Monitoring report form for CDM project activity
(Version 06.0)

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

MONITORING REPORT		
Title of the project activity	Reforestation of grazing Lands in Santo Domingo, Argentina	
UNFCCC reference number of the project activity	4127	
Version number of the PDD applicable to this monitoring report	06	
Version number of this monitoring report	01	
Completion date of this monitoring report	06/11/2018	
Monitoring period number	02	
Duration of this monitoring period	16/10/2012 – 13/05/2018	
Monitoring report number for this monitoring report	Not applicable	
Project participants	Novartis Pharma AG Novartis Argentina S.A.	
Host Party	Argentina	
Sectoral scopes	14, afforestation and reforestation	
Applied methodologies and standardized baselines	AR-AM0005, version 03	
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
	13,414	338,254
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	351,668	

SECTION A. Description of project activity

A.1. General description of project activity

The project activity "Reforestation of grazing Lands in Santo Domingo, Argentina" is a FSC certified reforestation project using native and exotic species which aims at credible carbon sequestration and generating high value forestry products. The project activity fosters application of native species in forestry plantations in northern Argentina and hence contributes to environmental and social benefits in the region.

The project activity has a project area of 2,292 ha which has been planted completely. The planting of trees started in June 2007 and ended in 2009. In certain sections of the plantation area, enrichment plantings were conducted between 2009 and 2012. The main species planted on the project area are the native species *Peltophorum dubium* and *Tabebuia* and the exotic species *Grevillea robusta, Pinus elliottii* and *Pinus taeda*.

A.2. Location of project activity

The project activity is located at Santo Domingo, Ituzaingó Department, Province of Corrientes, Argentina, between latitudes 27°37'25" S and 27°42'12" S and longitudes 56°12'10" W and 56°07'40" W.

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Argentina (host Party)	Novartis Argentina S.A.	No
Switzerland	Novartis Pharma AG	No

A.4. Reference to applied methodologies and standardized baselines

- AR-AM0005 "Afforestation and reforestation project activities implemented for industrial and/or commercial uses" (Version 03)
- AR-TOOL14 "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/RCDM project activities (Version 04.2)
- AR-TOOL17 "Demonstrating appropriateness of allometric equations for estimation of aboveground tree biomass in A/R CDM project activities" (Version 1)
- AR-TOOL18 "Demonstrating appropriateness of volume equations for estimation of aboveground tree biomass in A/R CDM project activities" (Version 1.0.1)

A.5. Crediting period type and duration

Crediting period of the project activity: 02/05/2007 – 01/05/2027 (20 years, renewable)

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

Project area

The project activity has a total project area of 2,292 ha which have been planted completely (Figure 1). The planting of trees started in June 2007 and ended in 2009. In 2010, additional areas were planted within the project boundary, mainly small patches and roads which were not used any more, with a total area of approximately 100 ha. These additional areas were not included in the project area and are also not considered in the calculation of the net anthropogenic GHG removals by sinks. In certain sections of the project area, enrichment plantings were conducted between 2009 and 2012. Mainly native species were used for the enrichment plantings.

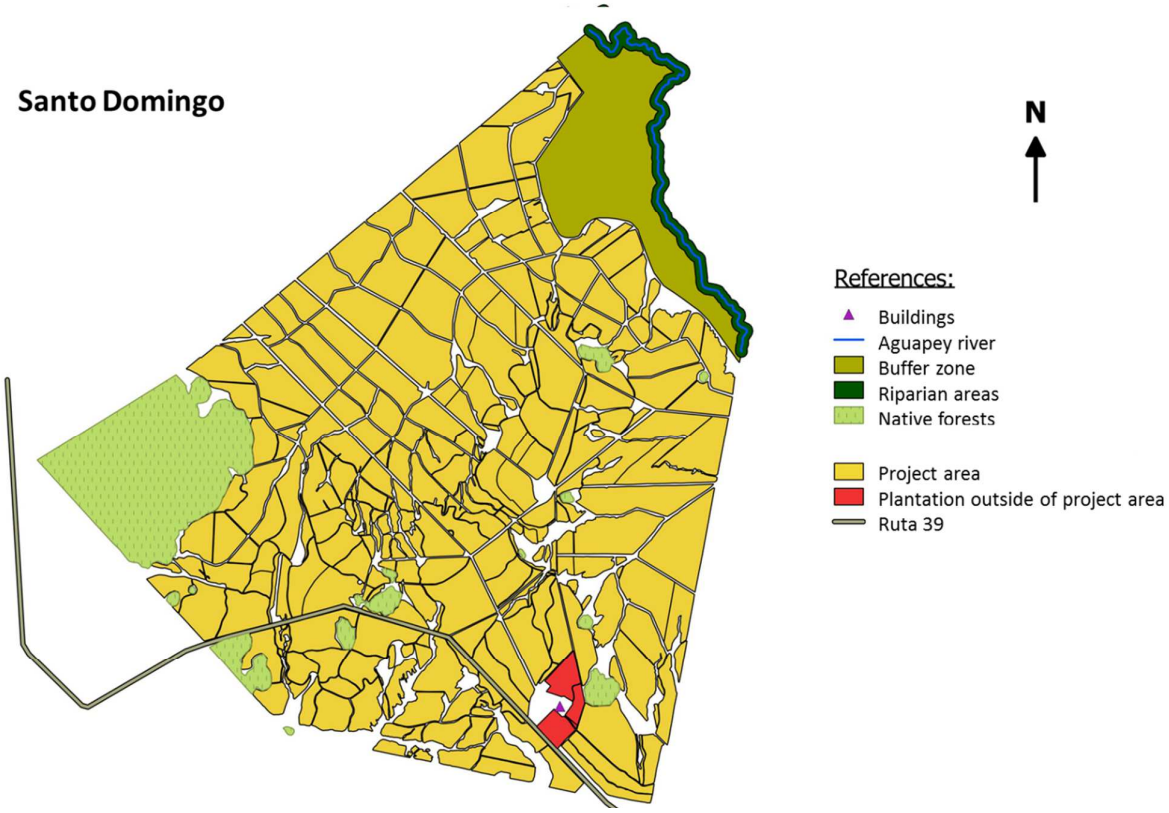

Figure 1: Project area

Species

The following native and exotic species were planted and/or grown as natural regeneration on the project area:

Species (common name)	Species (scientific name)	Native / exotic
Anchico colorado	Parapiptadenia rigida	Native
Araucaria angustifolia	Araucaria angustifolia	Native
Cedro misionero	Cedrela fissilis	Native
Caña fistula	Peltophorum dubium	Native
Grevillea robusta	Grevillea robusta	Exotic
Guayubira	Patagonula americana	Native
Incienso	Myrocarpus frondosus	Native
Ingá	Inga uruguensis	Native
Lapacho amarillo	Tabebuia ochracea/pulcherrima	Native
Lapacho negro	Tabebuia heptaphylla	Native
Lapacho rosado	Tabebuia impetiginosa	Native
Loro blanco	Bastardiopsis densiflora	Native
Loro negro	Cordia trichotoma	Native
Pino elliottii	Pinus elliottii	Exotic
Pino híbrido	Pinus elliottii x Pinus caribaea var. hondurensis	Exotic
Pino taeda	Pinus taeda	Exotic

Timbó colorado	Enterolobium contortisiliquum	Native
Tipa colorada	Pterogyne nitens	Native
Ambay	Cecropia adenopus	Native
Cancharana	Cabralea oblongifoliola	Native
Curupí caí	Sapium haematospermum	Native
Canelo de venado	Helietta longifoliata	Native
Fagara	Fagara rhoifolia	Native
Fumo bravo	Solanum auriculatum	Native
Horquetero	Tabernaemontana catharinensis	Native
Laurel amarillo	Nectandra lanceolata	Native
Mamón del monte	Carica quercifolia	Native
Palmera	Syagrus romanzoffiana	Native
Paraiso	Melia azedarach	Native
Tala	Celtis brasiliensis	Native

The share of native species planted on the project area was 25%, and 75% exotic species were planted. Due to poor survival rates of native species in certain zones of the project area, the share of exotic species increased up to 90%. Through the thinning activities, which started in 2013 and only affected exotic species, the share of exotic species reached again the original level in 2018 and will further decrease, as thinning and harvesting activities will also in future years focus on exotic species. During the biomass measurements, natural regeneration of native species was observed in several zones.

Forest establishment and management

Replanting: Usually native species were used for replanting during the monitoring period, except in areas where native species did not perform. Approx. 92 ha were therefore partially replanted with *Pinus elliottii x Pinus caribaea var. hondurensis*, whereas 115 ha were partially replanted with native species

Thinning and harvesting: On 70 % of the project area, non-commercial thinning was conducted between 2013 and 2015 where only *Pinus* species were extracted. In 2017 and 2018, commercial thinning of *Pinus* species was performed on 3 % of the project area.

Diseases and pest: So far healthy and large trees of *Peltophorum dubium* were dying in the last months prior to the monitoring event 2018. For this reason, the condition of each *Peltophorum dubium* tree within the sample plots was evaluated during the biomass inventory. 25% of *Peltophorum dubium* trees within the sample plots were dead, 15% in bad conditions and only 46% were found to be in good conditions. The cause is being investigated but has not yet been identified.

Fire: During the monitoring period, the plantation was not affected by any fire event.

Sample plots: The circular sample plots with an area of 400 m^2 were established between August 2011 and October 2012.

Stratification of the project area

The stratification was adapted for this monitoring period in order to consider the thinning activities. 35 cases were created considering the plantation year, soil characteristics as well as the tree density of *Pinus*, *Grevillea robusta* and native species. These cases were grouped into 13 strata which are presented in the following table.

Stratum	Plantation year	Topgraphy	Tree density (trees/ha)		
			Pinus	Native	Grevillea
1	2007, 2008	Bajo	300-500		
2	2007	Bajo	600-700		
3	2007, 2008	Bajo	300-500	100-800	
4	2007, 2008	Loma	200-500	100-1000	
5	2007	Bajo	600-700	100	
6	2008, 2009	Bajo, Loma	500, 600		
7	2008, 2009	Bajo	700		
8	2008, 2009	Bajo, Loma	800-1000		
9	2008, 2009	Bajo	600-700	300-1000	
10	2008	Bajo, Loma	800-900	100-300	
11	2008, 2009	Bajo, Loma	300-700	200-1000	
12	2008	Loma	1000-1400	0-200	
13	2009	Bajo, Loma		700-1000	300-700

B.2. Post-registration changes

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

No temporary deviations

B.2.2. Corrections

(a) Corrections that have been approved by the Board as applicable from the period prior to this monitoring period

One of the four geographical coordinates of the project boundary indicated in the registered PDD was corrected.

- Geographical coordinates according to the registered PDD: between latitudes 27°37'25'' S and 21°41'42'' S and longitudes 56°12'10'' W and 56°07'40'' W
- Corrected geographical coordinates in the revised PDD, version 06, 01/05/2013: between latitudes 27°37'25" S and 27°42'12" S and longitudes 56°12'10" W and 56°07'40" W

This correction was approved by the Board on 09/12/2013 (PRC-4127-001).

(b) Corrections that have been approved by the Board as applicable from this monitoring period

None

(c) Corrections that are being submitted with this monitoring report as part of the request for issuance (post-registration change – issuance track) as applicable from this monitoring period.

None.

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

No changes to the start date of the crediting period.

B.2.4. Inclusion of monitoring plan

Not applicable

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

The actual net GHG removals by sinks were calculated according to the AR-TOOL14 "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/RCDM project activities".

B.2.6. Changes to project design

There were no changes to the project design which would require prior approval by the Board. The changes compared to the PDD only consist of changes specific to afforestation and reforestation project activities which do not require prior approval by the Board according to the "Guidelines on accounting of specified types of changes in A/R CDM project activities from the description in registered project design documents" (Version 02.0).

Changes in species composition: The same native species as mentioned in the registered PDD were planted, and *Peltophorum dubium* is the most planted native species as already foreseen in the registered PDD. *Grevillea robusta*, *Pinus elliottii* and *Pinus taeda* are the most planted exotic species as foreseen in the registered PDD. A small part of planned *Pinus elliotii* and *Pinus taeda* plantations were replaced by *Pinus elliottii x Pinus caribaea var. hondurensis*.

