Federal Offset Protocol: Landfill Methane Recovery and Destruction

Version 2.0
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Canada's Greenhouse Gas Offset Credit System

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Canada

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Foreword

Canada's Greenhouse Gas (GHG) Offset Credit System is established under Part 2 of the *Greenhouse Gas Pollution Pricing Act* to provide an incentive to implement projects that result in domestic GHG reductions that would not have been generated in the absence of the project, that go beyond legal requirements and that are not subject to carbon pollution pricing mechanisms.

Canada's GHG Offset Credit System consists of:

- The *Canadian Greenhouse Gas Offset Credit System Regulations* (the Regulations), which establish the system, implement operational aspects and set general requirements applicable to all project types
- Federal offset protocols, included in the *Compendium of Federal Offset Protocols* (the Compendium), each containing requirements for project implementation and methods for quantifying GHG reductions for a given project type, and
- The Credit and Tracking System (CATS) to register offset projects, issue and track offset credits, and share key information through Canada's GHG Offset Credit System Public Registry

Only projects following a federal offset protocol included in the Compendium and meeting all requirements outlined in the Regulations can generate GHG reductions for which federal offset credits may be issued under the Regulations.

Document revision history

Version number	Publication date	Summary of changes
2.0	September 9, 2026	The displacement of fossil fuels by eligible landfill gas actively recovered by the project to generate supplemental GHG emission reductions was included in the protocol (Sections 4.3, 8.1.2 and 10.4). Some elements were added in the reporting (Section 11.0). Some provisions were clarified or streamlined consistent with the original intent.
1.1	February 24, 2023	The approach for the destruction efficiency values for destruction devices was modified regarding the use of either default values or device-specific values (Section 8.2). Eligibility is no longer restricted to landfills designed and constructed by landfill cells but is now inclusive of landfills not designed and constructed by landfill cells (Section 4.1). Some provisions were clarified or streamlined consistent with the original intent.
1.0	June 8, 2022	Initial version of the protocol.

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1.0 Introduction

Methane emissions from landfills are generated by the anaerobic decomposition of organic material in the buried waste. The installation of a landfill gas (LFG) recovery system and an eligible destruction device enables the landfill methane to be converted into biogenic carbon dioxide, instead of allowing it to be passively released to the atmosphere.

The *Landfill Methane Recovery and Destruction* federal offset protocol is intended for use by a proponent implementing a project that actively recovers LFG and combusts it in an eligible destruction device to generate greenhouse gas (GHG) emission reductions for which federal offset credits may be issued under the *Canadian Greenhouse Gas Offset Credit System Regulations* (the Regulations). Eligible destruction devices are open and enclosed flares, boilers, turbines, internal combustion engines, stations for the direct injection of upgraded LFG into a natural gas network, and stations for the compression or liquefaction of upgraded LFG prior to its transport and injection into a natural gas network.

The proponent must follow the quantification methodology and requirements set out in this protocol, including those to quantify and report GHG emission reductions generated by eligible project activities. The requirements contained in this protocol are part of the Regulations and must be read in conjunction with provisions in the Regulations.

This protocol is designed to ensure a project generates GHG emission reductions that are real, additional, quantified, verified, unique and permanent. The protocol is also developed in accordance with the principles of ISO 14064-2:2019 *Greenhouse gases – Part 2 – Specification with guidance at the project level for quantification, monitoring and reporting greenhouse gas emission reductions or removal enhancements* to ensure reported GHG emission reductions generated as a result of implementing a project are relevant, complete, consistent, accurate, transparent, and conservative.

A project that uses actively recovered LFG instead of fossil fuels to produce energy may also generate GHG emission reductions from fossil fuel displacement (that is, fuel switching). However, when the GHG emission reductions are from sources that are subject to a federal or provincial pricing mechanism for GHG emissions, GHG emission reductions from fossil fuel displacement are not additional and are not eligible for federal offset credit issuance.

The proponent is also responsible for ensuring that any GHG emission reductions credited under Canada's GHG Offset Credit System are unique, that is, they are not credited under another offset program or another GHG reduction mechanism.

2.0 Terms and definitions

Act

means the *Greenhouse Gas Pollution Pricing Act*.

Active recovery

means the recovery of LFG by a system, which includes gas collection wells, connective piping, blowers, and other technologies, creating a pressure gradient to actively extract LFG.

This does not include passive venting.

Adjacent destruction facility

means a facility adjacent to the landfill site where LFG is combusted and landfill methane (CH_4) destroyed in an eligible destruction device.

Biogenic carbon dioxide (CO_2)

means CO_2 resulting from the decomposition or destruction of organic material, including those produced from the destruction of landfill CH_4.

Biogenic CO_2 is considered to be part of the natural carbon cycle.

Eligible destruction device

means a device, listed in Table 1, that combusts LFG, destroys landfill CH_4 and converts it into biogenic CO_2 to generate GHG emission reductions.

Global Warming Potential (GWP)

means a metric representing the ability of a GHG to trap heat in the atmosphere compared to CO_2, as set out in Schedule 3 to the Act.

Landfill

means an identifiable area of land where waste is or has been intentionally placed above or below ground for permanent disposal.

Landfill cell

means a unique and discrete section of a landfill designed and constructed to contain a volume of waste.

Landfill gas (LFG)

means a mixture of gases resulting from the decomposition of organic material disposed of in a landfill comprised primarily of landfill CH_4, biogenic CO_2, and other compounds in low concentrations.

Landfill methane (landfill CH_4)

means the CH_4 portion of LFG, generated by the anaerobic decomposition of organic material disposed of in a landfill.

Landfill site

means an identifiable area of land where a landfill and all supporting buildings and infrastructure are located.

Project site

means the area of the landfill site from which LFG is actively recovered and the area where it is combusted in the eligible destruction device(s) as part of the project, which may include portions of an adjacent destruction facility.

Regulations

means the *Canadian Greenhouse Gas Offset Credit System Regulations.*

3.0 Baseline scenario

3.1 Baseline condition

For a project to be eligible under this protocol, the following baseline condition must be met before the project start date:

- Within the project site, LFG has never been actively recovered

4.0 Project scenario

4.1 Project conditions

To be eligible under this protocol, a project must meet the following project conditions on and after the project start date.

- Within the project site, the LFG is actively recovered and combusted in one or more eligible destruction devices listed in Table 1
- For landfills that are designed and constructed by landfill cells, the project site consists of a minimum of one landfill cell
- For landfills that are not designed and constructed by landfill cells, the project site consists of a minimum of one clearly delineated discrete section of the landfill
- The active LFG recovery system is installed and operated on or after January 1, 2017

4.2 Eligible project activities and equipment

Eligible project activities include the:

- installation and operation of an active LFG recovery system within the project site
- treatment, purification and/or upgrading of LFG actively recovered from within the project site
- operation of eligible destruction device(s) for the combustion of LFG actively recovered from within the project site
    - only the destruction devices listed in Table 1 below are considered eligible under this protocol
    - the project must use a minimum of one eligible destruction device

  - eligible destruction devices can be installed for the purposes of the project, or can have been installed and operated prior to January 1, 2017
  - flares (open and enclosed) must be located within the landfill site
  - eligible destruction devices other than a flare may be located at an adjacent destruction facility

In cases where an eligible destruction device in a project is located at an adjacent destruction facility, the proponent must have an agreement with the owner of the adjacent destruction facility to ensure that:

- the proponent and verification body can access the eligible destruction device and related equipment and can obtain all data and information needed for ensuring compliance with requirements in the protocol
- requirements in subsection 4(3) and paragraphs 8(1)(b) and 8(1)(c) of the Regulations are met

Table 1: Eligible destruction devices

Type	Description
Open flare	A device with a pilot flame at the top of a vertical stack that is exposed to atmosphere that combusts a gas.
Enclosed flare	A device with an insulated cylinder stack surrounding a burner manifold and combustion/cooling air louvers that combusts a gas.
Boiler	A device that combusts a fuel in order to heat a fluid, such as water or leachate, generating vapour that provides thermal energy for various purposes.
Turbine (micro or large)	A device that compresses air to combust with a fuel in order to produce expanding gas that turns turbine blades, generating mechanical energy that can be harnessed by a load (for example, a generator producing electricity).
Internal combustion engine (stationary or mobile)	A device that compresses and combusts an air-fuel mixture in a cylinder in order to produce expanding gas that moves a piston and crankshaft, generating rotary mechanical energy that can be harnessed by a load (for example, a generator producing electricity).
Station for direct injection of upgraded LFG into a natural gas network[1]	A device that monitors and prepares upgraded LFG for injection into a natural gas network; this can include odourizing the gas, metering the flow, regulating the pressure, and monitoring the chemical composition prior to injection.
Station for compression or liquefaction of upgraded LFG prior to transport and injection into a natural gas network	A device that compresses or liquefies upgraded LFG for transport to a station for its injection into a natural gas network (see above).

