[Reference to the Methodological tool "Emissions from solid waste disposal sites" is pending EB 65 approval]

Draft Methodological Tool

"Project and leakage emissions from composting"

(Version 01.0.0)

I. DEFINITIONS, SCOPE, APPLICABILITY AND PARAMETERS

Definitions

For the purpose of this tool the following definitions apply:

Actively aerated composting. A type of composting where air is blown into the waste using a compressor or a blower.

Closed composting installation. A facility for actively aerated composting that is enclosed. Exhaust air from the installation is collected in an exhaust pipe.

Co-composting. A type of composting where solid wastes and wastewater are composted together.

Composting. A process of biodegradation of waste under aerobic (oxygen-rich) conditions. Waste that can be composted must contain solid biodegradable organic material. Composting converts biodegradable organic carbon to mostly carbon dioxide (CO_2) and a residue (compost) that can be used as a fertilizer. Other outputs from composting can include, *inter alia*, methane (CH_4), nitrous oxide (N_2O), and run-off wastewater (in case of co-composting).

Composting cycle. The length of time to compost organic matter in the waste. The cycle begins with fresh waste and finishes when compost is produced.

Digestate. Spent contents of an anaerobic digester. Digestate may be liquid, semi solid or solid. Digestate may be further stabilized aerobically, applied to land, sent to a solid waste disposal site (SWDS) or kept in a storage or evaporation pond.

Solid waste disposal site (SWDS). Designated areas intended as the final storage place for solid waste.

Windrow. A composting installation where waste is composted in a long, low ridge. This shape is designed to passively aerate the waste by making use of wind and natural drafts caused by the increased temperatures of the biodegradation process.

Scope and applicability

This tool provides procedures to calculate project and/or leakage emissions from composting and co-composting. Typical applications of the tool include projects composting municipal solid wastes, agricultural wastes and digestate.

The following sources of project emissions are accounted for in this tool:

(a) CH_4 and N_2O emission from composting;

(b) CO_2 emissions from consumption of fossil fuels and electricity associated with composting; and

(c) CH_4 emissions from run-off wastewater associated with co-composting.

The following source of leakage emissions is accounted for in this tool:[1]

(a) CH_4 emissions from the anaerobic decay of the residual organic content of compost disposed of in a landfill or subjected to anaerobic storage.

Transport emissions are not accounted for in this tool because it is assumed that similar transportation activities would occur in the baseline.[2]

This tool also refers to the latest approved versions of the following tools:

- Methodological tool "Emissions from solid waste disposal sites";
- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption";
- "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"; and
- "Tool to determine the mass flow of a greenhouse gas in a gaseous stream".

For more information regarding the proposed new methodologies and the tools as well as their consideration by the CDM Executive Board please refer to <http://cdm.unfccc.int/goto/MPappmeth>.

The applicability conditions of these tools also apply.

Parameters

This tool provides procedures to determine the following parameters:

Parameter	SI Unit	Description
$PE_{COMP,y}$	t CO_2e	Project emissions associated with composting in year *y* (t CO_2e/yr)
$LE_{COMP,y}$	t CO_2e	Leakage emissions associated with composting in year *y* (t CO_2e/yr)

II. PROJECT EMISSIONS PROCEDURE

The project emissions from composting ($PE_{COMP,y}$) are determined as follows:

$$PE_{COMP,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH4,y} + PE_{N2O,y} + PE_{RO,y} \quad \textbf{(1)}$$

[1] If this source is inside the project boundary, then it may be accounted for as project emissions.

[2] For example, the waste that is transported to the composting installation in the project activity would in the baseline scenario be transported to an alternative treatment location (e.g. a SWDS). The compost that is transported to its place of application in the project activity, would replace the need to transport fertilizer to the same place of application.

