valid for all years encompassed by the 2nd 7-year crediting period is the 3-year generation-weighted average based on the most recent data public available (years of 2014, 2015 and 2016). Calculated annual official values are made available by the DNA of Brazil.
Value(s) applied	0.4979
Choice of data or measurement methods and procedures	Official value is determined/calculated by the DNA of Brazil. Values are made available online: http://www.mct.gov.br/index.php/content/view/363726.html
Purpose of data/parameter	Calculation of project emissions (due to the consumption of grid-sourced electricity by the project activity).
Additional comments	-

Data/Parameter	**$SPEC_{flare}$**
Unit	°C (for temperature values) Nm^3/h (for LFG flow values) Number of days (for maintenance schedule interval values)
Description	Manufacturer's flare specifications for temperature, flow rate and maintenance schedule interval.
Source of data	Flare manufacturer[3]

[3] The manufacturer of the flare is "Brasmetano Ind. e Com. Ltda..", which is a flaring equipment manufacturer based in Brazil.

<table>
<tr><td>Value(s) applied</td><td>The specifications of the installed flare are listed below:

<table>
<tr><th>$SPEC_{flare}$</th><th>Min.</th><th>Max.</th></tr>
<tr><td>Operational LFG flow (for continuous operation):</td><td>200 Nm^3/h</td><td>1,500 Nm^3/h</td></tr>
<tr><td>Required temperature of the exhaust gas of the flare (to ensure LFG destruction (combustion) under high CH_4 destruction efficiency):</td><td>500 ^oC</td><td>1,000 ^oC</td></tr>
<tr><td>Required minimum frequency for inspection and maintenance service (incl. inspection in the conditions of the flare isolation ceramics revetment material):</td><td colspan="2">Min. every year (min each 365 days)</td></tr>
<tr><td>Required/recommended minimum frequency for replacement of the flare isolation ceramics revetment material:</td><td colspan="2">After 10 years of regular and appropriate operation</td></tr>
</table></td></tr>
<tr><td>Choice of data
or measurement methods
and procedures</td><td>As established by the methodological tool “Project emissions from flaring”, the flare specifications and operational + maintenance requirements (as set/recommended by the equipment manufacturer) are documented and considered for the ex-ante determination of applicable values for the parameter $SPEC_{flare}$. During the 2nd 7-year crediting period, ex-ante selected data will be compared against monitored data related to the operation of the flare, including:
a) Minimum and maximum monitoring records for data regarding inlet LFG flow rate, if necessary converted to flow rate at reference conditions or heat flux,
(b) Minimum and maximum monitoring records for data of temperature in the exhaust gas of each individual high temperature enclosed flare; and
(c) Duration in days of time periods between maintenance events for each individual high temperature enclosed flare.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of baseline emissions[4].</td></tr>
<tr><td>Additional comments</td><td>All flare specification and operation details/requirements are based on information provided by the equipment manufacturer.</td></tr>
</table>

[4] As also highlighted in Section B.3, it is important to note that residual project emissions of CH_4 due to the combustion of LFG in the installed enclosed flare are considered in the context of the determination of baseline emissions (although ACM0001 (version 18.0) refers to the term “project emissions from flaring”.

Ex-ante determined parameters not used in the context of ex-post determination and calculation of emission reductions achieved by the project activity:

The following ex-ante determined parameters (that are also included in the PDD) are not used for the purpose of ex-post determination of baseline emissions and project emissions achieved by the project activity during the considered monitoring period:

- Efficiency of the LFG capture system that will be installed in the project activity (η_{PJ})
- Default value for model correction factor to account for model uncertainties ($\varphi_{default}$)
- Oxidation factor (reflecting the amount of methane from the considered SWDS that is oxidized in the soil (or other material covering the waste)) (OX)
- Fraction of methane in the SWDS gas (volume fraction) (F)
- Fraction of degradable organic carbon (DOC) in MSW that decomposes in the considered SWDS ($DOC_{f,default}$)
- Methane correction factor ($MCF_{default}$)
- Fraction of degradable organic carbon in the waste type j (weight fraction) (DOC_j)
- Decay rate for the waste type *j* (k_j)
- Weight fraction of the waste type *j* (W_j)

As also outlined in the PDD, data for the above-listed parameters are used only in the context of ex-ante estimation of annual accumulated values for the "Amount of methane in the LFG which is destroyed or utilized by the project activity" ($F_{CH4,PJ,y}$) (in the context of ex-ante estimation of emission reductions to be achieved by the project activity during the 2nd 7-year renewable crediting period). Due to that, details for the above-listed parameters are not included in this Section as they are not relevant in the context of determination of emission reductions achieved by the project activity during the considered monitoring period. Relevant details for such not reported parameters are included in Section B.6.2 of the PDD.

D.2. Data and parameters monitored

Data/Parameter	**Management of SWDS**
Unit	Dimensionless
Description	Management of the SWDS

Measured/calculated/ Default	As per the adopted monitoring procedure for the project activity, the management of the Bragança landfill is yearly compared against the previously conceived original construction and operational design for the Bragança landfill in order to confirm that the overall management and operation for the landfill (including relevant aspects related to landfilling practice) were not deliberately modified with the unique aim to intentionally increase the generation of methane at the landfill. By performing the checking annually, it is monitored whether any practice aiming to increase methane generation in the landfill has occurred or promoted. As required by ACM0001 (version 18.0), any change in the management of the Bragança landfill after the implementation of the project activity should be justified by referring to applicable technical or regulatory specifications.
Source of data	An initial technical evaluation was performed by the independent 3rd party engineering company Carrer Engenharia. The findings for the performed evaluations are reported in a declaration document issued by such company that is dated 12/12/2017. This initial evaluation covers the period from 01/01/2008 (date when the project activity started to operate) to 12/12/2017 (issuance date of the declaration document for the performed evaluation). As per the applicable monitoring procedure, a sequential technical evaluation was also performed by the independent 3rd party engineering company Carrer Engenharia in April 2018. The findings for such performed technical evaluations are reported in the declaration document issued by Carrer Engenharia that is dated 06/04/2018. As part of the performed evaluation, the current configuration and operational conditions of the Bragança landfill were compared against the previously conceived design and operational conditions of the landfill prior of the occurred implementation of the project activity on the basis of different sources and assessments including inter alia: - The original design documents of the landfill (as described in the documentation required for all phases of the environmental licensing and operational permitting for the Bragança landfill); - Applicable local or national regulations;

Value(s) of monitored parameter	As outlined in the issued internal technical evaluation/declaration reports dated 12/12/2017 and 06/04/2018, the previously conceived original design of the Bragança landfill (dated prior to the implementation of the project activity) is confirmed not to being deliberately modified during the period from 01/01/2008 (date when the project activity started to operate) until 06/04/2018 (date of issuance of the report for the latest performed technical evaluation). Furthermore, no modification in the previously conceived original design of the Bragança landfill has occurred or was promoted during the period. The issued technical reports confirm that no practice to increase methane generation at the Bragança landfill have occurred or have been promoted (when compared to management and MSW landfilling practices prior to implementation of the project activity). Aspects, conditions and circumstances related to management of the landfill (e.g. waste disposal, waste covering, waste compacting, management of leachate, draining of rainwater, etc.) were not changed with an aim to increase methane generation on site. It is relevant to note that MSW management business (collection and disposal of MSW) in Brazil (and in most of the developing countries) has its own economics, dynamics, politics and related regulations. That makes MSW disposal activity for the Bragança landfill and other similar landfills in Brazil completely independent from the CDM mechanism and/or revenues of commercialization of CERs generated by project-based destruction of methane in landfills. In the particular case of the Bragança landfill, it is important to note that this landfill was designed and has operated inter alia as per terms and conditions for solid waste disposal contracts established with the different municipalities and private companies. The design and operation of the landfill is also under conformance with terms and conditions for the environmental licensing that were previously defined and are regularly monitored by the competent environmental authority from São Paulo State (CETESB). Currently, there is still no climate change of waste management policy in Brazil which would provide an incentive or a mandate to have MSW being disposed in landfills with better/improved LFG collection / destruction systems (such as the project's LFG collection and destruction system currently implemented at the Bragança landfill).
Monitoring equipment	Not applicable. No measuring equipment is used for monitoring management of the Bragança landfill.
Measuring/reading/recording frequency	Annual checking is performed.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Araúna Participações e Investimentos Ltda. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS).
Purpose of data/parameter	Calculation of baseline emissions

Additional comments	As required by ACM0001 (version 18.0), any change in the management of the landfill after the implementation of the project activity will be justified by referring to technical or regulatory specifications and impacts of such changes in the determination of baseline emissions should in this case be taken into account appropriately. Such monitoring requirement will be used for the determination/confirmation of baseline emissions and/or confirmation of the project's implementation as described in the PDD (in terms of operation and management conditions of the landfill from which LFG is combusted).

