Draft revision to the methodological tool

~~“to determine methane emissions avoided from disposal of waste at a solid waste disposal site”~~
“Emissions from solid waste disposal sites”

(Version 06.0.0)

I. DEFINITIONS, SCOPE, APPLICABILITY AND PARAMETERS

Definitions

For the purpose of this tool, the following definitions apply:

Managed SWDS. A SWDS that has controlled placement of waste (i.e. waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) leveling of the waste. In this tool, a SWDS that does not meet this definition is considered an unmanaged SWDS.

Municipal solid waste (MSW). A heterogeneous mix of different solid waste types, usually collected by municipalities or other local authorities. MSW includes household waste, garden/park waste and commercial/institutional waste.

Residual waste. A solid waste type with largely homogenous properties. This includes, inter alia, material that remains after the waste is treated, e.g. anaerobic digestate and compost, and biomass residues (by-product, residue or waste stream from agriculture, forestry and related industries).

Solid waste. Material that is unwanted and insoluble (including gases or liquids in cans or containers). Hazardous waste is not included in the definition of solid waste. Solid waste may include residual wastes.

Solid waste disposal site (SWDS). Designated areas intended as the final storage place for solid waste. Stockpiles are considered a SWDS if (a) their volume to surface area ratio is 1.5 or larger and if (b) a visual inspection by the DOE confirms that the material is exposed to anaerobic conditions (i.e. it has a low porosity and is moist).

Stockpile. A pile of solid waste (not buried below ground). Anaerobic conditions are not assured in a stockpile with low volume to surface area ratios (less than 1.5) because the waste may be exposed to higher aeration.

Scope and applicability

This tool provides procedures to calculate baseline, project or leakage emissions of methane from solid waste~~ that, in the absence of the project activity, would be ~~disposed or prevented from disposal at ~~solid waste disposal sites (~~a SWDS~~).~~

The tool can be used to determine emissions for the following types of applications:

- **Application A: The CDM project activity mitigates methane emissions from a specific existing SWDS.** Methane emissions are mitigated by capturing and flaring or combusting the methane (e.g. ACM0001). The methane is generated from waste disposed in the past, including prior to the start of the CDM project activity. In these cases, the tool is only applied for an *ex-ante* estimation of emissions in the CDM-PDD. The emissions will then be monitored during the crediting period using the applicable approaches in the relevant methodologies (e.g. measuring the amount of methane captured from the SWDS).
- **Application B: The CDM project activity avoids or involves the disposal of waste at a SWDS.** An example of this application of the tool is AM0025, in which MSW is treated with an alternative option, such as composting or anaerobic digestion, and is then prevented from being disposed of in a SWDS. The methane is generated from waste disposed or avoided from disposal during the crediting period. In these cases, the tool can be applied for both *ex-ante* and *ex-post* estimation of emissions.

These two types of applications are referred to in the tool for determining parameters.

In the case that (a) different types of residual waste are disposed or prevented from disposal or that (b) both MSW and residual waste(s) are prevented from disposal, then the tool should be applied separately to each residual waste and to the MSW.

~~The tool is not applicable to stockpiles[1]. Emission reductions are calculated with a first order decay model. The tool is applicable in cases where the solid waste disposal site where the waste would be dumped can be clearly identified. The tool is not applicable to hazardous wastes.~~

Parameters

This tool provides procedures to determine the following parameters:

Parameter	SI Unit	Description
$BE_{CH4,SWDS,y}$ $PE_{CH4,SWDS,y}$ $LE_{CH4,SWDS,y}$	t CO_2e / yr	Baseline, project or leakage m~~M~~ethane emissions occurring in year *y* ~~avoided during the year *y* from preventing~~ generated from waste disposal at ~~the~~ ~~solid waste disposal site~~ a SWDS during a time period ending in year *y* (where y is a period of 12 consecutive months)
$BE_{CH4,SWDS,m}$ $PE_{CH4,SWDS,m}$ $LE_{CH4,SWDS,m}$	t CO_2e / m	Baseline, project or leakage methane emissions occurring in month *m* generated from waste disposal at a SWDS during a time period ending in month *m*

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[1] ~~In this context, stockpiles are solid waste disposal sites where anaerobic conditions are not ensured because they are exposed to higher aeration due to a larger surface area to volume ratio, or because their permanence cannot be ensured, for example waste can be easily moved from one place to another or is subject to the risk of incidental fires. The approach to determine emissions from stockpiles as described in AMS-III.E cannot be used for large-scale project activities.~~

II. ~~BASELINE~~ METHODOLOGY PROCEDURE

Procedure to determine methane emissions from the SWDS

~~In the absence of the project activity,be t~~The amount of methane ~~that would be~~ generated from disposal of waste at the SWDS ~~($BE_{CH4,SWDS,y}$)~~ is calculated ~~with a multi-phase model. The calculation is~~ based on a first order decay (FOD) model.[1] The model differentiates between the different types of waste *j* with ~~respectively different~~ respective constant decay rates (k_j)and ~~different~~ fractions of degradable organic carbon (DOC_j). ~~t~~The model calculates the methane generation occurring in year *y* (a period of 12 consecutive months) or month *m* based on the ~~actual~~ waste streams of waste types *j* ($W_{j,x}$ or $W_{j,i}$) disposed in the SWDS over a specified time period (years or months). ~~in each year x , starting with the first year after the start of the project activity until the until the end of the year y, for which baseline emissions are calculated (years x with x = 1 to x = y).~~

In cases where at the SWDS methane is captured (e.g. due to safety regulations) and flared, combusted or used in another manner that prevents emissions of methane to the atmosphere, the ~~baseline~~ emissions are adjusted for the fraction of methane captured (f_y) ~~at the SWDS,~~.