Where:

$PE_{COMP,y}$	=	Project emissions associated with composting in year *y* (t CO_2e/yr)
$PE_{EC,y}$	=	Project emissions from electricity consumption associated with composting in year *y* (t CO_2/yr)
$PE_{FC,y}$	=	Project emissions from fossil fuel consumption associated with composting in year *y* (t CO_2/yr)
$PE_{CH4,y}$	=	Project emissions of methane from the composting process in year *y* (t CO_2e/yr)
$PE_{N2O,y}$	=	Project emissions of nitrous oxide from the composting process in year *y* (t CO_2e/yr)
$PE_{RO,y}$	=	Project emissions of methane from run-off wastewater associated with co-composting in year *y* (t CO_2e/yr)

Determination of the quantity of waste composted (Q_y)

The quantity of waste composted is a parameter required in the determination of emissions associated with each source of project emissions. There are two options to determine the quantity of waste composted in year *y* (Q_y). In case of co-composting, wastewater is not accounted for in the estimation of Q_y.

Option 1: Procedure using a weighing device

Monitor the weight of waste delivered to the composting installation using an on-site weighbridge or any other applicable and calibrated weighing device (e.g. belt-scales).

Option 2: Procedure without using a weighing device

This procedure shall only be applied in the case that there is no weighbridge or any other applicable and calibrated weighing device available on site. Under this procedure, Q_y is calculated based on the carrying capacity of each truck delivering waste to the composting installation in year *y* (CT_y), as follows:

$$Q_y = \sum_t CT_{t,y} \tag{2}$$

Where:

Q_y	=	Quantity of waste composted in year *y* (t / yr)
$CT_{t,y}$	=	Carrying capacity of truck *t* used in year *y* to deliver waste to the composting installation (t)
t	=	Waste deliveries in trucks to the composting installation in year *y*

Determination of project emissions from electricity consumption ($PE_{EC,y}$)

Where the composting activity involves electricity consumption from the grid or from a fossil fuel fired on-site power plant, $PE_{EC,y}$ shall be calculated using the latest approved version of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption", where the project emission source *j* referred to in the tool is composting.

When applying this tool, if monitored data for electricity consumption is not available, then electricity consumption from composting ($EC_{PJ,\ comp,y}$) may be determined based on a default value for the specific quantity of electricity consumed per tonne of waste composted ($SEC_{comp,default}$), according to equation 3. Note that the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" also provides options to calculate emission based on non-monitored parameters, including a default emission factor for the emissions per MWh of electricity consumed and an option to estimate electricity consumption based on the rated capacity of the captive power plant (if applicable).

$$EC_{PJ,comp,y} = Q_y \cdot SEC_{comp,default} \quad (3)$$

Where:

$EC_{PJ,comp,y}$	=	Quantity of electricity consumed for composting in year *y* (MWh/yr)
Q_y	=	Quantity of waste composted in year *y* (t/yr)
$SEC_{comp,default}$	=	Default value for the specific quantity of electricity consumed per tonne of waste composted (MWh/t)

Determination of project emissions from fossil fuel consumption ($PE_{FC,y}$)

Where the composting activity involves fossil fuel consumption, project participants may choose between the following two options to calculate $PE_{FC,y}$:

Option 1: Procedure using monitored data

$PE_{FC,y}$ shall be calculated using the latest approved version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion", where the project emission source *j* referred to in the tool is *composting*.

Option 2: Procedure using a default value

Project emissions from fossil fuel consumption associated with composting are calculated as follows:

$$PE_{FC,y} = Q_y \cdot EF_{FC,default} \quad (4)$$

Where:

$PE_{FC,y}$	=	Project emissions from fossil fuel consumption associated with composting in year *y* (t CO2 / yr)
Q_y	=	Quantity of waste composted in year *y* (t/yr)
$EF_{FC,default}$	=	Default emission factor for fossil fuels consumed by the composting activity per tonne of waste (t CO_2/t)

Determination of project emissions of methane ($PE_{CH4,y}$)