Data/Parameter	$V_{t,wb}$
Unit	m^3 wet gas/h
Description	Volumetric flow of LFG stream in time interval *t* on a wet basis.
Measured/calculated/ default	Continuously measured by a LFG flow meter.
Source of data	Measured as part of the operation of the project activity by applying appropriate monitoring instruments (flow meter) (with recordable electronic signal).
Value(s) of monitored parameter	The main emission reduction calculation spreadsheet (that is enclosed to this Monitoring Report) include all records of measurement data of LFG flow sent to the installed high temperature enclosed flare during the considered monitoring period. Measurement data is recorded and reported with an every-minute frequency.
Monitoring equipment	Measurements are performed by a LFG flow meter that is installed in an independent section of the LFG pipeline located between the centrifugal blowers and the installed high temperature enclosed flare, *Specifications and calibration details for the installed LFG flow meter:* - Manufacturer: Contech Indústria e Comércio de Equipamentos Eletrônicos Ltda. - Model: FT-2 - Accuracy: ±1% - Serial Number: 1306018 - Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): Calibration events are performed every 2 years - Date(s) for performed calibration event(s) valid for the considered monitoring period: 26/04/2017 - Validity of the performed calibration event(s): The calibration event dated 26/04/2017 is valid until 25/04/2019 (2 years) - Entity/company responsible for performing the calibration event(s): Field Serviços de Instrumentação Ltda.
Measuring/reading/recording frequency	Continuous measurements are recorded and reported with an every-minute frequency.
Calculation method (if applicable)	Not applicable.

QA/QC procedures	Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of manufacturer. Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Araúna Participações e Investimentos Ltda. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS).
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	The design of the installed LFG flow meters ensures that measurement data is automatically converted and recorded in normal cubic meters per hour (Nm^3/h). Due to that, measurements of LFG pressure and LFG temperature are not required for performing GHG calculations (see further details in Section E.1). Reported values of $V_{t,wb}$ are used for the determination of the amount of methane in the LFG flared by the project activity ($F_{CH4,flared,y}$) as per Option C of the applicable methodological "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (measurements of volume flow in a wet basis).

Data/Parameter	$\mathbf{v_{CH4,t,wb}}$
Unit	m^3 CH_4/m^3 wet gas
Description	Volumetric fraction of CH_4 in the collected LFG in time interval *t* on a wet basis.
Measured/calculated/ default	Continuously measured by continuous CH_4 content gas analyzer.
Source of data	Measured as part of the operation of the project activity by applying appropriate monitoring instruments (CH_4 content gas analyser) (with continuous measurements being electronically recorded).
Value(s) of monitored parameter	The main emission reduction calculation spreadsheet (that is enclosed to this Monitoring Report) include measurement data for $v_{CH4,t,wb}$ that are recorded and reported with an every-minute frequency.

Monitoring equipment	*Continuous CH_4 content gas analyzer unit:* Specifications of the installed continuous CH_4 content gas analyzer are described below: - Manufacturer: Landtec - Model: AEMS - Accuracy: ±1% - Serial number (S/N): GM08642/06 - Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): Calibration events are performed every year - Calibration event(s) valid for the considered monitoring period: Calibration event dated 23/07/2017 - Validity of the performed calibration event(s): The calibration event dated 23/07/2017 is valid until 22/07/2018 (1 year) - Entity/company responsible for performing the calibration event(s): Souza Engenharia
Measuring/reading/recording frequency	Continuously measurements are recorded/reported every minute.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of their manufacturer. Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Araúna Participações e Investimentos Ltda. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS). While there is no calibration event valid for the period from 19/06/2017 to 23/07/2017 within the considered monitoring period, as outlined in Section B.1., during the period from March 2015 to 14 August 2017, no data from the LFG related monitoring instruments were recorded/reported by the project's data acquisition system and no emission reductions are thus claimed during this period. Thus, such delay in the performance of the calibration event does not affect the calculation of emission reductions achieved by the project activity during the considered monitoring period.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	**T_t**
Unit	K
Description	Temperature of the LFG stream in time interval *t*

Measured/calculated/ default	Continuously measured by a temperature sensor installed along the LFG pipeline of the project activity within the flaring facility. Measurements are primarily recorded and reported in ^{o}C. Recorded/reported data is converted into Kelvin and data is also reported in this unit, thus meeting the related monitoring requirement as per the PDD.
Source of data	Measured as part of the operation of the project activity by applying appropriate monitoring instrument (temperature sensor with recordable electronic signal).
Value(s) of monitored parameter	The main emission reduction calculation spreadsheet (that is enclosed to this Monitoring Report) include measurement data for T_t that are recorded and reported with an every-minute frequency.
Monitoring equipment	Measurements of temperature of LFG which is sent to the flare are performed by a temperature sensor that is installed in the main LFG pipeline within the flaring facility in a section between the centrifugal blowers and the high temperature enclosed flare. The specifications of the temperature sensor set utilized during the considered monitoring period are as follows; - Manufacturer: Warme do Brasil Instrumentação e Automação Industrial - Model: PT-100 - Accuracy: ± 1.0ºC - Serial number (S/N): 48419 - Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): Calibration events are performed every year - Calibration event(s) valid for the considered monitoring period: Calibration event dated 04/05/2017 - Validity of the performed calibration event(s): The calibration event dated 04/05/2017 is valid until 04/05/2018 (1 year) - Entity/company responsible for performing the calibration event(s): Field Serviços de Instrumentação Ltda.
Measuring/reading/recording frequency	Continuously measurements are recorded/reported every minute.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of their manufacturer. Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Araúna Participações e Investimentos Ltda. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS).
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	**P_t**
Unit	Pa

Description	Pressure of the LFG stream in time interval *t*
Measured/calculated/ default	Continuously measured by a pressure sensor installed along the LFG pipeline of the project activity within the flaring facility. Measurements of pressure of LFG are primarily recorded and reported in mbar. Recorded/reported data is converted into Pascal and data is also reported in this unit, thus meeting the related monitoring requirement as per the PDD.
Source of data	Measured as part of the operation of the project activity by applying appropriate monitoring instrument (pressure sensor with recordable electronic signal).
Value(s) of monitored parameter	The main emission reduction calculation spreadsheet (that is enclosed to this Monitoring Report) includes measurement data for P_t that are recorded and reported with an every-minute frequency.
Monitoring equipment	Measurements of pressure of LFG which is sent to the flare are performed by a pressure sensor that is installed in the main LFG pipeline within the flaring facility in a section between the centrifugal blowers and the high temperature enclosed flare. The specifications of the LFG pressure sensor utilized during the considered monitoring period are as follows: - Manufacturer: Warme do Brasil Instrumentação e Automação Industrial - Model: WTP-4010 - Serial Number: 41645 - Accuracy: ±0.5% - Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): Calibration events are performed every year - Calibration event(s) valid for the considered monitoring period: Calibration event dated 03/04/2017 - Validity of the performed calibration event(s): The calibration event dated 03/04/2017 is valid until 02/04/2018 (1 year) - Entity/company responsible for performing the calibration event(s): Field Serviços de Instrumentação Ltda.
Measuring/reading/recording frequency	Continuously measurements are recorded/reported every minute.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of manufacturer. Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Araúna Participações e Investimentos Ltda. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS).
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