[1] Upgraded LFG injected into a natural gas network is considered to be combusted once it is delivered to a station for direct injection or a station for compression or liquefaction.

4.3 Eligible LFG for displacement of fossil fuels

LFG actively recovered from within the project site and combusted in an eligible destruction device generating energy may displace fossil fuels. This LFG is eligible to generate GHG emission reductions from the displacement of fossil fuels under this protocol, provided the following conditions are met:

- The LFG is displacing fossil fuels combusted in equipment present and in operation at the project site, including any adjacent destruction facility, during the 3 years preceding the project start date
- The LFG is displacing fossil fuels that are not subject to a federal or provincial pricing mechanism for GHG emissions
- The LFG is not used to produce renewable natural gas (RNG) for injection into a natural gas network

5.0 Additionality

5.1 Legal additionality

GHG emission reductions generated by a project must not occur as a result of federal, provincial or territorial law (including regulations), municipal by-laws, or any other legally binding mandates such as operating permits. This includes legal requirements to recover and combust all or a portion of LFG from the landfill to reduce GHG emissions from the landfill or control of the release of LFG for reasons such as safety precautions (to reduce potential for an explosion) or odour control.

A project at a landfill site with a legal requirement to recover and combust any portion of its LFG is not considered to be additional and, therefore, is not eligible for registration.

If at any time after project registration the GHG emission reductions generated by the project become required by law or the result of a legal requirement, the GHG emission reductions will no longer be additional and, therefore, federal offset credits can only be issued for GHG emission reductions generated up to the date immediately preceding the date on which the law or the legal requirement comes into force.

5.2 Provincial or federal pricing mechanisms for GHG emissions

GHG emission reductions from sources that are subject to a federal or provincial pricing mechanism for GHG emissions are not eligible for federal offset credits. This includes on-site landfills at covered facilities under the federal Output-Based Pricing System.

6.0 General requirements

6.1 Project start date

The start date of a project corresponds to the first day that LFG actively recovered from within the project site is combusted in an eligible destruction device. In the case of the injection of upgraded LFG

into a natural gas network, the LFG is considered to be combusted once it is delivered to a station for direct injection or a station for compression or liquefaction.

6.2 Project site location and geographic boundaries

The proponent must document the location and geographic boundaries of the project site and prepare a site plan. The site plan must show:

- where the project site is situated with respect to the landfill site and any adjacent destruction facilities, including the delineation of relevant landfill cells or discrete landfill sections
- the location and arrangement of all the project components associated with LFG recovery and combustion, including the active recovery system within the project site; treatment, purification and upgrading equipment; eligible destruction devices; measuring devices; and any other equipment associated with the GHG sources, sinks and reservoirs (SSRs) within the project GHG boundary (Section 7.0)

The geographic boundary of the project site must be established as per the Regulations.

6.3 Environmental and social safeguards

The proponent must ensure that the project activities and the project site comply with any operating permits, municipal by-laws and regulations applicable to the landfill site, including those related to minimizing odour. The proponent must ensure the safe operation of all systems within the project site.

7.0 Project GHG boundary

The project GHG boundary (Figure 1) contains the SSRs that must be included or excluded by the proponent in the baseline and project scenarios to determine the GHG emission reductions generated by the project.

Table 2 provides additional details on the SSRs identified for the baseline and project scenarios, as well as justification for their inclusion or exclusion in the quantification of GHG emission reductions. The proponent must assess each of the “included” SSRs that are relevant to the baseline and project scenarios.

Three GHGs are relevant to the SSRs in this protocol: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Biogenic CO_2 is excluded from the quantification of GHG emission reductions under this protocol, that is biogenic CO_2 from SSR 4, SSR 7, SSR 8, SSR 9, SSR 10, SSR 12 and SSR 13.[2]

[2] This is consistent with the Intergovernmental Panel on Climate Change (IPCC). 2001. Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, Chapter 5 (Waste) (PDF), and Canada's national GHG inventory.

