ARTICLE 6.4 MECHANISM

A6.4-MEP009-A03

Draft Methodological tool

Emissions from solid waste disposal sites

Version 02.0

United Nations
Framework Convention on
Climate Change

COVER NOTE

1. Procedural background

1. The Supervisory Body of the mechanism established by Article 6, paragraph 4, of the Paris Agreement (the Article 6.4 mechanism), at its fifteenth meeting,[1] approved its workplan for 2025 for the Methodological Expert Panel (MEP) and requested the MEP to initiate work on the revision of Clean Development Mechanism (CDM) methodologies, methodological tools, standards, and guidelines, including the CDM tool "TOOL04: Emissions from solid waste disposal sites" (hereinafter referred to as the approved CDM Tool)[2].

2. The MEP, at its eight meeting, considered a draft version of the "Methodological tool: Emissions form solid waste disposal sites"[3] and agreed to seek inputs from stakeholders. This draft version of the methodological tool was prepared by incorporating revisions to the approved CDM tool to align with the requirements of Article 6.4 mechanism standards approved by the SBM for the development of new mechanism methodologies.

3. The public consultation was open from 9 September to 30 September 2025, and a total of 2 comments were received. A summary of the comments is provided in Section 4 below.

2. Purpose

4. The purpose of this methodological tool is to provide the requirements, approaches, and guidelines to determine methane baseline emissions, project emissions or leakage emissions from solid waste disposed of, or prevented from disposal at a solid waste disposal site (SWDS).

3. Key issues and proposed solutions

5. This methodological tool was developed based on the approved CDM Tool but revised to align with the Article 6.4 mechanism framework and standards.

6. The tool may be used to determine emissions for the following types of applications:

   (a) **Application A:** Methane capture and destruction at an existing SWDS (landfills).

   (b) **Application B:** Avoidance/diversion of waste to prevent methane generation (e.g., composting, anaerobic digestion).

7. This methodological tool incorporates updated default factors and equations to calculate the emissions of methane, and guidance on uncertainty analysis from the "2019

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[1] See https://unfccc.int/sites/default/files/resource/A6.4-SBM015.pdf

[2] See https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v8.1.pdf/history_view

[3] See https://unfccc.int/sites/default/files/resource/A6.4-MEP008.pdf

Refinement to the 2006 IPCC guidelines for national greenhouse gases inventories”[4]. Conservative adjustments (e.g., uncertainty factors) are applied to avoid underestimation or overestimation of the methane generated in a SWDS.

8. The methodological tool also and provides the following approaches for determining the oxidation factor (parameter OX_y):

(a) **Option 1:** Annual monitoring of the parameter J_{out} (flux of methane leaving the surface, in g_{CH4}/m^2d) using the flux box method[5] and using the corresponding values for OX_y based on the methane flux that are more conservative than the standalone value included in the approved CDM Tool;

(b) **Option 2:** Monitoring of the parameter J_{out} using the flux box method once prior to the start of each crediting period or if changes to the cover are made during the crediting period, and using the corresponding values for OX_y based on the methane flux that are more conservative than the standalone value included in the approved CDM Tool;

(c) **Option 3:** Use of the conservative default values that is more conservative than the standalone value included in the approved CDM Tool.

9. The table below provides a comparison of the key changes made to the approved CDM tool

Table Comparison of the main changes between the approved CDM tool and the methodological tool

Approved CDM tool	Methodological tool
The oxidation factor is a fixed value equals to 0.1	Three options are provided to determine the oxidation factor: Option 1: ex-post monitoring of the methane flux in the surface of the landfill (J_{out}). Under this option, a specific oxidation factor is also determined ex-post for each zone *i* of the SWDS based on different ranges of J_{out}, and the oxidation factor is the weighted average value based on the size of each zone of the SWDS; Option 2: monitoring of J_{out} once prior to the start of the Article 6.4 activity. Under this option, a specific oxidation factor is determined for each zone *i* of the SWDS based on different ranges of J_{out}, and the oxidation factor is the weighted average value based on the size of each zone of the SWDS and remains fixed for the crediting period;

[4] IPCC, *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Volume 1: General guidance and reporting, Chapter 3: Uncertainties. See https://www.ipcc-nggip.iges.or.jp/public/2019rf/vol1.html

[5] Refer to Appendix 1 of this methodological tool for the monitoring requirements using the flux box method.

Approved CDM tool	Methodological tool
	Option 3: use a conservative default oxidation factor that remains fixed through the crediting period In addition, the methodological tool provides guidance on how to apply Options 1, 2 and 3 to Application A and Application B. Finally, the methodological tool provides the monitoring requirements for determining J_{out} using the flux box method for each zone *i* of the SWDS and for calculating the oxidation factor based on the weighted average value based on the size of each zone.
Default factors sourced from the 2006 IPCC guidelines for national greenhouse gases inventories	Default factors updated based on the 2019 refinement to the 2006 IPCC guidelines for national greenhouse gases inventories
N/A	Inclusion of “bulk wate” and the respective default factors as a type of waste, and inclusion of conditions when “bulk waste” can be used.
No uncertainty needs to be considered	Guidance on determining and incorporating uncertainties were included.

4. Consideration of public comments

10. A detailed compilation of the public comments received are provided in the information note “Information note: Summary of the comments received from stakeholders on the draft methodology “Flaring or use of landfill gas” and on the associated draft methodological tools”. The sub-sections below include the proposed assessment and recommended action by the MEP (if any).

4.1. Definitions

11. One comment proposes to expand the definition of “municipal solid waste” to recognise the importance of accounting for the direct/indirect effects of post-consumer plastic waste, and the MEP recommends the stakeholder to submit proposed values for the DOC_j and k through a request for revision of the methodological tool and to further substantiate the emissions based on the biological decomposition of post-consumer plastic waste.

4.2. Data and parameters not monitored

12. One comment was received requesting to clarify under which conditions the “Bulk waste” should be used to account the methane emissions, and the MEP recommends including a note indicating when to use "bulk waste" in the methodological approaches and in the Data and parameters monitored sections and including the default factors DOC_f and k for the bulk waste in the data and parameters not monitored.

13. One comment was submitted highlighting that the meaning of “stockpile” is included in the “definitions” section but it’s not clear under what SWDS type this waste management scenario would fall and what MCF value should be chosen, and the MEP recommends

revising the methodological tool by including the stockpiles under the same category as “Unmanaged – shallow (< 5m waste)” in the “Data / Parameters table 5”.

14. One comment was submitted requesting to clarify the meaning of “degree of control of scavenging” and “degree of control of fires” to classify the SWDS as Anaerobic managed, and the MEP recommends including explanations in the Data / Parameters table 5 that "degree of control of scavenging” means no scavengers are allowed to enter the site and “degree of control of fires” means a limited number of incidents of fire throughout the year (which would not impact composition of the waste in the SWDS).

4.3. Data and parameters monitored

15. One comment was submitted highlighting an inconsistency between the requirements for the parameter f in the methodological tool (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 that shall be determined ex-ante for Application A) and a requirement of the mechanism methodology the mechanism methodology to update annually the regulatory analysis to determine $F_{CH4,BL,y}$. The MEP clarifies that the methodological tool is used for ex-ante purpose only and requires the parameter f to be equal to zero

5. Impacts

16. The approval of this methodological tool will allow the development of new Article 6.4 activities that aim to capture and destroy or use the landfill gas (LFG) generated in SWDSs, or that aim to prevent the generation of methane in a SWDS through alternative solid waste treatment options.

6. Subsequent work and timelines

17. The MEP notes that the methodological tool applies only to Article 6.4 projects and may be amended in the future to cover activities at other scales (e.g., programmes of activities, policies, sectoral approaches) once the adopted standards for the development of mechanism methodologies (e.g., additionality standard, baseline-setting standard) are revised to incorporate other scales.

7. Recommendations to the Supervisory Body

18. The MEP recommends the Supervisory Body to adopt the methodological tool.

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1. Introduction

1.1. Scope

1. This methodological tool provides approaches and guidelines to determine emissions of methane from solid waste disposed of, or prevented from disposal, at a solid waste disposal site (SWDS).