Changes in stocking density: In certain sections of the project area, enrichment plantings were conducted for which mainly native species were used. The enrichment plantings did therefore not lead to an increase in the percentage of exotic species on the project area, and baseline identification and additionality demonstration made at validation stage are not affected by the enrichment plantings.

Changes in stratification for sampling: The stratification is adapted ex post prior to each monitoring event according to the applied A/R baseline methodology. For this monitoring report, the stratification was adapted in order to consider the thinning activities (section B.1).

Changes in number of sample plots and their allocation to strata: The number of sample plots and their allocation to strata is adapted ex post prior to each monitoring event in accordance with the ex-post stratification. A total of 116 sample plots were allocated to the 13 strata defined in section D.3. of this report.

Changes in parameters, equations, or methods used in tree biomass estimation: For the ex-ante estimation of net GHG removals by sinks, age-dependent volume equations were used for native species and *Grevillea robusta*, and the SISPINUS model for Pinus. For the ex-post calculation of actual net GHG removals by sinks, species-specific equations were applied, which use the diameter at breast height (DBH) and in certain cases also the total tree height as variables. These equations were created based on measurements and are in compliance with the following tools: AR-TOOL17 "Demonstrating appropriateness of allometric equations for estimation of aboveground tree biomass in A/R CDM project activities" and AR-TOOL18 "Demonstrating appropriateness of volume equations for estimation of aboveground tree biomass in A/R CDM project activities". The equations are provided in Appendix 2 of this report.

Changes in parameters, equations, or methods used in tree biomass estimation: For the ex-ante estimation of net GHG removals by sinks, the wood density value of *Peltophorum dubium* was used for all native species and the wood density value of *Pinus elliottii* was also used for *Pinus taeda*. For the ex-post calculation of net GHG removals by sinks, species-specific basic wood densities are applied, where available, which increases the precision of the estimation of tree biomass.

Changes in parameters, equations, or methods used in tree biomass estimation: The net anthropogenic GHG removals by sinks were calculated according to the AR-TOOL14 "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/RCDM project activities".

SECTION C. Description of monitoring system

Baseline net GHG removals by sinks

The baseline net GHG removals by sinks were determined ex-ante in the registered PDD and do not need to be monitored.

Actual net GHG removals by sinks

Monitoring

During the monitoring event in May 2018, the DBH of all trees within the 116 sample plots were measured by the monitoring team. For native species others than *Peltophorum dubium* and *Tabebuia* the total tree height was measured as well. Trees that were grown through natural regeneration and which have a DBH ≥ 2 cm were also considered in the biomass inventory.

The monitoring team was composed of experienced staff from GMF (company in charge of the plantation management) and the National University of La Plata. All members of the monitoring team were trained accordingly prior to the monitoring event. Measurements and observations made in each sample plot were recorded in the field (paper or electronically) and transferred to a central excel table on a laptop at the end of each monitoring day where the leader of the monitoring team checked the data for consistency and completeness. In case data was missing or did not seem to be realistic, the data was verified again in the respective sample plot.

No GHG emissions by sources are generated in the project activity and they do not need to be monitored according to the registered PDD.

Quality control / quality assurance

In order to verify that the measurements by the monitoring team were performed correctly, 10% of the sample plots were measured again (DBH, total tree height, species) few days after the monitoring. These control measurements were performed by experts who were not involved in the monitoring. The total biomass per plot measured during the quality control was on average slightly lower than the total biomass per plot measured by the monitoring team. In four out of twelve sample plots, the total biomass measured by the quality control team was considerably lower than that measured by the monitoring team. Another control visit confirmed that in three of these four sample plots the quality control team did not measure all trees within the respective sample plots, and in the fourth sample plot two trees were marked as missing although they were measured. It can therefore be concluded that the measurements by the monitoring team were performed correctly and the monitoring data do not present measurement errors which would lead to an overestimation of the biomass.

Data were archived electronically and in paper form, and copies were provided to each project participant.

Leakage

Animals (cattle) which were managed on the project area prior to the project start were slaughtered or sold to entities not involved in the project activity. As mentioned in the registered PDD, leakage emissions from displacement of activities prior to project implementation is therefore zero.

Forest establishment and management

GMF developed and implemented standard operating procedures for forest establishment and management, including procedures for the plantation, thinning, pruning, forest fires, soil erosion, protection of conservation areas, and monitoring of areas (GIS). All forest establishment and management activities are recorded by GMF in a central plantation management plan.

Figure 2 provides an overview on the organizational structure and data flow. Forest establishment and management activities are planned by GMF's head forest management together with the person responsible for the operations who also coordinates and controls the field work. The overseer supervises the activities implemented by the field workers and keeps an account of all activities in the field. The person responsible for the operations gathers all information on implemented forest establishment and management activities and reports to the head forest management who updates the central plantation management plan accordingly.

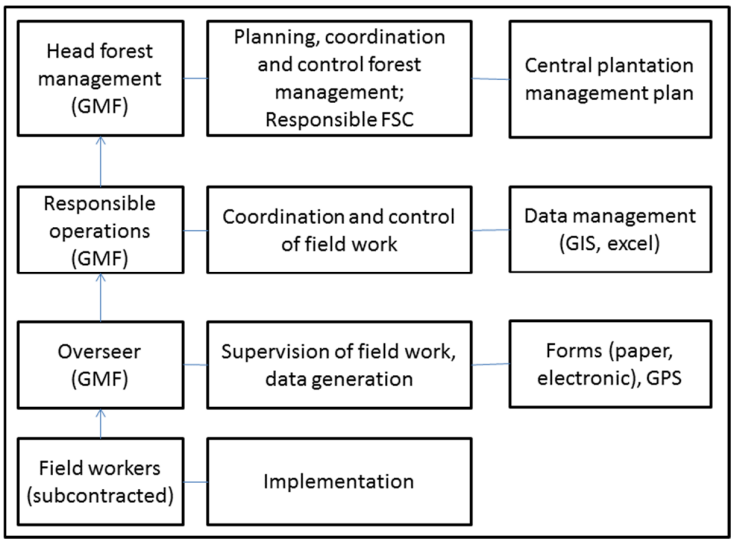

Figure 2: Organizational structure and data flow – forest establishment and management