Figure 1: Illustration of the project GHG boundary

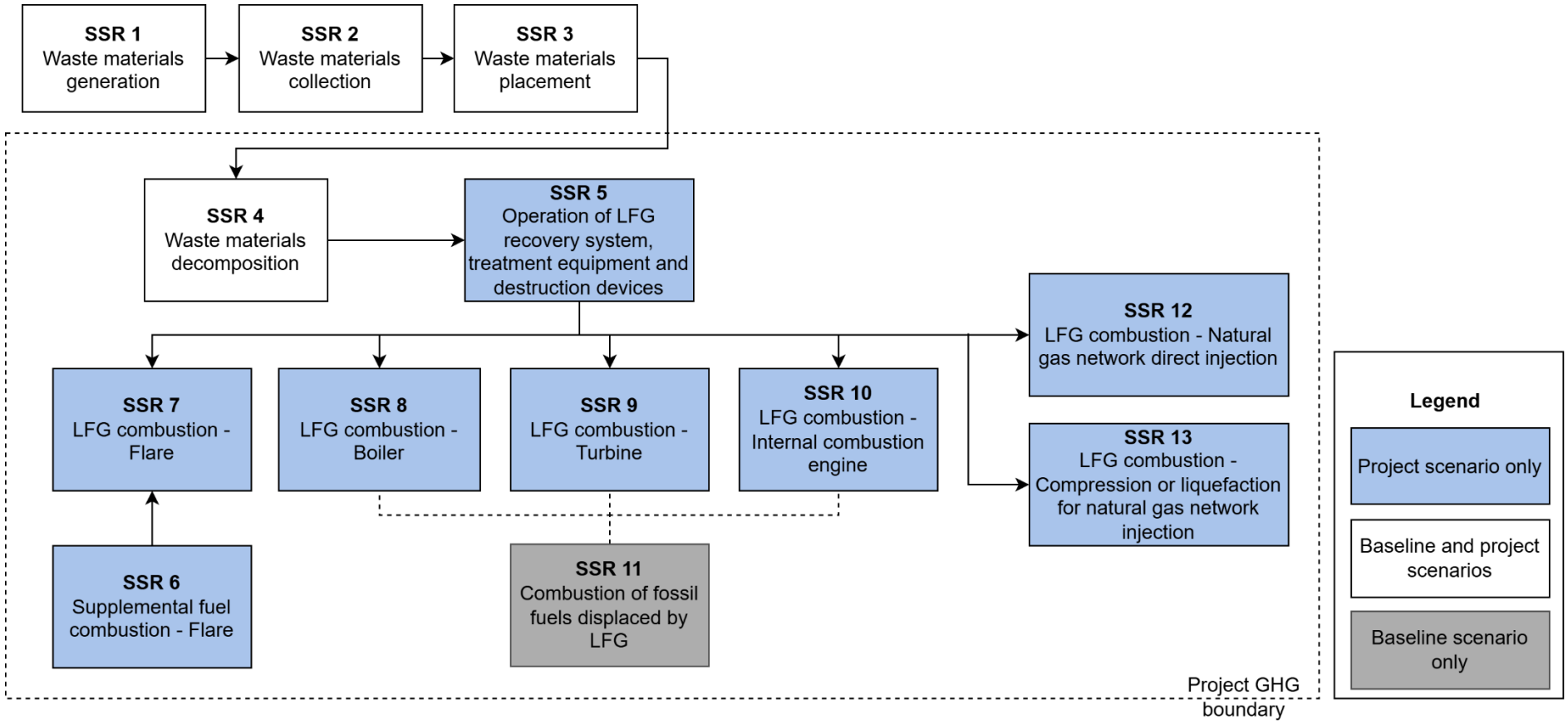

Table 2: Details on baseline and project scenario SSRs

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
1	Waste materials generation	Generation of waste materials before their collection and placement into the landfill.	Related	Baseline (B1) Project (P1)	CO_2	**Excluded:** The difference in GHG emissions between the baseline and project scenarios is assumed to be negligible.
					CH_4	
					N_2O	
2	Waste materials collection	Combustion of fossil fuels for vehicles used to collect waste materials and transport them to the landfill site.	Related	Baseline (B2) Project (P2)	CO_2	**Excluded:** The difference in GHG emissions between the baseline and project scenarios is assumed to be negligible.
					CH_4	
					N_2O	
3	Waste materials placement	Combustion of fossil fuels to operate equipment for the handling and placement of waste materials into the landfill.	Related	Baseline (B3) Project (P3)	CO_2	**Excluded:** The difference in GHG emissions between the baseline and project scenarios is assumed to be negligible.
					CH_4	
					N_2O	
4	Waste materials decomposition	Generation of LFG from the anaerobic decomposition of waste materials in the landfill.	Controlled	Baseline (B4)	CH_4	**Included:** Quantified based on the quantity of landfill CH_4 in the LFG actively recovered in the project scenario, using Equation 3.
					N_2O	**Excluded:** N_2O emissions from anaerobic decomposition are not significant.[3]
				Project (P4)	CH_4	**Included:** Quantified based on undestroyed landfill CH_4 following the combustion of LFG in the eligible destruction device(s), using Equation 12.

[3] The IPCC does not provide a methodology to quantify N_2O emissions from landfills as this emission source is not significant. This is consistent with IPCC. 2006. *Guidelines for National Greenhouse Gas Inventories, Volume 5: Waste, Chapter 3: Solid Waste Disposal. IPCC National Greenhouse Gas Inventories Programme* (PDF).

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
					N_2O	**Excluded:** N_2O emissions from anaerobic decomposition are not significant.
5	Operation of LFG recovery system, treatment equipment and destruction devices	Combustion of fossil fuels or consumption of grid electricity for the operation of the active LFG recovery system, treatment equipment, and destruction devices.[4]	Fossil Fuels: Controlled Electricity: Related	Project (P5)	CO_2	**Included:** Quantified using Equation 9 and Equation 10
					CH_4	
					N_2O	
6	Supplemental fuel combustion – Flare	Combustion of supplemental fossil fuel to support the operation of an open or enclosed flare.	Controlled	Project (P6)	CO_2	**Included:** Quantified based on combustion of supplemental fossil fuel in a flare, using Equation 11.
					CH_4	
					N_2O	
7	LFG combustion – Flare	Combustion of LFG in an open or enclosed flare, as identified in Table 1.	Controlled	Project (P7)	CH_4	**Included:** Quantified based on undestroyed landfill CH_4 and the generation of N_2O from the combustion of LFG in a flare, using Equation 13.
					N_2O	
8	LFG combustion – Boiler	Combustion of LFG in a boiler, as identified in Table 1.	Controlled	Project (P8)	CH_4	**Included:** Quantified based on undestroyed landfill CH_4 and the generation of N_2O from the combustion of LFG in a boiler, using Equation 13.
					N_2O	
9		Combustion of LFG in a turbine, as	Controlled	Project (P9)	CH_4	**Included:** Quantified based on undestroyed

[4] This SSR captures emissions from operating project components such as blowers; equipment for LFG treatment and purification; destruction devices (other than a flare); equipment for the conveyance of LFG to an adjacent destruction facility; equipment for the upgrading, compression or liquefaction, and injection of upgraded LFG into a natural gas network.

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
	LFG combustion – Turbine	identified in Table 1.			N_2O	landfill CH_4 and the generation of N_2O from the combustion of LFG in a turbine, using Equation 13.
10	LFG combustion– Internal combustion engine	Combustion of LFG in an internal combustion engine, as identified in Table 1.	Controlled	Project (P10)	CH_4 N_2O	**Included:** Quantified based on undestroyed landfill CH_4 and the generation of N_2O from the combustion of LFG in an internal combustion engine, using Equation 13.
11	Combustion of fossil fuels displaced by LFG	GHG emissions from the combustion of fossil fuels in the baseline scenario that are displaced by eligible LFG recovered in the project scenario.	Controlled	Baseline (B11)	CH_4 N_2O	**Included:** Quantified for fossil fuels displaced by eligible LFG, as per Section 4.3, based on the volume of fossil fuels that would have been needed to produce the amount of energy generated by CH_4 from the eligible LFG recovered from within the project site using Equation 6.
12	LFG combustion – Natural gas network direct injection	Combustion of upgraded LFG after its direct injection into a natural gas network, as identified in Table 1.	Related	Project (P12)	CH_4 N_2O	**Included:** Quantified based on undestroyed landfill CH_4 and the generation of N_2O from the combustion of LFG after its direct injection into a natural gas network, using Equation 13.
13	LFG combustion – Compression or liquefaction for natural gas network injection	Combustion of upgraded LFG after its compression or liquefaction, transport and injection into a natural gas network, as identified in Table 1.	Related	Project (P13)	CH_4 N_2O	**Included:** Quantified based on undestroyed landfill CH_4 and the generation of N_2O from the combustion of LFG after its compression or liquefaction, transport and injection into a natural gas network, using Equation 13.

8.0 Quantification methodology

This section contains the quantification methodology that the proponent must follow to quantify baseline and project scenario GHG emissions and subsequently, the GHG emission reductions generated by the project.

Baseline scenario GHG emissions are the GHG emissions from the SSRs within the project GHG boundary that would likely have been generated in the absence of the project from the business-as-usual management and operation of the landfill and quantified as per Section 8.1.

Project scenario GHG emissions are the GHG emissions from the SSRs within the project GHG boundary that are generated from the eligible project activities and quantified as per Section 8.2.

The GHG emission reductions generated by the project are quantified by deducting the project scenario GHG emissions from the baseline scenario GHG emissions as per Section 8.4.

The quantification of both the baseline and project scenario GHG emissions must include all the GHG emissions that were likely to occur in the absence of the project (baseline scenario) and did occur (project scenario) during a reporting period. The proponent must report the sub-totals in tonnes of CO_2 equivalent (t CO_2e) for each full or partial calendar year of the reporting period to support issuance of the offset credits by calendar year.

For an aggregation of projects, the proponent must quantify GHG emission reductions for each project separately. Subsequently, the GHG emission reductions for each project are to be summed together to determine the GHG emission reductions for the aggregation of projects. The proponent must report the sub-totals of each project within the aggregation in tonnes of CO_2 equivalent (t CO_2e) for each full or partial calendar year of the reporting period to support issuance of the offset credits by calendar year.

Some emission factors and other reference values used in the quantification methodology are provided in the *Emission Factors and Reference Values* document.[5] Raw data must be converted to align with the units presented in the quantification methodology, if necessary.

8.1 Baseline scenario GHG emissions

The proponent must use Equation 1 and the subsequent equations in Section 8.1 to quantify the baseline scenario GHG emissions for each full or partial calendar year covered by the reporting period, based on the included SSRs as set out in Table 2.

The baseline scenario GHG emissions are quantified using of a dynamic baseline approach based on measurements made in the project scenario instead of modelling the GHG emissions generated by the landfill in the baseline scenario. This means that the baseline scenario GHG emissions are quantified based on the quantity of landfill CH_4 in the LFG that is actively recovered in the project scenario, which may vary over time.

[5] To be used along with federal offset protocols, the *Emission Factors and Reference Values* document contains general and protocol-specific emission factors and other reference values that are needed for the quantification of GHG emission reductions.

Equation 1: Baseline scenario GHG emissions for a calendar year covered by the reporting period

$$BE_C = BLE_C + FDE_C$$

Parameter	Description	Units
BE_C	Baseline scenario GHG emissions for a calendar year covered by the reporting period	t CO_2e
BLE_C	Baseline scenario CH_4 emissions from the landfill for a calendar year covered by the reporting period, as per Equation 2	t CO_2e
FDE_C	Baseline scenario GHG emissions from the combustion of fossil fuels displaced by eligible LFG for a calendar year covered by the reporting period, as per Equation 6 (SSR B11)	t CO_2e
C	Calendar year	unitless

8.1.1 Baseline scenario CH_4 emissions from the landfill

The proponent must use Equation 2 to quantify the baseline scenario CH_4 emissions from the landfill for a calendar year covered by the reporting period.

