Argentina Landfill Protocol

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Abbreviations and Acronyms

ACF	Actual cubic feet
CDM	Clean Development Mechanism
CH_4	Methane
CNG	Condensed natural gas
CO_2	Carbon dioxide
EG	Emission Guidelines
EPA	U.S. Environmental Protection Agency
GWP	Global Warming Potential
GHG	Greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
LFG	Landfill gas
LNG	Liquefied natural gas
MG	Mega gram (1,000,000 grams or one tonne, or “t”)
MSW	Municipal solid waste
m^3	Cubic meter
m^3_s	Standard cubic meter (20ºC, 1 atm)
N_2O	Nitrous oxide
NG	Natural gas
NMOC	Non-methane organic compounds
NOM-083	Mexican Official Standard 083-SEMARNAT-2003
QA/QC	Quality Assurance/Quality Control
Reserve	Climate Action Reserve
SCF	Standard cubic feet at 0° C and 1 atm
VOC	Volatile organic compound

1 Introduction

The Climate Action Reserve (Reserve) Argentina Landfill Protocol provides guidance to account for, report, and verify greenhouse gas (GHG) emission reductions associated with installing a landfill gas collection and destruction system at a landfill located in Argentina. This protocol is designated to ensure the complete, consistent, transparent, accurate, and conservative quantification of GHG emission reductions associated with a landfill project.[1]

The Climate Action Reserve is the most trusted, efficient, and experienced offset registry for global carbon markets. A pioneer in carbon accounting, the Reserve promotes and fosters the reduction of greenhouse gas (GHG) emissions through credible market-based policies and solutions. As a high-quality offset registry for voluntary carbon markets, it establishes rigorous standards and issues carbon credits under those standards. The Reserve also supports compliance carbon markets and serves as an approved Offset Project Registry for the State of California’s Cap-and-Trade Program, or the Washington Cap-and-Invest Offsets Program. The Reserve is an environmental nonprofit organization operating virtually worldwide, with small physical officed located in Los Angeles, California. For more information, please visit www.climateactionreserve.org.

Project developers that install landfill gas capture and destruction technologies use this document to quantify and register GHG reductions with the Reserve. This protocol provides eligibility rules, methods to calculate reductions, performance-monitoring instructions, and procedures for reporting project information to the Reserve. Additionally, all project reports receive independent verification by Reserve-approved verification bodies. Guidance for verification bodies to verify reductions is provided in the Reserve Verification Program Manual and Section 8 of this protocol.

Project developers must comply with all local, state, and federal municipal solid waste (MSW), air and water quality regulations in order to register GHG reductions with the Reserve. To register GHG reductions with the Reserve, project developers are not required to take an annual entity-level GHG inventory of their MSW operations.

The Reserve develops protocols aligned with the laws, regulations and on-the-ground context of a specific jurisdiction or jurisdictions to establish standardized eligibility criteria and, additionally, reference scenarios. Therefore, this Protocol is aligned with the laws, rules and context of Argentina. See Section(s) 3.5.3 and Appendix C for more information on how these laws were incorporated into the performance standard test.

[1] See the WRI/WBCSD GHG Protocol for Project Accounting (Part I, Chapter 4) for a description of GHG accounting principles.

2 The GHG Reduction Project

2.1 Background

In Argentina, public sanitation services raise serious environmental concerns. Waste generation is closely linked to the number of inhabitants, resulting in more densely populated urban centers have adequate traditional disposal infrastructures (i.e., MSW landfills). Roughly 65% of municipal solid waste is deposited in landfills, while the rest of waste is managed in irregular final disposal systems, commonly open dumps. [2]

In landfills, bacteria decompose the organic material. A product of both the bacterial decomposition and oxidation of solid waste is landfill gas, which is composed of methane (CH_4) and carbon dioxide (CO_2) in approximately equal concentrations, as well as smaller amounts of non-methane organic compounds (NMOC), nitrogen (N_2), oxygen (O_2), and other trace gases. If not collected and destroyed, over time, this landfill gas is released to the atmosphere.

2.2 Project Definition

For the purpose of this protocol, the GHG reduction project defined as the collection of methane gas from one or more specified cells at an eligible landfill, and the destruction of such methane gas with one or more eligible destruction devices. The expansion of an existing Gas Collection and Control System (GCCS) to a new cell or cells can optionally be included within an existing landfill project or submitted as a new project. If any cells are to be considered as a new project, those cells must be engineered in such a way that LFG cannot migrate between cells in the proposed new project and cells in the existing project. Where a single landfill contains multiple cells, across multiple landfill projects, those projects may share common destruction devices, provided the flow of methane from each project is metered separately.

Qualifying destruction devices may include utility flares, enclosed flares, engines, turbines, microturbines, boilers, pipelines, leachate evaporators, kilns, sludge dryers, burners, furnaces, or fuel cells. Devices not specifically listed here may still be eligible under this protocol, provided written approval is obtained from the Reserve. Passive flares are considered non-qualifying destruction devices.

An eligible landfill is one that:

1. Is not subject to regulations or other legal requirements requiring the destruction of methane gas; and
2. Is not a bioreactor, as defined by the U.S. EPA: "a MSW landfill or portion of a MSW landfill where any liquid other than leachate (leachate includes landfill gas condensate) is added in a controlled fashion into the waste mass (often in combination with recirculating leachate) to reach a minimum average moisture content of at least 40 percent by weight to accelerate or enhance the anaerobic (without oxygen) biodegradation of the waste"[3]; and
3. Does not add any liquid other than leachate into the waste mass in a controlled manner.