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

Data/Parameter	**$\Delta C_{BSL,t}$**
Unit	tCO_2e/yr
Description	Baseline net GHG removals by sinks in tonnes of CO_2e/year for year t
Source of data	Registered PDD
Value(s) applied	Year: Value applied 2012 (2.5 months): 67 2013: 513 2014: 744 2015: 764 2016: 971 2017: 1,207 2018 (4.5 months): 550
Choice of data or measurement methods and procedures	not applicable
Purpose of data/parameter	Calculation of baseline net GHG removals by sinks
Additional comments	

Data/Parameter	**CF_{TREE}**
Unit	t C $(t\ d.m.)^{-1}$
Description	Carbon fraction of tree biomass
Source of data	Default value provided by the AR-TOOL14
Value(s) applied	0.47 (for all species)

Choice of data or measurement methods and procedures	not applicable
Purpose of data/parameter	Calculation of actual net GHG removals by sinks
Additional comments	

Data/Parameter	**$BEF_{2,j}$**
Unit	dimensionless
Description	Biomass expansion factor for conversion of tree stem biomass to above-ground tree biomass, for tree species j
Source of data	Default value provided by the AR-TOOL14
Value(s) applied	1.15 (applied to all native species except *Peltophorum dubium* and *Tabebuia*)
Choice of data or measurement methods and procedures	not applicable
Purpose of data/parameter	Calculation of actual net GHG removals by sinks
Additional comments	

Data/Parameter	**D_j**
Unit	t d.m. m^{-3}
Description	Density (over-bark) of tree species j
Source of data	Table 3A.1.9 of IPCC GPG-LULUCF 2003. For those species for which no IPCC values are available, other data sources were used as listed in Appendix 1 of this monitoring report
Value(s) applied	See Appendix 1 of this monitoring report
Choice of data or measurement methods and procedures	not applicable
Purpose of data/parameter	Calculation of actual net GHG removals by sinks
Additional comments	

Data/Parameter	**$GHG_{E,t}$**
Unit	t CO_2e
Description	GHG emissions in year t as a result of the implementation of the A/R CDM project activity within the project boundary
Source of data	Registered PDD
Value(s) applied	0
Choice of data or measurement methods and procedures	not applicable
Purpose of data/parameter	Calculation of actual net GHG removals by sinks
Additional comments	

D.2. Data and parameters monitored

Data/Parameter	**R_j**
Unit	dimensionless
Description	Root-to-shoot ratio for tree species j
Measured/calculated/ default	Calculated
Source of data	Calculated

Value(s) of monitored parameter	The values per sample plot are provided in the ER calculation spreadsheet.
Monitoring equipment	not applicable
Measuring/reading/recording frequency	not applicable
Calculation method (if applicable)	Calculated with the equation provided by the AR-TOOL14 (function of the above-ground biomass per hectare (in t d.m. ha^{-1}))
QA/QC procedures	not applicalbe
Purpose of data/parameter	Calculation of actual net GHG removals by sinks
Additional comments	

Data/Parameter	**DBH_l**
Unit	cm
Description	Diameter at breast height (at 1.30 m) of tree l
Measured/calculated/ default	Measured
Source of data	Measurements
Value(s) of monitored parameter	Measurement results are presented in the ER calculation spreadsheet.
Monitoring equipment	Measuring tape, precision 0.1 cm
Measuring/reading/recording frequency	DBH of all trees within the sample plots were measured during the monitoring event in May 2018.
Calculation method (if applicable)	not applicable
QA/QC procedures	10% of all sample plots were measured again by an independent team of experts.
Purpose of data/parameter	Calculation of actual net GHG removals by sinks
Additional comments	

Data/Parameter	**HT_l**
Unit	m
Description	Total tree height of tree l
Measured/calculated/ default	Measured
Source of data	Measurements
Value(s) of monitored parameter	Measurement results are presented in the ER calculation spreadsheet.
Monitoring equipment	Hypsometer (TruPulse), precision 0.1 m
Measuring/reading/recording frequency	Total tree height of all native trees (except *Peltophorum dubium* and *Tabebuia*) within the sample plots and with DHB ≥ 2 cm were measured during the monitoring event in May 2018.
Calculation method (if applicable)	not applicable
QA/QC procedures	10% of all sample plots were measured again by an independent team of experts.
Purpose of data/parameter	Calculation of actual net GHG removals by sinks
Additional comments	

Data/Parameter	**$A_{PLOT,i}$**
Unit	ha
Description	Size of sample plot in stratum i

Measured/calculated/ default	Default/measured
Source of data	The sample plot size was defined prior to the first CDM monitoring event in October 2012 and has been maintained since then. The border of the sample plots and hence their size are confirmed at each CDM monitoring event as only those trees which are inside the sample plot are considered. (Further details are provided in the manual for the biomass measurements (SD I 08 A1 Instructivo para Inventario de Captura de CO2_180509.pdf).
Value(s) of monitored parameter	0.04
Monitoring equipment	Measuring tape
Measuring/reading/recording frequency	At each monitoring event
Calculation method (if applicable)	not applicable
QA/QC procedures	10% of all sample plots were measured again by an independent team of experts.
Purpose of data/parameter	Calculation of actual net GHG removals by sinks
Additional comments	

Data/Parameter	**A_i**
Unit	ha
Description	Area of stratum i
Measured/calculated/ default	Calculated/Measured
Source of data	GIS database
Value(s) of monitored parameter	**Stratum i** / **A_i** 1 / 79.41 2 / 387.13 3 / 112.30 4 / 73.57 5 / 123.55 6 / 165.64 7 / 359.88 8 / 212.78 9 / 110.63 10 / 150.81 11 / 112.79 12 / 114.89 13 / 288.48
Monitoring equipment	GPS and GIS software
Measuring/reading/recording frequency	At each monitoring event
Calculation method (if applicable)	The stratum area is calculated as the sum of the planting areas allocated to the stratum, and individual planting areas are calculated by the GIS software.
QA/QC procedures	not applicable
Purpose of data/parameter	Calculation of actual net GHG removals by sinks
Additional comments	