2. This methodological tool establishes requirements to determine the following parameters:

Table 1. Parameters determined

Parameter	SI Unit	Description
$BE_{CH4,SWDS,y}$ $PE_{CH4,SWDS,y}$ $LE_{CH4,SWDS,y}$	tCO_2e/year	Baseline emissions, project emissions or leakage emissions occurring in year y generated from waste disposal at a SWDS during a time period ending in year *y* (where *y* is a period of 12 consecutive months)
$BE_{CH4,SWDS,m}$ $PE_{CH4,SWDS,m}$ $LE_{CH4,SWDS,m}$	tCO_2e/month	Baseline emissions, project emissions or leakage emissions occurring in month *m* generated from waste disposal at a SWDS during a time period ending in month *m*

1.2. Entry into force and validity

3. This methodological tool enters into force on DD/MM/YYYY

4. This methodological tool remains valid for five years, until DD/MM/YYYY, unless an earlier date applies if the methodological tool is revised or withdrawn in accordance with the "Procedure: Development, revision and clarification of methodologies and methodological tools" (A6.4-PROC-METH-001).[1]

2. Definitions

2.1. General terms

5. The following general terms are applied to this methodological tool:

(a) "Shall" is used to indicate requirements that must be followed;

(b) "Should" is used to indicate that, among several options, one course of action is recommended as particularly suitable;

(c) "May" is used to indicate what is permitted;

2.2. Methodological terms and definitions

6. The following methodological tool terms and definitions are applied to this methodological tool:

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[1] See https://unfccc.int/sites/default/files/resource/A6.4-PROC-METH-001.pdf

(a) **Activity participant:** A public or private entity that participates in an Article 6.4 activity;

(b) **Aged solid waste disposal site (SWDS) cell:** A SWDS cell containing waste that has been in the SWDS for more than 20 years;

(c) **Immature SWDS cell**: A SWDS cell containing waste that has been in the SWDS for less than five years;

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

(e) **Mature SWDS cell:** A SWDS cell containing waste which has been in the SWDS between five and twenty years;

(f) **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;

(g) **Residual waste**: A solid waste type with largely homogenous properties. This includes, inter alia, material that remains after the waste treatment, such as anaerobic digestate and compost, as well as biomass residues (by-products, residues or waste streams from agriculture, forestry and related industries);

(h) **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;

(i) **Solid waste disposal site (SWDS):** A 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 (b) a visual inspection by the DOE confirms that the material is exposed to anaerobic conditions (i.e., it has low porosity and is moist);

(j) **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.

7. Further definitions from the “Article 6.4 Glossary of Terms”, once adopted by the Supervisory Body, shall also apply to this methodological tool.

3. Applicability

8. This methodological tool may be used by mechanism methodologies related to emission reductions.

9. This version of the methodological tool applies only to Article 6.4 projects and may be amended in the future to cover activities at other scales (e.g., programmes of activities, policies, sectoral approaches) once the adopted standards for the development of

mechanism methodologies (e.g., additionality standard, baseline-setting standard) are revised to incorporate other scales.

10. This methodological tool may be used to determine methane emissions from a SWDS for the following types of applications:

(a) **Application A:** The Article 6.4 activity mitigates methane emissions from an existing specific SWDS. Methane emissions are mitigated by capturing and flaring or combusting the methane. The methane is generated from waste disposed in the past, including waste disposed prior to the start of the Article 6.4 activity. In these cases, this methodological tool is only applied for an ex-ante estimation of emissions in the project design document (PDD). Emissions shall then be monitored during the crediting period using the applicable approaches in the relevant mechanism methodologies (e.g. measuring the amount of methane captured from the SWDS);

(b) **Application B:** The Article 6.4 activity avoids or involves the disposal of waste at a SWDS. This applies, for example, where municipal solid waste (MSW) is treated under an Article 6.4 activity using an alternative waste treatment measure, such as composting or anaerobic digestion, and thus prevented from being disposed of in a SWDS. The methane is generated from waste disposed of, or avoided from disposal, during the crediting period. In these cases, the methodological tool shall be applied for both ex-ante and ex-post estimation of emissions. Under this application, activity participants may apply the simplified approach detailed in section 5.1 below when calculating baseline emissions.

11. These two types of applications are referred to in this methodological tool, for the purpose of determining relevant parameters.

12. If (a) different types of residual waste are disposed of or prevented from disposal; or (b) both MSW and residual waste(s) are prevented from disposal, then this methodological tool shall be applied separately to each residual waste type and to MSW.

13. This methodological tool may also be applied for:

(a) Monitoring the flux of methane leaving the surface a SWDS; and/or

(b) Determining the fraction of methane in the landfill gas (LFG) that is oxidized in the soil or other material covering the waste in the SWDS (OX_y).

14. Mechanism methodologies intending to use this methodological tool shall include a reference to this tool within the mechanism methodology and shall specify:

(a) Whether the methodological tool shall be applied by activity participants to determine methane emissions from SWDS and, if so:

(i) For which emission sources the tool shall be applied;

(ii) Which of the application cases in paragraph 10 above apply; and

(iii) Whether the simplified or regular approach shall be used;

(b) Whether the methodological tool shall be applied by activity participants to determine the fraction of methane in the landfill gas (LFG) that is oxidized in the soil or other material covering the waste in the SWDS and, if so, for which purposes this parameter is determined; and/or

(c) Whether the methodological tool shall be applied by activity participants to determine the flux of methane leaving the surface a SWDS and, if so, for which purposes the flux is determined.

15. Mechanism methodologies may specify additional provisions for the application of this methodological tool in relation to the mitigation activity types they cover. Where the mechanism methodology referring to this tool specifies approaches that differ from those described in this tool, the requirements contained in the mechanism methodology shall take precedence.

4. Normative and informative references

16. The following normative document is indispensable for the application of this methodological tool. The most recent version of the documents listed shall apply:

(a) Intergovernmental Panel on Climate Change (2019). *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.*[2]

(b) Intergovernmental Panel on Climate Change (2006). *2006 IPCC Guidelines for National Greenhouse Gas Inventories*.[3]

17. The following informative document provide supporting information that may assist in the application of this methodological tool:

(a) EUROPEAN COMMITTEE FOR STANDARDIZATION. *EN 15169:2007. Characterization of waste – Determination of loss on ignition in waste, sludge and sediments*. Brussels: CEN, 2007;

(b) SOLID WASTE INDUSTRY FOR CLIMATE SOLUTIONS (SWICS). *Methane Oxidation Addendum*. 19 November 2012. See https://downloads.regulations.gov/EPA-HQ-OAR-2012-0934-0088/content.pdf;

(c) ENVIRONMENT AGENCY. *Guidance on monitoring landfill gas surface emissions (LFTGN07 v2)*. Bristol: Environment Agency, 2010. See https://assets.publishing.service.gov.uk/media/5a74f8bded915d502d6cc7ad/LFTGN07.pdf.

5. Methodological approaches

18. Article 6.4 activities using the methodological tool to determine methane emissions from SWDSs, as per the applicability of paragraph 14(a) above, shall apply either section 5.1 (the simplified approach, applicable to calculate baseline emissions only for Article 6.4 activities under Application B only) or section 5.2 below (the regular approach, applicable to calculate baseline emissions, project emissions and leakage emissions for Article 6.4 activities under both Application A and Application B).

[2] See https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html

[3] See https://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html

19. Article 6.4 activities using the methodological tool to determine OX_y, as per paragraph 14(b) above, shall apply the provisions of section 5.3.2 below.

20. Article 6.4 activities using the methodological tool to measure the flux of methane leaving the surface, as per paragraph 14(c) above, shall apply the provisions from Appendix 1.

5.1. Simplified approach to determine methane emissions from the SWDS

21. Simplified approaches to determine methane emissions from the SWDS using the first order-decay (FOD) model and their respective calculations are detailed in the Appendix 2 and may only be applied if the solid waste type is MSW and if it is specified in the mechanism methodology that such simplified approach may be used.

22. Article 6.4 activities implementing a simplified approach do not need to apply the procedure detailed in section 5.2, and shall determine only the relevant parameters from section 5.3.

5.2. Regular approach to determine methane emissions from the SWDS

23. The amount of methane generated from the disposal of waste at the SWDS is calculated using the FOD model.[4] The model differentiates between waste types j with respective constant decay rates (k_j) and fractions of degradable organic carbon (DOC_j).

24. The model calculates the methane generation occurring in year y (a period of 12 consecutive months) or month m, based on waste streams of waste types j ($W_{j,x}$ or $W_{j,i}$) disposed of in the SWDS over a specified time period (years or months).

25. Where methane is captured at the SWDS (e.g. due to safety regulations) and flared, combusted, or used in another manner that prevents emissions to the atmosphere, emissions shall be adjusted for the fraction of methane captured (f_y).

