Monitoring report form for CDM project activity
(Version 07.0)

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

MONITORING REPORT		
Title of the project activity	Palmeras POME Co-composting Project	
UNFCCC reference number of the project activity	8918	
Version number of the PDD applicable to this monitoring report	05	
Version number of this monitoring report	3.0	
Completion date of this monitoring report	12/11/2019	
Monitoring period number	1st	
Duration of this monitoring period	01/01/2013 – 31/05/2019 (first and last days included)	
Monitoring report number for this monitoring period	01	
Project participants	Palmeras de la Costa S.A. Aretech Cambio Climático S.A.	
Host Party	Colombia	
Applied methodologies and standardized baselines	AMS-III.F. - Avoidance of methane emissions through composting (version 10.0)	
Sectoral scopes	13: Waste handling and disposal	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	0 t CO_2e	76,099 t CO_2e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	228,149 t CO_2e[1]	

[1] The amount of GHG emission reductions estimated ex ante for this monitoring period was calculated by multiplying the expected daily emission reduction by 2,342 days, the equivalent days to the 01/01/2013 - 31/05/2019 period.

SECTION A. Description of project activity

A.1. General description of project activity

This project activity is a co-composting project in Palmeras de la Costa, S.A., located in the region of Cesar, Colombia. The process of crude palm oil extraction produces 3 types of solid waste: Empty Fruit Bunches (EFB), Mesocarp Fibres, and Palm Kernel Shells (PKS). Further, wastewater in form of Palm Oil Mill Effluent (POME) with a high chemical oxygen demand is generated.

By treating the EFB and POME in an aerobic co-composting process, the project activity reduces avoids methane emissions that would otherwise have been generated in the anaerobic lagoons for wastewater treatment and emitted to the atmosphere.

EFB are composted utilizing the Windrow technology in an onsite composting plant, adding POME to maintain adequate moisture level in the composting process and provide additional nitrogen content for the final compost. Aerobic composting conditions are assured through frequent turning of the compost piles with the Windrow turners and are monitored through the compost quality control plan.

During the current reporting period from 01/01/2013 to 31/05/2019, the project has reduced 76,099 tons of CO2e.

A.2. Location of project activity

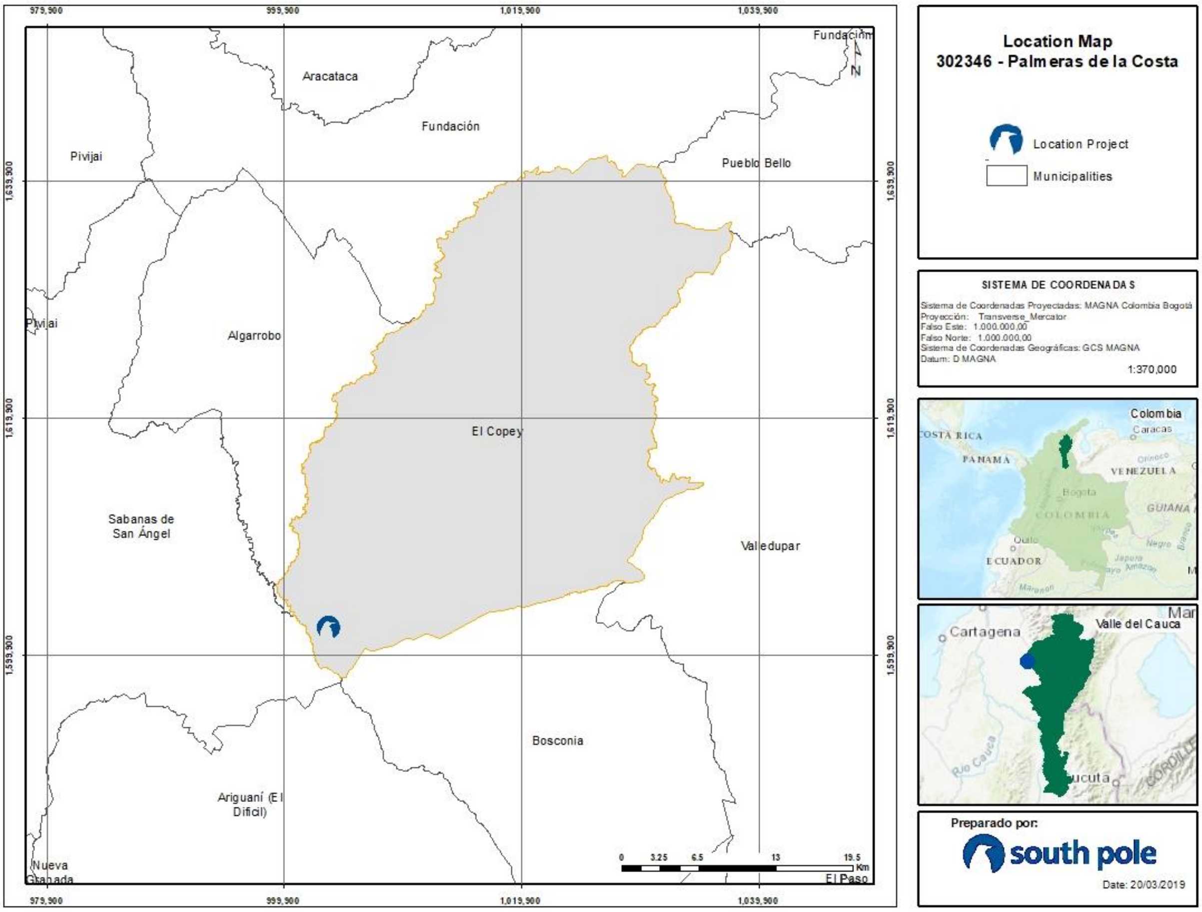

Figure 1: Location of the project activity

The composting plant is located on Palmeras' agroindustrial facility in the municipality of El Copey within the Department of Cesar. The map above shows the location of El Copey within Cesar and the location of Cesar within Colombia.

The mailing address for Palmeras' industrial facility is: Palmeras de la Costa, S.A., Carretera Vieja de Palmeras, El Copey, Cesar, Colombia. The coordinates of the industrial facility are: +10.0419º, -74.0436º.

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Colombia	Palmeras de la Costa S.A.	No
Colombia	Aretech Cambio Climático S.A.	No

A.4. References to applied methodologies and standardized baselines

The project uses the small-scale methodology AMS-III.F "Avoidance of methane emissions through composting" (version 10.0)[2]. This methodology also refers to the small-scale methodology AMS-III.H "Methane recovery in wastewater treatment" (version 16.0)[3] and to the methodological tool "Emissions from solid waste disposal sites" (version 06.0.0)[4]. Also, the project activity uses other CDM tools for minor project emissions from incremental energy consumption.

A.5. Crediting period type and duration

01/01/2013 – 31/12/2019 (renewable)

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

This project activity is a co-composting project that is owned and operated by Palmeras de la Costa S.A. The composting plant was installed within the existing palm oil mill.

The process of crude palm oil production generates 3 types of solid waste: EFB, Mesocarp Fibres, and Palm Kernel Shells (PKS). Also, liquid POME with a high chemical oxygen demand (COD) is generated. Before the implementation of the project activity, EFB were mulched and applied to plantations, and POME was treated in open lagoons that are required to provide enough retention time to lower the COD to permissible levels as per the local discharge standards. During the anaerobic digestion in lagoons, methane gas is generated and emitted to the atmosphere.

This project activity consists of a co-composting project to treat the EFB and POME in an aerobic co-composting process in order bypass the anaerobic wastewater treatment process and avoid methane emissions that would otherwise have been generated and emitted to the atmosphere.

EFB are composted utilizing the Windrow technology in an onsite composting plant, adding POME to maintain adequate moisture level in the composting process and provide additional nitrogen content for the final compost. Aerobic composting conditions are assured through frequent turning of the compost piles with the Windrow turners and are monitored through the compost quality control plan.

---

[2] http://cdm.unfccc.int/filestorage/D/Y/A/DYABR6QZTOW9SH2FM1J3GP5XVKL48N/EB59_repan05_AMS_III.F_ver10.pdf?t=cWR8cHA0dnp1fDCxN2SOqpuytVhYWeRL67T9

[3] http://cdm.unfccc.int/filestorage/8/R/I/8RIV5MZ4AG7YE9UQJ6HSL3NTFXD1C0/EB58_repan22_AMS-III.H_ver16.pdf?t=SEp8cHA0dzE5fDCfcZiio_xxYphWxXVbZcWA

[4] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v6.0.0.pdf

The composting plant is located adjacent to the existing wastewater treatment lagoons. The plant occupies approximately 20,000 m2.

The compost plant design includes:

- Site preparation and impermeabilization
- Composting plant roofing
- Windrow compost pile turners
- POME spray system
- Runoff water management system
- Plant monitoring and auxiliary equipment

In the composting plant, the organic waste is arranged with mechanical loaders in long narrow piles called “windrows”. The windrows are turned regularly with specialized equipment to ensure aerobic composting conditions.