Project emissions of methane from composting ($PE_{CH4,y}$) are determined as follows:

$$PE_{CH4,y} = Q_y \cdot EF_{CH4,y} \cdot GWP_{CH4} \quad (5)$$

Where:

$PE_{CH4,y}$	=	Project emissions of methane from the composting process in year *y* (t CO_2e / yr)
Q_y	=	Quantity of waste composted in year *y* (t / yr)
$EF_{CH4,y}$	=	Emission factor of methane per tonne of waste composted valid for year *y* (t CH4 / t)
GWP_{CH4}	=	Global Warming Potential of CH_4 (t CO_2e / t CH_4)

There are two options which project participants may choose for determining $EF_{CH4,y}$:

Option 1: Procedure using monitored data

$EF_{CH4,y}$ is determined based on measurements of the methane emissions during a composting cycle ($ECC_{CH4,c}$), as follows:

$$EF_{CH4,y} = \frac{\sum_{c=1}^{x} ECC_{CH4,c}/Q_c}{x} \quad (6)$$

Where:

$EF_{CH4,y}$	=	Emission factor of methane per tonne of waste composted valid for year *y* (t CH4/t)
$ECC_{CH4,c}$	=	Methane emissions from composting during the composting cycle *c* (t CH_4)
Q_c	=	Quantity of waste composted in composting cycle *c* (t)
c	=	Composting cycles for which measurements were undertaken
x	=	Number of composting cycles *c* for which emissions were measured in year *y* (at least three)

Option 2: Procedure using default values

A default value is used: $EF_{CH4,y} = EF_{CH4,default}$. The default value is provided in the "Data and parameters not monitored" section of this tool.

Determination of project emissions of nitrous oxide ($PE_{N2O,y}$)

Project emissions of nitrous oxide from composting ($PE_{N2O,y}$) are determined as follows:

$$PE_{N2O,y} = Q_y \cdot EF_{N2O,y} \cdot GWP_{N2O} \quad (7)$$

Where:

$PE_{N2O,y}$	=	Project emissions of nitrous oxide from composting in year *y* (t CO_2e/yr)
Q_y	=	Quantity of waste composted in year *y* (t/yr)
$EF_{N2O,y}$	=	Emission factor of nitrous oxide per tonne of waste composted valid for year *y* (t N_2O/t)
GWP_{N2O}	=	Global Warming Potential of N_2O (t CO_2e/t N_2O)

There are two options which project participants may choose for determining $EF_{N2O,y}$:

Option 1: Procedure using monitored data

$EF_{N2O,y}$ is determined based on measurements of the emissions during a composting cycle ($ECC_{N2O,c}$), as follows:

$$EF_{N2O,y} = \frac{\sum_{c=1}^{x} ECC_{N2O,c}/Q_c}{x} \quad (8)$$

Where:

$EF_{N2O,y}$	=	Emission factor of nitrous oxide per tonne of waste composted valid for year *y* (t N_2O/t)
$ECC_{N2O,c}$	=	Nitrous oxide emissions from composting during the composting cycle *c* (t N_2O)
Q_c	=	Quantity of waste composted in composting cycle *c* (t)
c	=	Composting cycles for which measurements were undertaken
x	=	Number of composting cycles *c* for which emissions were measured in year *y* (at least three)

Option 2: Procedure using default values

A default value is used: $EF_{N2O,y} = EF_{N2O,default}$. The default value is provided in the "Data and parameters not monitored" section of this tool.