Data/Parameter	**n_i**
Unit	dimensionless
Description	Number of sample plots in stratum i
Measured/calculated/ default	Calculated

Source of data	Allocation of sample plots to strata according to their location within the project area. Further details about the stratification of the project area are provided in section D.3. of this monitoring report.
Value(s) of monitored parameter	**Stratum i** / **n_i**: 1: 5; 2: 19; 3: 7; 4: 7; 5: 5; 6: 11; 7: 17; 8: 4; 9: 4; 10: 11; 11: 7; 12: 5; 13: 14
Monitoring equipment	GPS and GIS software
Measuring/reading/recording frequency	At each monitoring event
Calculation method (if applicable)	not applicable
QA/QC procedures	not applicable
Purpose of data/parameter	Calculation of actual net GHG removals by sinks
Additional comments	

Data/Parameter	**M**
Unit	dimensionless
Description	Number of tree biomass estimation strata
Measured/calculated/ default	Calculated
Source of data	Stratification (section D.3. of this monitoring report)
Value(s) of monitored parameter	13
Monitoring equipment	not applicable
Measuring/reading/recording frequency	At each monitoring event
Calculation method (if applicable)	not applicable
QA/QC procedures	not applicable
Purpose of data/parameter	Calculation of actual net GHG removals by sinks
Additional comments	

Data/Parameter	**T**
Unit	yr
Description	Time elapsed between two successive estimations ($T=t_2-t_1$)
Measured/calculated/ default	Calculated
Source of data	Calculated
Value(s) of monitored parameter	5.58
Monitoring equipment	not applicable
Measuring/reading/recording frequency	At each monitoring event

Calculation method (if applicable)	Excel
QA/QC procedures	not applicable
Purpose of data/parameter	Calculation of actual net GHG removals by sinks
Additional comments	

Data/Parameter	t_{VAL}
Unit	dimensionless
Description	Two-sided Student's t-value for a confidence level of 90 per cent and degrees of freedom equal to n-M, where n is total number of sample plots within the tree biomass estimation strata and M is the total number of tree biomass estimation strata
Measured/calculated/ default	Calculated
Source of data	Calculated
Value(s) of monitored parameter	1.66
Monitoring equipment	not applicable
Measuring/reading/recording frequency	At each monitoring event
Calculation method (if applicable)	Excel function
QA/QC procedures	not applicable
Purpose of data/parameter	Calculation of actual net GHG removals by sinks
Additional comments	

Monitoring parameters for forest management:

Parameter	**Monitoring frequency**	**Comment**
Thinning	During each thinning	Thinning date and area are recorded for each thinning.
Harvest	During each harvest	Harvest date and area are recorded for each harvest.
Diseases and pests	Annually	Areas affected by diseases and pests are mapped annually. Damage is assessed, and recovery is monitored.
Fire	After each fire event	Areas affected by fire are mapped after each fire event. Damage is assessed, and re-growth is monitored.
Re-growth after fire	After each fire event	Areas of re-growth after fire are mapped

The parameters site preparation, survival rate, weeding and fire breaks were listed in the first monitoring report (2007-2012). Since they were only relevant during forest establishment they have been removed from this list.

D.3. Implementation of sampling plan

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Sampling was applied for the estimation of the actual net GHG removals by sinks by measuring DBH, and in some cases also total tree height, in sample plots distributed over the whole project area.

Sample plots
The sample plots are circular plots with an area of 400 m^2. They were installed between August 2011 and October 2012. The distribution of the sample plots over the project area was defined by means of a regular grid with a random start. 101 sample plots were distributed in this way. In order to ensure compliance with the required confidence level and precision, 15 additional plots were installed which were distributed randomly.
The sample plots are marked with an invisible iron bar buried in the centre of the sample plot and a visible wooden stick with a red-white plastic tape located close to the iron bar. During the first years of monitoring, the centre of the sample plots was only marked with the invisible iron bar and locating of the iron bar was very difficult and time-consuming. Therefore, the plot centre was also marked with a visible wooden stick in order to facilitate the locating of the plot centre.

Table 1 provides an overview on the number of sample plots per stratum.

Table 1: Number of sample plots per stratum

Stratum	Number of sample plots
1	5
2	19
3	7
4	7
5	5
6	11
7	17
8	4
9	4
10	11
11	7
12	5
13	14
Total	**116**

