Landfill Methane Recovery and Destruction

Federal Offset Protocol

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Environment and Climate Change Canada
Environnement et Changement climatique Canada

Canada

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Forward

The Federal GHG Offset System is being developed under Part 2 of the Greenhouse Gas Pollution Pricing Act (GGPPA). The proposed Greenhouse Gas Offset Credit System Regulations (Canada) were published in Canada Gazette, Part I (PDF), on March 6, 2021.

The Federal Greenhouse Gas (GHG) Offset System is under development, to encourage cost-effective domestic GHG emissions reductions from activities that are not covered by carbon pollution pricing and that go beyond legal requirements.

The Federal GHG Offset System will consist of:

- regulations to implement the operational aspects of the system;
- a tracking system to register offset projects, issue and track offset credits, and share key information through a public registry; and
- federal offset protocols that establish the approach for quantifying GHG emissions reductions for a given project type.

Federal offset protocols set out a consistent approach for quantifying GHG emissions reductions for a given project type, including clear rules for establishing baselines for approved offset project activities. Only project activities following an approved federal offset protocol and meeting all regulatory requirements will be able to generate credits in the Federal GHG Offset System.

Text in blue boxes is provided throughout this draft version for context but will not be included in the final protocol.

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1.0 Introduction

Methane (CH_4) emissions from landfills are generated by the anaerobic decomposition of organic material in the buried solid waste. Installation of landfill gas (LFG) recovery and destruction systems allows for the destruction of this landfill CH_4, instead of allowing it to be passively released to the atmosphere.

This *Landfill Methane Recovery and Destruction Protoco*l is intended for use by a Proponent implementing LFG recovery and destruction systems to generate federal offset credits under the *Greenhouse Gas Offset Credit System Regulations (Canada)* [1].

The Proponent must follow the methodology and requirements contained within this protocol to quantify and report greenhouse gas (GHG) emission reductions achieved from the destruction of landfill CH_4. Emission reductions under this protocol cannot be generated from using LFG for energy generation or the associated displacement of GHG emissions from fossil fuel use or grid-delivered electricity.

This protocol is designed to ensure the complete, consistent, transparent, accurate, and conservative quantification of GHG emission reductions achieved as a result of implementing the project activities.

[1] Draft Regulations are posted in Canada Gazette, Part 1, Volume 155, Number 10: https://canadagazette.gc.ca/rp-pr/p1/2021/2021-03-06/html/reg1-eng.html

2.0 Terms and Definitions

Act

means the *Greenhouse Gas Pollution Pricing Act (GGPPA)*[2].

active recovery

means the recovery of landfill gas by a system that includes gas collection wells, connective piping, blowers, and other technologies to create a pressure gradient and actively extract landfill gas. This does not include passive venting.

biogenic carbon dioxide (CO_2) emissions

means CO_2 emissions resulting from the decomposition or destruction of organic material, including those produced from the destruction of landfill CH_4; they are considered to be a natural part of the carbon cycle.

destruction

means the combustion of landfill gas and the resulting conversion of landfill CH_4 into biogenic CO_2.

eligible destruction device

means a device, listed in Table 1, that can destroy landfill CH_4 and generate federal offset credits.

Global Warming Potential (GWP)

means a metric representing a greenhouse gas' ability to trap heat in the atmosphere compared to carbon dioxide, as outlined in Schedule 3 to the Act.

landfill

means an identifiable area of land where municipal solid 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 CH_4, CO_2, and other compounds in low concentrations.

landfill methane (landfill CH_4)

means the CH_4 portion of LFG.

project site

means the area from which LFG is recovered and where it is destroyed in the eligible destruction device(s).

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[2] https://laws-lois.justice.gc.ca/eng/acts/g-11.55/

3.0 Baseline Conditions

3.1 Baseline Scenario

The following baseline scenario condition must apply in order for the project to be eligible under this protocol:

- Landfill gas (LFG) is not actively recovered from within the project site and destroyed in an eligible destruction device identified in Table 1 prior to the project start date.

4.0 Project Conditions

4.1 Project Scenario

The project must involve the active recovery of LFG and its destruction by an eligible destruction device. Each project must have a minimum of one eligible destruction device and flares (enclosed and open) must be located within the landfill.

4.2 Eligible Project Activities & Equipment

Eligible project activities include the following:

- Installation and operation of active LFG recovery system infrastructure including a LFG collection wellfield and blowers at a landfill. If a landfill is currently actively recovering and destroying LFG, a project can occur in a landfill cell that has no existing recovery system infrastructure in place, provided the Proponent can demonstrate the project meets the baseline scenario condition set out in Section 3.1.
- Installation and operation of the eligible destruction device(s). Eligible destruction devices (other than a flare) can be located outside the landfill provided agreements between the Proponent and the end user of the LFG (e.g., an industrial facility purchasing the landfill gas from the Proponent), are established and the GHG reductions are not claimed by the end user.

Only the destruction devices listed in Table 1 below are eligible for use under this protocol.

Table 1: Eligible destruction devices

Type	Description
Enclosed Flare located at the landfill	A device with an insulated cylinder stack surrounding a burner manifold and combustion/cooling air louvers, which combusts and destroys a gas.
Open Flare located at the landfill	A device with a pilot flame at the top of a vertical stack that is exposed to atmosphere, which combusts and destroys a gas.
Boiler	A device that combusts a fuel in order to heat a fluid, such as water or leachate, generating vapour which 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 (i.e. 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 various loads (i.e. a generator producing electricity).

5.0 Additionality

5.1 Legal Additionality

GHG reductions achieved by the project must not have otherwise occurred due to federal, provincial or territorial regulations, municipal by-laws, or any other legally binding mandates such as operating permits requiring the landfill to recover and destroy all or a portion of LFG. This includes regulations related to the control of GHG emissions from the landfill or control of the release of LFG for safety reasons (to reduce potential for an explosion), odor control, etc. A landfill that is legally required to recover and destroy a portion of its LFG is not permitted to generate offset credits for any LFG recovery and destruction beyond its legal requirement.

If a project is implemented at a landfill that subsequently becomes subject to federal or provincial/territorial regulations, municipal by-laws, or any other legally binding mandates such as operating permits requiring the complete or partial installation of LFG recovery and destruction systems at the landfill, the GHG emission reductions achieved by the project may be quantified until the date that the installation and operation of the LFG recovery and destruction system is legally required.

As per the Regulations, the reductions can only be additional if those reductions were not required by law or the result of activities that are required by law.

5.2 Provincial or Federal Pricing Mechanisms for GHG Emissions

Any emission reductions from landfills that are included in a facility's GHG emission total reported under a federal, provincial or territorial pricing mechanism for GHG emissions are not eligible for federal offset credits.

GHG reductions due to the displacement of fossil fuels or grid-delivered electricity with LFG are not eligible for offset credits.

As per the Regulations, the reductions can only be additional if those reductions are from sources, sinks and reservoirs that are not subject to provincial or federal pricing mechanisms for GHG emissions.

6.0 General Requirements

6.1 Project Start Date

The start date of a project corresponds to the first day LFG recovered from the project site is destroyed in an eligible destruction device.

As per the Regulations, all projects must have started on or after January 1, 2017

6.2 Crediting Period

Federal offset projects implemented under this protocol have a crediting period specified in the Regulations.

6.3 Crediting Period Renewal

Federal offset projects implemented under this protocol are eligible for crediting period renewal as provided in the Regulations.

6.4 Aggregation

There are no additional provisions regarding aggregation for this project type.

6.5 Project Location & Geographic Boundaries

The Proponent must document and report the location and geographic boundaries of the project, including the physical location of the landfill or relevant landfill cell(s).

If LFG is destroyed in an eligible destruction device that is not located within the landfill, the Proponent must provide the location of each site where the destruction of LFG is carried out.