<table>
<tr><td>Data/Parameter</td><td>$EC_{PJ,grid,y}$</td></tr>
<tr><td>Unit</td><td>MWh</td></tr>
<tr><td>Description</td><td>Amount of grid electricity consumed by the project activity during the year y</td></tr>
<tr><td>Measured/calculated/ default</td><td>Measured as part of the operation of the project activity by applying appropriate electricity meter.</td></tr>
<tr><td>Source of data</td><td>Measured as part of the operation of the project activity by applying appropriate monitoring instrument (electricity meter).</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>Monthly records of grid-sourced electricity consumption valid for the considered monitoring period:

<table>
<tr><th>Month</th><th>Total amount of consumed grid electricity (MWh)</th></tr>
<tr><td>June 2017 (from 19/06/2017 to 30/06/2017)</td><td>0.025</td></tr>
<tr><td>July 2017</td><td>0.012</td></tr>
<tr><td>August 2017</td><td>1.201</td></tr>
<tr><td>September 2017</td><td>1.785</td></tr>
<tr><td>October 2017</td><td>1.698</td></tr>
<tr><td>November 2017</td><td>1.654</td></tr>
<tr><td>December 2017</td><td>1.458</td></tr>
<tr><td>January 2018</td><td>1.256</td></tr>
<tr><td>February 2018</td><td>1.478</td></tr>
<tr><td>March 2018</td><td>1.569</td></tr>
</table></td></tr>
<tr><td>Monitoring equipment</td><td>Specifications of the installed electricity meter

- Manufacturer: Itron Inc.
- Model: MY202A
- Serial Number: 1321986
- Accuracy: ±2%
- Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): Calibration events are performed every 5 years
- Calibration event(s) valid for the considered monitoring period: Calibration event dated 21/10/2014
- Validity of the performed calibration event(s): The calibration event dated 21/10/2014 is valid until 20/10/2019 (5 years)
- Entity/company responsible for performing the calibration event(s): CEIME Calibração e Comércio de Instrumentos Ltda.</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Continuous measurements performed by installed electricity meter are automatically transmitted, aggregated and recorded every hour. Accumulated measurement records are reported every week.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>Not applicable.</td></tr>
</table>

QA/QC procedures	Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of manufacturer. Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Araúna Participações e Investimentos Ltda. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS).
Purpose of data/parameter	Calculation of project emissions (due to consumption of grid-sourced electricity by the project activity).
Additional comments	-

Data/Parameter	$F_{CH4,EG,t}$
Unit	kg
Description	Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the time period *t*
Measured/calculated/ default	Measurements performed by a third party accredited entity.
Source of data	Related measurements were performed by the independent third party inspection services company "IST Tecnologia Internacional em Sensores Ltda.". Biannual measurements of mass flow of methane in the exhaust gas are performed on the basis of measurements of CH_4 concentration in a collected gas sample + measurements of speed of exhaust gas in the upper section of the flare with one hour of duration each. Measurements are performed by following applicable guidance and requirements of the following standards/methods: US-EPA Method 18 – Measurement of Gaseous Organic Compound Emission by Gas Chromatography (available online: https://www.epa.gov/emc/method-18-volatile-organic-compounds-gas-chromatography); CETESB L9.221 - "Pipelines and chimneys in stationary emission sources-Sampling points determination procedure) (available online: http://www.esaat.com.br/docs/met_cetesb/CETESB-L9.221.pdf) CETESB L9.222 - "Pipelines and chimneys in stationary emission sources – Determination of speed and outflow of gases) (available online: http://www.esaat.com.br/docs/met_cetesb/CETESB-L9.222.pdf) CETESB L9.223 - "Pipelines and chimneys in stationary emission sources – Determination of dry molecular mass and the excess of the air flow gas" (available online: http://www.esaat.com.br/docs/met_cetesb/CETESB-L9.223.pdf). CETESB L9.224 - "Pipelines and chimneys in stationary emission sources – Determination of humidity of effluents" (available online: http://www.esaat.com.br/docs/met_cetesb/CETESB-L9.224.pdf).

<table>
<tr><td>Value(s) of monitored parameter</td><td>For the determination of values of $F_{CH4,EG,t}$, average of the accumulated mass of methane measured during one hour measurements are considered (average of every-minute measurements).

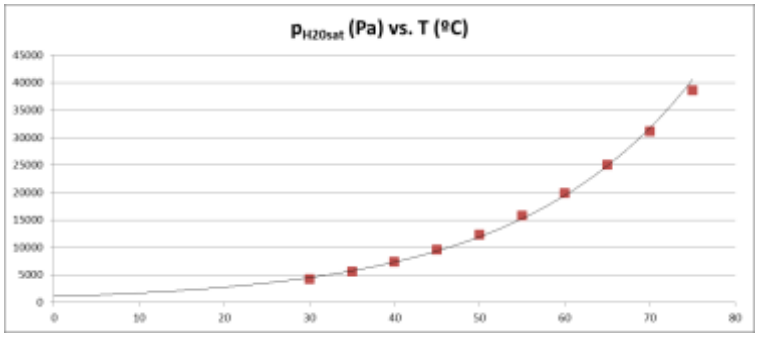
The table below summarizes the performed biannual determination of $F_{CH4,EG,t}$ for the installed flare valid for the considered monitoring period:

<table><tr><th>Measurements performed on 18/09/2017 (kg)</th><th>Measurements performed on 18/03/2018 (kg)</th></tr><tr><td>0.0034</td><td>0.0210</td></tr></table></td></tr>
<tr><td>Monitoring equipment</td><td>Measurements were performed by the independent 3rd party inspection service company “IST Tecnologia Internacional em Sensores Ltda.” using an appropriated chromatographer and a pitot tube.</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Biannual</td></tr>
<tr><td>Calculation method (if applicable)</td><td>-</td></tr>
<tr><td>QA/QC procedures</td><td>Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Araúna Participações e Investimentos Ltda. in accordance with detailed working instructions that are included in the company’s quality management and control (QA/QC) and environmental management system (EMS).

“IST Tecnologia Internacional em Sensores Ltda.” is an independent third party inspections services company specialized in inspections and testing of air emissions from stationary sources.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of baseline emissions</td></tr>
</table>

Additional comments	As demonstrated in the flare efficiency calculation spreadsheet (which is enclosed to this Monitoring Report), the average flow rate to the flare during the period in which measurements for $F_{CH4,EG,t}$ were made are greater than the average flow rate observed for the previous six months as required by the methodological tool "Project emissions from flaring" (version 02.0.0) for the application of its Option B.1. The flare efficiency calculation spreadsheet also calculates the average flow rate of LFG sent to the flare during the 6 months prior to each measurement event performed by "IST Tecnologia Internacional em Sensores Ltda." in order to demonstrate that related average value is lower than the average flow rate of LFG sent to the flare during each one of considered 1-hour period when measurement events for $F_{CH4,EG}$ were performed. Among the standards of which guidance and requirements were followed as part of performed biannual determination of $F_{CH4,EG,t}$ for the installed flare within the considered monitoring period, the US-EPA Method 18 – Measurement of Gaseous Organic Compound Emission by Gas Chromatography has been widely internationally recognized and/or accepted by different national and international organizations as a standard for performance of emission measurements from stationary emission sources in a wide range of industries (e.g. The California Air Resources Board (CARB), Scottish Environment Protection Agency (SEPA). Different agencies in the United States (USA) and in other countries require or recommend that determination of concentration of VOC portion in landfill gas is to be performed by applying US-EPA Method 18. The US-EPA Method 18 is also referred in the most popular and acknowledged pollution control handbooks and guides (i.e. Pollution Control Handbook for Oil and Gas Engineering, 2016, published by John Wiley & Sons, Inc. – USA, US-EPA Guidance for evaluating landfill gas emissions from closed or abandoned facilities, SEPA Guidance for monitoring landfill gas engine emissions, Pollution Prevention and Abatement Handbook 1998 – The World Bank Group, etc.). The technical test/evaluation reports for the performed biannual determination of $F_{CH4,EG,t}$ for the installed flare within the considered monitoring period (reports issued by the independent 3rd party inspection service company "IST Tecnologia Internacional em Sensores Ltda.") also refer to methods recommended by the environmental authority of São Paulo State in Brazil. Compliance with these methods has also been acknowledged as best practice for performance of air emission measurements by different environmental regulatory agencies in Brazil.