The entire composting site is protected from leachate by through an impermeable membrane installed beneath the composting plant. Runoff water is collected in concrete channels and pumped to one of the existing wastewater treatment lagoons for recycling to the compost piles, reutilization, and/or treatment prior to discharge.

Aerobic composting is a controlled biological process in which a succession of microbial populations converts organic material into a biologically stable product. Composting is characterized by a microbially active thermophilic (high temperature, over 55ºC) period (called “active phase”) while easily digestible materials are available, followed by a lower temperature period (called “curing phase”) where more complex material are slowly digested. Under the presence of oxygen, micro-organisms break down the organic matter into simpler substances. The effectiveness of the composting process is influenced by the environmental conditions present within the compost (temperature, moisture, organic matter, oxygen and the size and activity of microbial populations).

The following figures show the project boundary and a scheme with all the monitoring variables of the project activity.

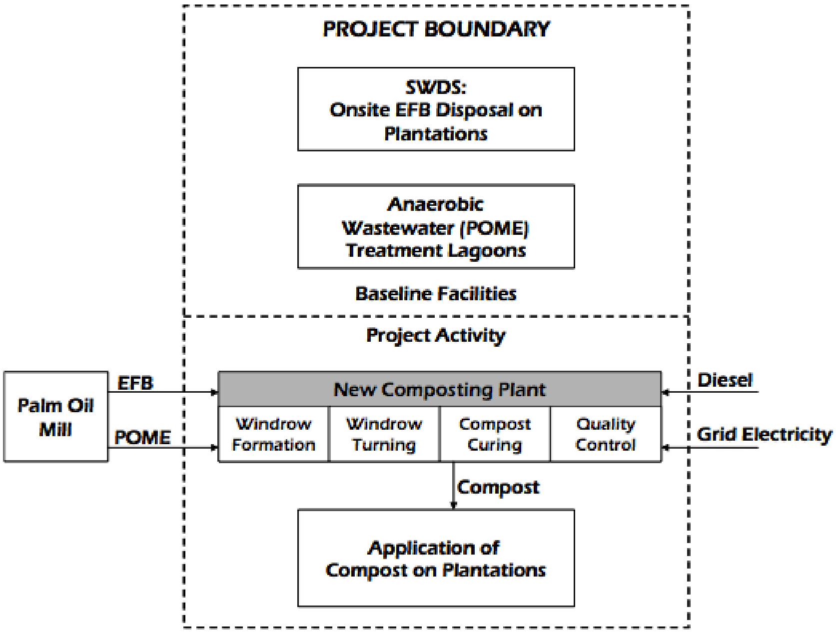

Figure 2: Project boundary of the project activity

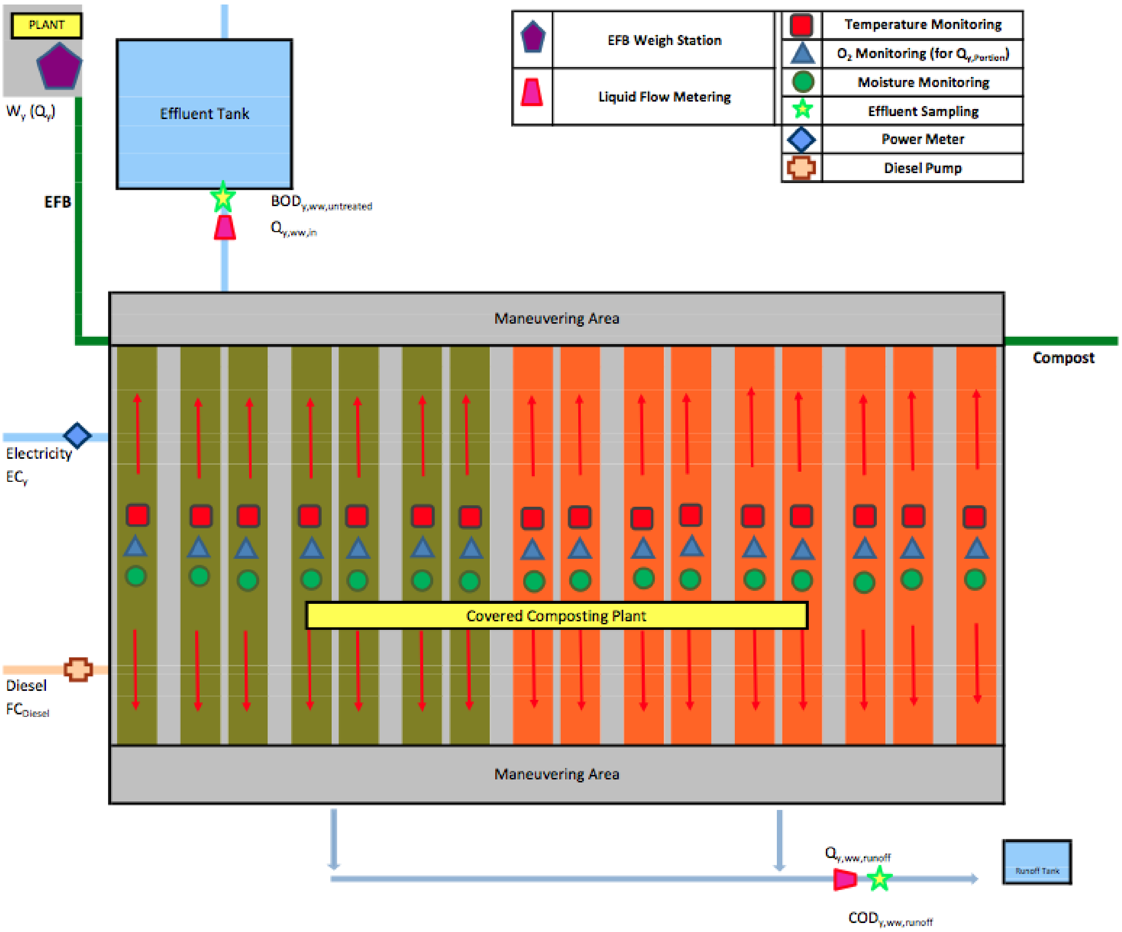

Figure 3: Scheme of the composting plant and the monitoring variables of the project activity

B.2. Post-registration changes

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

In the period 2013-2019 not all parameters of the monitoring plan were fully monitored. Also a few data gaps exist in the previous years. It is shown throughout this monitoring report, how the missing data are taken into account and emission reductions are conservatively determined.

$Q_{y,ww,in}$ and $Q_{y,ww,runoff}$ (25/08/2015 - 31/05/2019)

During the period from 25/08/2015 to 31/05/2019 the $\mathbf{Q_{y,ww,in}}$ parameter was not constantly monitored. For this period, zero conservative value was applied monthly amount of POME. Thus, the baseline emissions for the non-conforming monitoring period are considered as **zero**.

Also during the period from 25/08/15 to 31/05/19 the $\mathbf{Q_{y,ww,runoff}}$ parameter was not constantly monitored. For this period, the biggest monthly amount of the POME from measurements (2013-2015) was applied as a conservative correction.

BOD_{inflow} and $COD_{y,ww,runoff}$ (01/01/2013 – 31/05/2019)

- For the period 01/01/2013 – 31/12/2015 the minimum of 30 $\mathbf{BOD_{inflow}}$ and $\mathbf{COD_{y,ww,runoff}}$ samples was not achieved during the monitoring period (only 16 and 15 measurements), a statistical analysis was made with the Student's t-test, which is usually used in the verification of means of samples less than 30, in order to test the null hypothesis, which states that there is no effective difference between the observed sample mean and the hypothesized or stated population mean; i.e., that any measured difference is due only to chance[5]. It was defined as null hypothesis the following sentence: “There is no effective difference between the observed sample mean (mean BOD&COD 2013-2015) and stated population mean in the PDD (Values from the " Handbook for Palm Oil Mills")”, with a significance level of 0.001, which represents the most conservative value of the probability of erroneously rejecting the null hypothesis, then the resulting probability must be less than the defined level of significance to determine the statistically significant sample.

  The t-student test presented in the ER calculation spreadsheet resulted in the conclusion that by conducting less samples than what was previewed in the monitoring plan for COD and BOD, the results are still statistically significative (resulting probabilities: BOD 0.000263031 and COD 1.5845E-05), thus the results can be used as a good correlation of the population likewise if 30 samples were carried out. (see emission reductions calculation spreadsheet in tap “t-Student analysis”).

  Further, the target precision level (10%) is not achieved with the sampling made, thus the conservative procedure proposed in the “implementation plan of the Sampling Plan for Chemical Oxygen Demand” of the PDD was applied: from the average annual $\mathbf{BOD_{inflow}}$ and $\mathbf{COD_{y,ww,runoff}}$ from the samples, the difference of the determined relative precision and the target precision is discounted (inflow) or added (outflow) to be conservative (see emission reductions calculation spreadsheet in sheet “Adjusted BOD-COD”).

- For the period 01/01/2016 – 31/05/2019, the most conservative value of all samples made in previous years was applied, as no samples were made during this period (see emission reductions calculation spreadsheet in sheet “Adjusted BOD-COD”).