26. The amount of methane generated from waste disposal at the SWDS shall be calculated for year y ($BE_{CH4,SWDS,y}$ 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). Either of these two approaches may be used to calculate the amount of methane generated waste disposal at the SWDS. All data used to apply the equations shall be documented transparently in the PDD or in the monitoring reports.

27. The PDD shall 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 Article 6.4 activity and typically starts when the SWDS begins receiving waste.

28. The emissions shall be calculated as follows:

[4] 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.

$$\left.\begin{matrix} BE_{CH4,SWDS,y} \\ PE_{CH4,SWDS,y} \\ LE_{CH4,SWDS,y} \end{matrix}\right\} = \varphi_y \times (1 - f_y) \times GWP_{CH4} \times (1 - OX_y) \times \frac{16}{12} \times F \times MCF_y \times \sum_{x=1}^{y} \sum_{j} \left[W_{j,x} \times DOC_{f,j} \times DOC_j \times e^{-k_j \times (y-x)} \times (1 - e^{-k_j})\right]$$ Equation (1)

$$\left.\begin{matrix} BE_{CH4,SWDS,m} \\ PE_{CH4,SWDS,m} \\ LE_{CH4,SWDS,m} \end{matrix}\right\} = \varphi_y \times (1 - f_y) \times GWP_{CH4} \times (1 - OX_y) \times \frac{16}{12} \times F \times MCF_y \times \sum_{i=1}^{m} \sum_{j} \left[W_{j,i} \times DOC_{f,j} \times DOC_j \times e^{\frac{-k_j}{12} \times (m-1)} \times \left(1 - e^{\frac{-k_j}{12}}\right)\right]$$ Equation (2)

Where, for the yearly model:

$BE_{CH4,SWDS,y}$ $PE_{CH4,SWDS,y}$ $LE_{CH4,SWDS,y}$	=	Methane baseline, project emissions or leakage emissions occurring in year *y* generated from waste disposal at a SWDS during a time period ending in year *y* (t CO_2e/yr)
x	=	Years in the time 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*)
y	=	Year of the crediting period for which methane emissions are calculated (*y* is a consecutive period of 12 months)
$W_{j,x}$	=	Amount of solid waste type *j* disposed or prevented from disposal in the SWDS in the year *x* (t)

Where, for the monthly model:

$BE_{CH4,SWDS,m}$ $PE_{CH4,SWDS,m}$ $LE_{CH4,SWDS,m}$	=	Methane baseline, project emissions or leakage emissions occurring in month *m* generated from waste disposal at a SWDS during a time period ending in month *m* (t CO_2e/m)
m	=	Month of the crediting period for which methane emissions are calculated
i	=	Months in the time period in which waste is disposed of at the SWDS, extending from the first month in the time period (*i* = 1) to month *m* (*i* = m)
$W_{j,i}$	=	Amount of organic waste type *j* disposed of, or prevented from disposal, in the SWDS in the month *i* (t)

Where, for both the yearly and monthly model:

φ_y	=	Model correction factor to account for model uncertainties for year *y*
f_y	=	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents methane emissions to the atmosphere in year *y*
GWP_{CH4}	=	Global Warming Potential of methane
OX_y	=	Fraction of methane in the landfill gas (LFG) that is oxidized in the soil or other material covering the waste in the SWDS
F	=	Fraction of methane in the SWDS gas (volume fraction)
MCF_y	=	Methane correction factor for year *y*
DOC_j	=	Fraction of degradable organic carbon in the waste type *j* (weight fraction)
$DOC_{f,j}$		Fraction of degradable organic carbon (DOC) for each waste type *j* that decomposes under the specific conditions occurring in the SWDS (weight fraction)
k	=	Decay rate for the waste type *j* (1 / year)
j	=	Type of residual waste or types of waste in the MSW

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5.3. Determining the parameters required to apply the FOD model

29. Table 2 summarizes how the parameters required in this methodological 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 to be used depends on whether the methodological tool is used for Application A or Application B.

Table 2. Overview of the option to determine parameters

Parameter	Application A	Application B
φ_y	Project emissions or leakage emissions: default values Baseline emissions: default values or project-specific values estimated yearly	
OX_y	Default value	
F	Default value	
$DOC_{f,j,y}$ or $DOC_{f,j,m}$	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

5.3.1. Determining the model correction factor (φ_y)

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

5.3.1.1. Option 1: Use a default value

31. Use a default value: $\varphi_y = \varphi_{default}$. Default values for different applications and climatic conditions are provided in the section 5.5 below.

5.3.1.2. Option 2: Determine φ_y based on specific situation of the Article 6.4 activity

32. Undertake an uncertainty analysis for the specific situation of the proposed Article 6.4 activity. The overall uncertainty of the determination of the methane generated in year *y* (V_y) is calculated as follows:

$$V_y = \sqrt{a^2 + b^2 + c^2 + d^2 + e^2 + g^2} \quad \text{Equation (3)}$$

33. following the instructions in the table, and justify their selection.

Table 3. 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	$DOC_{f,j}$	5%	15%	Use the lower value if more than 50 per cent 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 per cent 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	$e^{-k_j \times (y-x)} \times (1 - e^{-k_j})$	5%	20%	The uncertainty values 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 three years ago. In all other cases, use the higher value

34. φy is then calculated as follows:

$$\varphi_y = \frac{1}{\left(1 + V_y\right)}$$ Equation (4)

35. For cases where the monthly FOD model is being used (Equation (2)), φ_y refers to the year *y* to which the month *m* belongs.

5.3.2. Determining the oxidation factor (OX_y)

36. The methodological tool provides three options to determine the oxidation factor:

(a) **Option 1:** Annual monitoring of the parameter J_{out} (flux of methane leaving the surface, in g_{CH4}/m^2d) using the flux box method[10] and using the corresponding value for OX_y from Table 4 below;

(b) **Option 2:** Monitoring of the parameter J_{out} using the flux box method once prior to the start of each crediting period and using the corresponding value for OX_y from Table 4 for the whole crediting period, unless any changes to the cover are made during the crediting period. In that case, the flux must be re-measured after the change in the affected zone(s) and the higher value of OX_y for the cover layer before the change and after the change shall be used;

(c) **Option 3:** Use of the default values provided in "Data / Parameters table 2" under section 5.5 below.

37. The options above are applied in standalone or in combination, depending on whether the methodological tool is used for determining methane emissions from SWDSs through Application A or Application B, or used for ex-post monitoring.

5.3.2.1. Application A

38. Select Option 3.

5.3.2.2. Application B

39. Select either Option 2 or Option 3.

40. Option 2 may only be selected if activity participants identifies, supported with evidence, the SWDS that would have received the solid waste treated under the Article 6.4 activity to conduce the measurements of J_{out}.

5.3.2.3. Ex-post monitoring

41. The mechanism methodology shall specify which of the three options, or which combination of options, may be applied to Article 6.4 activities.

42. To measure the methane flux under Option 1 and Option 2, activity participants shall divide the SWDS into different zones and measure the average flux of methane leaving the surface (J_{out}) for each zone, as per the procedure contained in Appendix 1. For each zone *i*, a value of the oxidation factor (OX_i) based on the measured flux shall be selected as per the Table 4 below:

Table 4. Values of OX_i, to be applied based on the measurements of J_{out}

J_{out} ($g_{CH4}/m^2.d$)	OX_i [(a)]
Lower than 10	0.383 +/- 8% uncertainty
Between 10 and 70	0.278 +/- 12% uncertainty
Above 70	0.124 +/- 21% uncertainty

[10] Refer to Appendix 1 of this methodological tool for the monitoring requirements using the flux box method.

[a] Uncertainties are based on the standard error, multiplied by 1.96 and divided by the mean, calculated from the statistics provided in table 3 of SWICS (2012), rounded up to the third decimal place, as per the guidance from Volume 1, Chapter 3 of the IPCC (2019 Refinement).

43. Since the average flux of methane from the surface of the SWDS could differ significantly between different zones, OX_y is determined as the weighted average value based on the size of each zone[11], as follows:

$$OX_y = \sum_{i=1}^{n} OX_i \times \frac{Area_i}{Area_{Total}}$$ Equation (5)

Where:

OX_y	=	Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline scenario (dimensionless)
OX_i	=	Average oxidation factor for the zone *i*
$Area_i$	=	Surface area of the zone *i* (m^2)
$Area_{Total}$	=	Surface area of the entire SWDS (m^2)
i	=	Zones of the SWDS

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

44. Where different waste types *j* are disposed of, or prevented from disposal, in the SWDS (for example, in the case of MSW), it is necessary to determine the amounts of the different waste types ($W_{j,x}$ or $W_{j,i}$).