Equation 2: Baseline scenario CH_4 emissions from the landfill for a calendar year covered by the reporting period

$$BLE_C = CH_4REC_C \times (1 - OX)$$

Parameter	Description	Units
BLE_C	Baseline scenario CH_4 emissions from the landfill for a calendar year covered by the reporting period	t CO_2e
CH_4REC_C	Quantity of landfill CH_4 in the LFG actively recovered for a calendar year covered by the reporting period, as per Equation 3 (SSR B4)	t CO_2e
OX	Factor for the oxidation of landfill CH_4 by bacteria in soil or materials covering the waste, as determined below	unitless
C	Calendar year	unitless

Baseline scenario GHG emissions are quantified based on the presumption that the LFG actively recovered in the project scenario would have been passively released to the atmosphere in the baseline scenario. Oxidation of landfill CH_4 must be accounted for in the baseline scenario. If a non-geomembrane cover system or other CH_4 oxidation technology is present, it can be presumed that the landfill CH_4 would have been subject to oxidation by bacteria in the soil or materials covering the waste prior to being released to the atmosphere. If a geomembrane covers the entire landfill area and no CH_4 oxidation technology is present, it can be presumed that the landfill CH_4 would not have been subject to oxidation.

Oxidation of landfill CH_4 must be accounted for in the following manner:

- A CH_4 oxidation factor of 0% **can only** be used for landfills with a geomembrane covering the entire landfill area and no CH_4 oxidation technology
- A CH_4 oxidation factor of 10% **must** be used for all other landfills, including those with a non-geomembrane cover system or other CH_4 oxidation technology[6]

The proponent must use Equation 3 and Equation 4 to quantify the quantity of landfill CH4 in the LFG that is actively recovered for each full or partial calendar year covered by the reporting period.

Equation 3: Quantity of landfill CH_4 in the LFG actively recovered for a calendar year covered by the reporting period

$$CH_4REC_C = \sum_{i}^{n} Q_i \times \frac{\rho_{CH_4}}{1000} \times GWP_{CH_4}$$

Parameter	Description	Units
CH_4REC_C	Quantity of landfill CH_4 in the LFG actively recovered for a calendar year covered by the reporting period (SSR B4)	t CO_2e
Q_i	Volume of landfill CH_4 delivered to eligible destruction device, i, during a calendar year covered by the reporting period, as per Equation 4	m^3 CH_4
ρ_{CH_4}	Reference density of CH_4 = 0.656	kg CH_4/m^3 CH_4
GWP_{CH_4}	GWP of CH_4, as set out in Schedule 3 to the Act	unitless
1000	Conversion factor, kilograms to tonnes	kg/t
n	Number of eligible destruction devices	unitless
i	Eligible destruction device	unitless
C	Calendar year	unitless

[6] IPCC. 2001. *Good Practise Guidance and Uncertainty Management in National Greenhouse Gas Inventories, Chapter 5 (Waste)* (PDF).

Equation 4: Volume of landfill CH_4 delivered to an eligible destruction device for a calendar year covered by the reporting period

$$Q_i = \sum_{t}^{n} (LFG_{i,t} \times LFG_{CH_4,t})$$

Parameter	Description	Units
Q_i	Volume of landfill CH_4 delivered to eligible destruction device, i, during a calendar year covered by the reporting period	m^3 CH_4
$LFG_{i,t}$	Corrected volume of LFG delivered to eligible destruction device, i, during measurement period, t, as per automatic correction or Equation 5	m^3 LFG
$LFG_{CH_4,t}$	Average CH_4 content of the LFG during measurement period, t	m^3 CH_4/m^3 LFG
i	Eligible destruction device	unitless
n	Number of measurement periods in a calendar year covered by the reporting period	unitless
t	Measurement period	unitless

All flow meter data must be corrected to the reference temperature and pressure conditions. If the flow meter does not automatically correct the measured volume to the reference temperature and pressure conditions, the proponent must quantify the corrected volume following Equation 5. Equation 5 is not needed if the flow meter automatically corrects the volume.

Equation 5: Volume of LFG delivered to an eligible destruction device, corrected to reference conditions

$$LFG_{i,t} = LFG_{UC,i,t} \times \frac{T_{ref}}{T_{i,t}} \times \frac{P_{i,t}}{P_{ref}}$$

Parameter	Description	Units
$LFG_{i,t}$	Corrected volume of LFG delivered to eligible destruction device, i, during measurement period, t	m^3 LFG
$LFG_{UC,i,t}$	Uncorrected volume of LFG delivered to eligible destruction device, i, during measurement period, t	m^3 LFG
$T_{i,t}$	Measured temperature of the LFG delivered to eligible destruction device, i, for the measurement period, t	K
T_{ref}	Reference temperature of the LFG = 298.15 K	K
$P_{i,t}$	Measured pressure of the LFG delivered to eligible destruction device, i, for the measurement period, t	kPa
P_{ref}	Reference pressure of the LFG = 101.325 kPa	kPa

i	Eligible destruction device	unitless
t	Measurement period	unitless

8.1.2 Baseline scenario GHG emissions from the combustion of fossil fuels displaced by eligible LFG

If the project actively recovers and combusts LFG eligible for the displacement of fossil fuels and the proponent chooses to quantify the resulting GHG emission reductions for credit issuance, they must use Equation 6 to quantify baseline scenario GHG emissions from the combustion of fossil fuels displaced by eligible LFG.

Equation 6: Baseline scenario GHG emissions from combustion of fossil fuels displaced by eligible LFG for a calendar year covered by the reporting period

$$FDE_C = \sum_{i}^{n} \begin{bmatrix} (FD_{i,C} \times EF_{CO_2,i}) \\ +(FD_{i,C} \times EF_{CH_4,i} \times GWP_{CH_4}) \\ +(FD_{i,C} \times EF_{N_2O,i} \times GWP_{N_2O}) \end{bmatrix} \div 1000$$

Parameter	Description	Units
FDE_C	Baseline scenario GHG emissions from the combustion of fossil fuels displaced by eligible LFG for a calendar year covered by the reporting period (SSR B11)	t CO_2e
$FD_{i,C}$	Volume of fossil fuel, i, displaced by eligible LFG and used in the baseline scenario for a calendar year covered by the reporting period, as per Equation 7	m^3
$EF_{CO_2,i}$	CO_2 emission factor for fossil fuel, i, as set out in the *Emission Factors and Reference Values* document	kg CO_2/m^3
$EF_{CH_4,i}$	CH_4 emission factor for fossil fuel, i, as set out in the *Emission Factors and Reference Values* document	kg CH_4/m^3
GWP_{CH_4}	GWP of CH_4, as set out in Schedule 3 to the Act	unitless
$EF_{N_2O,i}$	N_2O emission factor for fossil fuel, i, as set out in the *Emission Factors and Reference Values* document	kg N_2O/m^3
GWP_{N_2O}	GWP of N_2O, as set out in Schedule 3 to the Act	unitless
1000	Conversion factor, kilograms to tonnes	kg/t
n	Number of eligible fossil fuels displaced by eligible LFG	unitless
i	Fossil fuel displaced by eligible LFG	unitless
C	Calendar year	unitless

The volume of fossil fuels that would have been used in the baseline scenario ($FD_{i,C}$) to generate the equivalent amount of energy as the combustion of eligible LFG must be calculated using Equation 7. However, if the value of $FD_{i,C}$, obtained from Equation 7, is higher than the highest annual volume of fossil fuels used during the 3 years before the project start date, the proponent must use the highest annual volume of fossil fuel as the value of $FD_{i,C}$ in Equation 6.