EC_y (01/01/2016 – 29/02/2016)

[5] Revised bibliography on Student's t-test: https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/students-t-test

There are data gaps for the power consumption of the compost plant in January and February 2016. For these two months, the maximum possible power consumption of all equipment was determined by their maximum power consumption capacity (nameplate) multiplied by the total hours of each month in order to be conservative to determine the project emissions (see emission reductions calculation spreadsheet in sheet “ECy_FCdiesel records”).

$Q_{y,Portion}$ (01/01/2017 – 31/05/2019)

Of 14,686 samples taken during the monitored period, the waste material was not composted in the presence of less than 8% oxygen, thus, $Q_{y,Portion} = 0$. However, between 2017-2019 the sampling of oxygen content in compost piles was not done, therefore it is applied a correction factor of 50% as the most conservative assumption possible for a portion of waste material that is composted in the presence of less than 8% oxygen[6].

B.2.2. Corrections

There have not been any corrections to project information or parameters fixed at the registration or renewal of crediting period of the project activity.

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

There have not been any changes to the start date of the crediting period fixed at the registration of the project activity.

B.2.4. Inclusion of monitoring plan

There has not been any post-registration change to include a monitoring plan into the PDD.

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

There have not been any permanent changes to the registered monitoring plan, or permanent deviation of monitoring from applied methodologies, applied standardized baseline, or other applied standards or tools. There have not been any changes to the project design of the project activity.

B.2.6. Changes to project design

There have not been any changes to the project design of the project activity.

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

Not applicable

SECTION C. Description of monitoring system

The monitoring plan has been designed to integrate the measurement and record keeping of the data and parameters listed above within the Palmeras’ management system, certified to the ISO 9001 standard. Figure 3 shows as scheme with the monitoring variables of the project activity.

Classification of Data and Parameters

Type of monitoring	***Data and parameters***
Continuous automated monitoring with monthly register by the environmental coordinator	$Q_{ww,y}$ EC_y $Q_{y,ww,runoff}$
Continuous monitoring by lots with manual register by operators	Q_y FC_{Diesel}

[6] This represents an increase in project emissions, as insufficient aeration leads to the replacement of aerobic micro-organisms by anaerobic ones, with the consequent delay in decomposition, the appearance of hydrogen sulphide and the production of bad odours (Bidlingmaier, 1996).

Sampling onsite with manual register by operators	$Q_{y,Portion}$
Sampling with offsite analytical determination	$BOD_{inflow,y}$ $COD_{y,ww,runoff}$
Annual photographic monitoring	Adequate Soil Application of Compost
Annual monitoring of CDM variables	$MD_{y,reg}$ GWP_CH_4 TDL NCV_{Diesel} $EF_{CO2,Diesel}$
Integrated QA/QC	Compost Quality Control Program

Monitoring Equipment

Monitoring equipment was inventoried and included within Palmeras' registry of measurement equipment items.

Maintenance and calibration requirements for monitoring equipment was included within Palmeras' schedule for maintenance and calibration of measurement equipment items. Maintenance was carried out by preventative maintenance services. Calibration was contracted with registered service providers.

Monitoring equipment items are:

- Truck scale
- Diesel fuel pump
- Wastewater flow meter
- Compost plant runoff water flow meter
- Compost plant power meter
- Portable oxygen probe with 1m lance
- Temperature probe and humidity measurement for the Compost Quality Control Program

Operational and Management Structure

The operational and management structure for monitoring emission reductions assimilates into Palmeras' integrated management system (comprising both quality and environmental management), certified to the ISO 9001 standard:

- This project activity falls within the scope of the management structure for the production processes, overseen by the plant manager.
- The scope of Palmeras' quality control plan was enlarged to include the Compost Quality Control Program.
- Monitoring equipment for this project activity and their maintenance and calibration requirements were added to their respective registers within the integrated management system.
- Formats for recording data and data registers were listed within the integrated management system.

The responsibilities of Palmeras' personnel for monitoring activities are as follows:

Plan Manager	Global responsibility for operating the compost plant and monitoring operational data
Quality Coordinator	Record keeping of monitoring data
Environmental Coordinator	Recording of monitoring data except those by lots and CDM variables
Operators	Recording of monitoring by lots
Preventative Maintenance Services	Maintenance and calibration of monitoring equipment

Data Collection and Archiving

Within the integrated management system, data collection and archiving are managed as follows:

- Global procedure for document control and registry

- Predesigned formats for data collection
- Control of individual data registers (including access rights and data retention schedules)

Additional Monitoring Considerations

Erroneous or missing measurements

Provisions for erroneous or missing measurements only apply to those five parameters that are monitored continuously (Q_y, $Q_{y,ww,in}$, EC_y, FC_{Diesel}, and $Q_{y,ww,runoff}$). If specific CDM guidelines for erroneous or missing measurements are published, they are applied. Otherwise, this project activity will use the following conservative procedures.

Missing data that are used to calculate baseline emissions will be set to the 10th percentile of their observed values, prorated if necessary, by instrument downtime. Missing data that are used to calculate project emissions will be set to the 90th percentile of their observed values.

Erroneous measurements will be detected through the periodic calibration of the respective instruments if the error determined through calibration exceeds the precision limits specified by the manufacturer. A correction factor will be defined based upon the error determined at calibration and the most conservative of the upper or lower bound of the instrument precision. This correction factor will be applied to all data points from the previous calibration, including, if applicable, a retroactive correction for previous monitoring periods.

Emergency Conditions

Protection of worker safety during emergency conditions at the Palmeras' mill could lead to abandonment of the compost plant, thus halting windrow turning and possibly leading to unintentional emissions if compost piles decompose anaerobically. In case the compost plant is abandoned due to an emergency condition, a measurement campaign to determine oxygen content (as per parameter $Q_{y,Portion}$ in section B.7.1 of the PDD) will be carried out within three working days after having achieved process normalcy. However, so far, no emergency has occurred leading to the abandonment of the composting plant.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

Data/Parameter	$\eta_{BOD,BL}$
Unit	-
Description	COD/BOD removal efficiency of the baseline treatment system
Source of data	Historical records as per AMS III.H version 16.0 part 26
Value(s) applied	0.939
Choice of data or measurement methods and procedures	Part 26 of AMS III.H v16.0 requires historical records of at least 1 year prior to project implementation. This condition is satisfied by Palmeras' wastewater treatment system and data registers. Vintage 2009 was selected since it was the most recent year of data available at the time of deciding to implement the project.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	The subscripts for this variable have been modified for clarity.

Data/Parameter	$MCF_{ww,treatment}$
Unit	-

Description	Methane correction factor for the wastewater treatment system in the baseline scenario
Source of data	AMS III.H version 16.0 Table III.H.1
Value(s) applied	0.8
Choice of data or measurement methods and procedures	Palmeras' two anaerobic lagoons have a depth of 3 meters. This default value applies to anaerobic lagoons with a depth over 2 meters.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	**$B_{o,ww}$**
Unit	kg CH_4/kg BOD
Description	Methane producing capacity for the wastewater
Source of data	AMS III.H version 16.0
Value(s) applied	0.60
Choice of data or measurement methods and procedures	Default value in methodology, based on the IPCC default value. This project activity has chosen to measure BOD directly, not COD, as per the option provided in part 20 of the methodology.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	**UF_{BL}**
Unit	-
Description	Model correction factor to account for model uncertainties for wastewater
Source of data	AMS III.H version 16.0
Value(s) applied	0.89
Choice of data or measurement methods and procedures	Default value in methodology
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	**$EF_{CO2, Elec}$**
Unit	tCO_2e/MWh
Description	Emission factor for electricity consumed
Source of data	Tool to calculate baseline, project and/or leakage from electricity consumption, version 01
Value(s) applied	1.3
Choice of data or measurement methods and procedures	Default value as per tool
Purpose of data/parameter	Calculation of project emissions
Additional comments	-

Data/Parameter	**$EF_{composting}$**
Unit	t CH_4/ton waste treated
Description	Emission factor for composting of organic waste and/or manure
Source of data	AMS III.F version 10.0
Value(s) applied	0.004

Choice of data or measurement methods and procedures	IPCC default values. wet weight basis
Purpose of data/parameter	Calculation of project emissions
Additional comments	Waste quantities and waste characteristics were measured and reported on a wet basis

Data/Parameter	$\mathbf{B_{o,ww,runoff}}$
Unit	kg CH_4/kg COD
Description	Methane producing capacity of the wastewater
Source of data	AMS III.F version 10.0
Value(s) applied	0.25
Choice of data or measurement methods and procedures	Default value in methodology, based on the IPCC default value.
Purpose of data/parameter	Calculation of project emissions
Additional comments	-

Data/Parameter	$\mathbf{MCF_{ww,runoff}}$
Unit	-
Description	Methane correction factor for the wastewater treatment system where the runoff water is treated
Source of data	AMS III.H version 16.0 Table III.H.1
Value(s) applied	0.2
Choice of data or measurement methods and procedures	Runoff water, if not recycled, is treated in lagoons that no longer be in use. Depth is maintained less than 2 meters. This value applies to anaerobic shallow lagoons (depth less than 2 meters)
Purpose of data/parameter	Calculation of project emissions
Additional comments	The subscripts for this variable have been modified for clarity.