Determination of project emissions from run-off wastewater ($PE_{RO,y}$)

Project emissions of methane from run-off wastewater ($PE_{RO,y}$) are calculated only for the case of co-composting. Moreover, if run-off wastewater is collected and re-circulated to the composting process, then $PE_{RO,y}$ is assumed to be zero (for example, this is the case for tunnel co-composting technology). Otherwise, $PE_{RO,y}$ is calculated based on the quantity and chemical oxygen demand (COD) of run-off wastewater as follows:

$$PE_{RO,y} = Q_{COD,y} \cdot B_{0,ww} \cdot MCF_{ww,treatment} \cdot \varphi \cdot GWP_{CH4} \quad \textbf{(9)}$$

Where:

$PE_{RO,y}$	=	Project emissions of methane from run-off wastewater associated with co-composting in year *y* (t CO_2e / yr)
$Q_{COD,y}$	=	Quantity of COD of the run-off wastewater from the co-composting installation in year *y* (t COD / yr)
$B_{0,ww}$	=	Default methane producing capacity of the run-off wastewater (t CH_4 / t COD)
$MCF_{ww,treatment}$	=	Default methane correction factor for the wastewater treatment system where the run-off wastewater is treated
φ	=	Default model correction factor to account for model uncertainties of methane emissions from run-off wastewater
GWP_{CH4}	=	Global Warming Potential of methane (t CO_2e / t CH_4)

Project participants may choose between two options to calculate $Q_{COD,RO,y}$ based on monitoring the quantity and COD of the run-off wastewater or the quantity and COD of the wastewater co-composted:

Option 1: Procedure monitoring quantity and COD of the run-off wastewaster

In this option, $Q_{COD,y}$ is determined as follows:

$$Q_{COD,y} = Q_{RO,y} \cdot COD_{RO,y} \quad \textbf{(10)}$$

Where:

$Q_{COD,y}$	=	Quantity of COD of the run-off wastewater from the co-composting installation in year *y* (t COD / yr)
$Q_{RO,y}$	=	Volume of run-off wastewater from the co-composting installation in year *y* (m^3 / yr)
$COD_{RO,y}$	=	Average COD of the run-off wastewater from the co-composting installation valid for year *y* (t COD / m^3)

Option 2: Procedure monitoring quantity and COD of the wastewater co-composted

In this option, $Q_{COD,y}$ is estimated using a default factor and monitoring the quantity and COD of the wastewater co-composted. This option is given as a potential simplification, because the quantity and COD of the wastewater may already be monitored due to requirements in the methodology that is referring to this tool.

$$Q_{COD,y} = Q_{wastewater,y} \cdot COD_{wastewater,y} \cdot DF_{COD,RO} \quad \textbf{(11)}$$

Where:

$Q_{COD,y}$	=	Quantity of COD of the run-off wastewater from the co-composting installation in year *y* (t COD / yr)
$Q_{wastewater,y}$	=	Volume of wastewater co-composted in year y (m^3 / yr)
$COD_{wastewater,y}$	=	Average COD of the wastewater co-composted valid for year *y* (t COD / m^3)
$DF_{COD,RO}$	=	Default factor for the ratio of the amount of COD in run-off wastewater and wastewater co-composted

III. LEAKAGE EMISSIONS PROCEDURE

Leakage emissions from composting ($LE_{COMP,y}$) shall be accounted for if compost is subjected to anaerobic storage or disposed of in a SWDS.[3] $LE_{COMP,y}$ shall be estimated to account for methane emissions from the anaerobic decay of compost, using the methodological tool "Emissions from solid waste disposal sites". The following is required when applying the tool:

- $LE_{COMP,y}$ corresponds to the parameter $LE_{SWDS,y}$ in the tool;
- $W_{j,x}$ in the tool is the amount of compost produced that is disposed of in a SWDS or subjected to anaerobic storage, where:
  - *j* is compost and therefore the procedure in the tool to determine the amount of different waste types *j* disposed in the SWDS does not need to be followed ($W_{j,x} = W_x$); and
  - *x* refers to each year since the start of the first crediting period, up to and including year *y*.

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[3] If compost is used as a cover for a SWDS, rather than disposed of in it, then this is not accounted for as a source of leakage emissions.