Equation 7: Volume of fossil fuels displaced by eligible LFG for a calendar year covered by the reporting period

$$FD_{i,C} = LFD_C \times \left(\frac{HHV_{LFG}}{HHV_{FF,i}}\right)$$

Parameter	Description	Units
$FD_{i,C}$	Volume of fossil fuel, i, displaced by eligible LFG and used in the baseline scenario for a calendar year covered by the reporting period	m^3
LFD_C	Volume of LFG eligible for displacement of fossil fuels in the project scenario for a calendar year covered by the reporting period	m^3
HHV_{LFG}	Higher heating value (HHV) of LFG actively recovered from within the project site, as set out in the *Emission Factors and Reference Values* document	MJ/m^3
$HHV_{FF,i}$	HHV of fossil fuel, i, displaced by eligible LFG, as set out in the *Emission Factors and Reference Values* document	MJ/m^3
i	Fossil fuel displaced by eligible LFG	unitless
C	Calendar year	unitless

If eligible LFG has been upgraded to the standards required to be RNG, the proponent must use the applicable higher heating value for RNG, as set out in the *Emission Factors and Reference Values* document, for the parameter HHV_{LFG} in Equation 7.

If eligible LFG has not been upgraded to the standards required to be RNG, the proponent must use the higher heating value for biogas regardless of the CH_4 composition of the biogas, as set out in the *Emission Factors and Reference Values* document, for the parameter HHV_{LFG} in Equation 7.

Despite the previous provision, the proponent may determine a project-specific higher heating value for eligible LFG by measuring the energy density of the LFG following the requirements for fuel heat content monitoring set out in Section 2.D.3 of the latest available version of *Canada's Greenhouse Gas Quantification Requirements / Greenhouse Gas Reporting Program*, and corrected to standard conditions.

8.2 Project scenario GHG emissions

The proponent must use Equation 8 and the subsequent equations in Section 8.2 to quantify the project scenario GHG emissions for each full or partial calendar year covered by the reporting period, based on the included SSRs, as set out in Table 2.

The project scenario GHG emissions correspond to the GHG emissions from, as applicable:

- energy inputs into the active LFG recovery system, treatment equipment, and eligible destruction devices (other than a flare)
- supplemental fossil fuel used to support the operation of a flare
- the combustion of LFG in the eligible destruction device(s)

Equation 8: Project scenario GHG emissions for a calendar year covered by the reporting period

$$PE_C = FF_{GHG} + EL_{GHG} + FF_{flare,GHG} + LFG_{GHG}$$

Parameter	Description	Units
PE_C	Project scenario GHG emissions for a calendar year covered by the reporting period	t CO_2e
FF_{GHG}	GHG emissions from the use of fossil fuels for the operation of the active LFG recovery system, treatment equipment, and destruction devices for a calendar year covered by the reporting period, as per Equation 9 (SSR P5)	t CO_2e
EL_{GHG}	GHG emissions from the use of grid electricity for the operation of the active LFG recovery system, treatment equipment, and destruction devices for a calendar year covered by the reporting period, as per Equation 10 (SSR P5)	t CO_2e
$FF_{flare,GHG}$	GHG emissions from the use of supplemental fossil fuels to support the operation of a flare for a calendar year covered by the reporting period, as per Equation 11 (SSR P6)	t CO_2e
LFG_{GHG}	GHG emissions from the combustion of LFG in the eligible destruction device(s) for a calendar year covered by the reporting period, as per Equation 13 (SSR P7, SSR P8, SSR P9, SSR P10, SSR P12, SSR P13)	t CO_2e
C	Calendar year	unitless

Equation 9 and Equation 10 quantify the GHG emissions from the operation of the active LFG recovery system, treatment equipment, and destruction devices for each full or partial calendar year covered by the reporting period, which correspond to SSR P5. The proponent must use the appropriate equation(s) dependent on the energy inputs required for the operation of the active LFG recovery system, treatment equipment, and destruction devices; these can include blowers, equipment for LFG treatment and purification, destruction devices (other than flares), equipment for the conveyance of LFG to an adjacent destruction facility, and/or equipment for the upgrading, compression or liquefaction, and

injection of upgraded LFG into a natural gas network. If both fossil fuels and grid electricity are used for these purposes, the proponent must use the summation of Equation 9 and Equation 10 to quantify SSR P5.

Equation 9: GHG emissions from the combustion of fossil fuels for the operation of the active LFG recovery system, treatment equipment, and destruction devices for a calendar year covered by the reporting period

$$FF_{GHG} = \sum_{j}^{m} \begin{bmatrix} (FF_j \times EF_{CO_2,j}) \\ +(FF_j \times EF_{CH_4,j} \times GWP_{CH_4}) \\ +(FF_j \times EF_{N_2O,j} \times GWP_{N_2O}) \end{bmatrix} \div 1000$$

Parameter	Description	Units
FF_{GHG}	GHG emissions from the combustion of fossil fuels for the operation of the active LFG recovery system, treatment equipment, and destruction devices for a calendar year covered by the reporting period (SSR P5)	t CO_2e
FF_j	Volume of fossil fuel, j, consumed by the active LFG recovery system, treatment equipment, and destruction devices for a calendar year covered by the reporting period	m^3
$EF_{CO_2,j}$	CO_2 emission factor for fossil fuel, j, as set out in the *Emission Factors and Reference Values* document	kg CO_2/m^3
$EF_{CH_4,j}$	CH_4 emission factor for fossil fuel, j, as set out in the *Emission Factors and Reference Values* document	kg CH_4/m^3
GWP_{CH_4}	GWP of CH_4, as set out in Schedule 3 to the Act	unitless
$EF_{N_2O,j}$	N_2O emission factor for fossil fuel, j, as set out in the *Emission Factors and Reference Values* document	kg N_2O/m^3
GWP_{N_2O}	GWP of N_2O, as set out in Schedule 3 to the Act	unitless
1000	Conversion factor, kilograms to tonnes	kg/t
m	Number of types of fossil fuels	unitless
j	Type of fossil fuel	unitless

Equation 10: GHG emissions from the use of grid electricity for the operation of the active LFG recovery system, treatment equipment, and destruction devices for a calendar year covered by the reporting period

$$\mathrm{EL_{GHG}} = \frac{\mathrm{EL} \times \mathrm{EF_{EL,GHG}}}{1000}$$

Parameter	Description	Units
$\mathrm{EL_{GHG}}$	GHG emissions from the use of grid electricity for the operation of the active LFG recovery system, treatment equipment, and destruction devices for a calendar year covered by the reporting period (SSR P5)	t CO_2e
EL	Grid electricity consumed by the active LFG recovery system, treatment equipment, and destruction devices for a calendar year covered by the reporting period	MWh
$\mathrm{EF_{EL,GHG}}$	Emission factor for the electricity consumption GHG emission intensity for the grid of the project's province or territory, as set out in the *Emission Factors and Reference Values* document	kg CO_2e/MWh
1000	Conversion factor, kilograms to tonnes	kg/t

If the project includes a flare as a destruction device, the proponent must use Equation 11 to quantify the GHG emissions from supplemental fossil fuels used to support the operation of a flare for each full or partial calendar year covered by the reporting period, which corresponds to SSR P6.

Equation 11: GHG emissions from the combustion of supplemental fossil fuels to support the operation of a flare for a calendar year covered by the reporting period

$$\mathrm{FF_{flare,GHG}} = \sum_{\mathrm{j}}^{\mathrm{m}} \left[\begin{array}{c} \left(\mathrm{FF_{flare,j}} \times \mathrm{EF_{CO_2,j}}\right) \\ +\left(\mathrm{FF_{flare,j}} \times \mathrm{FF_{CH_4,j}} \times \rho_{\mathrm{CH_4}} \times \left(1 - \mathrm{DE_{CH_4}}\right) \times \mathrm{GWP_{CH_4}}\right) \\ +\left(\mathrm{FF_{flare,j}} \times \mathrm{EF_{N_2O,j}} \times \mathrm{GWP_{N_2O}}\right) \end{array} \right] \div 1000$$