Data/Parameter	$p_{H20,t,Sat}$
Unit	Pa (depending on measurement instrument, measurement records in mbar will be converted and also reported in Pa)
Description	Saturation pressure of H_2O at temperature T_t in time interval *t*
Measured/calculated/ default	Default values as per selected literature.
Source of data	Data selected as per the literature "*Fundamentals of Classical Thermodynamics*". Authors: Gordon J. Van Wylen, Richard E. Sonntag and Borgnakke; 4th Edition. Published by John Wiley & Sons, Inc.

<table>
<tr><td>Value(s) of monitored parameter</td><td>$p_{H2O,t,Sat}$ is determined as a function of temperature of LFG (T_t by the equation:
$p_{H2O,t,sat} = 1{,}031.3 * e^{(0.049 * Tt)}$, with a correlation coefficient of $R^2 = 0.998$.
Further details are presented below in “Calculation Method”.</td></tr>
<tr><td>Monitoring equipment</td><td>Not applicable.</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Not applicable</td></tr>
<tr><td>Calculation method (if applicable)</td><td>The Absolute Vapor Pressure of Water was obtained from the mentioned literature and is presented in the following table within the rage of interest for the required calculations:
<table>
<tr><th>Temperature</th><th>$p_{H2O,t,Sat}$</th></tr>
<tr><td>ºC</td><td>Pa</td></tr>
<tr><td>30</td><td>4,246</td></tr>
<tr><td>35</td><td>5,628</td></tr>
<tr><td>40</td><td>7,384</td></tr>
<tr><td>45</td><td>9,593</td></tr>
<tr><td>50</td><td>12,349</td></tr>
<tr><td>55</td><td>15,758</td></tr>
<tr><td>60</td><td>19,940</td></tr>
<tr><td>65</td><td>25,030</td></tr>
<tr><td>70</td><td>31,190</td></tr>
<tr><td>75</td><td>38,580</td></tr>
</table>
The following graphic represents the above data and the regression calculated to adjust data:
 

As $p_{H2O,t,Sat}$ is a function of temperature and best represented by an exponential function, the exponential regression method is applied to the above data and the following equation is obtained:
$p_{H2O,t,sat} = 1{,}031.3 * e^{(0.049 * Tt)}$
This equation represents the above data with a correlation coefficient of $R^2 = 0.998$.
Thus, by applying the above equation, $p_{H2O,t,sat}$ is determined as a function of the temperature.</td></tr>
<tr><td>QA/QC procedures</td><td>Not applicable.</td></tr>
</table>

Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	It is important to note that $p_{H2O,t,Sat}$ is only used in the context of the determination of the methane mass flow in the residual gas (in a dry basis) for each minute *m* of the two time periods in year *y* during which the flare efficiency is measured (parameter $F_{CH4,RG,t}$). The calculations of every-minute values of $p_{H2O,t,Sat}$ for the 2 time periods during which the flare efficiency is measured is thus presented only in the flare efficiency calculation spreadsheet.

Data/Parameter	**$T_{EG,m}$**
Unit	^oC
Description	Temperature in the exhaust gas of the enclosed flare in minute *m*
Measured/calculated/ default	Continuously measured by a thermocouple installed in the upper section of the flare
Source of data	Measured as part of the operation of the project activity by applying appropriate monitoring instruments (thermocouple with recordable electronic signal).
Value(s) of monitored parameter	Values are reported in the main emission reduction calculation spreadsheet (that is enclosed to this Monitoring Report). Measurement data is recorded and reported with an every-minute frequency.
Monitoring equipment	The specifications of the installed thermocouple are as follows; - Manufacturer: Warme do Brasil Instrumentação e Automação Industrial - Model: WTT-5000, type K - Serial Number: 67894 - Accuracy: ±0.15% - Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): Calibration events are performed every year - Calibration event(s) valid for the considered monitoring period: Calibration event dated 03/04/2017 - Validity of the performed calibration event(s): The calibration event dated 03/04/2017 is valid until 02/04/2018 (1 year) - Entity/company responsible for performing the calibration event(s): Souza Engenharia
Measuring/reading/recording frequency	Continuous measurements are recorded/reported every minute.
Calculation method (if applicable)	-
QA/QC procedures	Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of manufacturer. Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Araúna Participações e Investimentos Ltda. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS).

Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	Measurements are required to determine if manufacturer's flare specifications for operating temperature are met.

Data/Parameter	**$Flame_m$**
Unit	Flame status "*on*" or flame status "*off*"
Description	Flame detection of flare in the minute *m*
Measured/calculated/ default	Continuously measured by Ultra violet (UV) flame detector
Source of data	Whenever flame is detected in the flare, flame status "*on*" or "1" value is attributed. Whenever no flame is detected in the flare, flame status "*off*" or "0" is attributed.
Value(s) of monitored parameter	Values are reported in the main emission reduction calculation spreadsheet (that is enclosed to this Monitoring Report). Measurement data is recorded and reported with an every-minute frequency.
Monitoring equipment	*Specifications and calibration details for the installed/utilized UV Flame detector:* - Manufacturer: Honeywell Analytics Ltd. - Model: C7061A Dynamic Self-Check Ultra-Violet Flame Detector - Serial Number: 1170 - Calibration frequency: No calibration is required as the equipment has a self-checking function.
Measuring/reading/recording frequency	Continuously measurements are recorded/reported every minute.
Calculation method (if applicable)	Not applicable
QA/QC procedures	Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of manufacturer. Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Araúna Participações e Investimentos Ltda. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS).
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	**$Maintenance_y$**
Unit	Calendar dates
Description	Maintenance events completed in year *y* as monitored by the project participants.

Measured/calculated/ default	-
Source of data	Maintenance logs
Value(s) of monitored parameter	The following relevant maintenance events (inspection and maintenance services) are applicable for the installed high temperature enclosed flare during the considered monitoring period: - 29/11/2016: General inspection/maintenance service on the Flare (incl. inspection of the condition of the flare isolation ceramics revetment material, checking of conditions of the LPG supply valve for pilot flame, checking of condition/function of the air inlet dumpers, checking of the conditions of the thermocouples, checking of the condition of the UV flame detector, checking of the condition of the flame arrester valve, checking of the conditions of the LFG injectors, checking of painting conditions). - 17/10/2017: General inspection/maintenance service on the Flare (incl. inspection of the condition of the flare isolation ceramics revetment material, checking of conditions of the LPG supply valve for pilot flame, checking of condition/function of the air inlet dumpers, checking of the conditions of the thermocouples, checking of the condition of the UV flame detector, checking of the condition of the flame arrester valve, checking of the conditions of the LFG injectors, checking of painting conditions). As per the applied maintenance practice for the project activity, general inspection/maintenance services on the flare are opportunely performed during planned or unplanned interruptions of operation of the flare within a time interval between 2 performed inspection/maintenance services events never higher than a year. The expected lifetime for the isolation ceramics revetment material for the flare is of at least 10 years (as established in details for the ex-ante determined parameter "Manufacturer's flare specifications for temperature, flow rate and maintenance schedule interval" ($SPEC_{flare}$)). After the project's commissioning, the isolation ceramics revetment material of the installed high temperature enclosed flare was replaced in June 2017. Performed maintenance and overhauling services in the flare are performed under by specialized technical service team under conformance with maintenance requirements for the flare (as established by equipment manufacturer) and as required by the ex-ante determined parameter $SPEC_{flare}$. Further details about the parameter $SPEC_{flare}$ are included in Section D.1.
Monitoring equipment	Not applicable.
Measuring/reading/recording frequency	Not applicable.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	The maintenance event logs and documentation for the whole project activity are recorded as per requirement of the company's quality and control (QA/QC) and environmental management (EMS) system that is implemented for activities undertaken at the Bragança landfill.
Purpose of data/parameter	Calculation of baseline emissions

Additional comments	Monitoring of this parameter is required for the case of enclosed flare and the project participant selects Option B to determine flare efficiency. These dates are required so that they can be compared to the maintenance schedule to check that maintenance events were completed within the minimum time between maintenance events specified by the manufacturer ($SPEC_{flare}$).