Captured landfill gas could be destroyed on-site, transported for off-site use (e.g., through a gas transmission and distribution pipeline), or used to power vehicles. Regardless of how project

[2] Ministry of Environment and Sustainable Development (2022). Available at: https://informe.ambiente.gob.ar/Informe_del_estado_del_ambiente_2022.pdf
[3] 40 CFR 63.1990 and 40 CFR 258.28a.

developers take advantage of the captured landfill gas, for the project to be eligible to register GHG reductions under this protocol, the ultimate fate of the methane must be destruction.

Landfill gas collection and destruction systems typically consist of wells, pipes, blowers, caps, and other technologies that enable or enhance the collection of landfill gas and convey it to a destruction technology. At some landfills, a flare will be the only device where landfill gas is destroyed. For projects that utilize energy or process heat technologies to destroy landfill gas, such as turbines, reciprocating engines, fuel cells, boilers, heaters or kilns, these devices will be where landfill gas is destroyed. Most projects that produce energy or process heat also include a flare to destroy gas during periods when the gas utilization project is down for repair or maintenance.

Direct use arrangements which entail the piping of landfill gas to be destroyed by an industrial end user at an off-site location are also an eligible approach to destruction of the landfill gas. For instances of direct use, agreements between the project developer and the end user of the landfill gas (i.e., an industrial client purchasing the landfill gas from the project developer), must include a legally binding agreement to assure that the GHG reductions will not be claimed by more than one party.

In addition to reducing methane, the installation and operation of a landfill gas collection and destruction system could impact anthropogenic carbon dioxide and methane emissions associated with the consumption of electricity and fossil fuels. Depending on the project's particular circumstances, this effect could either increase or decrease operational GHG emissions. Section 4, the GHG Assessment Boundary, delineates the scope of the accounting framework.

2.3 The Project Developer

The "project developer" is an entity that has an active account on the Reserve, submits a project for listing and registration with the Reserve, and is ultimately responsible for all project reporting and verification. Project developers may be landfill facility operators, GHG project developers, or other entities such as municipalities, or waste management companies. The project developer must have clear ownership of the project's GHG reductions. Ownership of GHG reductions must be established by clear and explicit title, such as through a legal contract to transfer the rights to the project's GHG emission reductions to another entity.

Each time a project is verified, the project developer must attest that no other entities are reporting or claiming (e.g., for voluntary reporting or regulatory compliance purposes) the GHG reductions caused by the project by signing the Reserve's Attestation of Title form.[4] The Reserve will not issue CRTs for GHG reductions that are reported or claimed by entities other than the project developer (e.g., waste generators, landfills, or municipalities not designated as the project developer).

2.4 Additional GHG Reduction Activities in the Solid Waste Sector

The Reserve recognizes that project developers could implement a variety of GHG reduction activities associated with the collection, transportation, sorting, recycling and disposal of solid waste; installing technology to capture and destroy methane from landfills is but one of many GHG emission reduction projects that could occur within the solid waste sector.

[4] Attestation of Title form, available at: https://www.climateactionreserve.org/how/program-resources/forms/

However, GHG reduction activities not associated with the installation of a landfill gas collection and destruction system do not meet this protocol's definition of the GHG reduction project. Furthermore, production of power for the electricity grid, which results in the displacement of fossil-fueled power plant GHG emissions, is a complementary and separate GHG project activity to destroying methane gas from landfills and is not currently included within this protocol's accounting framework.

3 Eligibility Rules

Project developers using this protocol must satisfy the following eligibility rules to register reductions with the Reserve. These criteria apply only to projects that meet the definition of a GHG reduction project as defined in Section 2.

Eligibility Rule I:	Location	→	*Argentina*
Eligibility Rule II:	Project Start Date	→	*No more than 12 months prior to project submission*
Eligibility Rule III:	Crediting Period	→	*Emission reductions may only be reported during the crediting period; the crediting period may be renewed two times*
Eligibility Rule IV:	Additionality	→	*Meet performance standard*
		→	*Avoid exceeding limits on credit stacking*
		→	*Exceed legal requirements*
Eligibility Rule V:	Regulatory Compliance	→	*Compliance with all applicable laws*

3.1 Location

All projects located at landfill operations in Argentina are eligible to register reductions with the Reserve.

3.2 Project Start Date

The project start date shall be defined by the project developer but must be no more than 90 days after landfill gas is first destroyed in a project destruction device, regardless of whether sufficient monitoring data are available to report reductions. The start date is defined in relation to the commencement of methane destruction, not other activities that may be associated with project initiation or development.

To be eligible, projects are required to submit for listing within 12 months of becoming operational.[5] Those that fail to list within this 12-month period will be considered non-additional and excluded from eligibility. Projects may always be submitted for listing by the Reserve prior to their start date. Projects with previous destruction that have been inactive may be allowed to come back online under the Argentina Landfill Protocol as long as the project developer can demonstrate that the project can still be considered additional. The Reserve maintains the right to determine if the project is eligible. Contact the Reserve prior to project submittal to determine the eligibility of an inactive project.

3.3 Project Crediting Period

The Reserve will issue CRTs for GHG reductions quantified and verified using this protocol for a period of ten years following the project start date. The project crediting period begins at the project start date regardless of whether sufficient monitoring data is available to verify GHG reductions. However, the Reserve will cease to issue CRTs for GHG reductions if at any point in

[5] A project is considered "submitted" when the project developer has fully completed and filed the appropriate Project Submittal Form, available on the Reserve's website.

the future landfill gas destruction becomes legally required at the landfill. If an eligible project has begun operation at a landfill that later becomes subject to a regulation, ordinance or permitting condition that would call for the installation and operation of a landfill gas control system, the Reserve will issue CRTs for GHG reductions achieved up until the date that the landfill gas control system is legally required to be operational.