IV. DATA AND PARAMETERS NOT MONITORED

Data / Parameter:	$B_{0,ww}$
Data unit:	t CH4 / t COD
Description:	Default methane producing capacity of the wastewater
Source of data:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value to be applied:	0.25
Any comment:	Applicable to the step "Determination of project emissions from run-off wastewater ($PE_{RO,y}$)"

Data / Parameter:	$EF_{CH4,default}$
Data unit:	t CH4 / t
Description:	Default emission factor of methane per tonne of waste composted (wet basis)
Source of data:	The emission factor was selected based on studying published results of emission measurements from composting facilities, literature reviews on the subject and published emission factors. Data from recent, high quality sources was analyzed and a value conservatively selected from the higher end of the range in results.
Value to be applied:	0.002
Any comment:	Applicable to Option 2 in the step "Determination of methane and nitrous oxide emissions from the composting process"

Data / Parameter:	$EF_{N2O,default}$
Data unit:	t N2O / t
Description:	Default emission factor of nitrous oxide per tonne of waste composted (wet basis)
Source of data:	The emission factor was selected based on studying published results of emission measurements from composting facilities, literature reviews on the subject and published emission factors. Data from recent, high quality sources was analyzed and a value conservatively selected from the higher end of the range in results
Value to be applied:	0.0002
Any comment:	Applicable to Option 2 in the step "Determination of methane and nitrous oxide emissions from the composting process"

Data / Parameter:	$SEC_{comp,default}$
Data unit:	MWh / t
Description:	Default value for the specific quantity of electricity consumed per tonne of waste composted
Source of data:	Based on a review of information from relevant validation reports of CDM projects
Value to be applied:	0.01
Any comment:	Applicable to the step "Determination of project emissions from electricity consumption ($PE_{EC,y}$)"

Data / Parameter:	$EF_{FC,default}$
Data unit:	t CO_2 / t
Description:	Default emission factor for fossil fuel consumed by the composting activity per tonne of waste composted (wet basis)
Source of data:	Based on a review of fossil fuel consumption per tonne of waste composed in relevant validation reports of CDM projects and using a conservative default emission factor for diesel (from the 2006 IPCC Guidelines)
Value to be applied:	0.0207
Any comment:	Applicable to Option 2 in the step “Determination of project emissions from fossil fuel consumption ($PE_{FC,y}$)”

Data / Parameter:	GWP_{CH4}
Data unit:	t CO_2e / t CH_4
Description:	Global Warming Potential of CH_4
Source of data:	IPCC
Value to be applied:	21 for the first commitment period. Shall be updated for future commitment periods according to any future COP/MOP decisions
Any comment:	-

Data / Parameter:	GWP_{N2O}
Data unit:	t CO_2e / t N_2O
Description:	Global Warming Potential of N_2O
Source of data:	IPCC
Value to be applied:	310 for the first commitment period. Shall be updated for future commitment periods according to any future COP/MOP decisions
Any comment:	-

Data / Parameter:	$MCF_{ww,treatment}$
Data unit:	-
Description:	Default methane correction factor for the wastewater treatment system where the run-off wastewater is treated
Source of data:	Default values from chapter 6 of volume 5. *Waste* in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (see Table 1 below)

Value to be applied:	Use the default values below corresponding to the type of wastewater treatment system. If this is not possible, then as a conservative estimation, waste water treatment can be assumed to take place under completely anaerobic conditions, where $MCF_{ww,\ treatment}$ equals 1

Table 1: IPCC default values for MCF

Type of wastewater treatment and discharge pathway or system	MCF value
Discharge of wastewater to sea, river or lake	0.1
Aerobic treatment, well managed	0.0
Aerobic treatment, poorly managed or overloaded	0.3
Anaerobic digester for sludge without methane recovery	0.8
Anaerobic reactor without methane recovery	0.8
Anaerobic shallow lagoon (depth less than 2 metres)	0.2
Anaerobic deep lagoon (depth more than 2 metres)	0.8
Septic system	0.5

Any comment:	Applicable to the step "Determination of emissions from run-off wastewater ($PE_{RO,y}$)"