45. If only one type of waste is disposed of (for example, residual waste) or if the waste is classified as "bulk waste" by activity participants (if data to determine the different waste types do not exist or is limited but information is available on bulk waste disposed), then $W_{j,x} = W_x$ and $W_{j,i} = W_i$ and the guidance from paragraphs 46 to 48 below do not need to be applied (e.g. waste sampling is not required).

5.3.3.1. Application A

46. 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 tonnes/m^3. 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 historical information on amounts, composition and origin of the waste should be found in SWDS administration documents (e.g. contracts with clients and invoices to clients) or obtained from old business plans or business evaluations.

[11] Appendix 1 of this methodological tool contains guidance to divide the landfill into different zones and to determine the number of locations and quantity of samples.

5.3.3.2. Application B

47. Determine the amounts of different waste types through sampling and calculate the mean from the samples either using Equation (6) to determine the value of $W_{j,x}$ for the yearly model or using Equation (7) to determine the value of $W_{j,i}$ for the monthly model, as follows:

$$W_{j,x} = W_x \times p_{j,x} \quad \text{Equation (6)}$$

Where:

$W_{j,x}$	=	Amount of solid waste type j disposed of, or prevented from disposal. in the SWDS in the year *x* (t)
W_x	=	Total amount of solid waste disposed of, or prevented from disposal, in the SWDS in year *x* (t)
$p_{j,x}$	=	Average fraction of the waste type *j* in the waste in year *x* (weight fraction)
j	=	Types of solid waste
x	=	Years in the time period for which waste is disposed of at the SWDS, extending from the first year in the time period (*x* = 1) to year *y* (*x* = y)

$$W_{j,i} = W_i \times p_{j,i} \quad \text{Equation (7)}$$

Where:

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

48. The fraction of the waste type *j* in the waste for the year *x* or month *i* is calculated according to Equations (8) and (9), as follows:

$$p_{j,x} = \frac{\sum_{n=1}^{Z_x} p_{n,j,x}}{Z_x} \quad \text{Equation (8)}$$

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 of at the SWDS, extending from the first year in the time period (*x* = 1) to year *y* (*x* = y)

$$p_{j,i} = \frac{\sum_{n=1}^{3} p_{n,j,i}}{3} \quad \text{Equation (9)}$$

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 near month *i* (weight fraction)
n	=	The three most recent samples collected during or prior to month *i*
j	=	Types of solid waste
i	=	Months in the time period in which waste is disposed of at the SWDS, extending from the first month in the time period (*i* = 1) to month *m* (*i* = m)

5.3.4. Determining the fraction of DOC for the waste type *j* that decomposes in the SWDS ($DOC_{f,j,y}$)

5.3.4.1. Application A

49. $DOC_{f,j,y}$ is given as a default value for each waste type *j* provided in the section 5.5 below.

5.3.4.2. Application B

50. If the methodological tool is applied to MSW, activity participants shall choose either to apply default values for each waste type *j* or to determine $DOC_{f,j,y}$ or $DOC_{f,j,m}$ based on measurements of the biochemical methane potential of MSW (BMP_{MSW}), as follows:

$$DOC_{f,j,y} = 0.7 \times \frac{12}{16} \times \frac{BMP_{MSW}}{F \times p_{j,y} \times DOC_j} \quad \text{Equation (10)}$$

and

$$DOC_{f,j,m} = 0.7 \times \frac{12}{16} \times \frac{BMP_{MSW}}{F \times p_{j,m} \times DOC_j} \quad \text{Equation (11)}$$

Where:

$DOC_{f,j,y}$	=	Fraction of degradable organic carbon (DOC) for each waste type *j* that decomposes under the specific conditions occurring in the SWDS for year *y* (weight fraction)
$DOC_{f,j,m}$	=	Fraction of degradable organic carbon (DOC) for each waste type *j* that decomposes under the specific conditions occurring in the SWDS for month *m* (weight fraction)

BMP_{MSW}	=	Biochemical methane potential for the MSW disposed of, 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
i	=	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

51. If the methodological tool is applied to residual waste, activity participants shall determine $DOC_{f,j,y}$ or $DOC_{f,j,m}$ based on measurements of the biochemical methane potential of the residual waste type j (BMP_j), as follows:

$$DOC_{f,j,y} = DOC_{f,j,m} = 0.7 \times \frac{12}{16} \times \frac{BMP_j}{F \times DOC_j}$$ Equation (12)

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 of, 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 methodological 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

5.3.5. Procedure to determine the methane correction factor (MCF_y)

5.3.5.1. Application A

52. The MCF should be selected as a default value ($MCF_y = MCF_{default}$) provided in the section 5.5 below.

5.3.5.2. Application B

53. If the water table lies above the bottom of the SWDS (for example, when waste is used to fill inland water bodies such as ponds, rivers, or wetlands), MCF_y should be determined as follows:

$$MCF_y = MAX\left\{\left(1 - \frac{2}{d_y}\right), \frac{h_{w,y}}{d_y}\right\}$$ Equation (13)

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)

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

5.4. Uncertainty determination

55. The uncertainty shall be determined by considering the uncertainty in data and measurements of all required parameters, following the guidance of Volume 1, Chapter 3 of the IPCC (2019 refinement). The uncertainty shall be expressed as the standard error of the mean and incorporated into the uncertainty calculations in the mechanism methodology.

5.5. Data and parameters not monitored

56. For parameters that do not contain uncertainty, activity participants shall assume uncertainty based on expert judgement and justify the estimates.

Data / Parameter table 1.

Data/parameter	$\boldsymbol{\varphi_{default}}$
Description	Model correction factor to account for model uncertainties for year *y*
Data unit	-
Equations referred	(1), (2), (4)
Purpose of data	☒ Baseline emissions ☒ Project emissions ☒ Leakage emissions
Value(s) applied	For project emissions or leakage emissions: $\varphi_{default}$ = 1. For baseline emissions: refer to the table below to identify the appropriate factor based on the application of the methodological tool (Application A or Application B) and the climate where the SWDS is located **Table 5. Default values for the model correction factor**

Type of application	Humid/wet conditions	Dry conditions
Application A	0.75	0.75
Application B	0.85	0.80

Source of data	☐ Measured ☒ Other sources
Choice of data or measurement methods and procedures	-
Additional comments	Table 5 above is applicable to Option 1 in section "5.3.1. Determining the model correction factor (φ_y)"

Data / Parameter table 2.

Data/parameter	OX_y
Description	Fraction of methane in the LFG that is oxidized in the soil or other material covering the waste in the SWDS
Data unit	-
Equations referred	(1), (2)
Purpose of data	☒ Baseline emissions ☒ Project emissions ☒ Leakage emissions
Value(s) applied	Use the default values based on the type of baseline SWDS, the age of SWDS cell and the type of cover provided in the table below:

Table 6. Default factors for OX_y based on the type of SWDS, the age of the SWDS cell and the type of cover

Type of SWDS	Age of the SWDS cell	Type of cover material	OX_y *(mean)*	*Uncertainty*
Existing SWDS	Immature and mature	No cover (LDCs/SIDS)	0	N/A
		No cover (non-LDCs/SIDS)	0.1	
		Synthetic	0.1	
		Soil	0.383	± 8%
	Aged	Soil	0.383	± 8%
Hypothetical SWDS	N/A	Synthetic	0.1	
		Soil	0.383	± 8%

Source of data	☐ Measured ☒ Other sources
Choice of data or measurement methods and procedures	- Volume 5, Chapter 3 of the IPCC (2019 Refinement) proposes a value of 0 for SWDSs without cover. The default value of 0 is proposed for existing SWDSs in LDCs/SIDS with no cover, taking into account the circumstances of LDCs/SIDS, since negligible amounts of CH_4 may be oxidized in such cases;

	- The default value of 0.1 is proposed for existing SWDSs with immature and/or mature waste cells located in non-LDCs/SIDS with no cover, as a conservative assumption, since negligible amounts of CH_4 may be oxidized without cover; - The default value of 0.1 is proposed for SWDSs with synthetic cover as a conservative assumption; - The default value of 0.384 is proposed for existing SWDSs with immature, mature and/or aged cells located in non-LDCs/SIDS with soil cover. This value is calculated from the statistics provided in table 3 of SWICS (2012) for flux below 10 g_{CH4}/m^2d (low-flux), rounded up to the third decimal place. The associated uncertainty is ± 8 per cent; - If it is not possible to determine the age of the cell, use the most conservative default value.
Treatment of uncertainties	Refer to the values provided in row “Value(s) applied”
Additional comments	Default values are only applicable if the parameter is determined through Option 3 of section “5.3.2. Determining the oxidation factor (OX_y)”,

Data / Parameter table 3.