At the end of a project's first crediting period, a project developer may be eligible to apply for eligibility under another 10-year crediting period, they must do so no sooner than six months before the end of the previous crediting period.

A project may be eligible for a renewed crediting period even if the project has failed to maintain continuous reporting up to the time of applying for a crediting period renewal, provided the project developer elects to take a zero-credit reporting period for any period for which continuous reporting was not maintained.[6] The renewed crediting period shall begin on the day following the end date of the previous crediting period. A project may only apply for a maximum of three crediting periods.

3.4 Additionality

The Reserve strives to support only projects that yield surplus GHG reductions that are additional to what might otherwise have occurred. That is, the reductions are above and beyond "business as usual," the baseline case. Project developers satisfy the "additionality" eligibility rule by passing two tests:

1. The Performance Standard Test
2. The Legal Requirement Test

3.4.1 The Performance Standard Test

Project developers pass the Performance Standard Test by meeting a program-wide performance threshold (i.e., a standard of performance applicable to all landfill projects, established on an *ex-ante* basis). The performance threshold represents "better than business as usual." If the project meets the threshold, then it exceeds what would happen under the "business as usual" scenario and generates surplus/additional GHG reductions.

For this protocol, the Reserve uses a practice-change threshold that focuses on the baseline scenario and changes made in the project scenario. A project passes the Performance Standard Test if it involves one of the following activities:

1. Installation of a landfill gas collection system and a new qualifying destruction device at an eligible landfill where landfill gas has never been collected and destroyed prior to the project start date.

2. Installation of a new qualifying destruction device at an eligible landfill where landfill gas is currently collected and vented but has never been destroyed in any manner prior to the project start date.

3. Installation of a new qualifying destruction device at an eligible landfill where landfill gas was collected and destroyed at any time prior to the project start date using:

[6] See zero-credit reporting period guidance and requirements in the Reserve Program Manual, http://www.climateactionreserve.org/how/program/program-manual/.

   a. A non-qualifying destruction device (e.g., passive flare); or
   b. A destruction device that is not otherwise eligible under the protocol (e.g., a destruction device installed prior to the earliest allowable project start date, a destruction device installed with or without metering prior to the installation of a new destruction device).

4. Installation of a new gas collection system on a physically-distinct[7] cell (or cells) where neither gas collection nor destruction has previously occurred, and connection of this new collection system to an existing landfill gas destruction system. The new collection system must have its own metering that satisfies the requirements of this protocol. In this scenario, more than one project may exist at a single landfill. The start date for this project shall be no more than 90 days following the first flow of landfill gas from the new collection system to the destruction system, regardless of the presence of adequate metering for crediting.

Destruction devices that were installed temporarily and utilized only for pilot or testing purposes specifically in anticipation of the GHG project shall not be considered in determining project eligibility or quantification. Devices may only be excluded under this provision if they were installed as a direct precursor to the project activity in order to gather information or determine project viability. Pilot testing is limited to 9 months. The project developer should contact the Reserve if pilot testing is expected to exceed 9 months. Verifiable evidence of this intent and duration must be presented, such as device invoices, service agreements, or monitoring data. Changes in landfill ownership, or in the ownership of destruction devices, are not considered in determining prior landfill gas management practices. If landfill gas was previously collected and destroyed (in the given cells of the project) by a party other than the project developer, it still qualifies as “prior” collection and destruction.

Under scenarios (1), (2), and (3) above, expanding an existing well-field constitutes a system expansion rather than initiation of a new project. Expanding a well-field is eligible as a new, separate project only if it meets the conditions described in scenario (4). In these scenarios, expanding a well-field initiates a new crediting period.

The practice change threshold is applied as of the project start date and is evaluated at the project’s initial verification.

All projects that pass this test are eligible to register reductions with the Reserve for the lifetime of the project crediting period, even if the Performance Standard Test changes during mid-period. If a project upgrades to a newer version of the protocol for a subsequent verification, it must meet the Performance Standard Test of that version of the protocol, applied as of the original project start date. If a project is submitted for a renewed crediting period, it is subject to the Performance Standard Test in the most current version of the protocol at that time, applied as of the original project start date.

3.4.2 Limits on Credit Stacking

When multiple forms of incentive credits are sought for a single activity at a single facility or on a single piece of land, with some temporal overlap between the different credits or payments, it is referred to as “credit stacking”. Under this protocol, credit stacking is defined as receiving both offset credits and other types of mitigation credits for the same activity on spatially overlapping

[7] The landfill cell must be engineered in such a way that landfill gas cannot migrate between that cell and other landfill cells.

areas (i.e., in the same landfill). Mitigation credits are any instruments issued for the purpose of offsetting the environmental impacts of another entity, such as emissions of GHGs, or the displacement of fossil fuel emissions from transport applications, to name a few.

Project developers are strongly encouraged to reach out to the Reserve as early as possible when considering credit stacking. Furthermore, they must disclose any such payments to the Reserve at the time of listing and to the verification body and the Reserve at the time of verification. The Reserve maintains the right to determine if stacking has occurred, or is occurring, and whether it would impact project eligibility.

The Reserve has identified market opportunities for the upgrade of landfill gas into high-Btu fuels, or other fuel or renewable energy certificates programs that provides an incentive sufficient to raise additionality concerns. Analysis reveals that the strength of these incentives is driving investment in landfill gas projects at present, and that such projects can be considered "business as usual", without the additional presence of carbon offset revenues.[8] Therefore, projects that receive mitigation credits for upgrading landfill gas into high-Btu fuels, or other mitigation credits directly related to the project activity will not be eligible to receive offset credits for the same period of time under this protocol.