Data/Parameter	**Status of biogas destruction device**
Unit	-
Description	Operational status of biogas destruction devices
Measured/calculated/ default	Every-minute records of the status of the flare are reported based on the flame status of the flare (parameter $Flame_m$).
Source of data	Every-minute records of the status of the flare are reported based on the flame status of the flare (parameter $Flame_m$).
Value(s) of monitored parameter	Not applicable.
Monitoring equipment	Specification details for the UV flame detector of the flare are presented in the applicable table for the parameter $Flame_m$.
Measuring/reading/recording frequency	Continuous measurements will be recorded and reported with an every minute frequency.
Calculation method (if applicable)	Not applicable
QA/QC procedures	-
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

The following monitoring parameters (which are also included in the monitoring plan of the PDD) were not monitored as the methodological options for which they are applicable were not selected as the monitoring or calculation approaches for the determination of baseline emissions and/or project emissions achieved by the project activity during the considered monitoring period:

- Volumetric flow of LFG stream in time interval t on a dry basis ($V_{t,db}$)
- Volumetric fraction of CH_4 in the collected LFG in time interval t on a dry basis ($v_{CH4,t,db}$)
- Mass flow of the LFG stream in time interval t on dry basis for ($M_{t,db}$)
- Volumetric fraction of component *i* in the residual gas on a dry basis in the minute m where *i* = CH_4, CO, CO_2, O_2, H_2, H_2S, NH_4, N_2 ($v_{i,RG,m}$)
- Mass flow of the residual gas on a dry basis at reference conditions in the minute *m* ($M_{RG,m}$)
- Volumetric fraction of O_2 in the exhaust gas on a dry basis at reference conditions in the minute *m* ($v_{O2,EG,m}$)
- Concentration of methane in the exhaust gas of the flare on a dry basis at reference conditions in the minute *m* ($fc_{CH4,EG,m}$)
- Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the time period *t* ($F_{CH4,EG,t}$)

D.3. Implementation of sampling plan

>>

Not applicable.

SECTION E. Calculation of emission reductions or net anthropogenic removals

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

>>

Under conformance with provisions and calculation approaches of the registered PDD, Baseline emissions (BE_y) for the considered monitoring period are determined (in tCO_2e) as follows:

$$BE_y = BE_{CH4,y}$$

Where:

$BE_{CH4,y}$ Baseline emissions of methane from the SWDS[5]. As established by both ACM0001 (version 18.0) and the PDD, the determination of $BE_{CH4,y}$ is based on the amount of methane that is actually captured and combusted (through destruction of collected LFG in the flare) by the project activity. As established by both ACM0001 (version 18.0) and the PDD, the amount of methane that, in the absence of the project activity (baseline scenario), would be otherwise captured and destroyed in the landfill (by the pre-project previously existent conventional LFG destruction system) is also taken into account. In addition, the effect of methane oxidation (that, as per ACM0001 (version 18.0) is assumed as existing in the baseline and not in the project scenario) is also taken into account. $BE_{CH4,y}$ is thus determined as follows:

$$BE_{CH4,y} = ((1 - OX_{top\_layer}) * F_{CH4,PJ,y} - F_{CH4,BL,y}) * GWP_{CH4}$$

Where:

OX_{top_layer} Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline scenario. OX_{top_layer} is ex-ante determined as 10%. Further details about the selection of the value for OX_{top_layer} is included in Section D.1 and in the PDD.

$GWP_{CH4,y}$ Global warming potential of CH_4. GWP_{CH4} is ex-ante determined as 25. Further details about the selection of the value for GWP_{CH4} is included in Section D.1 and in the PDD.

$F_{CH4,BL,y}$ Amount of methane in the LFG that would be flared in the baseline scenario (absence of project activity). As outlined in Section B.6.1 of the PDD, $F_{CH4,BL,y}$ is calculated as follows:

$$F_{CH4,BL,y} = F_{CH4,hist,y} = F_{CH4,BL,x-1} / F_{CH4,x-1} * F_{CH4,PJ,y}$$

Where:

$F_{CH4,x-1}$ Amount of methane in the LFG generated in the SWDS in the year prior to the implementation of the project activity. $F_{CH4,2007}$ is ex-ante determined as 2,430.66 tCH_4.

[5] SWDS = Solid Waste Disposal Site. For the case of the project activity, the SWDS is the Bragança landfill.

$F_{CH4,BL,x-1}$ Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity. $F_{CH4,BL,x-1}$ is ex-ante determined as 71.20 tCH_4. Further details about the selection of the value for $F_{CH4,BL,x-1}$ is included in Section D.1 and in the PDD.

$F_{CH4,PJ,y}$ Amount of methane in the LFG which is flared and/or used in the project activity. Details about the determination of every-minute values of the parameter $F_{CH4,PJ,y}$ are presented below.

$F_{CH4,BL,y}$ is thus determined as follows:

$F_{CH4,BL,y} = (71.20 / 2{,}430.66) * F_{CH4,PJ,y} = 0.0293 * F_{CH4,PJ,y}$

For the considered monitoring period, the accumulated value for $F_{CH4,BL,y}$ is calculated and reported as 16 tCH_4. Related calculation is presented in the main emission reduction calculation spreadsheet that is enclosed to the Monitoring Report.

$F_{CH4,PJ,y}$ Amount of methane in the LFG which is flared and/or used in the project activity. In the particular case of the project activity, $F_{CH4,PJ,y}$ is determined as follows:

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

Where:

$F_{CH4,flared,y}$ Amount of methane in the LFG which is destroyed by flaring (in tCH_4). In accordance with calculation guidance included in the PDD and by following applicable guidance of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", every-minute values for $F_{CH4,flared,y}$ are determined as the difference between the amount of methane supplied to the flare and residual methane emissions from combustion of LFG in the flare, as follows:

$F_{CH4,flared,y} = F_{CH4,sent\_flare,y} – (PE_{flare,y} / GWP_{CH4})$

Where:

$F_{CH4,sent\_flare,y}$ Amount of methane in the LFG which is sent to the flare. Details for the determination of every-minute values for $F_{CH4,sent\_flare,y}$ are presented below (under "*Determination of every-minute values for the calculation parameter $F_{CH4,sent\_flare,y}$*").

$PE_{flare,y}$ Project emissions from flaring of the residual gas stream. Details for the determination of every-minute values for $PE_{flare,y}$ for each individual flare are presented below (under "*Determination of $PE_{flare,y}$*").

Determination of every-minute values for the calculation parameter $F_{CH4,sent\_flare,y}$:
For the considered monitoring period, Option C of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (where the gaseous stream the tool shall be applied to is the stream of collected LFG that is sent to the flare)[6] is the selected option for determination of values of $F_{CH4,sent\_flare,y}$.

By following calculation option C (that is one of the applicable calculation methods the PDD refers to), the mass flow of greenhouse gas *i* for the installed flare ($F_{i,t}$, where $i = CH_4$) for the installed flare during the whole considered monitoring period is determined as follows:

$F_{CH4,sent\_flare,y} = F_{CH4,t} = V_{t,wb,n} * v_{CH4,t,wb} * \rho_{CH4,n}$

Where:

$V_{t,wb,n}$ Volumetric flow of the gaseous stream (LFG) to the flare in time interval *t* on a wet basis at normal conditions. For the considered monitoring period, every-minute values of the calculation parameter $V_{t,wb,n}$ are measured and reported (in Nm³ wet gas/h) in the main emission reduction calculation spreadsheet valid for the considered monitoring period (and enclosed to this Monitoring Report). While in the particular case of the project activity, during the considered monitoring period, volumetric flow of the gaseous stream (LFG) is already measured in Nm³ of wet gas/h (normal conditions), the following assumption is thus valid:

$V_{t,wb,n,flare}$ is equivalent to $V_{t,wb,flare}$

Where:

$V_{t,wb}$ Volumetric flow of the gaseous stream (LFG) sent to the flare in time interval *t* on a wet basis (in actual conditions)

Note: in accordance with the PDD, since measurements of LFG flow sent to the flare are automatically converted and recorded in normalized cubic meters (by considering standard temperature and pressure (STP) conditions), monitoring of "Pressure of the LFG stream in time interval t" (P_t) and "Temperature of the LFG stream in time interval *t*" (T_t) are thus not required for the determination of $V_{t,wb,n}$. Further monitoring details about the monitoring parameter $V_{t,wb}$ are included in Section D.2.