Data/Parameter	$\mathbf{UF_{b,runoff}}$
Unit	-
Description	Model correction factor to account for model uncertainties for runoff
Source of data	AMS III.F version 10.0
Value(s) applied	1.12
Choice of data or measurement methods and procedures	Default value in methodology.
Purpose of data/parameter	Calculation of project emissions
Additional comments	The subscripts for this variable have been modified for clarity.

D.2. Data and parameters monitored

Data/Parameter	$\mathbf{MD_{y,reg}}$
Unit	tons
Description	Amount of methane that would have to be captured and combusted in the year y to comply with the prevailing regulations
Measured/calculated/ default	Default

Source of data	Compilation of environmental laws and regulations published on the web page of the environmental ministry
Value(s) of monitored parameter	0
Monitoring equipment	Literature review of promulgated regulations
Measuring/reading/recording frequency	Yearly
Calculation method (if applicable)	-
QA/QC procedures	Informal consultation with regional authority (Corpocesar) to confirm regulatory analysis
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	A review of the regulatory framework emissions from stationary sources was made (Res 909, 2008) and until now there is no obligation for methane capture and combustion.

Data/Parameter	**GWP_CH4 / GWP_{CH4}**
Unit	-
Description	GWP for CH_4
Measured/calculated/ default	Default
Source of data	UNFCCC
Value(s) of monitored parameter	25
Monitoring equipment	Literature review for CDM requirements
Measuring/reading/recording frequency	Yearly
Calculation method (if applicable)	-
QA/QC procedures	N/A
Purpose of data/parameter	Calculation of baseline and project emissions
Additional comments	As per 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” version 01.0, this value will be updated effective 01/01/2013 to be in accordance with decision 4/CMP.7.

Data/Parameter	**Q_y**
Unit	Tons
Description	Amount of organic waste type j prevented from disposal in the SWDS in the year *x* (EFB)
Measured/calculated/ default	Measured
Source of data	Onsite weigh scale
Value(s) of monitored parameter	see table below

Year	2013	2014	2015	2016	2017	2018	2019
Qy	22,328	20,419	18,809	17,114	18,451	15,924	7,135

<table>
<tr><td>Monitoring equipment</td><td>Vehicle weight scales (serial / calibration dates):
<table>
<tr><th>Type</th><th>Operation</th><th colspan="3">Serial / Calibration dates</th></tr>
<tr><td>80 ton</td><td>2012-present</td><td>88917040
16/09/2012
20/04/2014</td><td>270515/1842
13/03/2016
13/04/2017</td><td>2504182955
30/09/2018</td></tr>
<tr><td>50 ton</td><td>2012-2017</td><td>990920/894
17/10/2012</td><td>18140408
08-09-2013</td><td>160514/1525
13/03/2016
13/042017</td></tr>
</table>
See “additional comments” for explanation of calibration dates</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>
<table>
<tr><td>Method</td><td>Direct measurement</td></tr>
<tr><td>Frequency</td><td>Each lot</td></tr>
<tr><td>Calibration</td><td>Onsite calibration and certification annually</td></tr>
<tr><td>Accuracy</td><td>±1% of full scale</td></tr>
<tr><td>Responsibility</td><td>Plant operators</td></tr>
</table></td></tr>
<tr><td>Calculation method
(if applicable)</td><td>-</td></tr>
<tr><td>QA/QC procedures</td><td>Measurement was included within the plant’s integrated management system (certified to ISO 9001)

EFB weight was cross-checked with Fresh Fruit Bunch (FFB) within the plant’s data management system. The EFB/FFB ratio decreased by 10% on average compared to the historical average at the Palmeras mills (23%). This was probably due to the increase in by-products from the milling process.</td></tr>
<tr><td>Purpose of data/parameter</td><td>-</td></tr>
<tr><td>Additional comments</td><td>The gaps in the calibration of the weight scales has impact on emission reductions only if a portion of waste material is composted in the presence of less than 8% oxygen ($Q_{y,Portion}$). 14,686 samples of oxygen were taken during 2013 and 2016, none with them with a critical oxygen content below 8%. Thus, $Q_{y,Portion}$ = 0 for this period (2013 – 2016). However, between 13/03/2017 - 12/04/2017 and 13/04/2018 - 29/09/2018 there were gaps in the calibration of the weight scales and in addition oxygen sampling was not done. Therefore the maximum error between the established accuracy level in the last calibration (<1%) and the target accuracy level as per the monitoring plan (1%) was applied as a correction on $Q_{y,Portion}$ parameter for this period (2017 – 2018).

The integrated management system of the plant is still operational; however, the ISO 9001 certification was valid until 2015, it has not yet been renewed.</td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>$Q_{ww,y}$</td></tr>
<tr><td>Unit</td><td>m^3</td></tr>
<tr><td>Description</td><td>Volume of wastewater entering the co-composting facility in the year y (POME)</td></tr>
<tr><td>Measured/calculated/
default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>Onsite flow meter</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>The following annual values were applied, including the corrections as explained in “additional comments” below (see emission reductions calculation spreadsheet):
<table>
<tr><th>Year</th><td>2013</td><td>2014</td><td>2015</td><td>2016</td><td>2017</td><td>2018</td><td>2019</td></tr>
<tr><th>$Q_{ww,y}$ (m^3)</th><td>192,508</td><td>150,981</td><td>73,293</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table></td></tr>
</table>

<table>
<tr><td>Monitoring equipment</td><td>
<table>
<tr><th>Flow meter</th><th colspan="2">Serial / Calibration Date</th></tr>
<tr><td>Contingency</td><td>06110635
09/06/2011</td><td>11122019
11/09/2019</td></tr>
<tr><td>Irrigation</td><td>05118633
21/05/2011</td><td>042017002386
11/09/2019</td></tr>
</table>
</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>
<table>
<tr><td>Method</td><td>Direct measurement</td></tr>
<tr><td>Frequency</td><td>Continuous monitoring; monthly recordings</td></tr>
<tr><td>Calibration</td><td>Offsite calibration every three years</td></tr>
<tr><td>Accuracy</td><td>±4%</td></tr>
<tr><td>Responsibility</td><td>Environmental coordinator</td></tr>
</table>
</td></tr>
<tr><td>Calculation method
(if applicable)</td><td>-</td></tr>
<tr><td>QA/QC procedures</td><td>Measurement was included within the plant's integrated management system (certified to ISO 9001)

POME volume was cross-checked with Fresh Fruit Bunch (FFB) within the plant's data management system. The POME/FFB ratio kept a close average (1.02 m^3/ton) to the historical average at the Palmeras mill (0.8 m^3/ton). There was no representative deviation.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comments</td><td>The flow meters were replaced on 12/09/2013, therefore the calibration is delayed since 13/09/2013. In order to account for the inaccuracy, a calibration of the meter was done on 11/09/2019 and the maximum error between the established accuracy level in the calibration (1%) and the target accuracy level as per the monitoring plan (4%) was applied as a correction for entire monitoring report.

During the period from 25/08/15 to 31/05/19 this parameter was not constantly monitored. For this period, zero conservative value was applied monthly amount of POME..

The flows measured by the contingency and irrigation flow meter were summed as they both measured the POME entering individual tanks from the palm oil extraction process.

The integrated management system of the plant is still operational; however, the ISO 9001 certification was valid until 2015, it has not yet been renewed</td></tr>
</table>

<table>
<tr><th>Data/Parameter</th><th>$BOD_{inflow,y}$</th></tr>
<tr><td>Unit</td><td>tonnes/m^3</td></tr>
<tr><td>Description</td><td>Biological oxygen demand of the wastewater entering the co-composting facility in the year y</td></tr>
<tr><td>Measured/calculated/
default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>Offsite laboratory</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>The following table shows the monitoring values with the correction due to imprecision applied. The detailed calculation is shown in the emission reductions calculation spreadsheet in tap “Adjusted BOD-COD”.

<table>
<tr><th>Year</th><th>2013</th><th>2014</th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th></tr>
<tr><td>$BOD_{inflow,y}$</td><td>0.0306</td><td>0.0290</td><td>0.0339</td><td>0.0219</td><td>0.0219</td><td>0.0219</td><td>0.0219</td></tr>
</table>
</td></tr>
</table>

Monitoring equipment	External laboratory accredited nationally for environmental control
Measuring/reading/recording frequency	Method: Grab sampling and laboratory analysis Frequency: Minimum 30 samples as per the sampling plan, Annex A4.3 of the PDD. Calibration: As per laboratory protocol for BOD measurement Accuracy: ±10% precision at 90% confidence level as per the sampling plan, Annex A4.3 of the PDD Responsibility: Environmental coordinator
Calculation method (if applicable)	-
QA/QC procedures	Measurement was included within the plant's integrated management system (certified to ISO 9001)
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Sampling plan according to the "Standard for sampling and surveys for CDM project activities and programme of activities" v03.0 is included in Annex A4.3. of the PDD. This project activity has selected the BOD option instead of COD measurement. Variable names and subscripts have been modified for clarity to reflect this methodological choice. Since a minimum of 30 BOD samples are not achieved during the monitoring period, a statistical analysis was made with the Student's t-test that allowed to determine that the sample size made can be considered statistically significant (see emission reductions calculation spreadsheet in tap "t-Student analysis"). Further, the target precision level (10%) is not achieved with the sampling made, thus the conservative procedure proposed in the "implementation plan of the Sampling Plan for Chemical Oxygen Demand" of the PDD was applied: from the average annual BOD_{inflow} from the samples, the difference of the determined relative precision and the target precision is discounted (see emission reductions calculation spreadsheet in sheet "Adjusted BOD-COD"). For the period 2016 – 2019, the most conservative value of all samples made in previous years was applied, as no samples were made during this period (see emission reductions calculation spreadsheet in sheet "Adjusted BOD-COD"). The integrated management system of the plant is still operational; however, the ISO 9001 certification was valid until 2015, it has not yet been renewed.