The amount of methane ~~produced~~ generated from disposal of waste at the SWDS is calculated for ~~in the~~ year *y* ~~($BE_{CH4,SWDSt,y}$) is calculated~~ ($BE_{CH4,SWDS,y}$ or $PE_{CH4,SWDS,y}$ or $LE_{CH4,SWDS,y}$) using equation (1) or for month *m* ($BE_{CH4,SWDS,m}$ or $PE_{CH4,SWDS,m}$ or $LE_{CH4,SWDS,m}$) using equation (2) ~~as follows~~. The basis selected (yearly or monthly calculation) must be consistent during the project and should be documented in the CDM-PDD. All data used to apply the equations should be documented transparently in CDM-PDD or the monitoring reports. The CDM-PDD should also clearly specify the time period (the consecutive years *x* or months *i*) in which waste disposal is considered in the calculation. For application A, this time period may begin before the start of the project activity and typically starts when the SWDS starts receiving waste. For application B, only waste disposed of or avoided from the disposal after the start of the first crediting period shall be considered and, hence, the time period shall not start earlier than the start of the first crediting period of the proposed CDM project activity.

The emissions are calculated as follows:

~~$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^{y} \sum_j W_{j,x} \cdot DOC_j \cdot e^{-k_j \cdot (y-x)} \cdot (1-e^{-k_j})$~~ ~~(1)~~

$$\left.\begin{array}{l} BE_{CH4,SWDS,y} \\ PE_{CH4,SWDS,y} \\ LE_{CH4,SWDS,y} \end{array}\right\} = \varphi_y \cdot (1-f_y) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_{f,y} \cdot MCF_y \cdot \sum_{x=1}^{y} \sum_j W_{j,x} \cdot DOC_j \cdot e^{-k_j \cdot (y-x)} \cdot (1-e^{-k_j}) \quad \textbf{(1)}$$

$$\left.\begin{array}{l} BE_{CH4,SWDS,m} \\ PE_{CH4,SWDS,m} \\ LE_{CH4,SWDS,m} \end{array}\right\} = \varphi_y \cdot (1-f_y) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_{f,m} \cdot MCF_y \cdot \sum_{i=1}^{m} \sum_j W_{j,i} \cdot DOC_j \cdot e^{-\frac{k_j}{12} \cdot (m-i)} \cdot \left(1-e^{-\frac{k_j}{12}}\right) \quad \textbf{(2)}$$

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[1] As an approximation, methane generation in the SWDS is described as a function of time according to a first order decay process with rapid, moderate and slow degrading organic fractions distinguished.

Where, for the yearly model:
$BE_{CH4,SWDS,y}$ = Baseline, project or leakage methane emissions occurring in year *y* generated from waste disposal at a SWDS during a time period ending in year *y* (t CO_2e / yr)
$PE_{CH4,SWDS,y}$
$LE_{CH4,SWDS,y}$
x = Years in the time~~ during the crediting~~ period in which waste is disposed at the SWDS, extending from the first year in the time period (*x* = 1) to year *y* (*x* = *y*).~~: x runs from the first year of the first crediting period (x = 1) to the year y until year y for which avoided emissions are calculated (x = y).~~
y = Year of the crediting period for which methane emissions are calculated (*y* is a consecutive period of 12 months)
$DOC_{f,y}$ = Fraction of degradable organic carbon (DOC) that ~~can~~ decomposes under the specific conditions occurring in the SWDS for year *y* (weight fraction)
$W_{j,x}$ = Amount of ~~organic~~ solid waste type *j* disposed or prevented from disposal in the SWDS in the year *x* (t~~ons~~)

Where, for the monthly model:
$BE_{CH4,SWDS,m}$ = Baseline, project or leakage methane emissions occurring in month *m* generated from waste disposal at a SWDS during a time period ending in month *m* (t CO_2e / m)
$PE_{CH4,SWDS,m}$
$LE_{CH4,SWDS,m}$
m = Month of the crediting period for which methane emissions are calculated
i = Months in the time period in which waste is disposed at the SWDS, extending from the first month in the time period (*i* = 1) to month *m* (*i* = m)
$DOC_{f,m}$ = Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS for month *m* (weight fraction)
$W_{j,i}$ = Amount of organic waste type *j* disposed/prevented from disposal in the SWDS in the month *i* (t)

And, where for both the yearly and monthly models:
~~Φ~~ φ_y = Model correction factor to account for model uncertainties for year *y* ~~(0.9)~~
f_y = Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year *y*
GWP_{CH4} = Global Warming Potential ~~(GWP)~~ of methane~~, valid for the relevant commitment period~~
OX = Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste)
F = Fraction of methane in the SWDS gas (volume fraction) ~~(0.5)~~
MCF_y = Methane correction factor for year *y*
DOC_j = Fraction of degradable organic carbon ~~(by weight)~~ in the waste type *j* (weight fraction)
k_j = Decay rate for the waste type *j* (1 / yr)
j = Type of residual waste or types of waste in the MSW ~~type category (index)~~

Determining the parameters required to apply the FOD model

Table 1 summarizes how the parameters required in this tool can be determined. This includes the use of default values, one time measurements or monitoring throughout the crediting period. The selection of the option that can be used depends on whether the tool is used for application A or B.