6.6 Environmental and Other Safeguards

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

7.0 Project GHG Boundary

The Project GHG Boundary (Figure 1) contains the eligible project activities and the GHG sources, sinks, and reservoirs (SSRs) that shall be assessed by the Proponent in order to determine the total reductions in GHG emissions achieved by the eligible project activities relative to the baseline scenario.

Three GHGs are relevant to the SSRs in this protocol: CO_2, CH_4, and nitrous oxide (N_2O). CO_2 emissions from the decomposition of organic material and destruction of landfill CH_4 are considered biogenic and are excluded from the emissions reductions calculations in this protocol.

Figure 1: Illustration of the Project GHG Boundary

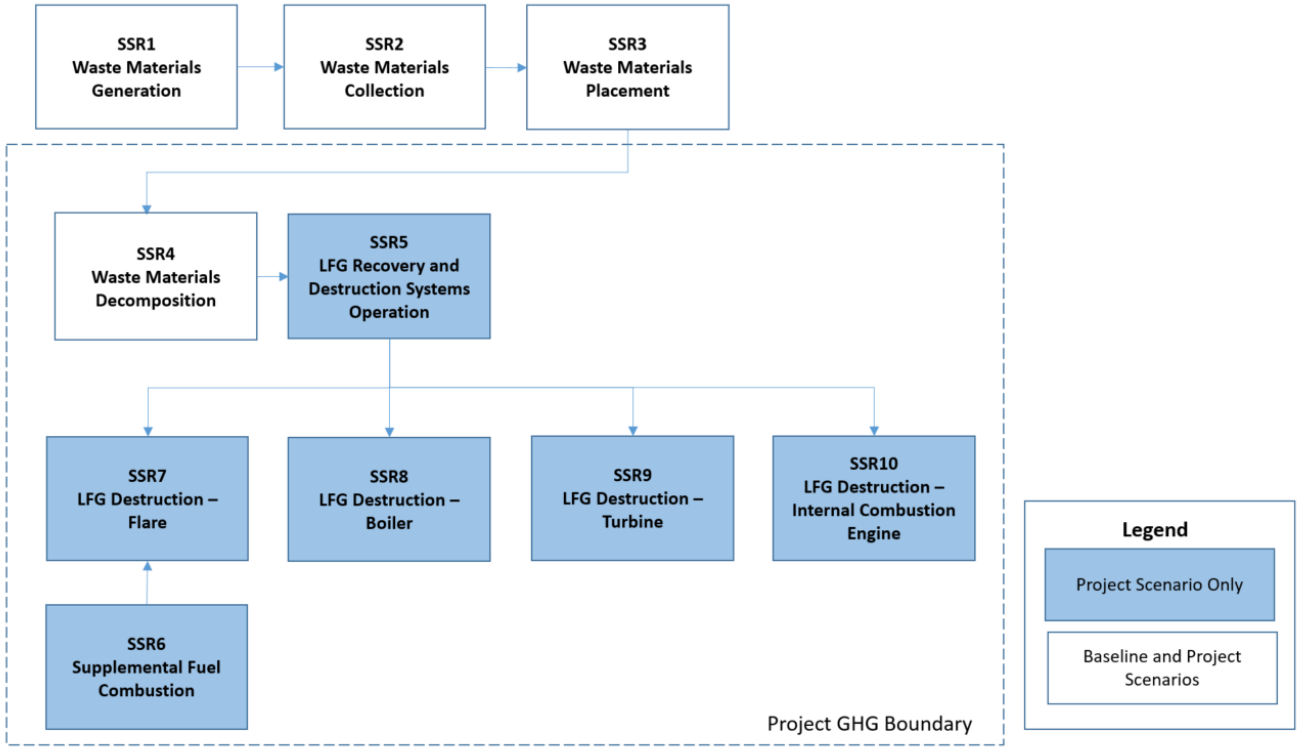

Table 2 provides additional details on the relevant SSRs identified for the baseline and project scenarios, as well as justification for their inclusion or exclusion in the quantification of emission reductions. The Proponent must quantify and report on each of the "included" SSRs identified, if applicable.

Table 2: Details on Baseline and Project Scenario SSRs

SSR	Title	Description	Type	Project or Baseline	GHG[3]	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:** GHG emissions from this source are assumed to be equal in the baseline and project scenarios.
					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.	Related	Baseline (B2) Project (P2)	CO_2	**Excluded:** GHG emissions from this source are assumed to be equal in the baseline and project scenarios.
					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:** GHG emissions from this source are assumed to be equal in the baseline and project scenarios.
					CH_4	
					N_2O	
4	Waste Materials Decomposition	Anaerobic decomposition of waste materials in the landfill/landfill cell.	Controlled	Baseline (B4)	CH_4	**Included:** CH_4 emissions quantified based on landfill CH_4 recovered in the project scenario, using Equation 2.
					N_2O	**Excluded:** N_2O emissions from anaerobic decomposition are assumed to be negligible.
5	LFG Recovery and Destruction	Combustion of fossil fuels or consumption of grid electricity for the operation of the	Fossil Fuels: Controlled	Project (P5)	CO_2	**Included**: Quantified using Equation 6 and Equation 7.
					CH_4	

[3] Biogenic CO_2 emissions from SSR 4; SSR 7; SSR 8, SSR 9, and SSR 10 are not quantified. This is consistent with *Penman, J & Galbally, I & Hiraishi, T & Nyenzy, B & Emmanul, S & Buendia, L & Hoppaus, R & Martinsen, T & Meijer, J & Miwa, K & Tanabe, K. (2001). IPCC Good Practise Guidance and Uncertainty Management in National Greenhouse Gas Inventories Chapter 5 (Waste)*

SSR	Title	Description	Type	Project or Baseline	GHG[3]	Included or Excluded
	Systems Operation	LFG recovery and destruction systems (e.g., blowers, gas purification or upgrading systems, destruction devices, conveyance of LFG to end user facility).	Electricity: Related		N_2O	
6	Supplemental Fuel Combustion	Combustion of supplemental fossil fuel to support the operation of the eligible flare.	Controlled	Project (P6):	CO_2	**Included:** Quantified based on combustion of supplemental fossil fuel in the eligible flare using Equation 8.
					CH_4	
					N_2O	
7	LFG Destruction – Flare	Destruction of LFG in an eligible flare, as identified in Table 1.	Controlled	Project (P7)	CH_4	**Included:** Quantified based on undestroyed landfill CH_4 and N_2O from the destruction of LFG in the eligible flare using Equation 9 and Equation 10.
					N_2O	
8	LFG Destruction – Boiler	Destruction LFG in an eligible boiler, as identified in Table 1.	Controlled	Project (P8)	CH_4	**Included:** Quantified based on undestroyed CH_4 and N_2O from the destruction of LFG in an eligible boiler using Equation 9 and Equation 10.
					N_2O	
9	LFG Destruction – Turbine	Destruction of LFG in an eligible turbine, as identified in Table 1.	Controlled	Project (P9)	CH_4	**Included:** Quantified based on undestroyed CH_4 and N_2O from the destruction of LFG in an eligible turbine using Equation 9 and Equation 10.
					N_2O	
10	LFG Destruction – Internal Combustion Engine	Destruction of LFG in an eligible internal combustion engine, as identified in Table 1.	Controlled	Project (P10)	CH_4	**Included** Quantified based on undestroyed CH_4 and N_2O from the destruction of LFG in an eligible internal combustion engine using Equation 9 and Equation 10.
					N_2O	
					CH_4	
					N_2O	

8.0 Quantification Methodology

This section contains the equations that must be followed to calculate baseline and project scenario emissions, which are subsequently used to calculate the total GHG emission reductions achieved by the project.