$v_{CH4,t,wb}$ Volumetric fraction of CH_4 in the gaseous stream in time interval *t* on a wet basis. As per the applied monitoring procedure, every-minute values of the monitoring parameter $v_{CH4,t,wb}$ (in m³ of CH_4 / m³ of wet LFG) are reported in the main emission reduction calculation spreadsheet valid for the considered monitoring period (and enclosed to this Monitoring Report). Further monitoring details about the monitoring parameter $v_{CH4,t,wb}$ are included in Section D.2.

$\rho_{CH4,n}$ Density of CH_4 in the gaseous stream (LFG) at normal conditions. For the considered monitoring period, value of $\rho_{CH4,n}$ (in kg of CH_4 / m^3 of CH_4) is calculated and reported in the main emission reduction calculation spreadsheet valid for the considered monitoring period (and enclosed to this Monitoring Report) as follows:

[6] It is relevant to note that the PDD states the following regarding the calculation approach for values of $F_{CH4,sent\_flare,y}$:

> "*Applicable guidance of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" will be applied to determine $F_{CH4,sent\_flare,y}$ by using one of the options A, B, C or D. The selection of the determination option will depend on project conditions and equipment to be installed."*

$\rho_{CH4,n} = (P_n * MM_i) / (R_u * T_n)$

Where:

P_n Absolute pressure at normal conditions. P_n is ex-ante determined as 101,325 Pa. Further details about the ex-ante determined parameter P_n are included in Section D.1 and in the PDD.

T_n Temperature at normal conditions. T_n is ex-ante determined as 273.15 Kelvin. Further details about the ex-ante determined parameter T_n are included in Section D.1 and in the PDD.

MM_i Molecular mass of greenhouse gas *i* (*i* = CH_4). MM_i (*i* = CH_4) is ex-ante determined as 16.04 kg/mol. Further details about the ex-ante determined parameter MM_i (*i* = CH_4) are presented in Section D.1 and in the PDD.

R_u Universal ideal gases constant. R_u is ex-ante determined as 8,314 $Pa.m^3$ /kmol.K. Further details about the ex-ante determined parameter R_u are presented in Section D.1 and in the PDD.

$\rho_{CH4,n}$ is calculated as 0.7156650 $kgCH_4$ / m^3CH_4 as reported in the main emission reduction calculation spreadsheet valid for the considered monitoring period.

Determination of $PE_{flare,y}$:
$PE_{flare,y}$ is determined by following the applicable stepwise guidance of the methodological tool "Project emissions from flaring". Every minute values for $PE_{flare,y}$ are determined as a function of every-minute records of mass flow of methane sent to the flare as well as based on calculated values for flare efficiency ($\eta_{flare,m} = \eta_{flare,calc,y}$) as follows:

$$PE_{flare,y} = GWP_{CH4} * \sum_{m=1}^{525,600} F_{CH4,RG,m} * (1 - \eta_{flare,m}) * 10^{-3}$$

Where:

$F_{CH4,RG,m}$ Mass flow of methane in the residual gas in the minute *m*. For each minute *m* of the considered monitoring period, values for $F_{CH4,RG,m}$ are equal to every-minute reported measurement records of the calculation sub-parameter "Amount of methane in the LFG which is sent to the flare" ($F_{CH4,sent\_flare,y}$).

$\eta_{flare,m}$ Flare efficiency in minute *m*. For the considered monitoring period, $\eta_{flare,m}$ is calculated based on performed measurements of methane in exhaust gas of the flare by following applicable guidance as per Option B (Measured flare efficiency) of the methodological tool "Project emissions from flaring" from which the following related guidance of the registered PDD is applied:

> "(…)
> *Option B: Measured flare efficiency:*
> *The flare efficiency in the minute m is determined as a value which is calculated based on performed related measurements ($\eta_{flare,m} = \eta_{flare,calc,m}$) when the following two conditions are simultaneously met (in order to demonstrate that the flare is operating):*
> *(1) The temperature of the exhaust gas of the flare (monitoring parameter $T_{EG.m}$) and the flow rate LFG to the flare (monitoring parameter $F_{CH4,RG,m}$) is within the manufacturer's specification for the flare ($SPEC_{flare}$) in minute m*

(2) Flame is detected in the flare in minute m (monitoring parameter $Flame_m$).

Otherwise $\eta_{flare,m}$ is set as 0%.
(…)"

In applying Option B, the project participants chose to determine $\eta_{flare,calc,m}$ by applying guidance of Option B.1 (with related measurements of emission of methane in the exhaust gas of the flare being performed by an accredited independent third party entity (e.g. an independent inspection/analysis service company) on a biannual basis).

In order to calculate the flare efficiency value for the flare ($\eta_{flare,calc,m}$) biannual values for the monitoring parameter "Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the time period t" ($F_{CH4,EG,t}$)) are considered as per the following calculation formula[7]:

Option B.1: Biannual measurement of the flare efficiency":
The calculated flare efficiency $\eta_{flare,calc,y}$ for low-height flares is determined as follows:

$$\eta_{flare,calc,y} = 1 - \frac{1}{2}\sum_{t=1}^{2}\left(\frac{F_{CH4,EG,t}}{F_{CH4,RG,t}}\right) - 0.1$$

Where:

t The two time periods in year y during which the flare efficiency is measured, each a minimum of one hour and separated by at least six months. Related measurements valid for the considered monitoring period were performed

$F_{CH4,RG,t}$ Mass flow of methane in the residual gas on a dry basis at reference conditions in the time period *t.* Details for the determination of every-minute values for $F_{CH4,RG,t}$ are presented below.

Determination of $F_{CH4,RG,t}$:

As per the applicable guidance of the methodological tool "Project emissions from flaring" and also as per the PDD, the methane mass flow in the residual gas (in a dry basis) for each minute *m* of the two time periods in year *y* during which the flare efficiency is measured shall be calculated by following the applicable guidance of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream". Values for the parameter $F_{CH4,RG,t}$ are thus calculated as follows:

$F_{CH4,RG,t} = V_{t,db,n} * v_{CH4,t,db} * \rho_{CH4,n}$

[7] As per the provisions of the Methodological tool "Project emissions from flaring" (Version 02.0.0), for enclosed flares that are defined as low height flares (which is the case of the flare installed in the Project Activity), the flare efficiency shall be adjusted, as a conservative approach, by subtracting 0.1 from the efficiency as determined in Options A or B.

Where:

$\rho_{CH4,n}$ Density of greenhouse gas *i* (*i* = CH_4) in the gaseous stream (LFG) at normal conditions. Further details for the determination of $\rho_{CH4,n}$ are presented above under the sub-section "*Determination of every-minute values for the calculation parameter $F_{CH4,sent\_flare,y}$*".

$v_{CH4,t,db}$ Volumetric fraction of greenhouse gas *i* (*i* = CH_4) in the gaseous stream in a time interval *t* on a dry basis. The following is stated in footnote 3 of the methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream":

> "*(…) Flow measurement on a dry basis is not feasible at reasonable costs for a wet gaseous stream, so there will be no difference in the readings for volumetric fraction in wet basis analyzers and dry basis analyzers (…).*"

Thus, every-minute values of $v_{CH4,t,db}$ are regarded as equal to every-minute values of the monitoring parameter $v_{CH4,t,wb}$ (for which further details are presented above under the sub-section "*Determination of every-minute values for the calculation parameter $F_{CH4,sent\_flare,y}$*").