Data/Parameter	**EC_y**
Unit	MWh
Description	Electricity consumption from project equipment items in the year y
Measured/calculated/ default	Measured
Source of data	Onsite power meter
Value(s) of monitored parameter	Values with correction applied (see emission reductions calculation spreadsheet in tap "ECy_FCdiesel records"):

Year	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
EC_y	95.14	47.40	189.42	304.75	165.95	86.19	1.29

Monitoring equipment	Power meter with totalizer: **Type** / **Serial number** / **Calibration Date** Main / 17014280 / 16/09/2019 Backup / 15220400 / 16/09/2019
Measuring/reading/recording frequency	Method: Direct measurement Frequency: Continuous monitoring; monthly recordings Calibration: Offsite calibration every three years Accuracy: ±2% Responsibility: Environmental coordinator
Calculation method (if applicable)	-
QA/QC procedures	Measurement was included within the plant's integrated management system (certified to ISO 9001)
Purpose of data/parameter	Calculation of project emissions
Additional comments	The power meter was no calibrated during the monitoring period. In order to account for the inaccuracy, a calibration of the meter was done on 16/09/2019 and the maximum error between the established accuracy level in the manufacturer's technical specifications (0.2%) and the target accuracy level as per the monitoring plan (2%) was applied as a correction. Further, there are data gaps for the power consumption of the compost plant in January and February 2016. For these two months, the maximum possible power consumption of all equipment was determined by their maximum power consumption capacity (nameplate) multiplied by the total hours of each month in order to be conservative to determine the project emissions. The integrated management system of the plant is still operational; however, the ISO 9001 certification was valid until 2015, it has not yet been renewed.

Data/Parameter	**TDL**
Unit	-
Description	Average technical transmission and distribution losses for the power grid
Measured/calculated/ default	Default
Source of data	Tool to calculate baseline, project and/or leakage from electricity consumption, version 01
Value(s) of monitored parameter	0.2
Monitoring equipment	Review of CDM tool, in case default value is updated
Measuring/reading/recording frequency	Annually
Calculation method (if applicable)	-
QA/QC procedures	-
Purpose of data/parameter	Calculation of project emissions
Additional comments	Default value as per tool

Data/Parameter	$FC_{Diesel,y}$
Unit	kl
Description	Consumption of diesel fuel from project equipment in the year y
Measured/calculated/ default	Measured
Source of data	Onsite fuel pump

Value(s) of monitored parameter	<table><tr><th>Year</th><th>2013</th><th>2014</th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th></tr><tr><td>$FC_{Diesel,y}$</td><td>76.90</td><td>67.79</td><td>27.77</td><td>9.24</td><td>13.58</td><td>10.20</td><td>4.67</td></tr></table>
Monitoring equipment	Fuel pump, serial number: 0061-17
Measuring/reading/recording frequency	<table><tr><td>Method</td><td>Direct measurement of fuelling of project activity equipment</td></tr><tr><td>Frequency</td><td>Each fuelling event</td></tr><tr><td>Calibration</td><td>Annually</td></tr><tr><td>Accuracy</td><td>±4%</td></tr><tr><td>Responsibility</td><td>Plant operators</td></tr></table>
Calculation method (if applicable)	-
QA/QC procedures	Measurement was included within the plant's integrated management system (certified to ISO 9001) All onsite diesel consumption is measured and assigned to operational cost centres. This data was cross-checked through accounting records. Physical records available between 2013-2015 were compared to accounting records, the biggest percentage difference was 7.5%. In the calculation of emission reductions, the upper values were used.
Purpose of data/parameter	Calculation of project emissions
Additional comments	The external entity Terpel SA operates the pump and Palmeras de la Costa buys the fuel required for all its operations. Therefore, the maintenance, calibration and supply depend of Terpel. The integrated management system of the plant is still operational; however, the ISO 9001 certification was valid until 2015, it has not yet been renewed.

Data/Parameter	**NCV_{Diesel}**
Unit	GJ/kl
Description	Net calorific value of diesel fuel in volumetric units
Measured/calculated/ default	Default
Source of data	IPCC Guidelines
Value(s) of monitored parameter	36.359
Monitoring equipment	Review of IPCC guidelines
Measuring/reading/recording frequency	-
Calculation method (if applicable)	-
QA/QC procedures	N/A
Purpose of data/parameter	Calculation of project emissions
Additional comments	Data source d) for this parameter is chosen since NCVs are not reported on purchasing records of commercial liquid fuels; only volumes are reported. The IPCC value of 43.3 GJ/t (95% confidence level upper value, table 1.2, Volume 2, 2006 Guidelines) is converted to volumetric units as required by the applicable tool (am-tool-03-v2) using 0.8397 kg/l (Reece, Mieke. Densities of Oil Products. IEA, Paris. Nov 2004), published by the International Energy Agency and thus well-documented and reliable as per data source c) for density within the referenced tool

Data/Parameter	**$EF_{CO2,Diesel}$**
Unit	tCO_2/GJ
Description	Emission factor for diesel fuel

Measured/calculated/ default	Default
Source of data	IPCC Guidelines
Value(s) of monitored parameter	0.0748
Monitoring equipment	Review of IPCC Guidelines
Measuring/reading/recording frequency	-
Calculation method (if applicable)	-
QA/QC procedures	N/A
Purpose of data/parameter	Calculation of project emissions
Additional comments	Data source d) for this parameter is chosen since EFs are not reported on purchases of commercial liquid fuels, only volumes. The IPCC value at validation is 0.0748 tCO2/GJ (95% confidence level upper value, table 1.4, Volume 2, 2006 Guidelines).

<table>
<tr><td>Data/Parameter</td><td>$Q_{y,Portion}$</td></tr>
<tr><td>Unit</td><td>t</td></tr>
<tr><td>Description</td><td>Portion of waste material that is composted in the presence of less than 8% oxygen</td></tr>
<tr><td>Measured/calculated/
default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>Continuous measurement of waste material (please see variable Q)
Onsite oxygen sampling and analysis</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>Values with correction applied (see emission reductions calculation spreadsheet in tap “CERs calculation”):
<table>
<tr><th>Year</th><th>2013</th><th>2014</th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th></tr>
<tr><td>$Q_{y,Portion}$</td><td>0</td><td>0</td><td>0</td><td>0</td><td>9,410</td><td>8,122</td><td>3,568</td></tr>
</table></td></tr>
<tr><td>Monitoring equipment</td><td>Portable oxygen meter with a 1m lance, serial number: 802779</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>
<table>
<tr><td>Method</td><td>Spot sampling of oxygen content in compost piles and statistical determination as per the “Standard for sampling and surveys for CDM project activities and programme of activities” v03.0.</td></tr>
<tr><td>Frequency</td><td>Minimum 271 samples as per sampling plan, Annex A4.2</td></tr>
<tr><td>Calibration</td><td>Self-calibrating oxygen probe before each sampling complying with the operating manuals (zero and full-scale).</td></tr>
<tr><td>Accuracy</td><td>±10% precision at 90% confidence level as per the sampling plan, Annex A4.2 of the PDD</td></tr>
<tr><td>Responsibility</td><td>Plant operators</td></tr>
</table></td></tr>
<tr><td>Calculation method
(if applicable)</td><td>-</td></tr>
<tr><td>QA/QC procedures</td><td>Measurement was included within the plant’s integrated management system (certified to ISO 9001)</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of project emissions</td></tr>
</table>

<table>
<tr><td>Additional comments</td><td>Sampling plan according to the “Standard for sampling and surveys for CDM project activities and programme of activities” v03.0 is included in Annex A4.2 of the PDD.

This variable is determined by multiplying the total volume of waste to be composted (Q) by the fraction produced in the presence of less than 8% oxygen.

Of 14,686 samples taken during the monitored period, the waste material was not composted in the presence of less than 8% oxygen,thus, $Q_{y,Portion} = 0$. However, between 2017-2019 the sampling of oxygen content in compost piles was not done, therefore it is applied a correction factor of 50% as the most conservative assumption possible for a portion of waste material that is composted in the presence of less than 8% oxygen[7]. Moreover, the maximum permissible weight scale error of 1% was applied as a correction for the calibration gaps between 2017-2018.