Parameter	Description	Units
$\mathrm{FF_{flare,GHG}}$	GHG emissions from the combustion of supplemental fossil fuels to support the operation of a flare for a calendar year covered by the reporting period (SSR P6)	t CO_2e
$\mathrm{FF_{flare,j}}$	Volume of supplemental fossil fuel, j, consumed by a flare for a calendar year covered by the reporting period	m^3
$\mathrm{EF_{CO_2,j}}$	CO_2 emission factor for supplemental fossil fuel, j, as set out in the *Emission Factors and Reference Values* document	kg CO_2/m^3
$\mathrm{FF_{CH_4,j}}$	Average CH_4 content of supplemental fossil fuel, j, obtained from the supplier	m^3 CH_4/m^3
$\rho_{\mathrm{CH_4}}$	Reference density of CH_4 = 0.656	kg CH_4/m^3 CH_4

DE_{CH_4}	CH_4 destruction efficiency of the flare, as set out in the *Emission Factors and Reference Values* document or specific to the device	unitless
GWP_{CH_4}	GWP of CH_4, as set out in Schedule 3 to the Act	unitless
$EF_{N_2O,j}$	N_2O emission factor for supplemental fossil fuel, j, as set out in the *Emission Factors and Reference Values* document	kg N_2O/m^3
GWP_{N_2O}	GWP of N_2O, as set out in Schedule 3 to the Act	unitless
1000	Conversion factor, kilograms to tonnes	kg/t
m	Number of types of supplemental fossil fuels	unitless
j	Type of supplemental fossil fuel	unitless

The proponent must use Equation 12 and Equation 13 to quantify GHG emissions due to the combustion of LFG in the eligible destruction device(s) for each full or partial calendar year covered by the reporting period. Equation 12 determines the undestroyed landfill CH_4 generated from the anaerobic decomposition of waste and released to atmosphere from the eligible destruction device(s), corresponding to SSR P4. This value is then accounted for within Equation 13, which must be used to quantify the quantity of undestroyed landfill CH_4 and generated N_2O emissions from the combustion of LFG in the eligible destruction device(s) for each full or partial calendar year covered by the reporting period, corresponding to SSR P7, SSR P8, SSR P9, SSR P10, SSR P12, and SSR P13.

Equation 12: Undestroyed landfill CH_4 released to atmosphere based on the destruction efficiency of the eligible destruction device(s) for a calendar year covered by the reporting period

$$CH_4UND = \sum_{i}^{n} \left[Q_i \times \left(1 - DE_{CH_4,i}\right) \right] \times \frac{\rho_{CH_4}}{1000} \times GWP_{CH_4}$$

Parameters	Description	Units
CH_4UND	Undestroyed landfill CH_4 released to atmosphere based on the destruction efficiency of the eligible destruction device(s) for a calendar year covered by the reporting period (SSR P4)	t CO_2e
Q_i	Volume of landfill CH_4 delivered to eligible destruction device, i, during a calendar year covered by the reporting period, as per Equation 4	m^3 CH_4
$DE_{CH_4,i}$	CH_4 destruction efficiency of eligible destruction device, i, as set out in the *Emission Factors and Reference Values* document or specific to the device	unitless
ρ_{CH_4}	Reference density of CH_4 = 0.656	kg CH_4/m^3 CH_4
GWP_{CH_4}	GWP of CH_4, as set out in Schedule 3 to the Act	unitless

1000	Conversion factor, kilograms to tonnes	kg/t
n	Number of eligible destruction devices	unitless
i	Eligible destruction device	unitless

The amount of landfill CH_4 destroyed in each eligible destruction device is dependent on the CH_4 destruction efficiency for each device (DE_{CH4}). The *Emission Factors and Reference Values* document sets out default CH_4 destruction efficiencies that the proponent must use for each eligible destruction device in the project.

Despite the previous provision, the proponent may determine a device-specific destruction efficiency for each eligible destruction device in the project. Testing for the device-specific destruction efficiency must be conducted each full or partial calendar year, and include at least three test runs, with the accepted final value being one standard deviation below the mean of the measured efficiencies.

Equation 13: GHG emissions from the destruction of LFG in the eligible destruction device(s) for a calendar year covered by the reporting period

$$\mathrm{LFG_{GHG}} = \mathrm{CH_4UND} + \left[\sum_{i}^{n}\left(\mathrm{Q_i} \times \frac{\mathrm{EF_{LFG,\,N_2O,i}}}{1000}\right) \times \frac{\rho_{\mathrm{CH_4}}}{1000} \times \mathrm{GWP_{N_2O}}\right]$$

Parameter	Description	Units
$\mathrm{LFG_{GHG}}$	GHG emissions from the destruction of LFG in the eligible destruction device(s) for a calendar year covered by the reporting period (SSR P7, SSR P8, SSR P9, SSR P10, SSR P12, SSR P13)	t CO_2e
$\mathrm{CH_4UND}$	Undestroyed landfill CH_4 released to atmosphere based on the destruction efficiency of the eligible destruction device(s) for a calendar year covered by the reporting period, as per Equation 12 (SSR P4)	t CO_2e
$\mathrm{Q_i}$	Volume of landfill CH_4 delivered to eligible destruction device, i, during a calendar year covered by the reporting period, as per Equation 4	m^3 CH_4
$\rho_{\mathrm{CH_4}}$	Reference density of CH_4 = 0.656	kg CH_4/m^3 CH_4
$\mathrm{EF_{LFG,\,N_2O,i}}$	N_2O emission factor for the destruction of LFG in eligible destruction device, i, as set out in the *Emission Factors and Reference Values* document	kg N_2O/t CH_4
1000	Conversion factor, kilograms to tonnes	kg/t
$\mathrm{GWP_{N_2O}}$	GWP of N_2O, as set out in Schedule 3 to the Act	unitless
n	Number of eligible destruction devices	unitless
i	Eligible destruction device	unitless

8.3 Leakage

While waste could be diverted away from a landfill site due to increased costs or tipping fees resulting from the implementation of a project, which would cause the landfill CH_4 emissions to be passively released to the atmosphere elsewhere, the high costs associated with collecting and transporting this waste to a farther location are presumed to render this leakage scenario improbable.

As a result, leakage was determined to be inapplicable to this project type and there is no leakage discount factor (which corresponds to variable C_i in the formula in subsection 20(2) of the Regulations) to be applied for the quantification of GHG emission reductions generated by a project implemented following this protocol.

8.4 Project GHG emission reductions

The proponent must use Equation 14 to quantify the GHG emission reductions (ER_C) generated by the project, which correspond to the GHG reductions determined in accordance with section 20 of the Regulations.

Equation 14: Project GHG emission reductions for a calendar year covered by the reporting period

$$\mathrm{ER_C} = \mathrm{BE_C} - \mathrm{PE_C}$$

Parameter	Description	Units
$\mathrm{ER_C}$	Project GHG emission reductions for a calendar year covered by the reporting period	t CO_2e
$\mathrm{BE_C}$	Baseline scenario GHG emissions for a calendar year covered by the reporting period, as per Equation 1	t CO_2e
$\mathrm{PE_C}$	Project scenario GHG emissions for a calendar year covered by the reporting period, as per Equation 8	t CO_2e
C	Calendar year	unitless

9.0 Measurement and data

9.1 Measuring devices

The proponent must ensure the appropriate measuring devices are installed and operated as per the requirements in Section 9.1.

9.1.1 Flow meters

The proponent must ensure that permanent flow meters directly and separately measure the volume of LFG actively recovered from within the project site and delivered to the individual eligible destruction device(s). The volume of any fossil fuels consumed for the operation of the active LFG recovery

system, treatment equipment, or eligible destruction devices must be measured by permanent flow meters or determined using purchasing records. Volume data must be converted into cubic metres (m^3) to align with the quantification methodology presented in Section 8.0.

9.1.2 Temperature and pressure gauges

If a flow meter automatically corrects the LFG volume to the reference temperature and pressure conditions set out in Equation 5, no additional temperature and pressure gauges are required.

If a flow meter does not automatically correct the LFG volume, permanent temperature and pressure gauges must be installed to measure temperature and pressure at the same measurement frequency as the uncorrected volume of LFG (Section 9.2). LFG temperature and pressure must be measured under the same conditions (wet or dry basis) as the LFG volume.

The LFG volume data must be corrected from measured temperature and pressure conditions to the reference temperature and pressure conditions using Equation 5.

9.1.3 Methane analyzers

The active LFG recovery system must include permanent methane analyzers (for example, gas chromatographs) that directly measure the CH_4 content in the LFG on a volumetric basis.