Data/parameter	F
Description	Fraction of methane in the SWDS gas (volume fraction)
Data unit	-
Equations referred	(1), (2), (10), (11), (12)
Purpose of data	☒ Baseline emissions ☒ Project emissions ☒ Leakage emissions
Value(s) applied	50% (uncertainty of +/- 5%)
Source of data	☐ Measured ☒ Other sources
Choice of data or measurement methods and procedures	Volume 5, Chapter 3 of the IPCC (2019 Refinement)
Treatment of uncertainties	Refer to the values provided in row “Value(s) applied”
Additional comments	Upon biodegradation, organic material is converted to a mixture of methane and carbon dioxide

Data / Parameter table 4.

Data/parameter	$DOC_{f,j}$
Description	Fraction of degradable organic carbon (DOC) for each waste type j that decomposes under the specific conditions occurring in the SWDS
Data unit	-
Equations referred	(1), (2), (10), (11), (12)
Purpose of data	☒ Baseline emissions ☒ Project emissions ☒ Leakage emissions

<table>
<tr><td>Value(s) applied</td><td>Select the applicable value from the table below:

Table 7. Default values and uncertainties for DOC_{f,j}
<table>
<tr><th>Waste type j</th><th>Value for DOC_{f,j}</th><th>Uncertainty</th></tr>
<tr><td>Less decomposable wastes
(e.g. wood, engineered wood products, tree branches)</td><td>0.1</td><td>+/- 90%</td></tr>
<tr><td>Moderately decomposable wastes
(e.g. paper, textile, nappies)</td><td>0.5</td><td>+/- 70%</td></tr>
<tr><td>Highly decomposable wastes
(e.g. food wastes, grasses, garden and park waste excluding tree branches)</td><td>0.7</td><td>+/- 30%</td></tr>
<tr><td>Bulk waste
(It is used when the fractions of less, moderately and highly decomposable wastes in MSW are not known)</td><td>0.5</td><td>+/- 70%</td></tr>
</table>
</td></tr>
<tr><td>Source of data</td><td>☐ Measured ☒ Other sources</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>Volume 5, Chapter 2 of the IPCC (2019 Refinement)</td></tr>
<tr><td>Treatment of uncertainties</td><td>Refer to the values provided in row “Value(s) applied”</td></tr>
<tr><td>Additional comments</td><td>-</td></tr>
</table>

Data / Parameter table 5.

Data/parameter	MCF_y
Description	Methane correction factor
Data unit	-
Equations referred	(1), (2), (12)
Purpose of data	☒ Baseline emissions ☒ Project emissions ☒ Leakage emissions

Value(s) applied	Select the applicable value from the table below. The uncertainties are provided below the default values:

Table 8. Default values and uncertainties for MCF_y

Type of SWDS	Value of MCF_y
Anaerobic managed solid waste disposal sites These must have controlled placement of waste (i.e. waste directed to specific deposition areas, no scavenging activities reported and a limited number of incidents of fires through the year) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) levelling of the waste	1.0 (-10%, +0%)
Managed poorly – semi-aerobic A semi-aerobic managed SWDS type is regarded as poorly managed if one of the following conditions apply: (i) condition of sunk of leachate drainage system; (ii) closing of valve of drainage or atmosphere-unopening of drainage exit; (iii) capping of gas ventilation exits.	0.8 (+/- 20%)
Managed poorly – active-aeration A SWDS equipped with active aeration is poorly managed if one of the following condition apply: (i) blockage of aeration system due to failure of drainage; (ii) lack of available moisture for microorganisms due to high- pressure aeration	0.7 (+/- 30%)
Managed well – semi-aerobic A semi-aerobic managed SWDS is regarded as well managed if one of the following conditions apply: (i) permeable cover material; (ii) leachate drainage system without sunk; (iii) regulating pondage; and (iv) gas ventilation system without cap, (v) connection of leachate drainage system and gas ventilation system.	0.5 (+/- 20%)
Unmanaged – shallow (< 5m waste), or stockpiles that are considered SWDS All SWDS not meeting the criteria of managed SWDS and with depths of less than 5 metres. This includes stockpiles of solid waste that are considered SWDS (according to the definition given for a SWDS)	0.4 (+/- 30%)
Managed well – active aeration Active aeration of managed landfills includes technologies such as in-situ low pressure aeration, air sparging, bioventing, and passive ventilation with extraction (suction). These must have controlled placement of waste and a leachate drainage system to avoid blockage of air penetration, and include at least one of the following: (i) cover material; (ii) air injection or gas extraction system without drying of waste.	0.4 (+/- 60%)

	Uncategorised SWDS This category may only be used if countries cannot categorise their SWDS into the above managed or unmanaged SWDS categories. — 0.6 (-50%, +60%)
Source of data	☐ Measured ☒ Other sources
Choice of data or measurement methods and procedures	Volume 5, Chapter 2 of the IPCC (2019 Refinement)
Treatment of uncertainties	Refer to the values provided between brackets in row "Value(s) applied"
Additional comments	-

Data / Parameter table 6.

Data/parameter	DOC_j
Description	Fraction of degradable organic carbon in waste type *j* (weight fraction)
Data unit	-
Equations referred	(1), (2), (10), (11), (12)
Purpose of data	☒ Baseline emissions ☒ Project emissions ☒ Leakage emissions
Value(s) applied	For MSW, the following values for DOC_j for the different waste types *j* shall be applied. The uncertainties are provided below the default values: (see Table 9)

Table 9. Default values and uncertainties for DOC_j

Waste type *j*	DOC_j (% wet waste)
Wood and wood products	43 (-16%, +7%)
Pulp, paper and cardboard (other than sludge)	40 (-10%, +13%)
Food, food waste, beverages and tobacco (other than sludge)	15 (-47%, +33%)
Textiles	24 (-17%, +67%)
Garden, yard and park waste	20 (+/- 10%)
Glass, plastic, metal, and other inert waste	0

<table>
<tr><td></td><td>
<table><tr><td>Bulk waste</td><td>15</td></tr></table>
For the following residual waste types, activity participants may use or derive default values, as follows:
(a) For empty fruit brunches (EFB), as their characteristics are similar to garden waste, the value for garden, yard and park waste in the table above may be used as a default
(b) For industrial sludge, either a value of 9 per cent (% wet sludge) may be used as a default, assuming an organic dry matter content of 35 percent, or alternatively, if the percentage of organic dry matter content is known, then the DOC value may be calculated as follows: DOC_j (% wet sludge) = 9 x (% organic dry matter content/35);
(c) For domestic sludge, either a value of 5 per cent (% wet sludge) may be used as a default, assuming an organic dry matter content of 10 per cent, or alternatively, if the percentage of organic dry matter content is known, then the DOC value may be calculated as follows: DOC_j (% wet sludge) = 5 x (% organic dry matter content/10).
If a waste type is not comparable to MSW and cannot clearly be described as a combination of waste types in the table above or if a default value is not available or if the activity participants wish to measure DOC_j, then activity participants should measure DOC_j in an ignition loss test according to the procedure in EN 15169:2007, or a similar national or international standard. This measurement is required only once for each waste type j and the value determined for DOC_j remains valid during the crediting period.
If an Article 6.4 activity applies Application A and data to determine the different waste types do not exist or is limited but information is available on bulk waste disposed, activity participants may consider “bulk waste” as the single type of waste deposited in the SWDS and apply the respective default factor.
</td></tr>
<tr><td>Source of data</td><td>☐ Measured ☒ Other sources</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>Adapted from Tables 2.4 and 2.5 of Volume 5, Chapter 2 of the IPCC (2006)</td></tr>
<tr><td>Treatment of uncertainties</td><td>Refer to the values between brackets provided in row “Value(s) applied”</td></tr>
<tr><td>Additional comments</td><td>-</td></tr>
</table>

Data / Parameter table 7.