The integrated management system of the plant is still operational; however, the ISO 9001 certification was valid until 2015, it has not yet been renewed.</td></tr>
</table>

<table>
<tr><td>**Data/Parameter**</td><td>$\mathbf{Q_{y,ww,runoff}}$</td></tr>
<tr><td>Unit</td><td>m^3</td></tr>
<tr><td>Description</td><td>Volume of runoff water in the year y</td></tr>
<tr><td>Measured/calculated/ default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>Onsite flow meter</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>The following annual values were applied, including the corrections as explained in “additional comments” below (see emission reductions calculation spreadsheet in tap “Qy,ww,in_Qy,ww,runoff records”):
<table><tr><th>Year</th><th>2013</th><th>2014</th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th></tr><tr><td>$\mathbf{Q_{y,ww,runoff}}$</td><td>66,454</td><td>66,367</td><td>58,629</td><td>104,324</td><td>104,324</td><td>104,324</td><td>43,468</td></tr></table></td></tr>
<tr><td>Monitoring equipment</td><td>Flow meter with totalizer, serial number: 11122013</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td><table><tr><td>Method</td><td>Direct measurement</td></tr><tr><td>Frequency</td><td>Continuous monitoring; monthly recordings</td></tr><tr><td>Calibration</td><td>Self-calibrating oxygen probe (zero and full-scale)</td></tr><tr><td>Accuracy</td><td>±4%</td></tr><tr><td>Responsibility</td><td>Environmental Coordinator</td></tr></table></td></tr>
<tr><td>Calculation method (if applicable)</td><td>-</td></tr>
<tr><td>QA/QC procedures</td><td>Measurement was included within the plant’s integrated management system (certified to ISO 9001</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of project emissions</td></tr>
</table>

Additional comments	After 2015 there was no flow meter installed on site and therefore it was not calibrated. Thus, the maximum error between the established accuracy level in the calibration of the contingency and irrigation meters (1%) and the target accuracy level as per the monitoring plan (4%) was applied as a correction for the entire monitoring report. During the period from 25/08/15 to 31/05/19 this parameter was not constantly monitored. For this period, the following conservative assumption was made: the biggest monthly amount of runoff water from measurements (2013-2015) was applied. The integrated management system of the plant is still operational; however, the ISO 9001 certification was valid until 2015, it has not yet been renewed.

Data/Parameter	**$COD_{y,ww,runoff}$**
Unit	tonnes/m^3
Description	Chemical oxygen demand of the runoff water leaving the composting facility in the year y
Measured/calculated/ default	Measured
Source of data	Offsite laboratory
Value(s) of monitored parameter	The following annual values were applied, including the corrections as explained in “additional comments” below (see also see emission reductions calculation spreadsheet in tap “Adjusted BOD-COD”): **Year**: **2013** 0.0467; **2014** 0.0201; **2015** 0.0529; **2016** 0.0747; **2017** 0.0747; **2018** 0.0747; **2019** 0.0747 ($COD_{y,ww,runoff}$)
Monitoring equipment	External laboratory accredited nationally for environmental control and certified to the standard ISO 17025
Measuring/reading/recording frequency	Method: Grab sampling and laboratory analysis Frequency: Minimum 30 samples as per the sampling plan, Annex A4.3 of the PDD. Calibration: As per laboratory protocol for COD measurement Accuracy: ±10% precision at 90% confidence level as per the sampling plan, Annex A4.3 of the PDD. Responsibility: Environmental Coordinator
Calculation method (if applicable)	-
QA/QC procedures	Measurement was included within the plant’s integrated management system (certified to ISO 9001)
Purpose of data/parameter	Calculation of project emissions

Values table:

Year	2013	2014	2015	2016	2017	2018	2019
$COD_{y,ww,runoff}$	0.0467	0.0201	0.0529	0.0747	0.0747	0.0747	0.0747

Measuring/reading/recording frequency:

Method	Grab sampling and laboratory analysis
Frequency	Minimum 30 samples as per the sampling plan, Annex A4.3 of the PDD.
Calibration	As per laboratory protocol for COD measurement
Accuracy	±10% precision at 90% confidence level as per the sampling plan, Annex A4.3 of the PDD.
Responsibility	Environmental Coordinator

Additional comments	Sampling plan according to the "Standard for sampling and surveys for CDM project activities and programme of activities" v03.0 is included in Annex A4.3. of the PDD. Since a minimum of 30 COD samples are not achieved during the monitoring period, a statistical analysis was made with the Student's t-test that allowed to determine that the sample size made can be considered statistically significant (see emission reductions calculation spreadsheet in tap "t-Student analysis"). Further, the target precision level (10%) is not achieved with the sampling made, thus the conservative procedure proposed in the implementation plan of the Sampling Plan for Chemical Oxygen Demand was applied for each year: from the average annual $COD_{y,ww,runoff}$ from the samples, the difference of the calculated relative precision and the target precision is added (see emission reductions calculation spreadsheet in tap "Adjusted BOD-COD"). For the period 2016 – 2019 the most conservative value of all samples made in previous years was applied, as no samples were made during this period (see emission reductions calculation spreadsheet in sheet "Adjusted BOD-COD"). The integrated management system of the plant is still operational; however, the ISO 9001 certification was valid until 2015, it has not yet been renewed.

Data/Parameter	**Compost Quality Control Program**
Unit	-
Description	The operation of the co-composting facilities was documented in a quality control program, monitoring the conditions and establishing the procedures that ensure the aerobic condition of the waste during the composting process (pile geometry, turning frequency, oxygen, moisture, temperature, etc.).
Measured/calculated/ default	-
Source of data	Record keeping of onsite measurements as per the quality management system.
Value(s) of monitored parameter	The compost quality control program was included within the scope of Palmeras' quality management system, certified to the ISO 9001 standard. These technical specifications are subject to modification, based on the commitment to continuous improvement under the ISO 9001 standard.
Monitoring equipment	-
Measuring/reading/recording frequency	-
Calculation method (if applicable)	-
QA/QC procedures	Incorporated within the quality management system.
Purpose of data/parameter	-
Additional comments	The initial technical specifications for this system are included in Annex A4.4 of the PDD. The integrated management system of the plant is still operational; however, the ISO 9001 certification was valid until 2015, it has not yet been renewed.

Data/Parameter	**Adequate Soil Application of Compost**
Unit	-
Description	Soil application of the compost was monitored

Measured/calculated/ default	Measured
Source of data	Delivery records and onsite inspection
Value(s) of monitored parameter	-
Monitoring equipment	Photographic device and weight scale
Measuring/reading/recording frequency	Dispatch of compost was measured on the mill's truck scale (please see variable Q for the precision and calibration of this instrument). All lots were weighed (sampling not applicable) The compost was applied to plantations in thin layers to assure aerobic decomposition. Photographic evidence was collected annually to document the adequate soil application of compost. Photographic evidence was collected on Palmeras' own plantations as well as all private plantations that are dispatched over 500 tons of compost annually. Since all significant plantations were observed, the requirement of part 25 of AMS III.F v10.0 for monitoring at a "representative sample of user sites" is exceeded.
Calculation method (if applicable)	-
QA/QC procedures	Dispatch of compost was included in the plant's integrated management system (certified to ISO 9001). Compost yields (as a percentage of EFB) were tracked monthly
Purpose of data/parameter	-
Additional comments	The integrated management system of the plant is still operational; however, the ISO 9001 certification was valid until 2015, it has not yet been renewed.

D.3. Implementation of sampling plan

The following sampling plan is established in the registered PDD and applied as explained:

Sampling Plan for Compost Pile Oxygen Content

Objectives and reliability requirements

The objective is to determine the fraction of the compost pile over the crediting period that is produced in the presence of less than 8% oxygen with 90% confidence and 10% precision.

Target population

The target population is the oxygen content within the production of the compost at all points in time over the crediting period.

Sampling method

Simple random sampling was used, since the compost piles are homogeneous.

Sample size

Since the population is a continuous medium (oxygen within the compost piles), the population size is infinite, and the approximate equation can be used (part 56, "Guidelines for sampling and surveys for CDM project activities and programme of activities" version 02.0):

$$n \geq \frac{1.645^2(1-p)}{0.1^2 \times p}$$

Where *p* is the percentage of compost that is produced in the presence of less than 8% oxygen. According to the compost quality management plan (appendix A4.4 of the PDD), the oxygen content should always be above 10%. Therefore, the process target is that this fraction is zero. Since composting is a biological process, upsets might occur due to a number of reasons. The ex-ante emission reduction calculation assumes a conservative value of 20%. The sample size is calculated based on the most conservative assumption possible for a proportion: 50%. This value of 50% is introduced in the above equation to yield:

$n \geq 271$

Sampling frame

The sampling frame is the set of compost piles each time sampling is carried out.

Data to be Collected

Field measurements

Each sampling campaign was carried out by measuring the oxygen content with a portable, self-calibrating probe, in all compost piles. Sampling campaigns were carried out throughout the year to avoid any seasonal bias. The readings were recorded manually and entered into a spreadsheet.