Table 1: Overview of the option to determine parameters

Parameter	Application A	Application B
φ_y	Project or leakage emissions: default values Baseline emissions: default values or project specific value estimated yearly	
OX	Default value	
F	Default value	
$DOC_{f,y}$ or $DOC_{f,m}$	Default value	In the case of MSW: default value or estimated once In the case of residual waste: estimated once
MCF_y	Default values (based on SWDS type)	Monitored for SWDS with a water table above the bottom of the SWDS Default values (based on SWDS type) for SWDS without a water table above the bottom of the SWDS
k_j	Default values (based on waste type)	
$W_{j,x}$ or $W_{j,i}$	Estimated once	Calculated based on monitored data
DOC_j	Default values (based on waste type)	Default values or waste specific value estimated once
f_y	Estimated once	Monitored

Determining the model correction factor (φ_y)

The model correction factor (φ_y) depends on the uncertainty of the parameters used in the FOD model. If project or leakage emissions are being calculated, then $\varphi_y = \varphi_{default} = 1$. If baseline emissions are being calculated, then project participants may choose between the following two options to calculate φ_y:

Option 1: Use a default value

Use a default value: $\varphi_y = \varphi_{default}$. Default values for different applications and climatic conditions are provided in the section "Data and parameters not monitored" below.

Option 2: Determine φ_y based on specific situation of the project activity

Undertake an uncertainty analysis for the specific situation of the proposed project activity. The overall uncertainty of the determination of methane generation in year *y* (v_y) is calculated as follows:

$$v_y = \sqrt{a^2 + b^2 + c^2 + d^2 + e^2 + g^2} \quad \textbf{(3)}$$

The factors *a, b, c, d, e* and *g* quantify the effect of the uncertainty of different parameters (listed in the second column of Table 2), used in the FOD model, on the overall uncertainty of the methane generation in year *y*. Project participants shall select for each factor a value within the range provided in Table 2[2], following the instructions in the table, and justify their selection.

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[2] These uncertainty values are estimated based on the 68% confidence level.

Table 2: Instructions for the selection of values for the factors a, b, c, d, e and g

Factor	**Parameter**	**Lower value**	**Higher value**	**Instructions for selecting the factor**
a	W	2%	10%	Use the lower value if solid waste is weighed using accurate weighbridges. Use the higher value if the amount of waste is estimated, such as from the depth and surface area of an existing SWDS
b	DOC_j	5%	10%	Use the lower value if the DOC_j is measured. Use the higher value if default values are used.
c	DOC_f	5%	15%	Use the lower value if more than 50% of the waste is rapidly degradable organic material or if the SWDS is located in a tropical climate. Otherwise use the higher value
d	F	0%	5%	Use the lower value if more than 50% of the waste is rapidly degradable organic material.
e	MCF_y	0%	50%	Use the lower value for managed SWDS. For unmanaged SWDS, use the higher value or determine the factor as 2/d, where d is the depth of the SWDS (in meters)
g	$e^{-k_j\cdot(y-x)}\cdot\left(1-e^{-k_j}\right)$	5%	20%	The uncertainty values provided express the uncertainty for the exponential term as a whole. Use the lower uncertainty value in the following cases: (i) Application B: if residual waste is disposed at the SWDS and if the value of *k* is larger than 0.2 y^{-1}); and (ii) Application A: if the SWDS compartments where the project is implemented were closed less than 3 years ago. In all other cases, use the higher value

φ_y is then calculated as follows:

$$\varphi_y = \frac{1}{(1+v_y)} \qquad \textbf{(4)}$$

For the case that the monthly FOD model is being used (equation (2)), then φ_y refers to the year *y* to which the month *m* belongs.

Determining the amounts of waste types j disposed in the SWDS ($W_{j,x}$ or $W_{j,i}$)

Where *different* waste types *j* are disposed or prevented from disposal in the SWDS ~~prevented from disposal~~ (for example, in the case of MSW), it is necessary to determine the amount of different waste types ($W_{j,x}$ or$W_{j,i}$) ~~through sampling and calculate the mean from the samples~~. In the case that only one type of waste is disposed (for example, in the case of a residual waste), then $W_{j,x} = W_x$ and $W_{j,i} = W_i$ and the following procedures do not need to be applied (e.g. waste sampling is not required).

Application A

Calculate $W_{j,x}$ or $W_{j,i}$ based on information from the SWDS owner and administration and from interviews with senior employees. The total amount of waste can be calculated from the SWDS surface area and average depth, assuming a specific weight of 1-1.2 t per cubic meter. If the SWDS has distinct compartments and if the amount of waste per compartment and the exploitation period of a compartment is known, then the amounts of waste for a specific series of years can be obtained. Further historic information on amounts, composition and origin of the waste might be found in SWDS administration documents (e.g. contracts with clients and invoices to clients) or obtained from old business plans or business evaluations.