Data/parameter	k_j
Description	Decay rate for the waste type *j*
Data unit	1/year
Equations referred	(1), (2)
Purpose of data	☒ Baseline emissions ☒ Project emissions ☒ Leakage emissions

Value(s) applied

Apply the following default values for the different waste types *j*. The uncertainties are provided below the default values.

Table 10. Default values and uncertainties for k_j

Waste type *j*		**Boreal and Temperate (MAT≤20°C)**		**Tropical (MAT>20°C)**	
		Dry (MAP/PET <1)	Wet (MAP/PET >1)	Dry (MAP< 1000mm)	Wet (MAP> 1000mm)
Slowly degrading	Pulp, paper, cardboard (other than sludge), textiles	0.04 (+/- 25%)	0.06 (+/- 17%)	0.045 (- 11%, +33%)	0.07 (- 14%, +21%)
	Wood, wood products and straw	0.02 (+/- 50%)	0.03 (+/- 33%)	0.025 (- 20%, +60%)	0.035 (- 14%, +43%)
Moderately degrading	Other (non-food) organic putrescible garden and park waste	0.05 (+/- 50%)	0.10 (- 40%, +0%)	0.065 (+/- 23%)	0.17 (- 12%, +18%)
Rapidly degrading	Food, food waste, sewage sludge, beverages and tobacco	0.06 (- 17%, +33%)	0.185 (- 46%, +8%)	0.085 (+/- 18%)	0.40 (- 58%, +75%)
Bulk waste		0.05 (+/- 20%)	0.09 (+/- 11%)	0.065 (+/- 23%)	0.17 (- 12%, +18%)

<u>Note</u>: MAT = mean annual temperature; MAP = Mean annual precipitation; PET = potential evapotranspiration. MAP/PET is the ratio between mean annual precipitation and potential evapotranspiration.

If a waste type disposed of in a SWDS cannot clearly be attributed to one of the waste types in the table above, activity participants should choose, among the waste types with 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 mechanism methodology.

	In the case of empty fruit branches (EFB), as their characteristics are similar to garden waste, the parameter values corresponding to 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. If an Article 6.4 activity applies Application A and data to determine the different waste types do not exist or is limited but information is available on bulk waste disposed, activity participants may consider "bulk waste" as the single type of waste deposited in the SWDS and apply the respective default factors.
Source of data	☐ Measured ☒ Other sources
Choice of data or measurement methods and procedures	Adapted from Table 3.3 of Volume 5, Chapter 3 of the IPCC (2019 Refinement).
Treatment of uncertainties	Refer to the values between brackets provided in row "Value(s) applied"
Additional comments	Document in the 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 table 8.

Data/parameter	$\boldsymbol{BMP_{MSW}}$; $\boldsymbol{BMP_j}$
Description	Biochemical methane potential (BMP) of MSW or of residual waste type *j* disposed of, or prevented from disposal
Data unit	t_{CH4}/t_{waste}
Equations referred	(10), (11), (12)
Purpose of data	☒ Baseline emissions ☒ Project emissions ☒ Leakage emissions
Value(s) applied	
Source of data	☒ Measured ☐ Other sources
Choice of data or measurement methods and procedures	Based on samples. Conduct a fermentation test on a sample of the MSW or the residual waste of 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 accommodate a sample size of 500 g or more. The duration of the fermentation test should continue until no further methane is generated, indicating the complete conversion of BMP to methane). Take the average of at least three test results. At least three samples should be taken from different batches. Once calculated, the value determined remains valid during the crediting period.
Additional comments	The BMP is the basis for estimating $DOC_{f,j,y}$ and $DOC_{f,j,m}$ 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 $DOC_{f,j,y}$ and $DOC_{f,j,m}$ may be used instead of measurement of the BMP

Data / Parameter table 9.

Data/parameter	GWP_{CH4}
Description	Global warming potential of CH_4
Data unit	tCO_2e/tCH_4
Equations referred	(1), (2)
Purpose of data	☒ Baseline emissions ☒ Project emissions ☒ Leakage emissions
Value(s) applied	28
Source of data	☐ Measured ☒ Other sources
Choice of data or measurement methods and procedures	Default value from the IPCC Fifth Assessment Report (AR5). This value shall be updated in accordance with any future CMA decisions.
Additional comments	-

6. Monitoring methodology

57. Monitoring consists of an annual assessment of the conditions at the SWDS where the waste is disposed of, or prevented from disposal.

6.1. Data and parameters monitored

Data / Parameter table 10.

Data/parameter	f_y	
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*	
Data unit	-	
Equations referred	(1), (2)	
Purpose of data	☒ Baseline emissions ☒ Project emissions ☒ Leakage emissions	
Measurement intervals	For Application A: Once for the crediting period ($f_y = f$) For Application B: Annually	
Measurement methods and procedures	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	
Entity/person responsible for the measurement	-	
Measuring instrument(s)	*Type of instrument*	N/A
	Accuracy class	N/A

	Calibration requirements	N/A
	Location	N/A
QA/QC procedures	-	
Additional comment	-	

Data / Parameter table 11.

Data/parameter	$J_{out,i}$	
Description	Flux of methane leaving the surface of zone *i* of the SWDS	
Data unit	$g_{CH4}/m^2.d$	
Equations referred	(5)	
Purpose of data	☒ Baseline emissions ☐ Project emissions ☐ Leakage emissions	
Measurement methods and procedures	Apply guidance from Appendix 1	
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	Flux box (designed as per Appendix 1)
	Accuracy class	N/A
	Calibration requirements	N/A
	Location	N/A
Measurement intervals	- Annual measurements if OX_y is determined based on Option 1. - Measured once prior to the start date of the crediting period if OX_y is determined based on Option 2.	
QA/QC procedures	As per Appendix 1	
Treatment of uncertainty	Uncertainty values for OX_y from “Data / Parameters table 1” are used based on the measured values of J_{out}	
Additional comment	-	

Data / Parameter table 12.

Data/parameter	W_x or W_i
Description	Total amount of waste disposed of in a SWDS in year *x* or month *i*
Data unit	-
Equations referred	(6), (7)
Purpose of data	☒ Baseline emissions ☒ Project emissions ☒ Leakage emissions
Measurement intervals	Continuously, aggregated at least annually for year *x* or monthly for month *i*

Measurement methods and procedures	Measure on a wet basis	
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	N/A
	Accuracy class	N/A
	Calibration requirements	N/A
	Location	N/A
QA/QC procedures	-	
Treatment of uncertainties	Uncertainties are determined based on the measuring instruments	
Additional comment	For Application B	

Data / Parameter table 13.

Data/parameter	$W_{org,x}$	
Description	Total amount of organic waste disposed of in a SWDS in year *x*	
Data unit	tonnes	
Equations referred	(3) of Appendix 2	
Purpose of data	☒ Baseline emissions ☒ Project emissions ☒ Leakage emissions	
Measurement intervals	Continuously, aggregated at least annually for year *x* or monthly for month *i*	
Measurement methods and procedures	Measure on a wet basis	
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	N/A
	Accuracy class	N/A
	Calibration requirements	N/A
	Location	N/A
QA/QC procedures	-	
Treatment of uncertainties	Uncertainties are determined based on the measuring instruments	

Additional comment	Applicable when applying the simplified approach “Reduced waste composition monitoring” as described in the Appendix 2

Data / Parameter table 14.

Data/parameter	$p_{n,j,x}$; $p_{n,j,i}$	
Description	Weight fraction of waste type *j* in the sample *n* collected during the year *x* or month *i*	
Data unit	%	
Equations referred	(8), (9)	
Purpose of data	☒ Baseline emissions ☒ Project emissions ☒ Leakage emissions	
Measurement intervals	A minimum of three samples every three months	
Measurement methods and procedures	Sample the waste composition, using the waste types *j*, as provided in the Table 9 (for DOC_j) and Table 10 (for k_j), and weigh each waste fraction (measure on wet basis)	
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	N/A
	Accuracy class	N/A
	Calibration requirements	N/A
	Location	N/A
QA/QC procedures	-	
Treatment of uncertainties	N/A	
Additional 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	

Data / Parameter table 15.

Data/parameter	z_x
Description	Number of samples collected during the year *x*
Data unit	%
Equations referred	(8)
Purpose of data	☒ Baseline emissions ☒ Project emissions ☒ Leakage emissions
Measurement intervals	Continuously, aggregated annually

Measurement methods and procedures	A minimum of three samples every three months	
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	N/A
	Accuracy class	N/A
	Calibration requirements	N/A
	Location	N/A
QA/QC procedures	The sample size and sampling technique must ensure the sample is representative.	
Treatment of uncertainties	N/A	
Additional comment	This parameter only needs to be monitored for Application B and if the waste includes more than one waste type *j*	

Data / Parameter table 16.