Quality assurance / Quality control

The overall quality control and assurance strategy is based on two key elements:

- Data quality is assured through the self-calibration of the portable oxygen meter.
- Data collection and management was handled through the compost quality control system.

Non-sampling errors such as refusals and non-response do not apply to this sampling plan. No outlier data was excluded from the dataset.

Analysis

The fraction (p) was determined by dividing the number of readings under 8% by the total number of samples taken. The standard error for *p* was determined by the conservative equation (part 256, “Guidelines for sampling and surveys for CDM project activities and programme of activities” version 02.0) as:

$$se = \sqrt{p * (1 - p)/n}$$

The check on meeting the reliability requirement was based on the larger of the two proportions (part 9, “Standard for sampling and surveys for CDM project activities and programme of activities” version 03.0). This check determines the precision (1.645 * standard error), the 90% confidence level (± precision), and the relative precision (precision divided by the larger of the two proportions). The relative precision was compared to the objective of 10%.

Implementation

Implementation plan

Data collection was carried out by the compost plant operators. They were trained in the use of the self-calibrating, portable oxygen probe and the manual recording formats.

Failure to achieve the target precision level

This sampling plan, overdesigned by assuming a 50% proportion value to determine sample size, assures that the target precision level always be achieved.

Result of the sampling for Compost Pile Oxygen Content of the monitoring period

Sampling campaigns were successfully carried during the 2013-2016:

Sample size	*14,686*
Oxygen measurements < 8%	*0*

In this monitored period there was no portion of waste material that is composted in the presence of less than 8% oxygen. However, between 2017-2019 the sampling of oxygen content in compost piles was not done, therefore it is applied a correction factor of 50% as the most conservative assumption possible for a portion of waste material that is composted in the presence of less than 8% oxygen.

Sampling Plan for Chemical Oxygen Demand

Sampling Design

Objectives and reliability requirements

The objective is to determine the biological or chemical oxygen demand (BOD / COD) of the wastewater used in composting and the runoff water with 90% confidence and 10% precision.

Target population

The target population is the BOD in the wastewater as well as the COD in the runoff water.

Sampling method

Simple random sampling was used, since the wastewater and runoff water streams are expected to be homogeneous.

Sample size

According to part 12, “Standard for sampling and surveys for CDM project activities and programme of activities” version 03.0, a minimum sample size of 30 shall be chosen.

Sine the minimum of 30 COD and BOD samples are not achieved during the monitoring period, a statistical analysis was made with the Student's t-test that allowed to determine that the sample size made can be considered statistically significant (see emission reductions calculation spreadsheet in tap “t-Student analysis”).Further, the target relative precision (10%) was not achieved during this monitoring period, the correction proposed below in the section “Implementation - Failure to achieve the target precision level" was applied as per the registered PDD.

Sampling frame

The sampling frame is determined by the grab samples taken of wastewater and runoff water.

Data to be Collected

Field measurements

Measurements and data were generated through the analysis of the grab samples in a certified laboratory. The field objective is to obtain grab samples periodically. Sampling campaigns were carried out throughout the year to avoid any seasonal bias.

Field data documents the time and location of the grab samples.

Analytical results of the BOD and COD determinations for wastewater and runoff water will be documented in laboratory results.

Quality assurance / Quality control

The overall quality control and assurance strategy is based on two key elements:

- Data quality is assured through the standardized procedures of the accredited laboratory.
- Data collection and management were handled through Palmeras' process control system.

Non-sampling errors such as refusals and non-response do not apply to this sampling plan. No outlier data was excluded from the dataset.

Analysis

The reported values for wastewater and runoff water in monitoring reports were the average of all values taken during the monitoring period. The standard error (se) of the samples was determined statistically.

The check on meeting the reliability requirement determines the precision (1.645 * standard error), the 90% confidence level (± precision), and the relative precision (precision divided by the mean). The relative precision was compared to the objective of 10%.

Implementation

Implementation plan

Grab sampling was carried out by qualified technicians from Palmeras' process control laboratory. Analytical determinations of BOD and COD were carried out by an external laboratory that is accredited for regulatory compliance in the host country.

Failure to achieve the target precision level

In case the target precision level is not achieved during a monitoring period, additional sampling would not be possible, since the wastewater and runoff water generated over the monitoring period would no longer exist. Therefore, discounting of emission reduction estimates would be the only recourse available to the project proponents.

As defined in the PDD the project applies the following conservative procedure for such a situation (pg. 40 of the PDD):

In case the actual precision has a higher bound than the target level, the value of BOD_{ww} was taken to be 10% more than the lower bound of the confidence interval. For example, if BOD_{ww} is determined by sampling to be 40 g/l with a 90% confidence interval between 34 and 46 (15% precision), the value to be used in the monitoring report would be 37.8 (34 ÷ 0.9) and its precision at 90% confidence would be reported as +22%/-10%. The converse would be applied in the case of COD_{runoff}. Under the same numerical example, its value to be used in the monitoring report would be 41.8 (46÷ 1.1) and its precision at 90% confidence would be reported as +10%/-19%.

Target precision level adjustment of the entire monitoring period:

Since target precision level (10%) is not achieved during the monitoring period and retroactive sampling is not possible, the conservative procedure proposed in the previous paragraph. The

results and conservative adjustments are summarized below (see emission reductions calculation spreadsheet in sheet “Adjusted BOD-COD”):

Year		2013	2014	2015
$COD_{y,ww,runoff}$	Mean mg O2/L	32,771.50	14,214.67	32,003.83
	Mean adjusted to 10%	46,709.77	20,100.71	52,867.53
$BOD_{inflow,y}$	Mean mg O2/L	33,527.86	31,359.67	36,408.83
	Mean adjusted to 10%	30,637.86	29,020.40	33,897.10

SECTION E. Calculation of emission reductions or net anthropogenic removals

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

According to part 14 of methodology AMS III.F v10.0, baseline emissions are to be calculated as follows:

$$BE_y = BE_{CH4,SWDS,y} + BE_{ww,y} + BE_{CH4,manure,y} - MD_{y,reg} * GWP\_CH_4 \qquad \textbf{Equation (1)}$$

Where:

BE_y	Baseline emissions associated with the project activity in the year y (tCO_2e)
$BE_{CH4,SWDS,y}$	Yearly methane generation potential of the solid waste composted by the project activity during the years “x” from the beginning of the project activity (x=1) up to the year y (tCO_2e)
$BE_{ww,y}$	Where applicable, baseline emissions from the wastewater co-composted, calculated as per the procedures in AMS III.H (tonne)
$BE_{CH4,manure,y}$	Where applicable, baseline emissions from manure composted by the project activities, as per the procedures of AMS-III.D
$MD_{y,reg}$	Amount of methane that would have to be captured and combusted in the year y to comply with the prevailing regulations (tonne)
GWP_CH_4	*GWP for CH4*

The term $BE_{CH4,manure,y}$ does not apply, since manure is not composted in this project activity. To be conservative, the term $BE_{CH4,SWDS,y}$ is accounted for as zero.

Part 14 of methodology AMS III.F v10.0 requires that the term $BE_{ww,y}$ be calculated as per methodology AMS III.H. Part 20 of methodology AMS III.H v16.0 stipulates that the term $BE_{ww,treatment,y}$ be calculated as follows:

$$BE_{ww,treatment,y} = \sum_i (Q_{ww,i,y} * COD_{\inf low,i,y} * \eta_{COD,BL,i} * MCF_{ww,treatment,BL,i}) * B_{o,ww} * UF_{BL} * GWP_{CH4}$$

Where:

$Q_{ww,i,y}$	Volume of wastewater entering the co-composting facility in the year y (m^3)
$COD_{inf,low,I,y}$	Chemical oxygen demand of the wastewater entering the co-composting facility in the year y (tonnes/m^3)
$\eta_{COD,BL,i}$	COD removal efficiency of the baseline WWTS
$MCF_{ww,treatment,BL,i}$	Methane correction factor for the wastewater treatment system in the baseline scenario
$B_{o,ww}$	Methane producing capacity for the wastewater (kg CH_4/kg BOD)
UF_{BL}	Model correction factor to account for model uncertainties for wastewater

The application of this formula is subject to the following observations:

- The subscripts of the variable BE are adjusted to be consistent with methodology AMS III.F v10.0
- Only one wastewater stream is used in this project activity, hence the summation sign and index i can be ignored.
- AMS III.H v16.0 allows either BOD or COD to be used to determine the organic content of the wastewater. This Project's Participants have selected the BOD option.