Application B

~~Where different waste types j are prevented from disposal,~~Determine the amount of different waste types ~~($W_{i,x}$)~~ through sampling and calculate the mean from the samples~~, as follows,~~ either using equation (5) to determine the value of $W_{j,x}$ for the yearly model or using equation (6) to determine the value of $W_{j,i}$ for the monthly model, as follows:

$$W_{j,x} = W_x \cdot \frac{\sum_{n=1}^{z} p_{n,j,x}}{z} \qquad (\cancel{2})$$

$$W_{j,x} = W_x \cdot p_{j,x} \qquad (5)$$

Where:

$W_{j,x}$ = Amount of ~~organic~~ solid waste type *j* disposed or prevented from disposal in the SWDS in the year *x* (t~~ons~~)

W_x = Total amount of ~~organic~~ solid waste disposed or prevented from disposal in the SWDS in year *x* (t~~ons~~)

$p_{\cancel{n,}j,x}$ = ~~Weight f~~Average fraction of the waste type *j* in the waste ~~sample *n* collected during the~~ in year *x*~~-~~(weight fraction)

j = Types of solid waste ~~type category (index)~~

x = Years in the time period for which waste is disposed at the SWDS, extending from the first year in the time period (x = 1) to year y (x = y)

$$W_{j,i} = W_i \cdot p_{j,i} \qquad (6)$$

Where:

$W_{j,i}$ = Amount of solid waste type *j* disposed or prevented from disposal in the SWDS in the month *i* (t)

W_i = Total amount of solid waste disposed or prevented from disposal in the SWDS in month *i* (t)

$p_{j,i}$ = Average fraction of the waste type *j* in the waste in month *i* (weight fraction)

j = Types of solid waste

i = Months in the time period in which waste is disposed at the SWDS, extending from the first month in the time period (*i* = 1) to month *m* (*i* = m)

The fraction of the waste type *j* in the waste for the year *x* or month *i* are calculated according to equations (7) and (8), as follows:

$$p_{j,x}=\frac{\sum_{n=1}^{z_x}p_{n,j,x}}{z_x} \quad \textbf{(7)}$$

Where:

$p_{j,x}$	=	Average fraction of the waste type *j* in the waste in year *x* (weight fraction)
$p_{n,j,x}$	=	Fraction of the waste type *j* in the sample *n* collected during the year *x* (weight fraction)
z_x	=	Number of samples collected during the year *x*
n	=	Samples collected in year *x*
j	=	Types of solid waste
x	=	Years in the time period for which waste is disposed at the SWDS, extending from the first year in the time period (x = 1) to year y (x = y)

$$p_{j,i}=\frac{\sum_{n=1}^{3}p_{n,j,i}}{3} \quad \textbf{(8)}$$

Where:

$p_{j,i}$	=	Average fraction of the waste type *j* in the waste in month *i* (weight fraction)
$p_{n,j,i}$	=	Fraction of the waste type *j* in the sample *n* collected during or recent to month *i* (weight fraction)
n	=	The three most recent samples collected during or previous to month *i*
j	=	Types of solid waste
i	=	Months in the time period in which waste is disposed at the SWDS, extending from the first month in the time period (*i* = 1) to month *m* (*i* = m)

Determining the fraction of DOC that decomposes in the SWDS ($DOC_{f,y}$)

Application A

$DOC_{f,y}$ is given as a default value ($DOC_{f,y} = DOC_{f,default}$) provided in the section “Data and parameters not monitored” below.

Application B

In the case that the tool is applied to MSW, then project participants may choose to either apply a default value ($DOC_{f,y} = DOC_{f,default}$) or to determine $DOC_{f,y}$ or $DOC_{f,m}$ based on measurements of the biochemical methane potential of the MSW (BMP_{MSW}), as follows:

$$DOC_{f,y} = 0.7 \cdot \frac{12}{16} \cdot \frac{BMP_{MSW}}{F \cdot \sum_{j} \left(p_{j,y} \cdot DOC_j\right)} \tag{9}$$

and

$$DOC_{f,m} = 0.7 \cdot \frac{12}{16} \cdot \frac{BMP_{MSW}}{F \cdot \sum_{j} \left(p_{j,m} \cdot DOC_j\right)} \tag{10}$$

Where:

$DOC_{f,y}$ = Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS for year *y* (weight fraction)
$DOC_{f,m}$ = Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS for month *m* (weight fraction)
BMP_j = Biochemical methane potential for the MSW disposed or prevented from disposal ($t\ CH_4$ / t waste)
F = Fraction of methane in the SWDS gas (volume fraction)
DOC_j = Fraction of degradable organic carbon in the waste type *j* (weight fraction)
$p_{j,y}$ = Average fraction of the waste type *j* in the waste in year *y* (weight fraction)
$p_{j,m}$ = Average fraction of the waste type *j* in the waste in month *m* (weight fraction)
j = Types of solid waste in the MSW
y = Year of the crediting period for which methane emissions are calculated (*y* is a consecutive period of 12 months)
m = Month of the crediting period for which methane emissions are calculated

In the case that the tool is applied to a residual waste, then project participants shall determine $DOC_{f,y}$ or $DOC_{f,m}$ based on measurements of the biochemical methane potential of the residual waste type *j* (BMP_j), as follows:

$$DOC_{f,y} = DOC_{f,m} = 0.7 \cdot \frac{12}{16} \cdot \frac{BMP_j}{F \cdot DOC_j} \tag{11}$$