If a landfill project transitions to reporting under one of these fuel standards but may wish to receive CRTs in future reporting periods, the project must maintain continuous reporting with the Reserve under the Argentina Landfill Protocol. To maintain continuous reporting, the project developer must submit a Zero-Credit Reporting Period Acknowledgment and Election form and a monitoring report no later than six months following the end of each relevant reporting period under the other fuel standard.

3.4.3 The Legal Requirement Test

All projects are subject to a Legal Requirement Test to ensure that the GHG reductions achieved by a project would not otherwise have occurred due to federal, state or local regulations, or other legally binding mandates. Projects pass the Legal Requirement Test when there are no laws, statutes, regulations, court orders, environmental mitigation agreements, permitting conditions or other legally binding mandates requiring the destruction of landfill gas methane at the project site. To satisfy the Legal Requirement Test, project developers must submit a signed Attestation of Voluntary Implementation form[9] prior to the commencement of verification activities each time the project is verified. In addition, the project's Monitoring Plan (Section 0) must include procedures that the project developer will follow to ascertain and demonstrate that the project at all times passes the Legal Requirement Test.

Landfills currently collecting and destroying landfill gas to comply with regulations or other legal mandates – or that are currently required by regulation or legal mandate to install a landfill gas control system in the future – are not eligible to register new projects with the Reserve. Landfills currently collecting and destroying landfill gas to comply with regulations or other legal mandates are not eligible to register GHG reductions associated with the early installation of gas control systems during landfill expansion into new cells.

If an eligible project begins operation at a landfill that later becomes subject to a regulation, ordinance, or permitting condition that calls for the installation of a landfill gas control system,

[8] Further information about the Reserve's performance standard analysis is available in 0
[9] Attestation of Voluntary Implementation form available at https://www.climateactionreserve.org/how/program-resources/forms/

GHG reductions may be reported to the Reserve up until the date that the installation of a landfill gas control system is legally required to be operational. If the landfill's methane emissions are included under an emissions cap (e.g., under a state or federal cap-and-trade program), emission reductions may likewise be reported to the Reserve until the date that the emissions cap takes effect.

3.5 Regulatory Compliance

As a final eligibility requirement, project developers must attest that the project is in material compliance with all applicable laws (e.g., air, water quality, safety, etc.) prior to verification activities commencing each time a project is verified. Project developers are required to disclose in writing to the verifier any and all instances of non-compliance of the project with any law. If a verifier finds that a project is in a state of recurrent non-compliance or non-compliance that is the result of negligence or intent, then CRTs will not be issued for GHG reductions that occurred during the period of non-compliance. Non-compliance solely due to administrative or reporting issues, or due to "acts of nature," will not affect CRT crediting.

Where projects are co-located at a single landfill, and in particular where projects share common equipment or infrastructure, the onus will be on the project developer(s) to demonstrate that a regulatory violation at the site is not relevant to all projects. Project developers should contact the Reserve to discuss potential regulatory non-compliance issues.

3.6 Social and Environmental Safeguards

The Reserve requires project developers to demonstrate that their GHG projects will not give rise to environmental or social harm. Moreover, offset projects can create long-term social and environmental benefits and have the potential to improve quality of life for nearby communities, both in terms of increased revenues and in terms of sustaining and improving landfill practices.

This Protocol includes specific social and environmental safeguards that must be considered in the project design and implemented throughout the project life to help guarantee that the project will have positive environmental and social outcomes. In addition, all projects must comply with the Reserve's Offset Program Manual, including the section on regulatory compliance and programmatic environmental and social safeguards. The safeguards in the protocol are intended to respect governmental processes, customs, and rights of landfill owners while ensuring projects are beneficial, both socially and environmentally. The sections on monitoring, reporting, and verification (MRV) (Sections 7 and 8) specify the criteria for verification of each of these safeguards and consequences for failure to achieve the minimum thresholds.

The social safeguards requirements include:

1. Free, Prior, and Informed Consent (FPIC):
   a. Project developers must address the following topics with the landfill operator prior to project approval:
      i. Concepts of climate change and carbon markets.
      ii. Requirements associated with landfill projects, including ongoing MRV.
      iii. Estimates of costs and benefits associated with the landfill project and the division of costs and distribution of benefits or benefit sharing. The source used for carbon pricing estimates must be disclosed to the landfill operator.
   b. After the topics to comply with 1.a (see above) have been addressed, landfill operators must approve the landfill carbon project and the project developer.
2. Ongoing Notification, Participation, and Documentation:

a. The project developer must review with the landfill operator on an annual basis the following topics:
    i. Ongoing project activities, including MRV.
    ii. Credits issued.
    iii. Purchase agreements, project finances, and ongoing benefit sharing arrangements.
b. Project notification and documentation must be presented to the landfill operator in an appropriate format and language to ensure understanding.

3. Labor and Safety: The project developer must attest that the project is in material compliance with all applicable laws, including labor or safety laws. See Section 3.6 Regulatory Compliance for further information. Furthermore, all construction, maintenance, and operations of project related equipment (generators, flares, pumps, meters, etc) must follow manufacturer guidance to avoid injury while working with methane and other volatile landfill gases.

4. Dispute Resolution: The Reserve holds a 30-day public comment period on all listed projects prior to registration and has an ongoing dispute resolution process. See the Reserve Offset Program Manual and website for further information on programmatic and project specific public consultation and dispute resolution processes. Projects that receive material complaints will not be registered until a satisfactory dispute resolution plan has been approved. The operator(s) and/or the project developer must attest that they have title to the entire project boundary, including all landfill facilities directly related to the carbon project.