Raw data must be converted to align with the units presented in the quantification methodology, if necessary (see Section 8.5 for a tabulated summary). Schedule A provides emission factors and additional variables that must be referenced and applied to complete the quantification. Emission factors will also need to be converted to align with the units presented in the quantification methodology.

Baseline scenario GHG emissions are those that would have occurred in the absence of the project, as quantified from SSRs within the Project GHG Boundary. Project scenario GHG emissions are the actual GHG emissions that occur from SSRs within the Project GHG Boundary.

The total GHG emission reductions achieved by the project are quantified by deducting the project scenario GHG emissions from the baseline scenario GHG emissions as outlined in section 8.4.

Both baseline and project emissions calculations must include all the emissions that occurred during the project reporting period, and must include sub-totals in tCO_2e for each calendar year to support serialization of the resulting offset credits by vintage year.

8.1 Baseline Scenario Quantification

The Proponent must follow the below quantification methodology to quantify the baseline scenario GHG emissions, based on the included SSRs outlined in Table 2.

This protocol quantifies the baseline scenario emissions through the use of a dynamic baseline approach based on measurements made in the project scenario instead of modelling the emissions generated by the landfill in the baseline scenario. This means that the GHG emissions in the baseline scenario are calculated based on the quantity of landfill CH_4 that is recovered in the project scenario, which may vary over time.

Equation 1: Total baseline scenario GHG emissions

$$BE = \mathrm{CH_4REC_{PR}} \times (1 - \mathrm{OX})$$

Where,			Units
BE	=	Baseline scenario GHG emissions during a calendar year covered in the reporting period	*t CO_2e*
$\mathrm{CH_4REC_{PR}}$	=	Total quantity of landfill CH_4 recovered by the LFG recovery system during a calendar year covered in the reporting period, as per Equation 2	*t CO_2e*
OX	=	Factor for the oxidation of landfill CH_4 by bacteria in soil or materials covering the waste	-

Baseline emissions are quantified based on the assumption that the landfill CH_4 recovered in the project scenario would have been passively released from the landfill to the atmosphere in the baseline scenario and, therefore, would have been subject to oxidation by the landfill cover. Oxidation of landfill CH_4 emissions in the landfill cover must be accounted for in the baseline in the following manner:

- Use a CH_4 oxidation factor of 0% for landfill sites with a synthetic liner covering the entire landfill area
- Use a CH_4 oxidation factor of 10% for landfill sites without a synthetic liner covering the entire landfill area

Equation 2 and Equation 3 must be used to calculate the quantity of landfill CH_4 recovered by the LFG recovery system.

Equation 2: Quantity of landfill CH_4 recovered by the LFG recovery system attributed to the anaerobic decomposition of waste (SSR B4)

$$CH_4REC_{PR} = \left[\frac{\sum_i^n (Q_i) \times \rho_{CH_4}}{1000}\right] \times GWP_{CH_4}$$

Where,			Units
CH_4REC_{PR}	=	Total quantity of landfill CH_4 recovered by the LFG recovery system during a calendar year covered in the reporting period (SSR B4)	*t CO_2e*
Q_i	=	Total volume of landfill CH_4 sent to eligible destruction device, i, during a calendar year covered in the reporting period, as per Equation 3	*m^3 CH_4*
ρ_{CH_4}	=	Reference density of CH_4, as set out in Schedule A – Reference Condition Variables	*kg CH_4/m^3 CH_4*
GWP_{CH_4}	=	Global Warming Potential of CH_4, as set out in Schedule 3 to the Act	*t CO_2e/t CH_4*[4]
1000	=	Conversion factor, kilograms to tonnes	*kg / t*
n	=	Number of eligible destruction devices	-
i	=	Eligible destruction device	-

[4] While GWP values are constants used as multipliers, this quantification methodology assigns units of equivalent mass in order to convert one unit of CH_4 or N_2O to one unit of CO_2e when it is released directly into the atmosphere.

Equation 3: Volume of landfill CH_4 sent to each eligible destruction device

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

Where,			Units
Q_i	=	Total volume of landfill CH_4 sent to eligible destruction device, i, during a calendar year covered in the reporting period	*m^3 CH_4*
$LFG_{i,t}$	=	Corrected volume of LFG sent to eligible destruction device, i, during measurement period, t, as per automatic correction or Equation 4	*m^3 LFG*
$LFG_{CH_4,t}$	=	Average CH_4 content of the LFG in measurement period, t	*m^3 CH_4/m^3 LFG*
n	=	Number of measurement periods in a calendar year covered in the reporting period	-
t	=	Measurement period	-

All flow meter data must be corrected to the reference temperature and pressure conditions, as set out in Schedule A – Reference Condition Variables. If the flow meter does not automatically correct the measured volume to the reference temperature and pressure conditions, the Proponent must calculate the corrected volume following Equation 4. Equation 4 does not need to be used if the flow meter automatically corrects the volume.

Equation 4: Volume of LFG sent to each eligible destruction device, corrected for temperature and pressure

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

Where,			Units
$LFG_{i,t}$	=	Corrected volume of LFG sent to eligible destruction device, i, during measurement period, t	*m^3 LFG*
LFG_{UC}	=	Uncorrected volume of LFG sent to eligible destruction device, i, during measurement period, t	*m^3 LFG*
T_m	=	Measured temperature of the LFG for the measurement period, t	*K*
T_{ref}	=	Reference temperature of the LFG, as set out in Schedule A – Reference Condition Variables	*K*
P_m	=	Measured pressure of the LFG for the measurement period, t	*kPa*
P_{ref}	=	Reference pressure of the LFG, as set out in Schedule A – Reference Condition Variables	*kPa*

8.2 Project Scenario Quantification

The Proponent must follow the below quantification methodology to quantify the project scenario GHG emissions, based on the included SSRs outlined in Table 2.

The project scenario emissions correspond to the emissions attributed to energy inputs into the LFG recovery and destruction systems, emissions from supplemental fossil fuel for flare operation, and emissions released to the atmosphere from the eligible destruction devices.

Equation 5: Total project scenario GHG emissions

$$PE = FF_{RD,GHG} + EL_{RD,GHG} + FF_{supp,GHG} + LFG_{GHG}$$

Where,			Units
PE	=	Project scenario GHG emissions during a calendar year covered in the reporting period	*t CO_2e*
$FF_{RD,GHG}$	=	Total quantity of GHG emissions attributed to the use of fossil fuels for the operation of the LFG recovery and destruction systems during a calendar year covered in the reporting period, as per Equation 6 (SSR P5)	*t CO_2e*
$EL_{RD,GHG}$	=	Total quantity of GHG emissions attributed to the use of grid electricity for the operation of the LFG recovery and destruction systems during a calendar year covered in the reporting period, as per Equation 7 (SSR P5)	*t CO_2e*
$FF_{supp,GHG}$	=	Total quantity of GHG emissions attributed to the use of supplemental fossil fuels to support the operation of the eligible flare during a calendar year covered in the reporting period, as per Equation 8 (SSR P6)	*t CO_2e*
LFG_{GHG}	=	Total quantity of GHG emissions attributed to the destruction of LFG in the eligible destruction device(s) during a calendar year covered in the reporting period, as per Equation 9 and Equation 10 (SSR P7+ SSR P8 + SSR P9 + SSR 10)	*t CO_2e*

Equation 6 and Equation 7 quantify the emissions from the operation of the LFG recovery and destruction systems, which correspond to SSR P5. The Proponent must use the appropriate equation(s) dependent on the energy inputs required for the operation of the LFG recovery and destruction systems. This includes blowers, gas purification or upgrading systems, destruction devices (other than flares), or equipment for the conveyance of LFG to an end user facility. If both fossil fuels and grid electricity are used for these purposes, the Proponent must use the summation of Equation 6 and Equation 7 to quantify SSR P5.