Where:

$DOC_{f,y}$ = Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS for year *y* (weight fraction)
$DOC_{f,m}$ = Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS for month *m* (weight fraction)
BMP_j = Biochemical methane potential for the residual waste type *j* disposed or prevented from disposal ($t\ CH_4$ / t waste)
F = Fraction of methane in the SWDS gas (volume fraction)
DOC_j = Fraction of degradable organic carbon in the waste type *j* (weight fraction)
j = Residual waste type applied to the tool
y = Year of the crediting period for which methane emissions are calculated (*y* is a consecutive period of 12 months)
m = Month of the crediting period for which methane emissions are calculated

Procedure to determine the methane correction factor (MCF_y)

Application A

The MCF should be selected as a default value ($MCF_y = MCF_{default}$) provided in the section “Data and parameters not monitored” below.

Application B

In case of a water table above the bottom of the SWDS (for example, due to using waste to fill inland water bodies, such as ponds, rivers or wetlands), the MCF should be determined as follows:

$$MCF_y = MAX\left\{\left(1 - \frac{2}{d_y}\right), \frac{h_{w,y}}{d_y}\right\} \quad \textbf{(12)}$$

Where:

MCF_y = Methane correction factor for year y

$h_{w,y}$ = Height of water table measured from the base of the SWDS (m)

d_y = Depth of SWDS (m)

In other situations, the MCF should be selected as a default value ($MCF_y = MCF_{default}$).

~~Changes required for methodology implementation in 2nd and 3rd crediting periods~~

~~At the renewal of the crediting period, the following data should be updated according to default values suggested in the most recently published IPCC Guidelines for National Greenhouse Gas Inventories:~~

- ~~Oxidation factor (*OX*);~~
- ~~Fraction of methane in the SWDS gas (*F*);~~
- ~~Fraction of degradable organic carbon (*DOC*) that can decompose (DOC_f);~~
- ~~Methane correction factor (*MCF*);~~
- ~~Fraction of degradable organic carbon (by weight) in each waste type *j* (*DOCj*);~~
- ~~Decay rate for waste type *j* (k_j).~~

~~Respectively,If the most recent IPCC Guidelines suggest different categorization of waste types, solid waste disposal sites or climate conditions, these should be applied.~~

Data and parameters not monitored

<table>
<tr><td>Data / Parameter:</td><td>~~Φ~~ $\varphi_{default}$</td></tr>
<tr><td>Data unit:</td><td>-</td></tr>
<tr><td>Description:</td><td>Default value for the model correction factor to account for model uncertainties</td></tr>
<tr><td>Source of data:</td><td>-</td></tr>
<tr><td>Value to be applied:</td><td>~~0.9~~
For project or leakage emissions: $\varphi_{default} = 1$.
For baseline emissions: refer to Table 3 to identify the appropriate factor based on the application of the tool (A or B) and the climate where the SWDS is located
Table 3: Default values for the model correction factor
<table>
<tr><td></td><td>Humid/wet conditions</td><td>Dry conditions</td></tr>
<tr><td>Application A</td><td>0.75</td><td>0.75</td></tr>
<tr><td>Application B</td><td>0.85</td><td>0.80</td></tr>
</table></td></tr>
<tr><td>Any comment:</td><td>~~Oonk et el. (1994) have validated several landfill gas models based on 17 realized landfill gas projects. The mean relative error of multi-phase models was assessed to be 18%. Given the uncertainties associated with the model and in order to estimate emission reductions in a conservative manner, a discount of 10% is applied to the model results~~
Table 3 is applicable to Option 1 in the procedure “Determining the model correction factor (φ_y)”</td></tr>
</table>

Data / Parameter:	OX
Data unit:	-
Description:	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data:	~~Conduct a site visit at the solid waste disposal site in order to assess the type of cover of the solid waste disposal site. Use the IPCC 2006 Guidelines for National Greenhouse Gas Inventories for the choice of the value to be applied.~~ Based on an extensive review of published literature on this subject, including the IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value to be applied:	~~Use~~ 0.1 ~~for managed solid waste disposal sites that are covered with oxidizing material such as soil or compost. Use 0 for other types of solid waste disposal sites~~
Any comment:	When methane passes through the top-layer, part of it is oxidized by methanotrophic bacteria to produce CO_2. The oxidation factor represents the proportion of methane that is oxidized to CO_2 This should be distinguished from the methane correction factor (MCF) which is to account for the situation that ambient air might intrude into the SWDS and prevent methane from being formed in the upper layer of SWDS

Data / Parameter:	F
Data unit:	-
Description:	Fraction of methane in the SWDS gas (volume fraction)
Source of data:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value to be applied:	0.5
Any comment:	Upon biodegradation, organic material is converted to a mixture of methane and carbon dioxide ~~This factor reflects the fact that some degradable organic carbon does not degrade, or~~ ~~degrades very slowly, under anaerobic conditions in the SWDS. A default value of 0.5 is recommended by IPCC~~

Data / Parameter:	$DOC_{f,default}$
Data unit:	Weight fraction
Description:	Default value for the ~~F~~fraction of degradable organic carbon (DOC) in MSW that ~~can decompose~~ decomposes in the SWDS
Source of data:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value to be applied:	0.5
Any comment:	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, in the SWDS. This default value can only be used for i) Application A; or ii) Application B if the tool is applied to MSW. An alternative to using the default factor is to estimate $DOC_{f,y}$ or $DOC_{f,m}$ using equations (9), (10) and (11) above