$V_{t,db,n}$ Volumetric flow of the gaseous stream (LFG) in time interval *t* on a dry basis which is sent to the flare. As per Option B of the applicable methodological "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", the volumetric flow of the gaseous stream on a dry basis which is sent to the flare is determined by converting the measured volumetric flow from wet basis to dry basis as follows:

$$V_{t,db,n} = V_{t,wb,n} / (1 + v_{H2O,t,db})$$

Where:

$V_{t,wb,n}$ Volumetric flow of the gaseous stream (LFG) in time interval *t* on a wet basis at normal conditions. Further details of $V_{t,wb,n}$ are presented above under the sub-section "*Determination of every-minute values for the calculation parameter $F_{CH4,sent\_flare,y}$*"

$v_{H2O,t,db}$ Volumetric fraction of H_2O in the gaseous stream in time interval *t* on a dry basis. As per applicable guidance of the methodological "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", $v_{H2O,t,db}$ is calculated as follows:

$$v_{H2O,t,db} = \frac{m_{H2O,t,db} * MM_{t,db}}{MM_{H2O}}$$

Where:

MM_{H2O} Molecular mass of H_2O. MM_{H2O} is ex-ante determined as 18.0152 kg/kmol.
Further details about the ex-ante determined parameter MM_{H2O} are included in Section D.1 and in the PDD.

$MM_{t,db}$ Molecular mass of the gaseous stream in time interval *t* on a dry basis.
As per applicable guidance of the methodological "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", $MM_{t,db}$ is calculated as follows:

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

Where:

k All gases, except H_2O, 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 simplification below.

$V_{k,t,db}$ Volumetric fraction of gas *k* in the gaseous stream in time interval *t* on a dry basis. Applicable guidance of the methodological "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" states the following:

> "*(…) The determination of the molecular mass of the gaseous stream ($MM_{t,db}$) 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."*

ACM0001 (version 18.0) does not include any restriction to such simplification. Thus, only the volumetric fraction of gases that are greenhouse gases and are considered in related calculations (CH_4 in the particular case of the project activity) should be measured and the difference to 100% is just considered as pure

nitrogen. Further details for the determination of the volumetric fraction of CH_4 in the gaseous stream ($V_{k,t,db}$ = $v_{CH4,t,db}$) are presented above under the calculation parameter $v_{CH4,t,db}$.

MM_k Molecular mass of gas *k* (*k* = CH_4 and N_2). The molecular mass of CH_4 and N_2 are ex-ante determined as 16.04 and 28.01, respectively. Further details about the ex-ante determined values for MM_k are included in Section D.1 and in the PDD.

$m_{H2O,t,db}$ Absolute humidity in the gaseous stream in time interval *t* n a dry basis. As per Option 2 of the methodological "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", by conservatively assuming that the gaseous stream is saturated ($m_{H2O,t,db}$ = $m_{H2O,t,db,Sat}$), $m_{H2O,t,db}$ is calculated as follows [8]:

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

Where:

MM_{H2O} Molecular mass of H_2O. MM_{H2O} is ex-ante determined as 18.0152. Further details about the ex-ante determined values for MM_{H2O} are

[8] It is important to note that the simplified approach for the calculation of the absolute humidity of the gaseous stream ($m_{H2O,t,db}$) as presented in Option 2 of the methodological "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" shall be applied by assuming the gaseous stream is dry or saturated depending on which is the conservative situation. Footnote 4 of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" explicitly states the following:

> "*An assumption that the gaseous stream is saturated is conservative for the situation that the mass flow of greenhouse gas I is underestimated (applicable for calculating baseline emissions). Conversely, an assumption that the gas stream is dry is conservative for the situation that the greenhouse gas t is overestimated (applicable for calculating project emissions).*"

In this particular case, $m_{H2O,t,db}$ is calculated for the determination of the mass flow of methane in the residual gas on a dry basis during the time period t ($F_{CH4,RG,t}$). While $F_{CH4,RG,t}$ is used for the determination of the parameter $PE_{flare,y}$ (project emissions from flaring the residual gas), the assumption that the gaseous stream is dry (conservatively applicable for calculating project emissions) would not be conservative in this case as an overestimation of the amount of methane in the residual gas would actually increase the calculated efficiency of the flare, thus resulting in a reduction of $PE_{flare,y}$ and consequent increment of emission reductions during the considered monitoring period.

included in Section D.1 and in the PDD.

P_t Absolute pressure of the gaseous stream in time interval *t*.
Further monitoring details for P_t are included in Section D.2.

$MM_{t,db}$ Molecular mass of the gaseous stream in a time interval *t* on a dry basis.
Further details for the determination of $MM_{t,db}$ are presented above.

$p_{H2O,t,Sat}$ Saturation pressure of H_2O at temperature T in time *t*.
Further monitoring details about the monitoring parameter $p_{H2O,t,Sat}$ are included in Section D.2.

In summary, for the considered monitoring period, a value of 0.8999094 was obtained for the parameter $\eta_{flare,m} = \eta_{flare,calc,y}$[9]. For every minute encompassed by the considered monitoring period, the validity of the determined value for $\eta_{flare,m} = \eta_{flare,calc,y}$ is dependent on fully meeting applicable flare operational criteria/requirements as explained below:

Meeting of applicable flare operational criteria/requirements:
As per the applied monitoring procedure, compliance with operational and maintenance requirements for the flare, as established by the *ex-ante* determined parameter "Manufacturer's flare specifications for temperature, flow rate and maintenance schedule interval" ($SPEC_{flare}$), is also considered for the determination and application of the values of $\eta_{flare,m} = \eta_{flare,calc,y}$ for the determination of $F_{CH4,PJ,y} = F_{CH4,flared,y}$ along the considered monitoring period. This is reflected in the main emission reduction calculation spreadsheet. Data records for the monitoring parameter "Flame detection of flare in the minute *m*" ($Flame_m$) are also considered for the determination and application of the values of $\eta_{flare,m}$ for the determination of values of $F_{CH4,PJ,y} = F_{CH4,flared,y}$ along the considered monitoring period. This is reflected in the main emission reduction spreadsheet.

The time the flare has operated is determined by monitoring the flame combustion status/condition by using an UV flame detector (of which status

[9] As per the provisions of the Methodological tool "Project emissions from flaring" (Version 02.0.0), for enclosed flares that are defined as low height flares (which is the case of the flare installed in the project activity), the flare efficiency shall be adjusted, as a conservative approach, by subtracting 0.1 from the efficiency as determined in Options A or B. 0.1 was thus subtracted as part of the determination/calculation of values of $\eta_{flare,m} = \eta_{flare,calc,y}$ for the installed flare.

signal (flame status "*on*" or "*off*") is continuously recorded and reported). Moreover, the monitoring requirements related to operational requirements/conditions for the flare (as provided by the manufacturer's specifications for operating conditions as per the ex-ante determined parameter $SPEC_{flare}$ (min. and max. flow of LFG to the flare + min and max. temperature of exhaust gas of the flare + meeting of maintenance requirements) are also considered in the context of the application of determined values for $\eta_{flare,m}$ along the considered monitoring period. As outlined in the main emission reduction spreadsheet, for each minute *m* within the considered monitoring period when the flare have combusted LFG by not operating in accordance with all the operational criteria/requirements as established by the ex-ante estimated parameter $SPEC_{flare}$ (in terms of LFG flow, temperature of exhaust gas or maintenance practice), no destruction of methane is accounted as part of the calculation values of $F_{CH4,PJ,y} = F_{CH4,flared,y}$ achieved by the project activity. The main emission reduction calculation spreadsheet enclosed to the Monitoring Report includes the compliance/meeting of all the operational criteria/requirements as established by the ex-ante estimated parameter $SPEC_{flare}$ (in terms of LFG flow, temperature of exhaust gas or maintenance practice) during every single minute of the considered monitoring period.

For the considered monitoring period, the accumulated value for $F_{CH4,PJ,y} = F_{CH4,flared,y}$ is calculated as 515 tCH_4.