Data/parameter	d_y	
Description	Depth of the SWDS	
Data unit	m	
Equations referred	(13)	
Purpose of data	☒ Baseline emissions ☒ Project emissions ☒ Leakage emissions	
Measurement intervals	Measured at the monitoring well that is also used to measure the height of the water table ($h_{w,y}$)	
Measurement methods and procedures	A minimum of three samples every three months	
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	N/A
	Accuracy class	N/A
	Calibration requirements	N/A
	Location	N/A
QA/QC procedures	Monthly, average annual values are to be used in the case of application of the yearly model (Equation (1))	

Treatment of uncertainties	N/A
Additional comment	This parameter shall be monitored to identify whether the SWDS has a water table above the bottom of the SWDS, (for example, when waste is used to fill inland water bodies, such as ponds, rivers or wetlands). If the SWDS does have a water table above the bottom, then this parameter is used to determine the MCF

Data / Parameter table 17.

Data/parameter	$h_{w,y}$	
Description	Height of the water table in the SWDS	
Data unit	m	
Equations referred	(13)	
Purpose of data	☒ Baseline emissions ☒ Project emissions ☒ Leakage emissions	
Measurement intervals	Monthly, average annual values are to be used in the case of application of the yearly model (Equation (1))	
Measurement methods and procedures	Monitoring well	
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	N/A
	Accuracy class	N/A
	Calibration requirements	N/A
	Location	N/A
QA/QC procedures	-	
Treatment of uncertainties	N/A	
Additional comment	This parameter shall be monitored to identify whether the SWDS has a water table above the bottom of the SWDS (for example, when waste is used 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 table 18.

Data/parameter	a, b, c, d, e, f, g
Description	Effect of the uncertainty of different parameters
Data unit	%

Equations referred	(3)	
Purpose of data	☒ Baseline emissions ☒ Project emissions ☒ Leakage emissions	
Measurement intervals	Annually if the conditions described in the “Instructions for selecting the factor” in Table 3 have changed (for example, a change in how the weight of the waste is measured). Once for the crediting period, if these conditions do not change	
Measurement methods and procedures	Using the instructions in Table 3 above	
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	N/A
	Accuracy class	N/A
	Calibration requirements	N/A
	Location	N/A
QA/QC procedures	-	
Additional comment	Used in Option 2 (section “5.3.1.2. Option 2: Determine φ_y based on specific situation of the Article 6.4 activity”) for determining the model correction factor	

Appendix 1. Measurements of methane flux leaving the surface of the landfill using flux box technique

1. General concept of the flux box method

1. The method elaboratd in this appendix is proposed based on the UK Environment Agency Guideline "*Guidance on monitoring landfill gas surface emissions*, (LFTGN07 v2)". Although the LFTGN07 v2 is intended for accurately estimating the baseline emissions from the entire SWDS's surface, selecting the most appropriate OX value requires a conservative estimation of the average flux from each zone of a SWDS using a passive flux box that consists of an enclosure of known volume, with two ports fitted to the top, where the inlet port is used for pressure equilibration and the outlet port for removing samples. The subsections below discusses the step-by-step guidance on designing a flux box survey in the LFTGN07 v2 and the adjustment that may be needed for the purpose of OX selection.[1]

2. Preparatory work

2. The LFTGN07 v2 recommends that a desk study be conducted based on the history of waste received, installation of the top cover and operation of the gas collection system in order to help identifying potential anomalies in the SWDS surface, to form some expectations about the flux and to help to identifying the most suitable timing for conducting the measurements.

3. The study referred above should be followed by a "walk-over" in which the SWDS is screened for hotspots using a handheld instrument to ensure that each zone is relatively homogeneous and to delineate any areas of high emissions ("features").

3. Survey design

4. The aim of the survey design should be to provide a representative estimate of the flux in each zone that would allow a conservative choice of OX, taking into consideration the spatial and temporal variability of flux.

5. Based on the findings during the desk study and walk-over exercises referred above, the SWDS should be divided into zones of homogenous flux. Once the zones are defined, for each zone, the number and locations of measurement points (sample number) must be determined. To decide an appropriate timing for conducting the measurements, the LFG collection maintenance schedule (if it exists prior to the project) and meteorological information should be consulted in order to determine the month of the year which represents the average conditions of the year. Details of each step are described below.

3.1. Zoning

6. The SWDS should be divided into zones, depending on the expected emissions, so as to capture any variability among zones and to ensure homogeneity within each zone.

[1] Detailed instructions on how to construct the flux box and conduct the measurements are contained in Appendix A of the LFTGN07v2.

7. Based on the desk study and walk-over exercises, the LFTGN07 v2 recommends the SWDS to be divided into closed and operational zones and features, both of which should be annotated on the site plan. More zones may be considered if different cover materials or thickness are used across the SWDS.

8. Features are areas from which emissions are higher (hotspots) and need to be delineated from the zone within which they exist for exclusion from the measurements. Features could arise from imperfection (e.g., cracks), installation (e.g. wells) or topography (e.g., slopes). For the purpose of flux box measurements, areas with daily cover, as opposed to intermediate cover, may be considered as feature, since emissions through such covers are typically high.

9. At minimum, SWDS should be divided into zones by cells since the flux is known to vary depending on the age of the waste. The cell may be further divided into smaller zones to ensure that each zone is homogenous in terms of surface methane emissions, for example, depending on the cover properties (materials, soil thickness, vegetation). This may include careful inspection of the surface during walkover, as well as history of the waste received.

10. Features must be correctly identified and excluded from zones as they are likely to have significantly higher flux than the rest. In addition, features typically have small areas and are situated in such a way that makes measurements difficult. Considering the cost implications and technical challenges, and more importantly, for the conservativeness of the resulting OX, features shall be excluded from the measurements.

3.2. Sample size and location

11. Number of measurements per zone *(n)* recommended by the LFTGN07 v2, is based solely on the area of the zone, $Area_i$ *(m^2)* and it is calculated as follows:

$$n = 6 + 0.15 \times \sqrt{Area_i}$$ Equation (1)

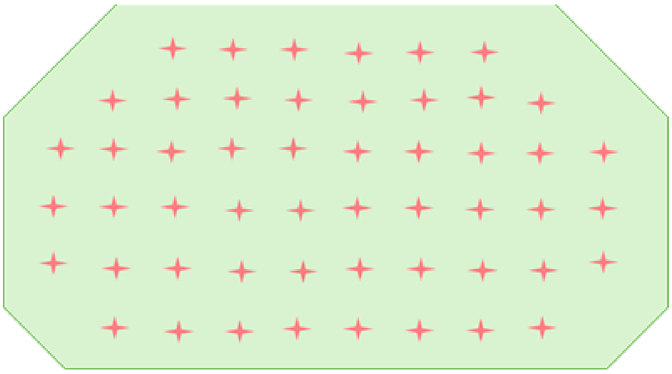
12. The table below lists examples of the number of locations necessary and approximate spacing between the measurement locations.

Table 11. Number of sample points and average spacing between them recommended by the Environment Agency (source: Table 5.2 of the LFTGN 07 v2)

Zone size (m^2)	Number of locations	Average spacing (approx.)
5,000	16	18 metres
10,000	21	22 metres
100,000	53	43 metres
1,000,000	156	80 metres

13. Assuming that each zone is homogenous with respect to the surface emissions, sampling points can be distributed evenly throughout the zone, but avoiding the edges of the zone, as illustrated in the figure below.

Figure 1. Illustration of distribution of sampling location in a zone



3.3. Timing of measurement

14. In order to ensure that the flux measured is representative, temporal variability must be taken into consideration, both seasonal (during a month that represents an average climate of the area, in terms of temperature and humidity) and diurnal (during late morning, avoiding between 12:00 pm and 6:00 pm during which emissions vary typically the highest).

15. In addition, measurements during any anomaly in the meteorological or ground conditions, or the operation of the gas collection system must be avoided. Based on the guidance in the LFTGN07 v2 and Environmental Protection Agency of Ireland (2011), the following may be considered:

    (a) Measurements be taken during normal operation of the gas collection system; maintenance, or any malfunctioning should be avoided.