Equation 6: Quantity of GHG emissions attributed to the use of fossil fuels for the operation of the LFG recovery and destruction systems (SSR P5)

$$FF_{RD,GHG} = \sum_{j}^{m} \left[\frac{\left(FF_{RD,j} \times EF_{CO_2,j}\right) + \left(FF_{RD,j} \times EF_{CH_4,j} \times GWP_{CH_4}\right) + \left(FF_{RD,j} \times EF_{N_2O,j} \times GWP_{N_2O}\right)}{1000} \right]$$

Where,			Units
$FF_{RD,GHG}$	=	Total quantity of GHG emissions attributed to the use of fossil fuels for the operation of the LFG recovery and destruction systems during a calendar year covered in the reporting period (SSR P5)	*t CO_2e*
$FF_{RD,j}$	=	Volume of fossil fuel, j, consumed by the LFG recovery and destruction systems during a calendar year covered in the reporting period	*m^3*
$EF_{CO_2,j}$	=	CO_2 emission factor for fossil fuel, j, as set out in Schedule A – Fossil Fuel Emission Factors	*kg CO_2/m^3*
$EF_{CH_4,j}$	=	CH_4 emission factor for fossil fuel, j, as set out in Schedule A – Fossil Fuel Emission Factors	*kg* CH_4/m^3
GWP_{CH_4}	=	Global Warming Potential of CH_4, as set out in Schedule 3 to the Act	*kg CO_2e/kg CH_4*
$EF_{N_2O,j}$	=	N_2O emission factor for fossil fuel, j, as set out in Schedule A – Fossil Fuel Emission Factors	*kg* N_2O */m^3*
GWP_{N_2O}		Global Warming Potential of N_2O, as set out in Schedule 3 to the Act	*kg CO_2e/kg N_2O*
1000	=	Conversion factor, kilograms to tonnes	*kg / t*
m	=	Number of types of fossil fuels	-
j	=	Type of fossil fuel	-

Equation 7: Quantity of GHG emissions attributed to the use of grid electricity for the operation of the LFG recovery and destruction systems (SSR P5)

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

Where,			Units
$EL_{RD,GHG}$	=	Total quantity of GHG emissions attributed to the use of grid electricity for the operation of the LFG recovery and destruction systems during a calendar year covered in the reporting period (SSR P5)	*t CO_2e*
EL_{RD}	=	Total grid electricity consumed by the LFG recovery and destruction systems during a calendar year covered in the reporting period	*MWh*

$EF_{EL,GHG}$	=	GHG consumption intensity emission factor for grid electricity from the project jurisdiction, as set out in Schedule A – Electricity Emission Factors	*kg CO_2e/MWh*
1000	=	Conversion factor, kilograms to tonnes	*kg / t*

Equation 8 must be used to calculate emissions from supplemental fossil fuel used for flares, which corresponds to SSR P6.

Equation 8: Quantity of GHG emissions attributed to the use of supplemental fossil fuels for the operation of the eligible flare (SSR P6)

$$FF_{supp,GHG} = \sum_{j}^{m}\left[\frac{(FF_{supp,j} \times EF_{CO_2,j}) + (FF_{supp,j} \times FF_{CH_4,j} \times \rho_{CH_4} \times (1 - DE_{CH_4}) \times GWP_{CH_4}) + (FF_{supp,j} \times EF_{N_2O,j} \times GWP_{N_2O})}{1000}\right]$$

Where,			Units
$FF_{supp,GHG}$	=	Total quantity of GHG emissions attributed to the use of supplemental fossil fuels to support the operation of the eligible flare during a calendar year covered in the reporting period (SSR P6)	*t CO_2e*
$FF_{supp,j}$	=	Volume of supplemental fossil fuel, j, consumed by the eligible flare during a calendar year covered in the reporting period	*m^3*
$EF_{CO_2,j}$	=	CO_2 emission factor for supplemental fossil fuel, j, as set out in Schedule A – Fossil Fuel Emission Factors	*kg CO_2/m^3*
$FF_{CH_4,j}$	=	Average CH_4 content of supplemental fossil fuel, j, obtained from supplier	*m^3 CH_4 /m^3*
ρ_{CH_4}	=	Reference density of CH_4, as set out in Schedule A – Reference Condition Variables	*kg CH_4/m^3 CH_4*
DE_{CH_4}	=	CH_4 destruction efficiency of the eligible flare, specific to device or as set out in Table 3	-
GWP_{CH_4}	=	Global Warming Potential of CH_4, as set out in Schedule 3 to the Act	*kg CO_2e/kg CH_4*
$EF_{N_2O,j}$	=	N_2O emission factor for supplemental fossil fuel, j, as set out in Schedule A – Fossil Fuel Emission Factors	*kg* N_2O/m^3
GWP_{N_2O}		Global Warming Potential of N_2O, as set out in Schedule 3 to the Act	*kg CO_2e/kg N_2O*
1000	=	Conversion factor, kilograms to tonnes	*kg / t*
m	=	Number of types of supplemental fossil fuels	-
j	=	Type of supplemental fossil fuel	-

Equation 9 and Equation 10 must be used to calculate the quantity of GHGs released to atmosphere due to the destruction of LFG in all eligible destruction devices. Equation 9 determines the undestroyed landfill CH_4 generated from the anaerobic decomposition of waste and released to atmosphere from eligible destruction devices operating in the project scenario. This value is then accounted for within Equation 10, which quantifies the GHG emissions from the destruction of LFG in the eligible destruction devices, corresponding to SSR P7, P8, P9, and P10.

Equation 9: Quantity of undestroyed landfill CH_4 generated from the anaerobic decomposition of waste and released to atmosphere based on destruction efficiency of all eligible destruction devices (SSR P4)

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

Where,			Units
CH_4UND	=	Total quantity of undestroyed landfill CH_4 released to atmosphere during a calendar year covered in the reporting period based on the destruction efficiency of the eligible destruction device(s)	*t CO_2e*
Q_i	=	Total volume of landfill CH_4 sent to eligible destruction device, i, during a calendar year covered in the reporting period, as per Equation 3	*m^3 CH_4*
$DE_{CH_4,i}$	=	CH_4 destruction efficiency of eligible destruction device, i, specific to device or as set out in Table 3	-
ρ_{CH_4}	=	Reference density of CH_4, as set out in Schedule A – Reference Condition Variables	*kg CH_4/m^3 CH_4*
GWP_{CH_4}	=	Global Warming Potential of CH_4, as set out in Schedule 3 to the Act	*t CO_2e/t CH_4*
1000	=	Conversion factor, kilograms to tonnes	*kg / t*
n	=	Number of eligible destruction devices	-
i	=	Eligible destruction device	-

The amount of landfill CH_4 destroyed in each eligible destruction device is dependent on the CH_4 destruction efficiency for each device ($DE_{CH4,i}$). If available, the Proponent must use a device-specific destruction efficiency. Testing for the device-specific destruction efficiency shall be conducted annually, and include at least three test runs, with the accepted final value being one standard deviation below the mean of the measured efficiencies. Only if a device-specific destruction efficiency is not available, may the Proponent reference the appropriate default value as set out in Table 3.

Table 3: Destruction Device Efficiency ($DE_{CH4,i}$)

Eligible Destruction Device	**Efficiency ($DE_{CH4,i}$)**
Enclosed Flare	0.995
Open Flare	0.96
Boiler	0.98
Turbine (micro or large)	0.995
Internal Combustion Engine (stationary or mobile)	0.936

Equation 10 must be used to calculate the quantity of undestroyed landfill CH_4 and generated N_2O emissions released to atmosphere from the destruction of LFG in the eligible destruction devices operating in the project scenario.