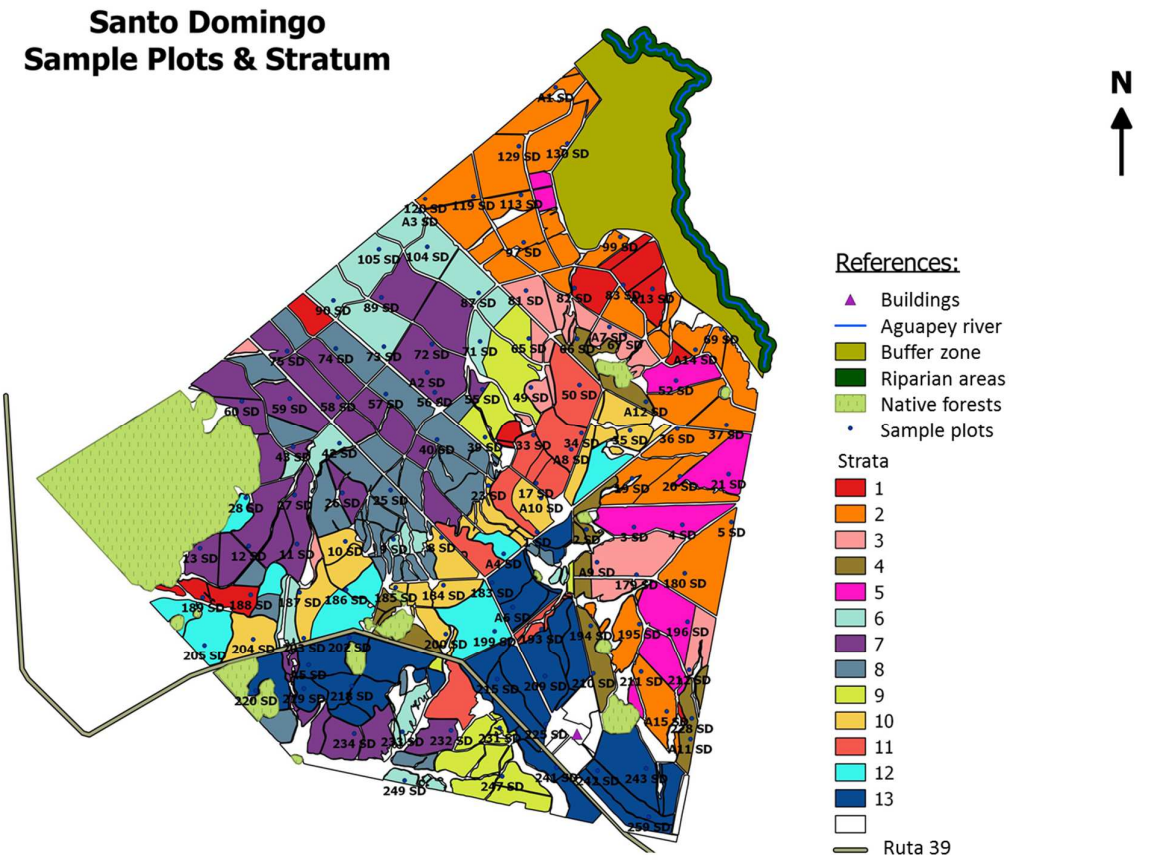

Figure 3: Sample plots and strata

Collected data
The measurement results (DBH and total tree heights) are listed in the ER calculation spreadsheet.

Data analysis
Based on the measured DBH and total tree heights, tree biomass was calculated and later summarized at plot and stratum level according to AR-TOOL14 (ER calculation spreadsheet).

Uncertainty
Uncertainty of the biomass measurement was calculated according to Equations 14-17 of the AR-TOOL14 (see section E.2. of this monitoring report).
Uncertainty of the biomass measurement 2018: u_C = 4.41%

SECTION E. Calculation of emission reductions or net anthropogenic removals

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

The baseline net GHG removals by sinks were determined ex-ante in the registered PDD.

Table 2: Baseline net GHG removals by sinks according to the registered PDD

Year	Baseline net GHG removals by sinks, $\Delta C_{BSL,t}$ (t CO_2e)
2012 (2.5 months)	67
2013	513
2014	744
2015	764
2016	971
2017	1,207
2018 (4.5 months)	534
Total	**4,800**

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

Actual net GHG removals by sinks were calculated according to AR-TOOL14 (Version 04.2), applying the following options:

Section in AR-TOOL14	Selected option
Section 6: Estimating change in carbon stock in trees between two points of time	(a) Difference of two independent stock estimations
Section 8: Estimating carbon stock in trees at a point of time	(a) Estimation by measurement of sample plots, with stratified random sampling
Appendix 1: Methods of plot biomass measurement	1. Measurement of fixed area plots

Plot biomass measurement

In order to calculate the tree biomass of individual trees, allometric equations and volume equations were applied which are listed in Appendix 2 of this monitoring report.

Species-specific allometric equations ($f_j(DBH_l)$) were applied to the six main species (*Peltophorum dubium*, *Tabebuia, Grevillea robusta, Pinus elliottii*, *Pinus taeda* and *Pinus elliottii x Pinus caribaea var. hondurensis*) in order to calculate the above-ground tree biomass based on the tree's diameter at breast height (DBH).

$$B_{TREE,l,j,p,i} = f_j(DBH_l) \times 1000 \times \left(1 + R_j\right)$$

For all native species, except *Peltophorum dubium* and *Tabebuia,* volume equations ($V_{TREE,j}(DBH_l, HT_l)$) were applied in order to calculate the above-ground tree biomass based on the tree's diameter at breast height (DBH) and the total tree height (HT).

$$B_{TREE,l,j,p,i} = V_{TREE,j}(DBH_l, HT_l) \times D_j \times BEF_{2,j} \times \left(1 + R_j\right)$$

$$R_j = \frac{e^{(-1.085+0.9256\times \ln b)}}{b}$$

$$b = \frac{\sum_{l,j} f_j(DBH_l)\times 1000}{A_{PLOT,i}} \quad \text{or} \quad b = \frac{\sum_{l,j} V_{TREE,j}(DBH_l,HT_l)\times D_j \times BEF_{2,j}}{A_{PLOT,i}}$$

Where:

$B_{TREE,l,j,p,i}$	Biomass of tree l of species j in sample plot p of stratum i; t d.m.
$f_j(DBH_l)$	Above-ground biomass of the tree returned by the allometric equation for species j relating the measurements of tree l, i.e. DBH, to the above-ground biomass of the tree; t d.m.
$V_{TREE,j}(DBH_l, HT_l)$	Stem volume of tree l of species j in sample plot p of stratum i, returned by the volume equation for species j on the basis of DBH and HT; m^3
DBH_l	Diameter at breast height of tree l; cm
HT_l	Total tree height of tree l; m
R_j	Root-shoot ratio for tree species j; dimensionless
D_j	Density (over-bark) of tree species j; t d.m. m^{-3}
$BEF_{2,j}$	Biomass expansion factor for conversion of tree stem biomass to above-ground tree biomass, for tree species j; dimensionless
b	Above-ground tree biomass per hectare; t d.m. ha^{-1}
$A_{PLOT,i}$	Size of sample plot in stratum i; ha

$$B_{TREE,j,p,i} = \sum_{l} B_{TREE,l,j,p,i}$$

$$B_{TREE,p,i} = \sum_{j} B_{TREE,j,p,i}$$

$$b_{TREE,p,i} = \frac{B_{TREE,p,i}}{A_{PLOT,i}}$$

Where:

$B_{TREE,l,j,p,i}$	Biomass of tree l of species j in sample plot p of stratum i; t d.m.
$B_{TREE,j,p,i}$	Biomass of trees of species j in sample plot p of stratum i; t d.m.
$B_{TREE,p,i}$	Tree biomass in sample plot p of stratum i; t d.m.
$b_{TREE,p,i}$	Tree biomass per hectare in sample plot p of stratum i; t d.m. ha^{-1}
$A_{PLOT,i}$	Size of sample plot in stratum i; ha

Estimation of carbon stock based on sample plots

$$b_{TREE,i} = \frac{\sum_{p=1}^{n_i} b_{TREE,p,i}}{n_i}$$

$$b_{TREE} = \sum_{i=1}^{M} w_i \times b_{TREE,i}$$

$$B_{TREE} = A \times b_{TREE}$$

$$C_{TREE} = \frac{44}{12} \times CF_{TREE} \times B_{TREE}$$

Where:

$b_{TREE,p,i}$	Tree biomass per hectare in sample plot p of stratum i; t d.m. ha^{-1}
$b_{TREE,i}$	Mean tree biomass per hectare in stratum i; t d.m. ha^{-1}
b_{TREE}	Mean tree biomass per hectare in the tree biomass estimation strata; t d.m. ha^{-1}
B_{TREE}	Tree biomass in the tree biomass estimation strata; t d.m.

n_i	Number of sample plots in stratum i
w_i	Ratio of the area of stratum i to the sum of areas of tree biomass estimation strata ($w_i=A_i/A$); t d.m. ha^{-1}
A_i	Area of stratum i; ha
A	Sum of areas of the tree biomass estimation strata ($A=\sum A_i$); ha
C_{TREE}	Carbon stock in trees in the tree biomass estimation strata; t CO_2e
CF_{TREE}	Carbon fraction of tree biomass; t C (t d.m.)$^{-1}$

Uncertainty in the estimation of carbon stock

$$s_i^2 = \frac{n_i \times \sum_{p=1}^{n_i} b_{TREE,p,i}^2 - \left(\sum_{p=1}^{n_i} b_{TREE,p,i}\right)^2}{n_i \times (n_i - 1)}$$

$$u_C = \frac{t_{VAL} \times \sqrt{\sum_{i=1}^{M} w_i^2 \times \frac{s_i^2}{n_i}}}{b_{TREE}}$$

Where:

s_i^2	Variance of tree biomass per hectare across all sample plots in stratum i; (t d.m. ha^{-1})^2
n_i	Number of sample plots in stratum i
$b_{TREE,p,i}$	Tree biomass per hectare in sample plot p of stratum i; t d.m. ha^{-1}
u_C	Uncertainty in C_{TREE}
t_{VAL}	Two-sided Student's t-value for a confidence level of 90 per cent and degrees of freedom equal to *n-M*, where *n* is total number of sample plots within the tree biomass estimation strata and *M* is the total number of tree biomass estimation strata
w_i	Ratio of the area of stratum i to the sum of areas of tree biomass estimation strata; t d.m. ha^{-1}
M	Number of tree biomass estimation strata
b_{TREE}	Mean tree biomass per hectare in the tree biomass estimation strata; t d.m. ha^{-1}

Difference of two independent stock estimations

$$\Delta C_{TREE} = C_{TREE,t_2} - C_{TREE,t_1}$$

$$u_{\Delta C} = \frac{\sqrt{\left(u_1 \times C_{TREE,t_1}\right)^2 + \left(u_2 \times C_{TREE,t_2}\right)^2}}{|\Delta C_{TREE}|}$$

Where:

$u_{\Delta C}$	Uncertainty in ΔC_{TREE}
u_1	Uncertainty in C_{TREE,t_1} (6.9% according to the first monitoring report (Version 04, 18/09/2013))
C_{TREE,t_1}	Carbon stock in trees as estimated at time t_1; t CO_2e (100,771 t CO_2e according to the first monitoring report (Version 04, 18/09/2013))
u_2	Uncertainty in C_{TREE,t_2} (section E.2 of this monitoring report)
C_{TREE,t_2}	Carbon stock in trees as estimated at time t_2; t CO_2e (section E.2. of this monitoring report)
ΔC_{TREE}	Change in carbon stock in trees during the period between two points of time t_1 and t_2; t CO_2e

Carbon stock and uncertainty of carbon stock at different points of time

	Date	C_{TREE} **(t CO_2e)**	u_C	ΔC_{TREE} **(t CO_2e)**	$u_{\Delta C}$
t_0	02/05/2007	0			
t_1	15/10/2012	100,771	6.90%	100,771	6.90%
t_2	13/05/2018	457,239	4.41%	356,468	5.99%

$u_{\Delta C}$ is less than 10% and therefore no uncertainty discount needs to be applied.

Change in carbon stock in a year

$$\Delta C_{TREE,t} = \frac{C_{TREE,t_2} - C_{TREE,t_1}}{T} \times 1\ year$$

Where:

$\Delta C_{TREE,t}$	Change in carbon stock in trees within the project boundary in year t; t CO_2e
C_{TREE,t_1}	Carbon stock in trees within the project boundary at time t_1; t CO_2e
C_{TREE,t_2}	Carbon stock in trees within the project boundary at time t_2; t CO_2e
T	Time elapsed between two successive estimations ($T=t_2-t_1$); yr

Actual net GHG removals by sinks

$\Delta C_{ACTUAL,t} = \Delta C_{TREE,t} - GHG_{E,t}$ (according to AR-AM0005, version 03)

Where:

$\Delta C_{ACTUAL,t}$	Actual net GHG removals by sinks in year t; t CO_2e
$\Delta C_{TREE,t}$	Change in carbon stock in trees within the project boundary in year t; t CO_2e
$GHG_{E,t}$	GHG emissions in year t as a result of the implementation of the A/R CDM project activity within the project boundary; t CO_2e

Year	**Actual net GHG removals by sinks, $\Delta C_{ACTUAL,t}$ (t CO_2e)**
2012 (2.5 months)	13,481
2013	63,905
2014	63,905
2015	63,905
2016	64,080
2017	63,905
2018 (4.5 months)	23,286
Total	**356,468**

E.3. Calculation of leakage emissions

According to the registered PDD, leakage emissions do not need to be monitored anymore. The confirmation letter that the entities involved in the project activity do not manage animals, which were formerly managed on the project area, was provided with the first monitoring report (Version 04, 18/09/2013).