    (b) Meteorological conditions:

        (i) Avoid periods of extremely high or low ambient pressure, or of rapid change, as low pressure is typically associated with higher flux and strong wind can interfere with the measurements.

        (ii) Avoid periods during or immediately after heavy rain (see also ground conditions).

        (iii) Avoid irregular ground conditions that impede or alter the courses of flux be avoided, including water-logged ground, and frost or ice-covered ground.

    (c) Measurement should be avoided if high ambient concentration of flammable substances is detected, as it can affect the sensitivity of the gas analyser.

16. The date and time of the measurements, as well as the ambient temperature, atmospheric pressure, relative humidity, and any other notable information related to the ambient (e.g., wind speed) and ground condition (e.g., puddles, frost), should be recorded for verification.

3.4. Number of measurements per location

17. The following options could be considered to ensure that the flux of each measurement location is representative:

    (a) At least 3 measurements per location, at least 30 minutes in between, within a period of one week; or

    (b) At least 3 measurements per location, except for immature SWDSs cells, for which at least 6 measurements should be taken per location, at least 30 minutes in between, within a period of one week; or

    (c) The number of measurements per each sampling location should be such that the estimated mean flux fits within either 10% or 20% of the true mean with 95% confidence.

3.5. Frequency of measurements

18. The methodology allows activity participants to choose between the monitoring once before the start of the crediting period and every year, based on the applicable Option.

4. Estimating the average flux of each zone

19. Assuming that each zone is homogenous with respect to flux, and the sampling points are distributed evenly, the average flux of each zone may be calculated as a simple arithmetic mean of all measurement points within the zone.

20. The duration of each measurement depends on the size of the box and the flux and should not extend beyond a point at which the concentration change starts slowing down.[2] Appendix C of the LFTGN07 v2 may be followed for the calculation methods and Appendix D for ways to minimise uncertainties.

21. Flux for each measurement is calculated as follows:

$$J_{out} = \frac{V \times {}^{dc}/_{dt}}{A} \times \frac{86{,}400}{1{,}000}$$ Equation (2)

Where:

	=	Flux of methane leaving the surface ($g_{CH4}/m^2.d$)
V	=	Internal volume of the box (m^3)
	=	Rate of change in the concentration of methane in the box ($mg_{CH4}/m^3.s$)
A	=	Surface area of the SWDS covered by the box (m^2)
$86{,}400$	=	Number of seconds in a year (s/d)
$1{,}000$	=	Number of milligrams in a gram (mg/g)

[2] The concentration measurements in the first few minutes may be unstable and after a certain period of time, as the concentration in the box becomes high, the rate starts to slow down, typically before 30 minutes, depending on the volume of the box.

22. The LFTGN07 v2 recommends the rate of change of the gas concentration *(dc/dt)* to be determined as follows:

(a) Plot the concentration (mg/m^3) measurements against time (in seconds).

(b) Remove individual data points from the ends[2]: first from the last datum collected and then the initial one, alternatingly until a correlation coefficient (R^2) is at least 0.8.

(c) Provided that the three criteria below are satisfied, *dc/dt* is the slope of the line correlation.

(i) $R^2 > 0.8$;

(ii) The plot has more than five data points remaining; and

(iii) The change in the concentration is greater than zero.

(d) If no change in concentration is detected, use the lower detection limit of the equipment.

Appendix 2. Simplified approaches

1. For projects of Application B type, as defined in Section 2.2 of this methodological tool, and which involve solely MSW, activity participants may use a simplified approach for the determination of methane baseline emissions. Two such approaches are available:

    (a) No waste composition monitoring;

    (b) Reduced waste composition monitoring.

1. No waste composition monitoring

2. In this approach, part of Equation (1) which corresponds to the property of waste and climate zone is replaced by default values, relieving activity participants of the task of analysing the composition of waste. The term which may be replaced[1] has the unit of tCO_2/tonne dry waste and is:

$$(1 - OX_y) \times \frac{16}{12} \times F \times \sum_{x=1}^{y} \sum_{j} DOC_j \times DOC_{f,j,y} \times e^{-k_j \times (y-x)} \times (1 - e^{-k_j})$$

Equation (1)

3. Equation (1) is therefore simplified with only W_x as a monitoring parameter:

$$BE_{CH4,SWDS,y} = \varphi_y \times (1 - f_y) \times GWP_{CH4} \times \sum_{x=1}^{y} Default_x \times W_x$$

Equation (2)

4. The value of $Default_x$ depends on the climate zone and on year x since the disposal of the waste. The default values have been derived from an analysis of registered projects with verified waste compositions, and they are selected to ensure conservativeness of the resulting baseline emissions (using 95 per cent confidence and 10 per cent precision).

Table 1. *$Default_x$* values for simplified procedure

x	Tropical wet	Tropical dry	Boreal/ temperate wet	Boreal/temperate dry
1	0.005800	0.001856	0.003382	0.001399
2	0.004212	0.001724	0.002913	0.001325
3	0.003093	0.001601	0.002511	0.001254
4	0.002275	0.001487	0.002163	0.001188
5	0.001657	0.001381	0.001861	0.001125
6	0.001198	0.001281	0.001599	0.001065
7	0.000867	0.001189	0.001371	0.001008
8	0.000635	0.001103	0.001174	0.000954

[1] The following assumed values were used in the calculation: OX = 0.1; F = 0.5; $DOC_{f,j,y}$ = 0.5; MCF = 1.

x	Tropical wet	Tropical dry	Boreal/ temperate wet	Boreal/temperate dry
9	0.000474	0.001024	0.001004	0.000904
10	0.000362	0.000950	0.000859	0.000855
11	0.000284	0.000881	0.000734	0.000810
12	0.000228	0.000817	0.000629	0.000766
13	0.000189	0.000757	0.000539	0.000725
14	0.000160	0.000702	0.000463	0.000687
15	0.000138	0.000651	0.000399	0.000650
16	0.000122	0.000603	0.000344	0.000615
17	0.000109	0.000559	0.000298	0.000582
18	0.000098	0.000518	0.000259	0.000551
19	0.000090	0.000480	0.000226	0.000521
20	0.000082	0.000445	0.000197	0.000493
21	0.000076	0.000413	0.000173	0.000467

2. Reduced waste composition monitoring

5. In this approach, instead of monitoring the composition of the waste in accordance with the waste types *j*, projects may monitor the total wet weight fraction of organic waste ($W_{org,y}$). Organic waste includes wood, paper, food waste, textiles and garden waste. As in the first approach, the term in Equation 13 of the appendix is replaced.

6. Equation (1) is therefore simplified:

$$BE_{CH4,SWDS,y} = \varphi_y \times \left(1 - f_y\right) \times GWP_{CH4} \times \sum_{x=1}^{y} Default_{org,x} \times W_{org,x}$$ Equation (3)

7. The value of $\text{Default}_{org,x}$ depends on the climate zone. These values were derived from an analysis of registered projects with verified waste compositions, and they are selected to ensure conservativeness of the resulting baseline emissions (using 95% confidence and 10% precision).

Table 2. $Default_{org,x}$ values for simplified procedure

x	Tropical wet	Tropical dry	Boreal/ temperate wet	Boreal/temperate dry
1	0.008263	0.002715	0.004905	0.002000
2	0.006066	0.002516	0.004254	0.001891
3	0.004527	0.002330	0.003686	0.001788
4	0.003324	0.002156	0.003177	0.001691
5	0.002348	0.001995	0.002714	0.001599
6	0.001657	0.001845	0.002305	0.001511
7	0.001185	0.001706	0.001953	0.001429
8	0.000862	0.001577	0.001654	0.001351

x	Tropical wet	Tropical dry	Boreal/ temperate wet	Boreal/temperate dry
9	0.000641	0.001458	0.001402	0.001277
10	0.000489	0.001347	0.001191	0.001207
11	0.000384	0.001246	0.001013	0.001141
12	0.000309	0.001152	0.000864	0.001079
13	0.000256	0.001065	0.000738	0.001020
14	0.000218	0.000985	0.000633	0.000964
15	0.000189	0.000911	0.000544	0.000911
16	0.000167	0.000842	0.000470	0.000862
17	0.000150	0.000779	0.000406	0.000815
18	0.000136	0.000721	0.000353	0.000770
19	0.000124	0.000668	0.000308	0.000728
20	0.000114	0.000618	0.000269	0.000689
21	0.000105	0.000572	0.000237	0.000651

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Document information

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