The formula is thus revised to reflect the above observations and results in the following expression which was used to calculate the baseline emissions from the wastewater co-composted:

$$BE_{ww,y} = Q_{ww,y} * BOD_{\inf low,y} * \eta_{BOD,y} * MCF_{ww,treatment} * B_{o,ww} * UF_{BL} * GWP_{CH4}$$ **Equation (2)**

Example: $BE_{ww,2013} = 192{,}508\ m^3 * 0.0306\ \frac{t}{m^3} *\ 0.939 * 0.8 * 0.6\ \frac{t\ CH_4}{t\ BOD} * 0.89 * 25\ \frac{t\ CO_2}{t\ CH_4} = 59{,}148\ t\ CO_2$

Where:

$BOD_{inflow,y}$	Biological oxygen demand of the wastewater entering the co-composting facility in the year y (tonnes/m^3)
$\eta_{BOD,y}$	BOD removal efficiency of the baseline WWTS
$MCF_{ww,treatment}$	Methane correction factor for the wastewater treatment system in the baseline scenario

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

According to part 15 of methodology AMS III.F v10.0, project emissions are to be calculated as follows:

$$PE_y = PE_{y,transp} + PE_{y,power} + PE_{y,comp} + PE_{y,runoff} + PE_{y,res\ waste}$$ **Equation (3)**

Example: $PE_{2013} = 358\ t\ CO_2 + 0\ t\ CO_2 + 4{,}346\ t\ CO_2 = 4{,}703\ t\ CO_2$

Where:

PE_y	Project activity emissions in the year y (tCO_2e)
$PE_{y,transp}$	Emissions from incremental transportation in the year y (tCO_2e)
$PE_{y,power}$	Emissions from electricity or fossil fuel consumption in the year y (tCO_2e)
$PE_{y,comp}$	Methane emissions during composting process in the year y (tCO_2e)
$PE_{y,runoff}$	Methane emissions from runoff water in the year y (tCO_2e)
$PE_{y,res,waste}$	In case produced compost is subject to anaerobic storage or disposed in a landfill: methane emissions from the anaerobic decay of the residual organic content (tCO_2e)

The project activity does not involve incremental transport or storage under anaerobic conditions. Therefore the terms $PE_{y,transp}$ and $PE_{y,res}$ waste do not apply.

The definition of the term $PE_{y,power}$ embraces both electric power and fossil fuel consumption from project equipment items. It is calculated as follows:

Project Electricity Consumption

This project uses the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” v01, as specified in part 27 of AMS III.F v10.0. Project emissions from electricity consumption are thus defined by the following formula:

$$PE_{EC,y} = EC_y * EF_{CO2,ELEC,y} * (1 + TDL_y)$$

For the emission factor, this project uses option A2 from the tool, a conservative default value of 1.3 tCO_2/MWh. For the system losses, this project uses the conservative default value of 20% as per the tool. These parameters are thus fixed for the crediting period and do not need to be monitored.

Project Fossil Fuel Consumption

The only fossil fuel to be consumed in this project is diesel fuel for the windrow turner and other mobile project equipment items. Part 27 of AMS III.F v10.0 refers to the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” v2. This tool requires the following formula to calculate fossil fuel emissions:

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

Where:

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

This project has only one process: composting. The index *j* can thus be ignored. This project consumes just one fossil fuel type: diesel. The index *i* and the summation over fuel types *i* can thus be ignored. The “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” v2 provides two options to calculate the parameter COEF. This project selects option B (based on net calorific value and fuel-specific emission factor), since the data to use option A (carbon content of fuel) is not readily available. Option B requires that the parameter COEF be calculated as follows:

$$COEF_{Diesel} = NCV_{Diesel} * EF_{CO2,Diesel}$$

Where:

NCV_{Diesel}	Net calorific value for diesel fuel (GJ/mass or volume unit)
$EF_{CO2,\ Diesel}$	CO_2 emission factor for diesel fuel (tCO_2e/GJ)

For the fuel consumption, this project measures diesel fuel volumetrically, as indicated by the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” v2. Volumetric measurement is international common practice for on- and off-road vehicle fuel filling.

Project emissions from diesel consumption are thus defined by the following formula:

$$PE_{FC,y} = FC_{Diesel,y} * NCV_{Diesel} * EF_{Diesel}$$

The term $PE_{y,power}$ is therefore calculated according to the following formula:

$$PE_{y,power} = EC_y * EF_{CO2,ELEC} * (1 + TDL) + FC_{Diesel,y} * NCV_{Diesel} * EF_{CO2,Diesel}$$ **Equation (4)**

Example: $PE_{2013,power} = 95.14\ MWh * 1.3 \frac{t\ CO_2}{MWh} * (1 + 0.2) + 76.9\ kl * 36.359 \frac{GJ}{kl} * 0.0748 \frac{t\ CO_2}{GJ}$

Where:

EC_y	Electricity consumption from Project equipment items in the year y (MWh)
$EF_{CO2,\ ELEC}$	CO_2 emission factor for electricity (tCO_2e/MWh)
TDL	Transmission and distribution losses
$FC_{Diesel,\ y}$	Consumption of diesel fuel in the year y (kl)
NCV_{Diesel}	Net calorific value for diesel fuel (GJ/kl)
$EF_{CO2,Diesel}$	CO_2 emission factor for diesel fuel (tCO_2e/GJ)

According to part 18 of methodology AMS III.F v10.0, the term $PEy_{,comp}$ is to be calculated as follows:

$$PE_{y,comp} = Q_y * EF_{composting} * GWP\_CH_4$$

Furthermore, the methodology offers the following option:

$EF_{composting}$ can be set to zero for the portions of Q_y for which the monitored oxygen content of the composting process is above 8%.

This project selects to use this option. Therefore, $EF_{composting}$ has a non-zero value only for the portion of the compost that is generated anaerobically – with a monitored oxygen content below 8%. As per the methodology, this was monitored via sampling with maximum margin of error of 10% at a 90% confidence level. The above equation is thus clarified to reflect this option as follows:

$$PE_{y,comp} = Q_{y,portion} * EF_{composting} * GWP\_CH_4$$ **Equation (5)**

Example: $PE_{2013,comp} = 0\ t * 0.004 \frac{t\ CH_4}{t\ waste\ treated} * 25 \frac{t\ CO_2}{t\ CH_4} = 0\ t\ CO_2$

Where:

$Q_{y,Portion}$	The portion of the total weight of wastes to be composted in year y on a wet basis (tonne), that is produced with a monitored oxygen content below 8%.
$EF_{composting}$	Emission factor for composting of organic waste and/or manure ($t\ CH_4$/ton waste treated)

According to part 19 of methodology AMS III.F v10.0, the term $PE_{y,runoff}$ is to be calculated as follows:

$$PE_{y,runoff} = Q_{y,ww,unoff} * COD_{y,ww,runoff} * B_{o,ww,runoff} * MCF_{ww,runoff} * UF_{b,runoff} * GWP\_CH_4$$ **Equation (6)**

Example: $PE_{2013,runoff} = 66{,}454\ m^3 * 0.0467 \frac{t}{m^3} * 0.25 \frac{t\ CH_4}{t\ BOD} * 0.2 * 1.12 * 25 \frac{t\ CO_2}{t\ CH_4} = 4{,}346\ t\ CO_2$

Where:

$Q_{y,ww,runoff}$	Volume of runoff water in the year y (m^3)
$COD_{y,ww,runoff}$	Chemical oxygen demand of the runoff water leaving the composting facility in the year y ($tonnes/m^3$)
$B_{o,ww,runoff}$	Methane producing capacity of the wastewater ($kg\ CH_4/kgCOD$)
$MCF_{ww,runoff}$	Methane correction factor for the wastewater treatment system where the runoff water is treated

$UF_{b,runoff}$	Model correction factor to account for model uncertainties for runoff

E.3. Calculation of leakage emissions

The project technology does not include any equipment transferred from another activity nor was any existing equipment is transferred to another activity. Therefore, as per paragraph 21 of AMS III.F v10.0, leakage does not apply.

Competing uses for the biomass

The sources cited in Section B.5 of the PDD clearly demonstrate:

- No EFB is used in Colombia for co-products or as an energy source
- All EFB generated in Colombia is disposed of in SWDS or piled on the plantations and, after decomposing, mulched.

Therefore, competing uses for EFB do not exist in Colombia. Furthermore, since the EFB would have been left to decay, clarification SSC_236 establishes that competing uses are absent and need not be assessed.

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

	Baseline GHG emissions or baseline net GHG removals (t CO_2e)	Project GHG emissions or actual net GHG removals (t CO_2e)	Leakage GHG emissions (t CO_2e)	GHG emission reductions or net anthropogenic GHG removals (t CO_2e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	128,004	51,905	0	0	76,099	76,099

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

Amount achieved during this monitoring period (t CO_2e)	Amount estimated ex ante for this monitoring period in the PDD (t CO_2e)
76,099	228,149

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

The amount of GHG emission reductions estimated ex ante for this monitoring period was calculated based on the ex-ante emission reductions in the PDD and proportional to the duration of this monitoring period from 01/01/2013 to 31/05/2019. The average daily emission reductions as per the ex-ante estimates in the PDD were 97.42 tCO_2/day multiplied with 2,342 days in this monitoring period, equaling 228,149 tCO_2.

E.6. Remarks on increase in achieved emission reductions

There is no increase in emissions achieved.

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

The project's annual emissions reduction have been less than 60 kt CO2 per year during this monitoring period.

- - - - -

Document information

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

Version	*Date*	*Description*
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.

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