Data / Parameter:	$MCF_{default}$
Data unit:	-
Description:	Methane correction factor
Source of data:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value to be applied:	In case that the SWDS does not have a water table above the bottom of the SWDS and in case of application A, then select the applicable value from the following: • 1.0 for **anaerobic managed solid waste disposal sites**. These must have controlled placement of waste (i.e.-waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) leveling of the waste; • 0.5 for **semi-aerobic managed solid waste disposal sites**. These must have controlled placement of waste and will include all of the following structures for introducing air to the waste layers: (i) permeable cover material; (ii) leachate drainage system; (iii) regulating pondage; and (iv) gas ventilation system; • 0.8 for **unmanaged solid waste disposal sites – deep ~~and/or with high water table.~~** This comprises all SWDS not meeting the criteria of managed SWDS and which have depths of greater than or equal to 5 meters; • 0.4 for **unmanaged-shallow solid waste disposal sites or stockpiles that are considered SWDS.** This comprises all SWDS not meeting the criteria of managed SWDS and which have depths of less than 5 meters. This includes

	stockpiles of solid waste that are considered SWDS (according to the definition given for a SWDS)
Any comment:	The ~~methane correction factor (~~MCF~~)~~ accounts for the fact that unmanaged SWDS produce less methane from a given amount of waste than managed SWDS, because a larger fraction of waste decomposes aerobically in the top layers of unmanaged SWDS. In case of a water table above the bottom of the SWDS, a larger proportion of the SWDS is anaerobic and MCF shall be estimated according to equation (12)

<table>
<tr><td>Data / Parameter:</td><td>DOC_j</td></tr>
<tr><td>Data unit:</td><td>-</td></tr>
<tr><td>Description:</td><td>Fraction of degradable organic carbon ~~(by weight)~~ in the waste type <i>j</i> (weight fraction)</td></tr>
<tr><td>Source of data:</td><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)</td></tr>
<tr><td>Values to be applied:</td><td>
<p>For MSW, ~~Apply~~ the following values for the different waste types <i>j</i> should be applied:</p>
<p>Table 4 Default values for DOC_j</p>
<table>
<tr><th>Waste type <i>j</i></th><th>DOC_j (% wet waste)</th><th>~~DOC_j (% dry waste)~~</th></tr>
<tr><td>Wood and wood products</td><td>43</td><td>~~50~~</td></tr>
<tr><td>Pulp, paper and cardboard (other than sludge)</td><td>40</td><td>~~44~~</td></tr>
<tr><td>Food, food waste, beverages and tobacco (other than sludge)</td><td>15</td><td>~~38~~</td></tr>
<tr><td>Textiles</td><td>24</td><td>~~30~~</td></tr>
<tr><td>Garden, yard and park waste</td><td>20</td><td>~~49~~</td></tr>
<tr><td>Glass, plastic, metal, other inert waste</td><td>0</td><td>~~0~~</td></tr>
</table>
<p>If a waste type~~, prevented from disposal by the proposed CDM project activity,~~ is not comparable to MSW and can not clearly be described as a combination ~~attributed to one~~ of ~~the~~ waste types in the table above, project participants should ~~choose among, among the waste types that have similar characteristics, the waste types where the values of DOCj and kj result in a conservative estimate (lowest emissions), or request a revision of/deviation from this methodology.~~ measure DOC_j in an ignition loss test according to the procedure in EN 15169 or similar national or international standards. This measurement is only required once for each waste type <i>j</i> and the value determined for DOC_j remains valid during the crediting period</p>
<p>For disposal of residual wastes, DOC_j will need to be measured in most situations, with the following default values available for some types of residual wastes: ~~In the case of e~~</p>
Empty fruit brunches (EFB), as their characteristics are similar to garden waste, the parameter value correspondent of garden shall be used; ~~In the case~~
</td></tr>
</table>

	~~of i~~ • Industrial sludge, a value of 9% (% wet sludge) shall be used assuming an organic dry matter content of 35 percent;[3] ~~In the case of d~~ • Domestic sludge, a value of 5% (wet sludge) shall be used, assuming an organic dry matter content of 10 percent[4]
Any comment:	The procedure for the ignition loss test is described in *BS EN 15169:2007 Characterization of waste. Determination of loss on ignition in waste, sludge and sediments.* The percentages listed in Table 4 are based on a wet waste basis which are concentrations in the waste as it is delivered to the SWDS. The IPCC Guidelines also specify DOC values on a dry waste basis, which are the concentrations after complete removal of all moist from the waste, which is not believed practical for this situation