The environmental safeguards requirements include:

1. Air and Water Quality: The project developer must attest that the project is in material compliance with all applicable laws, including environmental regulations (e.g., air and water quality). See Section 3.6 Regulatory Compliance and Appendix A Associated Environmental Impacts for further information.
2. Mitigation of Pollutants: Projects must be designed and implemented to mitigate potential releases of pollutants that may cause degradation of the quality of soil, air, surface and groundwater such as those described in Appendix A, and project developers must acquire the appropriate local permits prior to installation to prevent violation of all applicable laws.

4 The GHG Assessment Boundary

The GHG Assessment Boundary delineates the GHG sources, sinks, and reservoirs (SSRs) that shall be assessed by project developers in order to determine the total net change in GHG emissions caused by a landfill project.

The GHG Assessment Boundary for the project includes all emission sources from the operation of the landfill gas collection system to the ultimate destruction of the landfill gas.

CO_2 emissions associated with the generation and destruction of landfill gas are considered biogenic emissions[10] (as opposed to anthropogenic) and will not be included in the GHG reduction calculation. This is consistent with the Intergovernmental Panel on Climate Change's (IPCC) guidelines for captured landfill gas.[11]

This protocol does not account for CO_2 reductions associated with the displacement of fossil-based grid-delivered electricity or natural gas. This is classified as an indirect emission reduction activity because the change in GHGs occurs from sources owned and controlled by the power producer or the end user of the natural gas. Capturing and using methane to displace fossil-based electricity on the grid or natural gas in gas transmission and distribution systems could potentially be considered complementary and separate GHG reduction projects but are not included in the boundaries of this protocol.

Figure 4.1 below provides a general illustration of the GHG Assessment Boundary, indicating which SSRs are included or excluded from the boundary. All SSRs within the dashed line are accounted for under this protocol.

Table 4.1 provides greater detail on each SSR and provides justification for the inclusion or exclusion of SSRs and gases from the GHG Assessment Boundary.

[10] The rationale is that carbon dioxide emitted during combustion represents the carbon dioxide that would have been emitted during natural decomposition of the solid waste. Emissions from the landfill gas control system do not yield a net increase in atmospheric carbon dioxide because they are theoretically equivalent to the carbon dioxide absorbed during plant growth.
[11] *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*; p.5.10, ftnt.