Data / Parameter:	φ
Data unit:	-
Description:	Default model correction factor to account for model uncertainties of methane emissions from run-off wastewater
Source of data:	Default value from Draft Decisions On Methodological Issues Relating To Articles 5, 7 And 8 Of The Kyoto Protocol (Agenda Item 4 (B)) (FCCC/SBSTA/2003/10/Add.2, page 25)
Value to be applied:	1.12
Any comment:	An assigned uncertainty band of 40% was assumed when selecting this default value from the source referenced above. Applicable to the step "Determination of emissions from run-off wastewater ($PE_{RO,y}$)"

Data / Parameter:	$DF_{COD,RO}$
Data unit:	-
Description:	Default factor for the ratio of the amount of COD in run-off wastewater and wastewater co-composted
Source of data:	Based on a review of data in validated CDM projects
Value to be applied:	0.02
Any comment:	Applicable to Option 2 of the step "Determination of emissions from run-off wastewater ($PE_{RO,y}$)"

V. MONITORING METHODOLOGY PROCEDURE

Monitoring procedures

Monitoring involves an annual assessment of the amount of waste composted and, in case of co-composting, also the amount of run-off wastewater. For all other monitored parameters there are also options to use default values. If project participants choose to estimate the COD content in run-off wastewater ($COD_{RO,y}$) instead of conducting measurements of $COD_{RO,y}$, then the estimation procedure requires monitoring the amount of wastewater co-composted and its COD content (in many applications these two parameters will already be required to be monitored in the underlying methodology).

Data and parameters monitored

Data / Parameter:	Q_y
Data unit:	t / yr
Description:	Quantity of waste composted in year *y* (wet basis)
Measurement procedures:	Use a weighbridge or any other applicable and calibrated weighing device, e.g. belt-scales
Monitoring/recording frequency:	Continuously
QA/QC procedures:	Weighbridge or any other applicable weighing device is subject to periodic calibration (in accordance with stipulation of the weighing device supplier)
Any comment:	Applicable to Option 1 in the step "Determination of the quantity of waste composted". The parameter corresponds to the quantity of solid waste delivered to the composting installation, weighed on a wet basis. In the case of co-composting, the weight of liquid wastes is neglected

Data / Parameter:	$CT_{t,y}$
Data unit:	t
Description:	Carrying capacity of each truck delivering waste to the composting installation in year *y*
Measurement procedures:	The maximum carrying capacity as stated on the truck's nameplate is registered by personnel at the entrance gate of the composting installation.
Monitoring/recording frequency:	Register maximum carrying capacity of every truck delivery for the year *y*
QA/QC procedures:	-
Any comment:	Applicable to Option 2 in the step "Determination of the quantity of waste composted"

Data / Parameter:	Q_c
Data unit:	t
Description:	Quantity of waste composted in composting cycle *c* (wet basis)
Measurement procedures:	Weighed using weighbridge or any other applicable and calibrated weighing device, e.g. belt-scales
Monitoring/recording frequency:	Measure the weight of waste for every truck delivery and aggregate for the same composting cycle for which $ECC_{CH4,c}$ or $ECC_{N2O,c}$ is being estimated

QA/QC procedures:	Weighbridge or any other applicable weighing device is subject to periodic calibration (in accordance with stipulation of the weighing device supplier).
Any comment:	This is the specific amount of waste treated for the composting cycle *c* that emission measurements are made for ($ECC_{CH4,c}$, $ECC_{N2O,c}$) Applicable to Option 1 in the step "Determination of methane and nitrous oxide emissions from the composting process"