Equation 10: Quantity of GHG emissions attributed to the destruction of LFG in the eligible destruction device(s) (SSR P7, P8, P9, P10)

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

Where,			Units
LFG_{GHG}	=	Total quantity of GHG emissions attributed to the destruction of LFG in the eligible destruction device(s) during a calendar year covered in the reporting period (SSR P7+ SSR P8 + SSR P9 + SSR 10)	*t CO_2e*
CH_4UND	=	Total quantity of undestroyed landfill CH_4 released to atmosphere during a calendar year covered in the reporting period based on the destruction efficiency of the eligible destruction device(s)	*t CO_2e*
Q_i	=	Total volume of landfill CH_4 sent to eligible destruction device, i, during a calendar year covered in the reporting period, as per Equation 3	*m^3 CH_4*
ρ_{CH_4}	=	Reference density of CH_4, as set out in Schedule A – Reference Condition Variables	*kg CH_4/m^3 CH_4*
$EF_{LFG,\,N_2O,i}$	=	N_2O emission factor for destruction of LFG in eligible destruction device, i, as set out in Schedule A – Landfill Gas Emission Factors	*kg N_2O / t CH_4*
1000	=	Conversion factor, kilograms to tonnes	*kg / t*
GWP_{N_2O}	=	Global Warming Potential of N_2O, as set out in Schedule 3 to the Act	*t CO_2e/t N_2O*
n	=	Number of eligible destruction devices	-
i	=	Eligible destruction device	-

8.3 Leakage

Market-shifting and activity-shifting leakage do not apply to this project type.

8.4 Total GHG Emission Reductions

The Proponent must use Equation 11 to calculate the total GHG emission reductions achieved by the project for each full or partial calendar year covered in the reporting period.

Equation 11: Total GHG Emission Reductions

$$ER = BE - PE$$

Where,			Units
ER	=	Total GHG emission reductions during a calendar year covered in the reporting period.	*t CO_2e*
BE	=	Baseline scenario GHG emissions during a calendar year covered in the reporting period, as per Equation 1.	*t CO_2e*
PE	=	Project scenario GHG emissions during a calendar year covered in the reporting period, as per Equation 5.	*t CO_2e*

8.5 Summary of Quantification Parameters

Table 4 provides a summary of quantification equations and parameters as well as details regarding measurement and calculation frequency.

Table 4: Quantification Parameters for Landfill Methane Recovery and Destruction Projects

Parameter	Description	Units	Parameter Type	Measurement / Calculation Frequency
Equation 1: $BE = \mathrm{CH_4REC_{PR}} \times (1 - \mathrm{OX})$				
BE	Baseline scenario GHG emissions during a calendar year covered in the reporting period	t CO_2e	Calculated	Each calendar year covered in the reporting period
CH_4REC_{PR}	Total quantity of landfill CH_4 recovered by the LFG recovery system during a calendar year covered in the reporting period	t CO_2e	Calculated See Equation 2	Each calendar year covered in the reporting period
OX	Factor for the oxidation of landfill CH_4 by bacteria in soil or materials covering the waste	N/A	Specified See Section 8.1	Each calendar year covered in the reporting period
Equation 2: $\mathrm{CH_4REC_{PR}} = \left[\frac{\sum_i^n (\mathrm{Q_i}) \times \rho_{\mathrm{CH_4}}}{1000}\right] \times \mathrm{GWP_{CH_4}}$				
CH_4REC_{PR}	Total quantity of landfill CH_4 recovered by the LFG recovery system during a calendar year covered in the reporting period (SSR B4)	t CO_2e	Calculated	Each calendar year covered in the reporting period
Q_i	Total volume of landfill CH_4 sent to eligible destruction device, i, during a calendar year covered in the reporting period	m^3 CH_4	Calculated See Equation 3	Each calendar year covered in the reporting period
ρ_{CH4}	Reference density of CH_4	kg CH_4 /m^3 CH_4	Referenced Schedule A – Reference Condition Variables	N/A
GWP_{CH4}	Global Warming Potential of CH_4	t CO_2e / t CH_4	Referenced Schedule 3 to the Act	Each calendar year covered in the reporting period
Equation 3: $\mathrm{Q_i} = \sum_t^n (\mathrm{LFG_{i,t}} \times \mathrm{LFG_{CH_4,t}})$				
Q_i	Total volume of landfill CH_4 sent to eligible destruction device, i, during a calendar year covered in the reporting period	m^3 CH_4	Calculated	Each calendar year covered in the reporting period

Parameter	Description	Units	Parameter Type	Measurement / Calculation Frequency
$LFG_{i,t}$	Corrected volume of LFG sent to eligible destruction device, i, during measurement period, t	m^3 LFG	Measured **or** Calculated	Measured continuously with volume recorded every measurement period of a maximum of 15 minutes or Calculated as per Equation 4 if flow meter does not automatically correct volume
$LFG_{CH4,t}$	Average CH_4 content of the LFG in measurement period, t	m^3 CH_4/m^3 LFG	Measured	Measured continuously with CH_4 content recorded every measurement period of a maximum of 15 minutes
Equation 4: $LFG_{i,t} = LFG_{UC} \times \frac{T_{ref}}{T_m} \times \frac{P_m}{P_{ref}}$				
$LFG_{i,t}$	Corrected volume of LFG sent to eligible destruction device, i, during measurement period, t	m^3 LFG	Calculated	Each measurement period of a maximum of 15 minutes
LFG_{UC}	Uncorrected volume of LFG sent to eligible destruction device, i, during measurement period, t	m^3 LFG	Measured	Measured continuously with volume recorded every measurement period of a maximum of 15 minutes
T_m	Measured temperature of the LFG for the measurement period, t	K	Measured	Measured continuously with value recorded every measurement period of a maximum of 15 minutes (same frequency as LFG_{UC})

Parameter	Description	Units	Parameter Type	Measurement / Calculation Frequency
T_{ref}	Reference temperature of the LFG	K	Referenced Schedule A – Reference Condition Variables	N/A
P_m	Measured pressure of the LFG for the measurement period, t	kPa	Measured	Measured continuously with value recorded every measurement period of a maximum of 15 minutes (same frequency as LFG_{UC})
P_{ref}	Reference pressure of the LFG	kPa	Referenced Schedule A – Reference Condition Variables	N/A
Equation 5: $PE = FF_{RD,GHG} + EL_{RD,GHG} + FF_{supp,GHG} + LFG_{GHG}$				
PE	Project scenario GHG emissions during a calendar year covered in the reporting period	t CO_2e	Calculated	Each calendar year covered in the reporting period
$FF_{RD,GHG}$	Total quantity of GHG emissions attributed to the use of fossil fuels for the operation of the LFG recovery and destruction systems during a calendar year covered in the reporting period (SSR P5)	t CO_2e	Calculated See Equation 6	Each calendar year covered in the reporting period
$EL_{RD,GHG}$	Total quantity of GHG emissions attributed to the use of grid electricity for the operation of the LFG recovery and destruction systems during a calendar year covered in the reporting period (SSR P5)	t CO_2e	Calculated See Equation 7	Each calendar year covered in the reporting period
$FF_{supp,GHG}$	Total quantity of GHG emissions attributed to the use of supplemental fossil fuels to support the operation of the eligible flare during a calendar year covered in the reporting period (SSR P6)	t CO_2e	Calculated See Equation 8	Each calendar year covered in the reporting period