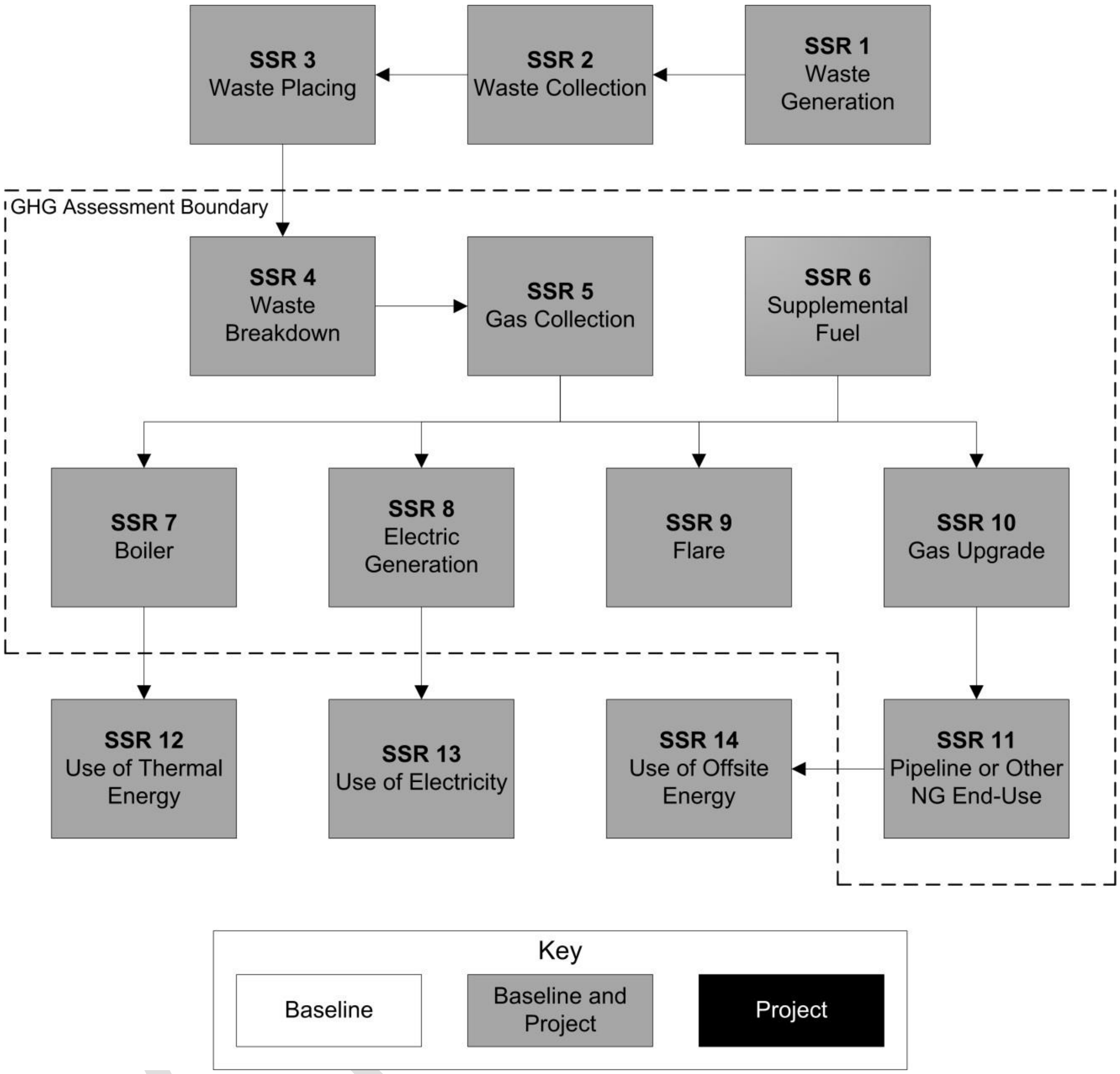


Figure 4.1. General illustration of the GHG Assessment Boundary

Table 4.1. Summary of Identified Sources, Sinks, and Reservoirs

SSR	Source	Gas	Relevant to Baseline (B) or Project (P)	Included/ Excluded	Justification/Explanation
1	Emissions from Waste Generation	N/A	B, P	Excluded	GHG emissions from this source are assumed to be equal in the baseline and project scenarios
2	Emissions from Waste Collection	CO_2	B, P	Excluded	GHG emissions from this source are assumed to be equal in the baseline and project scenarios
		CH_4		Excluded	GHG emissions from this source are assumed to be equal in the baseline and project scenarios
		N_2O		Excluded	GHG emissions from this source are assumed to be equal in the baseline and project scenarios s
3	Emissions from Waste Placing Activities	CO_2	B, P	Excluded	GHG emissions from this source are assumed to be equal in the baseline and project scenarios
		CH_4		Excluded	GHG emissions from this source are assumed to be equal in the baseline and project scenarios
		N_2O		Excluded	This emission source is assumed to be equal in the baseline and project scenarios
4	Emissions from Waste Breakdown in Landfill	CO_2	B, P	Excluded	Biogenic CO_2 emissions are excluded
		CH_4		Included	Primary source of GHG emissions in baseline. Calculated based on destruction in baseline and project destruction devices
5	Emissions from Gas Collection System	CO_2	P	Included	Landfill projects result in CO_2 emissions associated with the energy used for collection and processing of landfill gas
		CH_4		Excluded	This emission source is assumed to be very small
		N_2O		Excluded	This emission source is assumed to be very small
	Emissions from Baseline Gas Collection System	CO_2	B	Excluded	This emission source is assumed to be very small
		CH_4		Excluded	This emission source is assumed to be very small
		N_2O		Excluded	This emission source is assumed to be very small
6	Emissions from Supplemental Fuel	CO_2	P	Included	Landfill projects may require use of supplemental fossil fuel, resulting in significant new GHG emissions
		CH_4		Included	Calculated based on destruction efficiency of destruction device
		N_2O		Excluded	This emission source is assumed to be very small
	Emissions from Baseline	CO_2	B	Excluded	This emission source is assumed to be very small

SSR	Source	Gas	Relevant to Baseline (B) or Project (P)	Included/ Excluded	Justification/Explanation
	Supplemental Fuel Use	CH_4		Excluded	This emission source is assumed to be very small
		N_2O		Excluded	This emission source is assumed to be very small
7	Emissions from LFG Boiler Destruction	CO_2	B, P	Excluded	Biogenic CO_2 emissions are excluded
		CH_4		Included	Calculated in reference to destruction efficiency
		N_2O		Excluded	This emission source is assumed to be very small
8	Emissions from LFG Electricity Generation	CO_2	B, P	Excluded	Biogenic CO_2 emissions are excluded
		CH_4		Included	Calculated in reference to destruction efficiency
		N_2O		Excluded	This emission source is assumed to be very small
9	Emissions from LFG Flare Destruction	CO_2	B, P	Excluded	Biogenic CO_2 emissions are excluded
		CH_4		Included	Calculated in reference to destruction efficiency
		N_2O		Excluded	This emission source is assumed to be very small
10	Emissions from Upgrade of LFG	CO_2	B, P	Included	Landfill projects may result in GHG emissions from additional energy used to upgrade landfill gas
		CH_4		Excluded	This emission source is assumed to be very small
		N_2O		Excluded	This emission source is assumed to be very small
11	Emissions from LFG Pipeline or Other NG End-Use	CO_2	B, P	Excluded	Biogenic emissions are excluded
		CH_4		Included	Calculated in reference to destruction efficiency
		N_2O		Excluded	Assumed to be very small
12	Use of Generated Thermal Energy	CO_2	B, P	Excluded	This protocol does not cover displacement of GHG emissions from use of LFG-generated thermal energy
13	Use of Generated Electricity	CO_2	B, P	Excluded	This protocol does not cover displacement of GHG emissions from use of LFG-generated electricity
14	Use of Thermal Energy or Power from Pipeline Delivered NG	CO_2	B, P	Excluded	This protocol does not cover displacement of GHG emissions from use of LFG delivered through pipeline or other end uses

5 Quantifying GHG Emission Reductions

GHG emission reductions from a landfill project are quantified by comparing actual project emissions to baseline emissions at the landfill. Baseline emissions are an estimate of the GHG emissions from sources within the GHG Assessment Boundary (see Section 4) that would have occurred in the absence of the landfill project. Project emissions are actual GHG emissions that occur at sources within the GHG Assessment Boundary. Project emissions must be subtracted from the baseline emissions to quantify the project's total net GHG emission reductions (Equation 5.1).

GHG emission reductions must be quantified and verified on at least an annual basis. Project developers may choose to quantify and verify GHG emission reductions on a more frequent basis if they desire. The length of time over which GHG emission reductions are quantified and verified is called the "reporting period."e

The calculations provided in this protocol are derived from internationally accepted methodologies.[12] Project developers shall use the calculation methods provided in this protocol to determine baseline and project GHG emissions in order to quantify GHG emissions reductions.