Data / Parameter:	$ECC_{CH4,c}$, $ECC_{N2O,c}$
Data unit:	t CH_4, t N_2O
Description:	Methane and nitrous oxide emissions from the composting installation during the composting cycle *c*
Source of data:	On site measurement
Measurement procedures (if any):	Measurement procedures are specified for closed composting installations and non-closed composting installations: **Closed composting installation.** Choose between the following two options to measure emissions from a closed-composting system for composting cycle *c*: • Option 1*:* Measure methane and/or nitrous oxide concentrations, gas velocity, temperature and pressure in the exhaust pipe using appropriate analytical equipment (e.g. FID, IR, FTIR). Gas flow can be calculated from gas velocity and exhaust pipe diameter and has to be corrected for pressure and temperature. Methane and nitrous oxide emissions are obtained by integrating the product of gas flow and methane and nitrous oxide concentrations in the gas over the entire duration of the measurement (one composting cycle). • Option 2*:* Use the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream". When applying the tool, the following guidance is given: o The gaseous stream the tool shall be applied to is the exhaust gas from the closed composting installation; o CH_4 and/or N_2O are the greenhouse gases for which the mass flow should be determined; o The flow of the gaseous stream should be measured on an hourly basis or a smaller time interval; and o The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations 3 or 17 in the tool) **Non-closed composting installation (windrows)**. Measure emissions using a flux box. In a flux box measurement, the concentration increase of CH_4 and/or N_2O in the box is measured over time and the emission flux from the surface covered by the box is calculated (kilogram CH_4 or N_2O per square meter per hour). From the measurements made during the cycle, an overall emission flux value can be determined. Emissions during the composting cycle can then be calculated over the time of the composting cycle and the total surface area of the windrow (kg per windrow per hour) The measurements shall be conducted as follows: Select measurement sites (at least 10 measurement sites per windrow):

	• Identify at least two measurement cross sections (across the width), which are spaced equally along the length of the windrow; • In each cross-section, identify five measurement locations spaced equally apart; two on each side of the windrow, and one on the top Measurement frequency: • Perform at least five measurement events in each measurement site of the windrow during a composting cycle (resulting in at least 50 individual measurements). Measurement events must be at regular time intervals during the composting cycle Identify and repeat invalid measurements: • Make measurements at each measurement site over at least a continuous one minute period, with consecutive concentration readings stored at a frequency of at least one per second; • Identify if concentration increase is constant in time. If it is constant, then the measurement is valid. If the rate of increase is not constant, then this indicates a build up of pressure in the flux box and the measurement is invalid and must be repeated Identify the overall flux rate for the composting cycle: • Identify the 80% confidence interval for all measurement made during a composting cycle (this is at least 50 measurements); • Identify an overall flux rate as the upper value in the 80% confidence interval Note: When measuring emissions using a flux box, the use of SF_6 is strictly banned
Monitoring frequency:	Measure at least one composting cycle per climatic season, and at least two cycles in one climatic season. This means there are at least three measurements of $ECC_{CH4,cc}$/$ECC_{N2O,cc}$ in **each year in the case of two seasons**
QA/QC procedures:	Closed composting installation: • According to the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"; Flux box measurement: • Flux box equipment accuracies (as specified by the supplier of the flux box equipment) shall be 1 ppm or better for CH_4 and 100 ppb or better for N_2O
Any comment:	Applicable to Option 1 in the step "Determination of methane and nitrous oxide emissions from the composting process"

Data / Parameter:	$COD_{RO,y}$
Data unit:	t COD / m³
Description:	Average COD of the run-off wastewater from the co-composting installation valid for year *y*
Measurement procedures:	• Measure the COD according to national or international standards in liquid samples that are taken in a representative way from unfiltered run-off wastewater. $COD_{RO,y}$ is the average of the COD measurements of the 12 samples taken in year *y*. The location for taking the sample depends on the collection system: • If there is a dedicated drainage system for collecting only the run-off wastewater from the composting installation, then the sample should be taken from this system; • If there is no dedicated drainage system, then the sample should be taken from run-off wastewater exiting the installation and before entering a drainage system that collects run-off from other sites as well as the composting installation (if applicable)
Monitoring frequency:	Monthly
QA/QC procedures:	Document which national or international standard is applied for COD measurement in the monitoring report. Monitoring instruments shall be subject to regular maintenance and testing to ensure accuracy.
Any comment:	An example of an international standard is *ISO 6060:1989 Water quality -- Determination of the chemical oxygen demand.* Applicable to Option 1 of the step "Determination of emissions from run-off wastewater ($PE_{RO,y}$)"