Year	Leakage, $LK_{,t}$ (t CO_2e)
2012 (2.5 months)	0
2013	0
2014	0
2015	0
2016	0
2017	0
2018 (4.5 months)	0
Total	**0**

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	4,800	356,468	0	13,414	338,254	351,668

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)
351,668	608,808

E.6. Remarks on increase in achieved emission reductions

This section is not applicable for afforestation and reforestation (A/R) project activities.

Appendix 1: Wood densities

	Species	Density (t/m3)	Source #	Page
ac	*Parapiptadenia rigida*	1.07	6	
ar	*Araucaria angustifolia*	0.47	1	
ce	*Cedrela fissilis*	0.4	7	
cf	*Peltophorum dubium*	0.74	1	
gr	*Grevillea robusta*	0.55	2	16
gy	*Patagonula americana*	0.72	1	
in	*Myrocarpus frondosus*	0.8	1	
ig	*Inga uruguensis*	0.63	1	
la	*Tabebuia ochracea/pulcherrima*	0.91	7	
ln	*Tabebuia heptaphylla*	0.91	7	
lr	*Tabebuia impetiginosa*	0.91	7	
lob	*Bastardiopsis densiflora*	0.6	5	1
lon	*Cordia trichotoma*	0.6	1	
pe	*Pinus elliottii*	0.54	6	
ph	*Pinus elliottii x Pinus caribaea var. hondurensis*	0.409	3	36
pt	*Pinus taeda*	0.349	4	491
tb	*Enterolobium contortisiliquum*	0.4	1	
tc	*Pterogyne nitens*	0.69	7	
am	*Cecropia adenopus*	0.36	7	
can	*Cabralea oblongifoliola*	0.72	8	
cu	*Sapium haematospermum*	0.47	7	
cv	*Helietta longifoliata*	0.865	8	
fa	*Fagara rhoifolia*	0.78	8	
fb	*Solanum auriculatum*	0.385	8	
ho	*Tabernaemontana catharinensis/australis*	0.445	8	
lau	*Nectandra lanceolata*	0.52	7	
mm	*Carica quercifolia*	0.3	*	
pal	*Syagrus romanzoffiana*	0.3	*	
par	*Melia azedarach*	0.48	8	
ta	*Celtis brasiliensis*	0.59	7	

* A conservative value (lower than the lowest value observed in the plantation) was applied since no data on wood density is available.

#	Source
1	Chave J. et al. 2006. Database of wood density for species naturally occurring in Central and South America
2	Bobadilla E. A., Pereyra Obdulio, Silva Fidelina. (2004): Durabilidad Natural de la Madera de cinco especies aptas para la Industria de la Construcción. (Natural wood durability of five species suitable for the construction industry.)
3	Toon, P G. 2004. Wood Properties of Pinus caribaea hybrids in Queensland. Submitted in fulfillment of the degree of Masters of Science by Research, University of the Sunshine Coast.
4	E. M. Weber (2005). DENSIDAD BÁSICA DE MADERA DE Pinus taeda L. MARION DE DIFERENTES EDADES (Basic wood density of Pinus taeda L. Marion of different ages), MISIONES, ARGENTINA. FLORESTA, Curitiba, PR, v. 35, n. 3. p 487-494.
5	H. G. Richter y M. J. Dallwitz (1993). Maderas comerciales (Commercial woods). Bastardiopsis densiflora (Hook. & Arn.) Hassler (Loro blanco). http://delta-intkey.com/wood/es/index.htm and http://delta-intkey.com/wood/es/www/malbaden.htm

6	Zanne, A.E., Lopez-Gonzalez, G.*, Coomes, D.A., Ilic, J., Jansen, S., Lewis, S.L., Miller, R.B., Swenson, N.G., Wiemann, M.C., and Chave, J. 2009. Global wood density database. Dryad. Identifier: http://hdl.handle.net/10255/dryad.235.
7	IPCC GPG-LULUCF 2003, Table 3A.1.9
8	INTI (Instituto Nacional de Tecnología Industrial de Argentina) https://www.inti.gob.ar/maderaymuebles/pdf/densidad_comun.pdf

Appendix 2: Volume equations and allometric equations

Allometric equations developed by the National University of La Plata (Argentina): Above-ground biomass (kg d.m.) as a function of the tree's diameter at breast height (DBH in cm). (Technical report by National University of La Plata, 2018)

Species	Allometric equation (kg d.m.)	DBH min	DBH max	Sample size	R^2
Peltophorum dubium	1.04189+0.0183397*DBH^3.03753	1.4	24.1	54	94.43%
Tabebuia	0.186504*DBH^2.25654	1.9	23.9	46	95.35%
Grevillea robusta	0.0985654*DBH^2.33102	1.3	32.9	50	98.61%
Pinus elliottii	0.131941*DBH^2.20467	5.4	40.4	47	94.24%
Pinus elliottii x Pinus caribaea var. hondurensis	0.14077*DBH^2.13852	1.2	39.8	45	95.94%
Pinus taeda	0.104957*DBH^2.25195	1.8	42.3	46	94.11%

Since no species-specific volume or allometric equations could be found for native species others than Peltophorum dubium and Tabebuia, the volume equations of Peltophorum dubium and Tabebuia were applied to those species and the lower of the two values was used for the calculation of the tree biomass. They account for less than 1% of net GHG removals.

Volume equations developed by the National University of La Plata (Argentina): Stem volume (m^3) as a function of the tree's diameter at breast height (DBH in cm) and the total tree height (HT in m). (Technical report by National University of La Plata, 2018)

Species	Volume equation (m^3)	DBH min	DBH max	Sample size	R^2	HT min	HT max
Peltophorum dubium	0.0000775892*DBH^1.78047*HT^0.945042	1.4	24.1	49	97.75%	2.2	14.1
Tabebuia	0.0000662026*DBH^1.25793*HT^1.66493	1.9	23.9	41	99.31%	2.6	16.8

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.

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