[12] The Reserve's GHG reduction calculation method is derived from the Kyoto Protocol's Clean Development Mechanism (ACM0001 V.6 and AM0053 V.1), the EPA's Climate Leaders Program (Draft Landfill Offset Protocol, October 2006), the GE AES Greenhouse Gas Services Landfill Gas Methodology V.1, and the RGGI Model Rule (January 5, 2007).

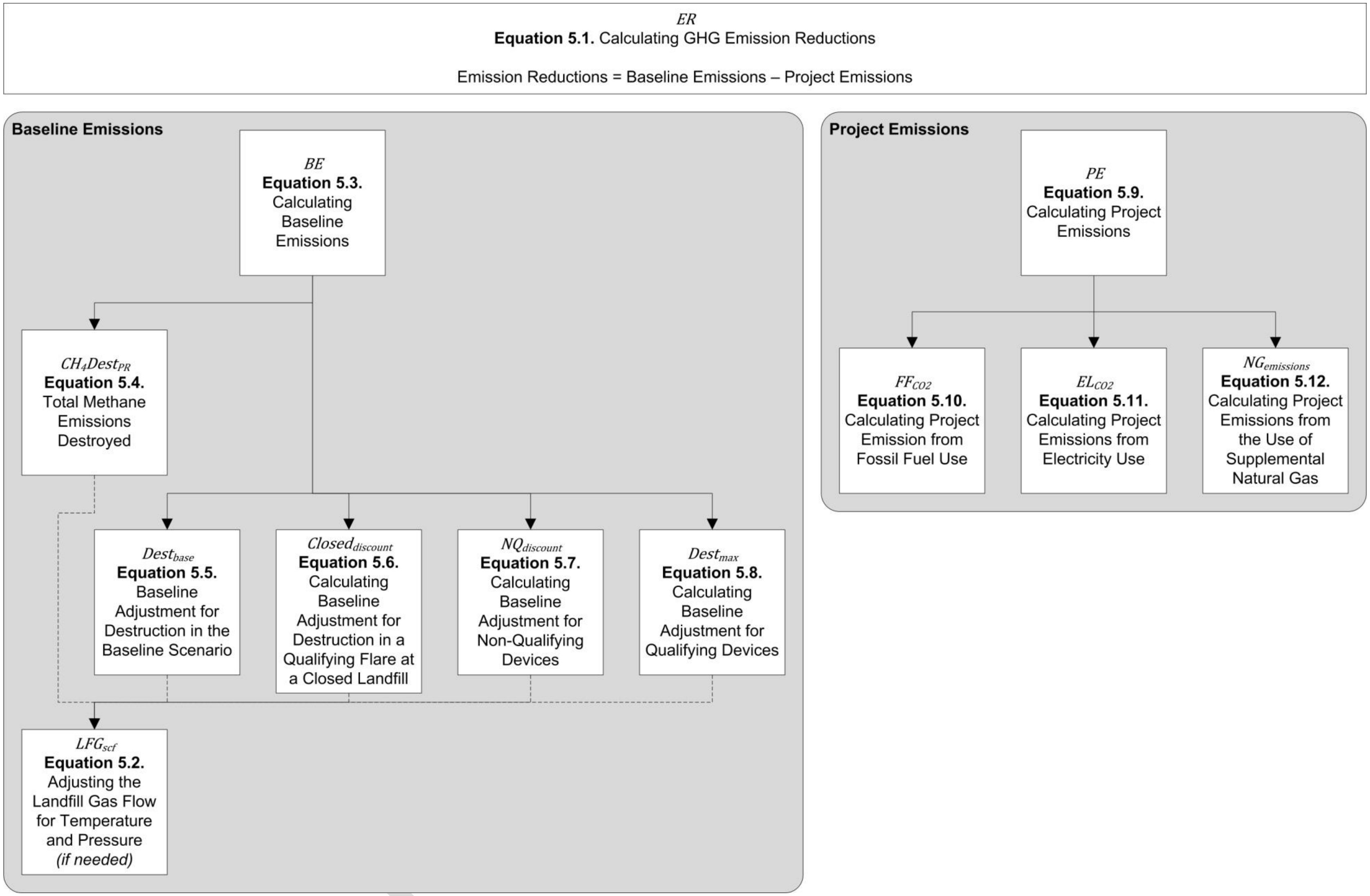


Figure 5.1. Organizational Chart for Equations in Section 5

Equation 5.1. Calculating GHG Emission Reductions

$$ER = BE - PE$$

Where,			Units
ER	=	GHG emission reductions of the project activity during the reporting period	tCO_2e
BE	=	Baseline emissions during the reporting period	tCO_2e
PE	=	Project emissions during the reporting period	tCO_2e

If any of the landfill gas flow metering equipment does not internally correct for the temperature and pressure of the landfill gas, separate pressure and temperature measurements must be used to correct the flow measurement. Corrected values must be used in all of the equations of this section. Apply Equation 5.2 only if the landfill gas flow metering equipment does not internally correct for temperature and pressure.