<table>
<tr><td>Data / Parameter:</td><td>k_j</td></tr>
<tr><td>Data unit:</td><td>1/yr</td></tr>
<tr><td>Description:</td><td>Decay rate for the waste type <i>j</i></td></tr>
<tr><td>Source of data:</td><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)</td></tr>
<tr><td>Values to be applied:</td><td>Apply the following default values for the different waste types <i>j</i>
Table 5 Default values for the decay rate (k_j)
<table>
<tr><th colspan="2" rowspan="2">Waste type <i>j</i></th><th colspan="2">Boreal and Temperate (MAT≤20°C)</th><th colspan="2">Tropical (MAT>20°C)</th></tr>
<tr><th>Dry (MAP/PET <1)</th><th>Wet (MAP/PET >1)</th><th>Dry (MAP< 1000mm)</th><th>Wet (MAP> 1000mm)</th></tr>
<tr><td rowspan="2">Slowly degrading</td><td>Pulp, paper, cardboard (other than sludge), textiles</td><td>0.04</td><td>0.06</td><td>0.045</td><td>0.07</td></tr>
<tr><td>Wood, wood products and straw</td><td>0.02</td><td>0.03</td><td>0.025</td><td>0.035</td></tr>
<tr><td>Moderately degrading</td><td>Other (non-food) organic putrescible garden and park waste</td><td>0.05</td><td>0.10</td><td>0.065</td><td>0.17</td></tr>
</table>
</td></tr>
</table>

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[3] This value, for industrial sludge, must be adjusted for other percentages of organic dry matter content as follows: DOC (% wet sludge) = 9 * (% organic dry matter content/35).

[4] This value, for domestic sludge, must be adjusted for other percentages of organic dry matter content as follows: DOC (% wet sludge) = 5 * (% organic dry matter content/10).

Rapidly degrading	Food, food waste, sewage sludge, beverages and tobacco	0.06	0.185	0.085	0.40

NB: MAT – mean annual temperature, MAP – Mean annual precipitation, PET – potential evapotranspiration. MAP/PET is the ratio between the mean annual precipitation and the potential evapotranspiration

If a waste type disposed in a SWDS ~~prevented from disposal by the proposed CDM project activity~~ can not clearly be attributed to one of the waste types in the table above, project participants should choose, among the waste types that have similar characteristics, the waste type where the values of DOC_j and k_j result in a conservative estimate (lowest emissions), or request a revision of/deviation from this methodology

In the case of ~~empty fruit bunches (~~EFB~~)~~, as their characteristics are similar to garden waste, the parameter values correspondent of garden waste shall be used. In case of sludge from pulp and paper industry, a conservative value of 0.03 shall be used for all precipitation and temperature combinations

Any comment:	Document in the CDM-PDD the climatic conditions at the SWDS site (temperature, precipitation and, where applicable, evapotranspiration). Use long-term averages based on statistical data, where available. Provide references

Data / Parameter:	BMP_{MSW} and BMP_j
Data unit:	t CH_4 / t waste
Description:	Biochemical methane potential (BMP) of MSW or the residual waste type *j* disposed or prevented from disposal
Source of data:	Samples
Measurement procedures (if any):	Conduct a fermentation test on a sample of the MSW or the residual waste that is at least 500 g in weight. The test should be undertaken according to a national or international standard, which may need to be adapted to conduct the test on a sample that is 500 g or more in weight. The duration of the fermentation test should be until no further methane is generated (indicating the complete conversion of BMP to methane). Take the average of at least three test results
Monitoring frequency:	At least three samples from different batches. Once calculated, the value determined is valid during the crediting period
QA/QC procedures:	According to the standard followed (or adapted) to measure BMP
Any comment:	The BMP is the basis of estimating $DOC_{f,y}$ and $DOC_{f,m}$ which describes the fraction of DOC that degrades under the specific conditions occurring in the SWDS (for example the moisture, temperature and salt content of the SWDS). For MSW, a default value for $DOC_{f,y}$ and $DOC_{f,m}$ may be used instead of measurement of the BMP

Data / Parameter:	~~GWP_{CH4}~~
Data unit:	~~tCO_2e / $t CH_4$~~
Description:	~~Global Warming Potential (GWP) of methane~~
Source of data:	~~Decisions under UNFCCC and the Kyoto Protocol (a value of 21 is to be applied for the first commitment period of the Kyoto Protocol)~~
Monitoring frequency:	~~Annually~~
Any comment:	~~-~~

Data / Parameter:	**GWP_{CH4}**
Data unit:	$t CO_2e$ / $t CH_4$
Description:	Global Warming Potential of methane
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:	-

III. MONITORING METHODOLOGY PROCEDURE

Monitoring procedures

Monitoring involves an annual assessment of the conditions at the ~~solid waste disposal site (~~SWDS~~)~~ where the waste~~, in the absence of the project activity,~~ ~~would be dumped~~ is disposed or prevented from disposal. ~~Methane emissions from preventing disposal of waste at the SWDS can only be claimed if there is no gas from the SWDS being captured and flared or combusted.~~

Data and parameters monitored

Data / Parameter:	f_y
Data unit:	-
Description:	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year *y*
Source of data:	Select the maximum value from the following: (a) contract or regulation requirements specifying the amount of methane that must be destroyed/used (if available) and (b) historic data on the amount captured ~~Written information from the operator of the solid waste disposal site and/or site visits at the solid waste disposal site~~
Measurement procedures (if any):	-
Monitoring frequency:	For application A: Once for the crediting period ($f_y = f$) For application B: Annually
QA/QC procedures:	-
Any comment:	

Data / Parameter:	W_x or W_i
Data unit:	t~~ons~~
Description:	Total amount of ~~organic~~ waste ~~prevented from disposal~~ disposed in a SWDS in year *x* or month *i* ~~(tons)~~
Source of data:	Measurements by project participants
Measurement procedures (if any):	Measure on wet basis
Monitoring frequency:	Continuously, aggregated at least annually for year *x* or monthly for month *i*
QA/QC procedures:	-
Any comment:	For application B