Parameter	Description	Units	Parameter Type	Measurement / Calculation Frequency
LFG_{GHG}	Total quantity of GHG emissions attributed to the destruction of LFG in the eligible destruction device(s) during a calendar year covered in the reporting period (SSR P7+ SSR P8 + SSR P9 + SSR 10)	t CO_2e	Calculated See Equation 10	Each calendar year covered in the reporting period
Equation 6: $FF_{RD,GHG} = \sum_{j}^{m} \left[\frac{(FF_{RD,j} \times EF_{CO_2,j}) + (FF_{RD,j} \times EF_{CH_4,j} \times GWP_{CH_4}) + (FF_{RD,j} \times EF_{N_2O,j} \times GWP_{N_2O})}{1000} \right]$				
$FF_{RD,GHG}$	Total quantity of GHG emissions attributed to the use of fossil fuels for the operation of the LFG recovery and destruction systems during a calendar year covered in the reporting period (SSR P5)	t CO_2e	Calculated	Each calendar year covered in the reporting period
$FF_{RD,j}$	Volume of fossil fuel, j, consumed by the LFG recovery and destruction systems during a calendar year covered in the reporting period	m^3	Measured **or** Calculated	Measured continuously with volume recorded at least every 15 minutes and summed for the calendar year **or** Calculated from fossil fuel purchasing records and/or equipment specifications and summed for the calendar year
$EF_{CO2,j}$	CO_2 emission factor for fossil fuel, j	kg CO_2/m^3	Referenced Schedule A – Fossil Fuel Emission Factors	Each calendar year covered in the reporting period
$EF_{CH4,j}$	CH_4 emission factor for fossil fuel, j	kg CH_4/m^3	Referenced Schedule A – Fossil Fuel Emission Factors	Each calendar year covered in the reporting period
GWP_{CH4}	Global Warming Potential of CH_4	kg CO_2e/kg CH_4	Referenced	Each calendar year covered in the reporting period

Parameter	Description	Units	Parameter Type	Measurement / Calculation Frequency
			Schedule 3 to the Act	
$EF_{N2O,j}$	N_2O emission factor for fossil fuel, j	kg N_2O /m^3	Referenced Schedule A – Fossil Fuel Emission Factors	Each calendar year covered in the reporting period
GWP_{N2O}	Global Warming Potential of N_2O	kg CO_2e/kg N_2O	Referenced Schedule 3 to the Act	Each calendar year covered in the reporting period
Equation 7: $EL_{RD,GHG} = \frac{EL_{RD} \times EF_{EL,GHG}}{1000}$				
$EL_{RD,GHG}$	Total quantity of GHG emissions attributed to the use of grid electricity for the operation of the LFG recovery and destruction systems during a calendar year covered in the reporting period (SSR P5)	t CO_2e	Calculated	Each calendar year covered in the reporting period
EL_{RD}	Total grid electricity consumed by the LFG recovery and destruction systems during a calendar year covered in the reporting period	MWh	Measured	Measured using meter and summed for the calendar year **<u>or</u>** Calculated from electricity purchasing records and/or equipment specifications and summed for the calendar year
$EF_{EL,GHG}$	GHG consumption intensity emission factor for grid electricity from the project jurisdiction	kg CO_2e/MWh	Referenced Schedule A – Electricity Emission Factors	Each calendar year covered in the reporting period
Equation 8: $FF_{supp,GHG} = \sum_{j}^{m} \left[\frac{(FF_{supp,j} \times EF_{CO_2,j}) + (FF_{supp,j} \times FF_{CH_4,j} \times \rho_{CH_4} \times (1 - DE_{CH_4}) \times GWP_{CH_4}) + (FF_{supp,j} \times EF_{N_2O,j} \times GWP_{N_2O})}{1000}\right]$				
$FF_{supp,GHG}$	Total quantity of GHG emissions attributed to the use of supplemental fossil fuels to support the operation of the eligible flare during a calendar	t CO_2e	Calculated	Each calendar year covered in the reporting period

Parameter	Description	Units	Parameter Type	Measurement / Calculation Frequency
	year covered in the reporting period (SSR P6)			
$FF_{supp,j}$	Volume of supplemental fossil fuel, j, consumed by the eligible flare during a calendar year covered in the reporting period	m^3	Measured **or** Calculated	Measured continuously with volume recorded at least every 15 minutes and summed for the calendar year **or** Calculated from fossil fuel purchasing records and/or equipment specifications and summed for the calendar year
$EF_{CO2,j}$	CO_2 emission factor for supplemental fossil fuel, j	kg CO_2/m^3	Referenced Schedule A – Fossil Fuel Emission Factors	Each calendar year covered in the reporting period
$FF_{CH4,j}$	Average CH_4 content of supplemental fossil fuel, j	m^3 CH_4 $/m^3$	Specified Obtained from supplier	Each calendar year covered in the reporting period
ρ_{CH4}	Reference density of CH_4	kg CH_4/m^3 CH_4	Referenced Schedule A – Reference Condition Variables	N/A
DE_{CH4}	CH_4 destruction efficiency of the eligible flare	-	Referenced Obtained from device-specific testing **or** See Table 3	N/A
GWP_{CH4}	Global Warming Potential of CH_4	kg CO_2e/kg CH_4	Referenced Schedule 3 to the Act	Each calendar year covered in the reporting period

Parameter	Description	Units	Parameter Type	Measurement / Calculation Frequency
$EF_{N2O,j}$	N_2O emission factor for supplemental fossil fuel, j	kg N_2O /m^3	Referenced Schedule A – Fossil Fuel Emission Factors	Each calendar year covered in the reporting period
GWP_{N2O}	Global Warming Potential of N_2O	kg CO_2e/kg N_2O	Referenced Schedule 3 to the Act	Each calendar year covered in the reporting period
Equation 9: $\mathrm{CH_4UND} = \left[\sum_i^n \left[\mathrm{Q_i} \times \left(1 - \mathrm{DE_{CH_4,i}}\right)\right] x \frac{\rho_{CH_4}}{1000}\right] \times \mathrm{GWP_{CH_4}}$				
CH_4UND	Total quantity of undestroyed landfill CH_4 released to atmosphere during a calendar year covered in the reporting period based on the destruction efficiency of the eligible destruction device(s)	t CO_2e	Calculated	Each calendar year covered in the reporting period
Q_i	Total volume of landfill CH_4 sent to eligible destruction device, i, during a calendar year covered in the reporting period	m^3 CH_4	Calculated See Equation 3	Each calendar year covered in the reporting period
$DE_{CH4,i}$	CH_4 destruction efficiency of eligible destruction device, i	N/A	Referenced Obtained from device-specific testing **or** See Table 3	N/A
ρ_{CH4}	Reference density of CH_4	kg CH_4/m^3 CH_4	Referenced Schedule A – Reference Condition Variables	N/A
GWP_{CH4}	Global Warming Potential of CH_4	t CO_2e/t CH_4	Referenced Schedule 3 to the Act	Each calendar year covered in the reporting period
Equation 10: $\mathrm{LFG_{GHG}} = [\mathrm{CH_4UND}] + \left[\sum_i^n \left(\frac{\mathrm{Q_i} \times \rho_{CH_4}}{1000} \times \frac{\mathrm{EF_{LM,N_2O,i}}}{1000}\right) \times \mathrm{GWP_{N_2O}}\right]$				
LFG_{GHG}	Total quantity of GHG emissions attributed to the destruction of LFG in the eligible destruction device(s) during a calendar year covered in the reporting period (SSR P7+ SSR P8 + SSR P9 + SSR 10)	t CO_2e	Calculated	Each calendar year covered in the reporting period

Parameter	Description	Units	Parameter Type	Measurement / Calculation Frequency
CH_4UND	Total quantity of undestroyed landfill CH_4 released to atmosphere during a calendar year covered in the reporting period based on the destruction efficiency of the eligible destruction device(s) (SSR P4)	t CO_2e	Calculated See Equation 9	Each calendar year covered in the reporting period
Q_i	Total volume of landfill CH_4 sent to eligible destruction device, i, during a calendar year covered in the reporting period	m^3 CH_4	Calculated See Equation 3	Each calendar year covered in the reporting period
ρ_{CH4}	Reference density of CH_4	kg CH_4/m^3 CH_4	Referenced Schedule A – Reference Condition Variables	N/A
$EF_{LFG,N2O,i}$	N_2O emission factor for the destruction of LFG in eligible destruction device, i	kg N_2O / t CH_4	Referenced Schedule A – Landfill Gas Emission Factors	Each calendar year covered in the reporting period
GWP_{N2O}	Global Warming Potential of N_2O	t CO_2e/t N_2O	Referenced Schedule 3 to the Act	Each calendar year covered in the reporting period
Equation 11: $ER = BE - PE$				
ER	Total GHG emission reductions during a calendar year covered in the reporting period	t CO_2e	Calculated	Each calendar year covered in the reporting period
BE	Baseline scenario GHG emissions during a calendar year covered in the reporting period	t CO_2e	Calculated See Equation 1	Each calendar year covered in the reporting period
PE	Project scenario GHG emissions during a calendar year covered in the reporting period	t CO_2e	Calculated See Equation 5	Each calendar year covered in the reporting period

9.0 Reversals

This section does not apply to this project type.