Data / Parameter:	$Q_{RO,y}$
Data unit:	m^3 / yr
Description:	Volume of run-off wastewater from the co-composting installation in year *y*
Measurement procedures:	Measurement procedures are distinguished based on whether the composting installation is roofed and whether it has a dedicated drainage system (meaning a system that only collects run-off wastewater from the composting installation and not from other areas or sites as well). • If run-off wastewater is collected in a **dedicated drainage system**, then measure the accumulative volume flow over time using a flow meter. If the site is unroofed, then also measure the rainfall precipitation on the surface of the composting installation. In the situation that the flow meter fails at an unroofed site (such as during a severe storm event), then for the period of time that the flow meter failed, substitute this missing data from the flow meter with the volume of precipitation on the surface of the composting installation. This is estimated as the amount of rainfall multiplied by the surface area of the site; • If there is **no dedicated drainage system** and **a roof covering the composting installation** then $Q_{RO,y}$ is the annual volume of wastewater applied ($Q_{wastewater,y}$) subtracted by the amount absorbed by the compost. The amount of wastewater absorbed is assumed to be the weight of the

	compost ($Q_{comp, y}$) multiplied by a default factor of 0.15 t/m^3; • If there is **no dedicated drainage system** and **no roof covering** the composting installation, then the annual volume of rainfall precipitation on the surface of the composting installation must be added to the amount of wastewater applied in excess of the amount absorbed by the compost, as calculated in the bullet points above
Monitoring frequency:	Continuously
QA/QC procedures:	Flow meters shall undergo maintenance and calibration in accordance with manufacturer specifications Rainfall shall be measured using an on-site rain gauge. The gauge shall be calibrated according to manufacturer specifications
Any comment:	Applicable to the step "Determination of emissions from run-off wastewater ($PE_{RO,y}$)"

Data / Parameter:	$Q_{wastewater,y}$
Data unit:	m^3 / yr
Description:	Amount of wastewater co-composted in year *y*
Measurement procedures	Flow meter
Monitoring frequency:	Monthly aggregated annually
QA/QC procedures:	Flow meters shall undergo maintenance and calibration in accordance with manufacturer specifications
Any comment:	Applicable to Option 2 in the step "Determination of emissions from run-off wastewater ($PE_{RO,y}$)" and shall be used to estimate $Q_{RO,y}$ for the situation there is no dedicated drainage system

Data / Parameter:	$COD_{wastewater,y}$
Data unit:	t COD / m^3
Description:	Average COD of wastewater co-composted valid for year *y*
Measurement procedures (if any):	Measure the COD according to national or international standards in liquid samples that are taken in a representative way from unfiltered wastewater. $COD_{wastewater,y}$ is the average of the COD measurements of the 12 samples taken in year *y*
Monitoring frequency:	Monthly
QA/QC procedures:	The monitoring instruments shall be subject to regular maintenance and testing to ensure accuracy
Any comment:	Applicable to Option 2 in the step "Determination of emissions from run-off wastewater ($PE_{RO,y}$)"

VI. REFERENCES AND ANY OTHER INFORMATION

Perera, M.D.N., Hettiaratchi, J.P.A., Achari, G. (2002): A mathematical modeling approach to improve the point estimation of landfill gas surface emissions using the flux chamber technique. Journal of Environmental Engineering Science 1, 451–463.

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History of the document

Version	Date	Nature of revision(s)
01.0.0	EB 65, Annex # 25 November 2011	To be considered at EB 65.
Decision Class: Regulatory **Document Type**: Tool **Business Function**: Methodology		