For the considered monitoring period, baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are calculated as 11,188 tCO_2e.

The summarized emission reduction calculation spreadsheets (that are enclosed to this Monitoring Report) summarizes the determination of $BE_y = BE_{CH4,y}$ for the considered monitoring period. For the considered monitoring period, BE_y = 11,188 tCO_2e

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

>>

As outlined in the registered PDD, the operation of the project activity requires consumption of grid-sourced electricity. As also established in the PDD, project emissions due to consumption of this energy carrier are determined by following the applicable guidance of the "Tool to calculated baseline, project and/or leakage emissions from electricity consumption".

Under conformance with provisions and calculation approaches of the registered PDD, project emissions (PE_y) for the considered monitoring period are determined (in tCO_2e) as follows:

$$PE_y = PE_{EC,grid,y}$$

Where:

$PE_{EC,grid,y}$ Project emissions due to the consumption of grid-sourced electricity by the project activity. $PE_{EC,grid,y}$ is calculated as per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" as follows:

$$PE_{EC,grid,y} = EC_{PJ,grid,y} * EF_{EL,grid,y} * (1 + TDL_{grid,y})$$

Where:

$TDL_{grid,y}$ Average technical transmission and distribution losses for grid sourced electricity consumed by the project activity in year *y.* $TDL_{grid,y}$ is ex-ante selected as 20%. Further details about the ex-ante determined parameter $TDL_{grid,y}$ are included in Section D.1 and in the PDD.

$EC_{PJ,grid,y}$ Quantity of grid sourced electricity consumed by the project activity in year *y* (in MWh). As per the applied monitoring procedure, monthly records of grid-sourced electricity consumption valid for the considered monitoring period are summarized below:

Month	Amount of grid-sourced electricity consumed by the project activity (MWh)
June 2017 (from 19/06/2017 to 30/06/2017)	0.025
July 2017	0.012
August 2017	1.201
September 2017	1.785
October 2017	1.698
November 2017	1.654
December 2017	1.458
January 2018	1.256
February 2018	1.478
March 2018	1.569

Additional monitoring details about the monitoring parameter $EC_{PJ,grid,y}$ are included in Section D.2.

$EF_{EL,grid,y}$ Emission factor for grid sourced electricity in year *y* (in tCO_2/MWh). $EF_{EL,grid,y}$ is determined as the combined margin emission factor ($EF_{grid,CM,y}$) that is calculated as the weighted average of the operating margin and build margin emission factors. To weight these two factors, the default values applicable to both for the 2nd crediting period are applied. The combined margin emission factor is thus obtained as follows:

$$EF_{grid,CM,y} = w_{OM} * EF_{grid,OM,y} + w_{BM} * EF_{grid,BM,y}$$

Where:

w_{OM} Weighting of operating margin emissions factor. w_{OM} is ex-ante selected as 0.25. Further details about the ex-ante selected parameter w_{OM} are included in Section D.1 and in the PDD.

w_{BM} Weighting of operating margin emissions factor. w_{BM} is ex-ante selected as 0.75. Further details about the ex-ante selected parameter w_{BM} are included in Section D.1 and in the PDD.

$EF_{grid,OM,y}$ Operating margin CO_2 emission factor in year *y* (in tCO_2/MWh). $EF_{grid,OM}$ is ex-ante determined as 0.4979 tCO_2/MWh. Further details about the ex-ante determined parameter $EF_{grid,BM}$ are included in Section D.1.

$EF_{grid,BM,y}$ Build margin CO_2 emission factor in year *y*. $EF_{grid,BM}$ is ex-ante determined as 0.1581 tCO_2/MWh. Further details about the ex-ante determined parameter $EF_{grid,BM}$ are included in Section D.1.

Based on the above-summarized ex-ante determined parameters, $EF_{EL,grid,y}$ is thus calculated as 0.2431 tCO_2/MWh.

For the considered monitoring period, project emissions due to the consumption of grid-sourced electricity by the project activity ($PE_{EC,grid,y}$) are thus calculated as 4 tCO_2 (rounded value).

The summarized emission reduction calculation spreadsheet (that is enclosed to this Monitoring Report) includes all calculations related to the determination of $PE_{EC,grid,y}$ for the considered monitoring period.

E.3. Calculation of leakage emissions

>>
Not applicable.

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

Emission reductions achieved by the project activity during the considered monitoring period are determined as the difference between baseline emissions (BE_y) and project emissions (PE_y) determined for such period. Calculations of baseline emissions (BE_y) are presented in Section E.1. Calculations of project emissions (PE_y) are presented in Section E.2. As summarized in the table below, during the monitoring period from 19/06/2017 to 31/03/2018, achieved emission reductions are calculated and reported as 11,184 tCO_2e (rounded value):

	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	11,188	4	-	-	11,184	11,184

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 (t CO_2e)
11,184	27,442[10]

E.6. Remarks on increase in achieved emission reductions

>>
Achieved emission reductions for the project activity are about ~59% lower than the calculated value of ex-ante estimation of emission reductions as per the PDD that is valid for the considered monitoring period. The following aspect justifies and explains the relative difference between such

[10] The 27,442 tCO_2e value is calculated as the sum of the share of the estimated total emission reductions for year 2017 to be achieved during the 196-day length considered monitoring period within year 2017 (calculated as 34,729 tCO_2e * 196 / 365) and the share of the estimated total emission reductions for year 2018 to be achieved during the 90-day length considered monitoring period within year 2018 (calculated as 35,660 tCO_2e * 90 / 365)

value for ex-ante estimation of emission reductions as per the PDD (calculated as applicable for the considered monitoring period) and emission reductions actually achieved by the project activity during the considered monitoring period:

Aspect/condition which represents a decrease factor of reported emission reductions for the considered monitoring period when compared against the *ex-ante* estimation of emission reduction for the same period in the PDD:

1) *Uncertainties associated with the application of First Order Decay (FOD) multi-phased model for estimating the emission reductions in the PDD:*
   As outlined in the PDD, like other similar CDM project activities encompassing LFG collection and destruction/utilization, the amount of methane to be generated by decomposition of MSW disposed at the Bragança landfill and collected by the project activity was derived by applying the First Order Decay (FOD) model as per the methodological tool "Emission from Solid Waste Disposal Sites" (version 08.0) in the context of the determination of ex-ante estimated emission reductions to be achieved during the 2nd 7-year renewable crediting period. By taking in account all potential uncertainties associated with the application of such multi-phased decay model, it is reasonable to assume that, in the particular case of the project activity during the considered monitoring period, the application of this model somehow overestimated the amount of LFG to be actually generated and collected by the project activity. In this particular context, it is crucial to note that, while the PDD assumes a LFG collection efficiency of 92.80% (ex-ante determined parameter "Efficiency of the LFG capture system that will be installed in the project activity" (η_{PJ})) in the context of the ex-ante estimates of emission reductions, as outlined in Section A.1 and B.2, during the considered monitoring period there were relevant number of LFG collection wells and conventional LFG venting/combustion drains that were not connected to project activity, thus negatively affecting the collection efficiency of LFG generated in the site during the considered period. Besides of minor uncertainty aspects, this particular aspect represents a relevant negative impact over emission reductions achieved during the period (when compared to estimates in the PDD).

2) *Project activity operating under a very reduced activity level:*
   It is relevant to note that, during the 3.5-year period from January 2014 until August 2017, the project activity operated with a very reduced activity level. Moreover, during this particular period, no data from the LFG related monitoring instruments were recorded/reported by the project's data acquisition system. Due to that, no emission reductions are thus claimed during such period in which the project operated under very reduced activity level. As a result of made efforts to have the project activity again under normal operation, the project's monitoring system finally resumed its regular operations (in terms of data gathering and recording) on 04/08/2017. From 04/08/2017 onwards the project's LFG collection and destruction infrastructure also resumed to its normal conditions (in terms of quantitative and qualitative aspects for the collection and destruction of LFG).

- - - - -

Document information

Version	*Date*	*Description*
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.
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.

Decision Class: Regulatory
Document Type: Form
Business Function: Issuance
Keywords: monitoring report