9.1 Reversal Risk Management Plan

This section does not apply to this project type.

9.2 Permanence Monitoring

This section does not apply to this project type.

10.0 Environmental Integrity Account

There are no additional provisions regarding the deposit of credits generated into the environmental integrity account.

As per the Regulations, the amount of credits to be deposited into the environmental integrity account for non-sequestration projects is 3% of the total GHG emission reductions.

11.0 Measurement and Data

11.1 Data and Information Management

There are no additional provisions regarding data and information management.

11.2 Measuring Devices

The Proponent is responsible for installing the appropriate measuring devices to ensure the frequency of data measurement outlined in Table 4 is achieved. If LFG is transported from the landfill to an end user, the Proponent must ensure that all measurements (LFG volume, temperature, pressure, CH_4 content) are made as the LFG leaves the landfill and as it is destroyed in the eligible destruction device(s).

The Proponent must ensure the volume and CH_4 content of the LFG recovered from within the project site are measured separately from any other existing LFG recovery system infrastructure at the landfill before being destroyed in an eligible destruction device.

11.2.1 Flow Meters

The LFG recovery and destruction systems shall include permanent flow meters that directly and separately measure the volume of LFG recovered by the project and delivered to each eligible destruction device. If applicable, the volume of any fossil fuels used for the operation of the recovery system or destruction devices must be measured by permanent flow meters. If required, volume data must be converted into cubic metres (m^3) to align with the quantification methodology presented in Section 8.0.

11.2.2 Temperature and Pressure Gauges

If the flow meter automatically corrects the LFG volume to the reference temperature and pressure conditions, no additional temperature and pressure gauges are required.

If the flow meter does not automatically correct the LFG volume, temperature and pressure must be measured separately at the same measurement frequency as the LFG volume (See Section 8.5). The LFG volume data must be corrected from measured conditions to the reference temperature and pressure conditions set out in Schedule A – Reference Condition Variables by using Equation 4.

11.2.3 Methane Analyzers

The LFG recovery and destruction systems shall include permanent CH_4 analyzers (ie. gas chromatographs) that directly measure the CH_4 content in the LFG on a volumetric basis.

11.2.4 Arrangement of Measuring Devices

LFG volume and CH_4 content measurements must be continuous; therefore, all measuring devices must be permanent.

The flow meters and CH_4 analyzers must be placed to ensure the data is representative of the LFG recovered and destroyed by the project.

- Flow meters must be placed to separately measure the volume of LFG delivered into each individual destruction device.
- If the LFG is delivered into each destruction device from a common manifold or header upstream of the destruction devices, one CH_4 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 into each destruction device from separate manifolds or header pipes, a separate CH_4 analyzer is required upstream of each individual destruction device.

Additionally, flow meters and CH_4 analyzers must be placed to:

- measure the volume and CH_4 content of the LFG recovered from the project site separately from any LFG recovered by existing LFG recovery system infrastructure.
- measure the volume and CH_4 content of the LFG before the introduction of any supplemental fossil fuels (if applicable, supplemental fossil fuels must be measured prior to their introduction).

LFG volume, temperature and pressure must be measured under the same conditions (wet or dry basis). CH_4 content should be measured under the same conditions (wet or dry basis) as LFG volume, temperature and pressure. A moisture-removing component may separate a CH_4 analyzer and a flow meter where the CH_4 analyzer is placed upstream of the moisture-removing component (CH_4 content measured on a wet basis), and the flow meter is downstream of the moisture-removing component (LFG volume measured on a dry basis). A moisture-removing component shall not separate a CH_4 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 CH_4 analyzer and a flow meter.

11.3 Quality Assurance (QA) / Quality Control (QC)

Quality Assurance / Quality Control (QA/QC) procedures must be implemented to ensure that all measurements and calculations have been made correctly and can be verified.

The measurement accuracy of measuring devices must show that the measuring device provides a reading that is within a ±5% accuracy range. When the accuracy of the measuring device deviates from the ± 5% range, appropriate corrective action(s) shall be taken, in accordance with the manufacturer's specifications.

After the corrective action(s), the measuring device shall be rechecked for accuracy. If the accuracy of the measuring device is still not within the ± 5% range, the measuring device shall be calibrated by the manufacturer or by a third party certified for that purpose by the manufacturer.

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 the measured values of the inaccurate measuring device can be corrected by the percentage that the instrument deviated from the ± 5% range.

11.4 Missing Data

If measuring devices fail to produce data as required in Table 4, missing data may be substituted using the methodology in this section. If missing data is not substituted using the methodology below, no offset credits will be issued for that period.

Missing data from a measuring device may only be replaced if the following two conditions are met:

1. The operational status of the eligible destruction device(s) can be demonstrated in accordance with the requirements in Section 11.5.
2. The operational status and proper functioning of the thermocouple or destruction device monitoring instrument(s) referred to in Section 11.5 can be demonstrated with the appropriate data.

Missing data from a flow meter or CH_4 analyzer may only be replaced in accordance with the following rules:

- LFG volume may be replaced when CH_4 content is not missing and the CH_4 analyzer is demonstrated to be consistent with normal operations; or
- CH_4 content may be replaced when LFG volume data is not missing and the flow meter is demonstrated to be consistent with normal operations.

For projects that destroy LFG in an eligible destruction device with LFG volume or CH_4 content data missing for a period of up to seven days, the appropriate substitution method from Table 5 may be employed to replace the data.

Table 5: Missing Data

Missing Data Period	Substitution Method
Less than 6 hours	Use the average of the 4 hours immediately before and following the missing data period.
6 to less than 24 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.
From 1 to 7 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.
More than 7 days	No data may be replaced, and no GHG reductions may be credited.

11.5 Operational Status of Eligible Destruction Devices

The operational status of each eligible destruction device shall be monitored with a destruction device monitoring instrument with measurements recorded at least hourly.

For a flare (enclosed or open), the operational status must be determined based on data from a thermocouple. The thermocouple must indicate a minimum combustion temperature that meets or exceeds 260 C. If the temperature is below 260 C, no offset credits can be issued for the period during which the temperature remains below 260 C.

If the eligible destruction device, thermocouple or other destruction device monitoring instrument is not functioning properly, no offset credits can be issued for the period during which they are not functioning properly.

If the engineering design of the LFG recovery and destruction systems is such that LFG is not delivered to an eligible destruction device when the eligible destruction device is not operating, hourly monitoring of operational status is not required.

12.0 Records

Records that support the implementation of a project, including invoices, contracts, metered results, maintenance logs, calculations, databases, photographs, and calibration records, must be kept by the Proponent for the period of time specified in the Regulations. For *Landfill Methane Recovery and Destruction* projects additional records include:

- All documentation related to environmental permits for the landfill, including those related to noise and odour controls.
- All documentation related to project design considerations for safe operations of eligible destruction devices.
- Supporting documentation to demonstrate the date of implementation of the LFG recovery system and the first day LFG recovered from the project site is destroyed in an eligible destruction device.