9.1.4 Arrangement of measuring devices

Flow meters and methane analyzers must be arranged in such a way as to ensure the data is representative of the LFG actively recovered by the project.

- **Flow meters:** Must be placed to separately measure the volume of LFG actively recovered from within the project site and delivered to the individual eligible destruction device(s)
- **Methane analyzers**: For a project with multiple eligible destruction devices, if the LFG is delivered to the eligible destruction devices from a common manifold or header upstream of the destruction devices, one methane analyzer can be placed to measure the CH_4 content of the LFG at that common manifold or header pipe. If the LFG is delivered to each eligible destruction device from separate manifolds or header pipes, a separate methane analyzer is required upstream of each individual destruction device

Additionally, flow meters and methane analyzers must be placed to:

- measure the volume and CH_4 content of the LFG actively recovered from within the project site separately from any other LFG recovered from within the landfill
- measure the volume and CH_4 content of the LFG before the introduction of any supplemental fossil fuel
- enable the measurement of the volume of supplemental fossil fuel prior to its introduction
- measure the volume and CH_4 content of the LFG actively recovered from within the project site separately from any other fuel sources prior to the combustion of the LFG in the eligible destruction device(s) at an adjacent destruction facility
- measure the volume of LFG eligible for the displacement of fossil fuels, as per Section 8.1.2, separately from LFG that is not eligible for the displacement of fossil fuels, in the case that the proponent intends to generate GHG emission reductions from the displacement of fossil fuels

Measuring devices should be arranged such that the CH_4 content of the LFG is measured under the same conditions (wet or dry basis) as the volume, temperature and pressure. However, a moisture-removing component may separate a methane analyzer and a flow meter where the methane analyzer is placed upstream of the moisture-removing component (CH_4 content measured on a wet basis), and the flow meter is placed downstream of the moisture-removing component (LFG volume measured on a dry basis). A moisture-removing component must not separate a methane analyzer and flow meter in any other configuration other than previously described. No other devices or equipment that could change the LFG composition by volume may separate a methane analyzer and a flow meter.

9.2 Measurement method and frequency

Table 3 identifies the parameters in the quantification methodology set out in Section 8.0 that must be measured and provides details regarding measurement method and frequency.

Table 3: Measurement method and frequency for measured parameters

Parameter	Description	Units	Measurement method and frequency	Equations
$LFG_{i,t}$	Corrected volume of LFG delivered to eligible destruction device, i, during measurement period, t.	m^3 LFG	Measured continuously with volume recorded every measurement period. The measurement period can be a maximum of 15 minutes. **or** Quantified as per Equation 5 if flow meter does not automatically correct volume.	4, 5
$LFG_{CH_4,t}$	Average CH_4 content of the LFG during measurement period, t.	m^3 CH_4/m^3 LFG	Measured continuously with CH_4 content averaged over the measurement period. The measurement period can be a maximum of 15 minutes.	4
$LFG_{UC,i,t}$	Uncorrected volume of LFG delivered to eligible destruction device, i, during measurement period, t.	m^3 LFG	Measured continuously with volume recorded every measurement period. The measurement period can be a maximum of 15 minutes.	5
$T_{i,t}$	Measured temperature of the LFG for the measurement period, t.	K	Measured continuously with value recorded every measurement period if flow meter does not automatically correct volume. The measurement period can be a maximum of 15 minutes but must be the same frequency as for $LFG_{UC,i,t}$.	5
$P_{i,t}$	Measured pressure of the LFG for the measurement period, t.	kPa	Measured continuously with value recorded every measurement period if flow meter does not automatically correct volume. The measurement period can be a maximum of	5

Parameter	Description	Units	Measurement method and frequency	Equations
			15 minutes but must be the same frequency as for $LFG_{UC,i,t}$.	
LFD_C	Volume of LFG eligible for displacement of fossil fuels in the project scenario for a calendar year covered by the reporting period.	m^3	Measured continuously with volume recorded every measurement period. The measurement period can be a maximum of 15 minutes. **or** Quantified as per Equation 5 if flow meter does not automatically correct volume.	7
FF_j	Volume of fossil fuel, j, consumed by the active LFG recovery system, treatment equipment, and destruction devices for a calendar year covered by the reporting period.	m^3	Measured continuously with volume recorded at least once every 15 minutes and summed for each calendar year covered by the reporting period. **or** Calculated from fossil fuel purchasing records and/or equipment specifications and summed for each calendar year covered by the reporting period.	9
EL	Grid electricity consumed by the active LFG recovery system, treatment equipment, and destruction devices for a calendar year covered by the reporting period.	MWh	Measured using meter and summed for each calendar year covered by the reporting period. **or** Calculated from electricity purchasing records and/or equipment specifications and summed for each calendar year covered by the reporting period.	10
$FF_{flare,j}$	Volume of supplemental fossil fuel, j, consumed by a flare for a calendar year covered by the reporting period.	m^3	Measured continuously with volume recorded at least once every 15 minutes and summed for each calendar year covered by the reporting period. **or** Calculated from fossil fuel purchasing records and/or equipment specifications and summed for each calendar year covered by the reporting period.	11

9.3 Quality assurance and quality control

The proponent must have documented quality assurance and quality control (QA/QC) procedures and must implement them to ensure that all measurements and calculations are made in accordance with this protocol and can be verified.

All flow meters and methane analyzers must be:

- checked for accuracy by following manufacturer specifications at least once each calendar year, with the last occurring no more than 2 months before or after the end of the reporting period
- calibrated by the manufacturer or by a third party certified for that purpose and following manufacturer specifications, in accordance with the manufacturer specified frequency or every 5 years, whichever is more frequent. However, if the device is factory calibrated and the manufacturer specifies that no recalibration is required, the factory calibration then needs to be validated on-site by either the manufacturer or a certified third party in accordance with the manufacturer specified frequency or every 5 years, whichever is more frequent

The measurement accuracy of all measuring devices must be within a ± 5% accuracy range. When the measurement accuracy of a measuring device exceeds the ± 5% range, the appropriate corrective actions must be taken on the device, in accordance with the manufacturer specifications.

After the corrective actions, the measuring device must be rechecked for accuracy. If the measurement accuracy of the measuring device is still not within the ± 5% range, the measuring device must be calibrated by the manufacturer or by a third party certified for that purpose and following manufacturer specifications, no more than 2 months after the accuracy check conducted following the corrective actions. If the measuring device was manufactured with no possibility of calibration, it must be replaced no more than 2 months after the accuracy check conducted following the corrective actions.

When the measurement accuracy of a measuring device indicates a reading outside of a ± 5% accuracy range, the following conditions must be followed for the entire period from the last time the measuring device showed a reading within ± 5% accuracy until the measuring device shows a return to ± 5% accuracy:

- When the inaccuracy of the measuring device indicates an under-reporting, the measured values must be used without correction
    - An under-reporting means a value indicated by the project measuring device is more conservative than the value indicated by the equipment used for accuracy checks
- When the inaccuracy of the measuring device indicates an over-reporting, the measured values must be corrected by the percentage that the accuracy of the measuring device deviated from the ± 5% range
    - An over-reporting means a value indicated by the project measuring device is less conservative than the value indicated by the equipment used for accuracy checks

9.4 Missing data

If a measuring device fails to produce data as required in Section 9.2, missing data may be substituted following the requirements in this section. If missing data cannot be substituted as per the applicable requirements, no GHG emission reductions can be quantified for the issuance of offset credits for the period during which data is missing.

Missing data from a measuring device may only be substituted if the following two conditions are met during the period of missing data:

- The operational status of the eligible destruction device(s) can be demonstrated in accordance with the requirements in Section 9.5

- The proper functioning of the thermocouple or destruction device monitoring instrument(s) referred to in Section 9.5 can be demonstrated with the appropriate data

Missing data from a flow meter or methane analyzer may only be substituted in accordance with the following rules:

- LFG volume data may be substituted when CH_4 content data is not missing and the methane analyzer is demonstrated to be functioning properly; or
- CH_4 content data may be substituted when LFG volume data is not missing and the flow meter is demonstrated to be functioning properly.

For a project with LFG volume or CH_4 content data missing for a period of up to 7 consecutive days, the proponent must use the appropriate substitution method set out in Table 4 to substitute the data.