Data / Parameter:	$p_{n,j,x}$ or $p_{n,j,i}$
Data unit:	-
Description:	Weight fraction of the waste type *j* in the sample *n* collected during the year *x* or month *i*
Source of data:	Sample measurements by project participants
Measurement procedures (if any):	Sample the waste composition ~~prevented from disposal~~, using the waste categories *j*, as provided in the table for DOC_j and k_j, and weigh each waste fraction (measure on wet basis)
Monitoring frequency:	Minimum of three samples every three months
QA/QC procedures:	-
Any comment:	This parameter only needs to be monitored for Application B and if the waste includes more than one waste type *j*. Sampling is not required if the waste comprises only one waste type. ~~This parameter only needs to be monitored the waste prevented from disposal includes several waste categories j, as categorized in the tables for DOCj and kj~~

Data / Parameter:	z_x
Data unit:	-
Description:	Number of samples collected during the year *x*
Source of data:	Project participants
Measurement procedures (if any):	Minimum of three samples every three months
Monitoring frequency:	Continuously, aggregated annually
QA/QC procedures:	-
Any comment:	This parameter only needs to be monitored for Application B and if the waste ~~prevented from disposal~~ includes ~~several~~ more than one waste category~~ies~~ *j*~~, as categorized in the tables for DOC_j and k_j~~

Data / Parameter:	d_y
Data unit:	m
Description:	Depth of the SWDS
Source of data:	Project participants
Measurement procedures (if any):	Monitoring well that is also used to measure the height of the water table ($h_{w,y}$)
Monitoring frequency:	Monthly, average annual values to be used in the case of application of the yearly model (equation (1))
QA/QC procedures:	-
Any comment:	This parameter needs to be monitored to identify whether the SWDS has a water table above the bottom of the SWDS, such as due to using waste to fill inland water bodies, such as ponds, rivers or wetlands. If the SWDS does have a water table above the bottom of the SWDS, then this parameter is used to determine the MCF

Data / Parameter:	$h_{w,y}$
Data unit:	m
Description:	Height of the water table in the SWDS
Source of data:	Project participants
Measurement procedures (if any):	Monitoring well
Monitoring frequency:	Monthly, average annual values to be used in the case of application of the yearly model (equation (1))
QA/QC procedures:	-
Any comment:	This parameter needs to be monitored to identify whether the SWDS has a water table above the bottom of the SWDS, such as due to using waste to fill inland water bodies, such as ponds, rivers or wetlands. If the SWDS does have a water table above the bottom of the SWDS, then this parameter is used to determine the MCF

Data / Parameter:	a, b, c, d, e, g
Data unit:	%
Description:	Effect of the uncertainty of different parameters
Source of data:	Project participants
Measurement procedures (if any):	Using the instructions in Table 3 above.
Monitoring frequency:	Annually if the conditions described in the “Instructions for selecting the factor” in Table 3 have changed (e.g. a change in how the weight of the waste is measured). Once for the crediting period, if these conditions do not change.
QA/QC procedures:	-
Any comment:	Used in Option 2 for determining the model correction factor.

IV. REFERENCES AND ANY OTHER INFORMATION

IPCC 2006, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 3 Waste.

~~Oonk H., Weenk A., Coops O., Luning L. (1994) Validation of landfill gas formation models; EWAB 9427; NOVEM, Utrecht, The Netherlands.~~

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History of the document

Version	Date	Nature of revision(s)
06.0.0	EB 65, Annex # 25 November 2011	• Option to determine DOCj based on measurements; • Update estimation of parameters: o Oxidation rate of 10% applied for managed and unmanaged SWDS; o Different model uncertainty factors specified based on application and climate, and a choice to calculate a project specific factor; o Account for the effect of the height of the water table on the methane correction factor. • Application of tool expanded to: o Stockpiles that may be considered SWDS; o Calculate project and leakage emissions; o Enable ex ante estimation of emissions. • Monthly calculation model included to allow more flexible choice of monitoring period; • Definitions section included and basis of monitoring and measurement requirements clarified. • Title changed.
05.1.0	EB 61, Annex 10 3 June 2011	Amendment to include a default value for the fraction of degradable organic carbon (DOCj) of sludge from domestic wastewater treatment plants (domestic sludge).
05	EB 55, Annex 18 30 July 2010	To provide default values for the fraction of degradable organic carbon (DOC) for industrial sludge and for the decay rate (k) for sludge from pulp and paper industry.
04	EB 41, Annex 10 02 August 2008	• The title was changed to read “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site”; • Clarified that the tool is not applicable to stockpiles.
03 [5]	EB 39, Annex 9 16 May 2008	Specified that k and DOC values for EFB shall be those corresponding to garden waste.
02	EB 35, Annex 10 19 October 2007	Added: • Example of how specific values of k & DOC should be chosen; • k value of sewage sludge.
01	EB 26, Annex 14 29 September 2006	Initial adoption.
Decision Class: Regulatory **Document Type**: Tool **Business Function**: Methodology		

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[5] The version was changed from 02.1 to 03 on 23 May 2008, due to incorrect numbering.