- All documentation providing details of the landfill cover including a description of the cover material, proportion of the landfill area that is covered and the installation date by landfill cell as evidence for justification of landfill CH_4 Oxidation Factor (OX).
- Details about each eligible destruction device including:
    - Documentation describing the location and arrangement of the eligible destruction devices, including if the eligible device is located at an end-user facility located outside the landfill.
    - The data and documentation pertaining to the device-specific destruction efficiency or the selected default destruction efficiency value from Table 3.
    - Data regarding the operational status of each eligible destruction device along with evidence that the equipment is operating according to the manufacturer's specifications.
- Details of fossil fuel and/or electricity consumed including:
    - Documentation describing the location and arrangement of all fossil fuel flow meters or electricity meters.
    - Metered quantities or purchase records that indicate the amount and types of fossil fuel and/or electricity consumed by the project.
    - Description of meters used and the meter model number or serial number. For commercial purchases, proof of commercial grade metering from the supplier is required.
    - Manufacturer's specifications, maintenance and calibration requirements for each meter.
- Details about each measuring device including:
    - Documentation describing the location and arrangement of all measuring devices included in the project, including flow meters, CH_4 analyzers, temperature or pressure gauges, thermocouples, and/or destruction device monitors.
    - Manufacturer specifications, maintenance, and calibration requirements for each flow meter, CH_4 analyzer, temperature or pressure gauge, thermocouple, destruction device monitor, including a description of device type, model number, serial number and manufacturer's maintenance and calibration procedures.
    - Data regarding the operational status and proper functioning of each for each flow meter, CH_4 analyzer, temperature or pressure gauge, thermocouple, destruction device monitor, and/or fossil fuel or electricity meter.
- The maintenance records for the LFG recovery, destruction and measuring systems and devices.
- The calibration certificates and/or other records from either the manufacturer or a qualified third-party certified by the manufacturer for each meter or measuring device which indicate calibration date, time and results, and the corrective measures applied if a piece of equipment fails to meet the requirements for measurement accuracy.
- All information and data use to support the calculation of the total GHG emission reductions including:
    - Measured temperature and pressure data for the LFG, if applicable.
    - All LFG volume data, corrected to the reference temperature and pressure conditions as set out in Schedule A – Reference Condition Variables. If the flow meter does not automatically correct the measured LFG volume to the reference temperature and pressure conditions, then the Proponent must calculate the corrected LFG volume following Equation 4 and supply all raw data for verification.
    - All LFG CH_4 content data.

13.0 Verification Requirements

13.1 Competency Requirements for Verification Teams

The Verification Body shall ensure that at least one individual on the verification team has experience related to waste, landfills or LFG management.

13.2 Site Visits for Aggregated Projects

There are no additional provisions regarding the verification of aggregated projects.

14.0 Reporting Requirements

The Proponent must report the quantified GHG emissions emitted or removed for each SSR included in the baseline and project scenarios, in tCO_2e.

Schedule A

Reference Variables and Emission Factors

Reference Condition Variables

Parameter	Description	Value	Units	Reference Source
T_{ref}	Reference temperature of the LFG	298.15	K	Physical constant
P_{ref}	Reference pressure of the LFG	101.325	kPa	Physical constant
ρ_{CH4}	Reference density of CH_4 (at T_{ref} and P_{ref} conditions)	0.656	kg / m^3	Physical constant

Fossil Fuel Emission Factors

Natural Gas[5]

Parameter	Description	Value	Units
$EF_{CO2,Natural\ Gas}$	CO_2 emission factor for natural gas	-	-
	Newfoundland and Labrador	1901	g CO_2/ m^3 NG
	Prince Edward Island	-	g CO_2/ m^3 NG
	Nova Scotia	1901	g CO_2/ m^3 NG
	New Brunswick	1901	g CO_2/ m^3 NG
	Quebec	1887	g CO_2/ m^3 NG
	Ontario	1888	g CO_2/ m^3 NG
	Manitoba	1886	g CO_2/ m^3 NG
	Saskatchewan	1829	g CO_2/ m^3 NG
	Alberta	1928	g CO_2/ m^3 NG
	British Columbia	1926	g CO_2/ m^3 NG
	Yukon	1901	g CO_2/ m^3 NG
	Northwest Territories	1901	g CO_2/ m^3 NG

[5] National Inventory Report – 2021 Edition, Part 2, Table A6.1-1, "Marketable" value for $EF_{CO2,Natural\ Gas}$, and National Inventory Report – 2021 Edition, Part 2, Table A6.1-3, "Residential, Construction, Commercial/Institutional, Agriculture" value for $EF_{CH4,Natural\ Gas}$ and $EF_{N2O,Natural\ Gas}$

	Nunavut	-	g CO_2/ m^3 NG
$EF_{CH4,Natural\ Gas}$	CH_4 emission factor for natural gas	0.037	g CH_4/ m^3 NG
$EF_{N2O,\ Natural\ Gas}$	N_2O emission factor for natural gas	0.035	g N_2O /m_3 NG

Propane[6]

Parameter	Description	Value	Units
$EF_{CO2,Propane}$	CO_2 emission factor for propane	1515	g CO_2 /L propane
$EF_{CH4,Propane}$	CH_4 emission factor for propane	0.024	g CH_4 /L propane
$EF_{N2O,\ Propane}$	N_2O emission factor for propane	0.108	g N_2O /L propane

Diesel[7]

Parameter	Description	Value	Units
$EF_{CO2,Diesel}$	CO_2 emission factor for diesel	2 681	g CO_2 /L diesel
$EF_{CH4,Diesel}$	CH_4 emission factor for diesel	0.078	g CH_4 /L diesel
$EF_{N2O,\ Diesel}$	N_2O emission factor for diesel	0.022	g N_2O /L diesel

Electricity Emission Factors[8]

Parameter	Description	Value	Units
$EF_{EL,\ GHG}$	GHG consumption intensity emission factor for grid electricity	-	-
	Newfoundland and Labrador	28	g CO_2e / kWh
	Prince Edward Island[9]	270	g CO_2e / kWh
	Nova Scotia	760	g CO_2e / kWh
	New Brunswick	270	g CO_2e / kWh
	Quebec	1.5	g CO_2e / kWh
	Ontario	30	g CO_2e / kWh

[6] National Inventory Report – 2021 Edition, Part 2, Table A6.1-4, “All Other Uses” value
[7] National Inventory Report – 2021 Edition, Part 2, Table A6.1-5, “Refineries and Others” value
[8] National Inventory Report – 2021 Edition, Part 3, Table A13-2 to Table A13-14, 2019 value
[9] Due to high level of imports from NB, PE takes NB value.

	Manitoba	1.3	g CO_2e / kWh
	Saskatchewan	710	g CO_2e / kWh
	Alberta	670	g CO_2e / kWh
	British Columbia	19.7	g CO_2e / kWh
	Yukon	113	g CO_2e / kWh
	Northwest Territories	200	g CO_2e / kWh
	Nunavut	890	g CO_2e / kWh

Landfill Gas Emissions Factors[10]

Parameter	Description	Value	Units
$EF_{LFG, N2O, i}$	N_2O emission factor for destruction of LFG in a boiler, turbine or internal combustion engine	0.05	kg N_2O / tonne CH_4
	N_2O emission factor for destruction of LFG in a flare	0[11]	kg N_2O / tonne CH_4

[10] National Inventory Report – 2021 Edition, Part 2, Table A6.6-2
[11] This emission factor is currently reported as "not estimated" in Canada's national GHG inventory. A value of zero has been assigned to this emission factor for the purposes of the quantification.