For data missing for more than 7 consecutive days, only the data for the period of up to 7 days may be substituted. No data may be substituted for the period after the 7th consecutive day, and no GHG emission reductions may be quantified for the issuance of offset credits for that period.

Table 4: Missing data substitution methods

Missing data period	Substitution method
Less than 6 consecutive hours	Use the average of the 4 hours immediately prior to **and** after the missing data period.
6 to less than 24 consecutive hours	Use the 95% upper or lower confidence limit of the 72 hours prior to **or** after the missing data period, whichever results in greater conservativeness.
1 to 7 consecutive days	Use the 90% upper or lower confidence limit of the 72 hours prior to **or** after the missing data period, whichever results in greater conservativeness.

In the event that periods of missing data occur more than once during the reporting period, data may be substituted to quantify:

- no more than 5% of the GHG emission reductions for the reporting period, if the GHG emission reductions are less than 100,000 tonnes of CO_2e; or
- no more than 2% of the GHG emission reductions for the reporting period, if the GHG emission reductions are equal to or greater than 100,000 tonnes of CO_2e

9.5 Operational status of eligible destruction devices

The operational status of the eligible destruction device(s) must be monitored with a destruction device monitoring instrument and recorded at least hourly to ensure LFG combustion is occurring.

For a flare (open or enclosed), the operational status must be determined based on data from a thermocouple. The thermocouple must indicate that the flare temperature meets or exceeds 260˚C, the minimum temperature for CH_4 destruction. If the temperature is below 260˚C, no GHG emission reductions can be quantified for the period during which the temperature remains below 260˚C.

For all other eligible destruction devices listed in Table 1, the destruction device monitoring instrument must monitor and measure an indicator of operational status appropriate for the destruction device such

as energy output. If the operational status is not monitored and an indicator is not measured, no GHG emission reductions can be quantified for the period during which monitoring data is not measured.

In cases where LFG is combusted in an eligible destruction device located at an adjacent destruction facility, monitoring data demonstrating the operational status of the eligible destruction device must be made available to the proponent, otherwise the GHG emission reductions can not be included in the quantification.

If an eligible destruction device, thermocouple or other destruction device monitoring instrument is not operating or functioning properly in accordance with the manufacturer specifications, no GHG emission reductions can be quantified for the period during which they are not operating or functioning properly.

10.0 Records

In addition to the record keeping requirements specified in the Regulations, the proponent must keep records of all data and information that support the implementation of the project and verification, including invoices, contracts, metered results, maintenance records, calculations, databases, photographs, and calibration records. The records must be kept and retained at the location and for the period of time specified in the Regulations. These records requirements apply to the entire project site, including the landfill site and any adjacent destruction facility, all project activities, eligible destruction devices, measuring devices or meters and monitoring instruments, as applicable.

10.1 Project site

The proponent must keep a record of the information about the project site, including:

- documentation demonstrating the quantity of waste in place and/or waste received/disposed per year at the landfill
- documentation related to all operating permits for the landfill site, including their effective dates and any details related to LFG recovery and combustion
- documentation providing details of the landfill cover system and CH_4 oxidation technologies in place, including the proportion of the landfill area that is covered and the installation date for all landfill covers (by landfill cell or discrete section, if applicable) and CH_4 oxidation technologies
- documentation demonstrating the geographic boundaries of the active LFG recovery system within the project site

10.2 Project activities

The proponent must keep a record of the information about the project activities, including:

- documentation related to project design considerations for the installation and safe operation of the active LFG recovery system and the eligible destruction device(s)
- documentation demonstrating the installation date of the active LFG recovery system and eligible destruction device(s) and the first day LFG actively recovered from within the project site is combusted in the eligible destruction device(s) (project start date)
- details of fossil fuel and electricity consumed
    - For meters under control of the proponent, this includes:

        - documentation describing all fossil fuel and/or electricity meters used, including the meter model number or serial number
        - manufacturer specifications for the maintenance and calibration of each meter
        - documentation indicating the proper functioning of each meter in accordance with the manufacturer specifications
    - For meters that are not under control of the proponent:
        - reasonable efforts must be made to obtain documentation describing all fossil fuel and/or electricity meters used and demonstrating that manufacturer specifications for maintenance and calibration have been met during the reporting period
    - Documentation describing the location and arrangement of all fossil fuel and/or electricity meters
    - Metered quantities or purchase records that indicate the quantity and types of fossil fuel and/or quantity of electricity consumed by the project

10.3 Eligible destruction devices

The proponent must keep a record of the information about the eligible destruction device(s) including:

- documentation describing the eligible destruction device(s) included in the project
- manufacturer specifications for the operation and maintenance of the eligible destruction device(s) included in the project
- if applicable, the testing data and documentation pertaining to the device-specific destruction efficiency for the eligible destruction device(s) included in the project
- documentation describing the location and arrangement of the eligible destruction device(s), including if an eligible destruction device is located at an adjacent destruction facility
- data indicating the operational status of the eligible destruction device(s) and records demonstrating that the equipment is operating according to the manufacturer specifications
- a copy of the agreements as per Section 4.2, if applicable
- documentation demonstrating the sale of any LFG to be combusted at the landfill site or adjacent destruction facility, directly injected into a natural gas network, and/or compressed or liquefied prior to transport and injection into a natural gas network, including the actual quantities sold during the reporting period, if applicable

10.4 Displacement of fossil fuels

If applicable, the proponent must keep a record of the information about the displacement of fossil fuels by eligible LFG, as per Section 3.1 and Section 4.3, including:

- documentation demonstrating that an energy-generating device combusting fossil fuel was:
    - in operation at the project site, including adjacent destruction facilities, for at least 3 years before the project start date
    - replaced by or converted to an eligible destruction device combusting LFG recovered from the landfill
- documentation, such as a purchase invoice, indicating the type and quantity of fossil fuel historically combusted by the device replaced by or converted to an eligible destruction device during the 3 years before the project start date

- metered quantities of eligible LFG having displaced fossil fuels

10.5 Measuring devices and other equipment

The proponent must keep a record of the information about the measuring devices and other equipment in the project, including:

- details about the measuring devices including:
    - documentation describing the device type, model number and/or serial number for each measuring device included in the project, including flow meters, methane analyzers, temperature or pressure gauges, thermocouples, and/or destruction device monitoring instruments
    - manufacturer specifications for the maintenance and calibration of each measuring device included in the project
    - documentation describing the location and arrangement of all measuring devices included in the project, including if a measuring device is located at an adjacent destruction facility
    - documentation indicating the proper functioning of each measuring device included in the project in accordance with the manufacturer specifications
- the maintenance records for the active LFG recovery system, destruction devices and measuring devices, including records of accuracy checks
- documentation describing the corrective measures applied if a measuring device or meter fails to meet the requirements for measurement accuracy
- the calibration certificates and/or other records, or as applicable the on-site validation certificates and/or other records, which indicate calibration or calibration validation date, time, and results from either the manufacturer or a third-party certified for that purpose for each measuring device or meter

10.6 Quantification

The proponent must keep a record of all information and data used to support the quantification of the GHG emission reductions including:

- all uncorrected LFG volume data, if a flow meter does not automatically correct volume
- measured temperature and pressure data for the LFG, if a flow meter does not automatically correct volume
- all LFG volume data, corrected to the reference temperature and pressure conditions, either automatically or using Equation 5
- all LFG CH_4 content data

11.0 Reporting

In addition to the reporting requirements specified in the Regulations, the proponent must include the following in project reports.

In the initial project report, the proponent must include:

- final design/implementation document showing the flow of landfill gas from wells to eligible destruction device(s) and arrangement of measuring devices, such as final piping and instrumentation diagram (P&ID)
- final design/implementation document showing the installation and arrangement of the thermocouple or destruction device monitoring instrument(s) of the eligible destruction device

In any project report, the proponent must include:

- the quantified GHG emissions for each SSR included in the baseline and project scenarios in t CO_2e for each full or partial calendar year covered by the reporting period
- data indicating the operational status of the eligible destruction devices, as per Section 9.5
- data indicating the amount of fossil fuel and electricity used for the period covered by the project report