Equation 5.2. Adjusting the Landfill Gas Flow for Temperature and Pressure

$$LFG_{i,t} = LFG_{unadjusted} \times \frac{273.15}{T} \times \frac{P}{1}$$

Where,			Units
$LFG_{i,t}$	=	Adjusted volume of landfill gas collected for the given time interval, measured at 0°C (273.15 K) and 1 atm	m^3
$LFG_{unadjusted}$	=	Unadjusted volume of landfill gas collected for the given time interval	m^3
T	=	Measured temperature of the landfill gas for the given time period (K = °C + 273.15)	K
P	=	Measured pressure of the landfill gas in for the given time interval	atm

5.1 Quantifying Baseline Emissions

Traditional baseline emission calculations are not required for this protocol for the quantification of methane reductions. The baseline scenario assumes that all uncontrolled methane emissions are released to the atmosphere except for the portion of methane that would be oxidized by bacteria in the soil of uncovered landfills, absent the project.[13]

[13] Landfill cover systems incorporating synthetic liners as part of the final cover systems should use a default methane oxidation rate of zero. A 10% methane oxidation factor shall be used for all other landfills, including those that utilize a synthetic cover in some, but not all of the area of the landfill with a final cover installed. A small portion of the methane generated in landfills (around 10%) is naturally oxidized to carbon dioxide by methanotrophic bacteria in the cover soils of well managed landfills. The 10% factor is based on Intergovernmental Panel on Climate Change (IPCC) guidelines (2006).

As noted in Section 3.4.1, projects are grouped into different categories depending upon the baseline state of the landfill and level of landfill gas management. These categories require a slightly different methodology for calculating relevant baseline emissions.

1. Landfills where no previous destruction took place prior to project implementation must deduct the following from baseline emissions:
   a. The amount of methane that would have been oxidized by soil bacteria in the absence of the project.

2. Landfills where previous collection and/or destruction took place with a non-qualifying destruction device must deduct the following from baseline emissions
   a. The amount of methane that would have been oxidized by soil bacteria in the absence of the project.
   b. The amount of methane destroyed from the non-qualifying destruction device (Equation 5.7).

3. Landfills where previous collection and destruction took place with a qualifying destruction device must deduct the following from baseline emissions:
   a. The amount of methane that would have been oxidized by soil bacteria in the absence of the project.
   b. The amount methane that could have been destroyed if the baseline destruction device was operating at full capacity (Equation 5.8).Equation 5.8

4. Closed landfills where previous collection and destruction took place in a qualifying flare must deduct the following from baseline emissions:
   a. The amount of methane that would have been oxidized by soil bacteria in the absence of the project.
   b. The amount of methane collected by pre-project landfill gas wells and destroyed from the qualifying flare (Equation 5.6).

5. Projects where an existing GCSS is connected to a new landfill cell that was previously not affected by the GCSS must deduct the following from baseline emissions:
   a. The amount of methane that would have been oxidized by soil bacteria in the absence of the project.
   b. If previous collection and destruction of methane from this cell (other than in the project GCCS), then the appropriate amount of methane shall be deducted according to the guidance in items 2-4 above, depending on which is relevant.

These conditions ensure that the reductions resulting from the GHG project can be accounted for separately from current collection and destruction. Only the landfill gas destroyed beyond that resulting from the baseline collection and destruction system is considered additional (i.e., those reductions resulting from the implementation of a new GHG reduction project).

As stated above, landfill operations that meet the U.S. EPA definition of a bioreactor are not eligible to use this protocol, as it is unclear what effects the bioreactor may have on the fugitive methane emissions relative to baseline conditions.

This protocol accounts for the difference in electricity consumption between the baseline scenario and the project by assuming no electricity consumption in the baseline and deducting the annual indirect CO_2 emissions due to the project activity from the annual project emission reductions.

Equation 5.3. Calculating Baseline Emissions

$$BE = [(CH_4Dest_{PR}) \times GWP \times (1 - OX) \times (1 - DF)] - Dest_{base} \times (1 - OX)$$

Where,			Units
BE	=	Total baseline GHG emissions	tCO_2e
$CH_4\ Dest_{PR}$	=	Total methane emissions destroyed by the project landfill gas collection and destruction system – see Equation 5.4	tCH_4
GWP	=	Global Warming Potential factor of methane to carbon dioxide equivalent[14]	tCO_2e / tCH_4
OX	=	Factor for the oxidation of methane by soil bacteria in the baseline. Equal to 0.10 for all landfills except those that incorporate a synthetic liner throughout the entire area of the final cover systems where OX = 0	
$Dest_{base}$	=	Adjustment to account for baseline LFG destruction device (see Equation 5.8)Equation 5.8. Equal to zero if no baseline LFG destruction system is in place prior to project implementation	tCO_2e
DF	=	Discount factor to account for uncertainties associated with the project monitoring equipment (see Section 6.1). Equal to zero if using continuous methane monitor	

The term CH_4Dest_{PR} represents the amount of methane destroyed by the project. This term is calculated according to Equation 5.4.

Equation 5.4. Calculating Methane Emissions Destroyed

$$CH_4Dest_{PR} = \sum_i (CH_4Dest_i) \times (0.717 \times 0.001)$$

Where,			Units
CH_4Dest_{PR}	=	Total methane destroyed by the project landfill gas collection and destruction system during the reporting period	tCH_4
$CH_4\ Dest_i$	=	Net quantity of methane destroyed by destruction device i (flare, engine, boiler, upgrade, etc.) during the reporting period	m^3
0.717	=	Density of methane at standard conditions, 0°C, 1 atm	$kgCH_4$ / m^3CH_4
0.001	=	Conversion factor	tCH_4 / $kgCH_4$

Equation 5.4 continued on next page

[14] Refer to Section 2.6.1 in the Reserve Offset Program Manual for the most recent GWP value.

Equation 5.4. Continued.

$$CH_4Dest_i = Q_i \times DE_i$$

Where,			Units
$CH_4\ Dest_i$	=	Net quantity of methane destroyed by device i during the reporting period	m^3
Q_i	=	Total quantity of landfill methane sent to destruction device i during the reporting period	m^3
DE_i	=	Default methane destruction efficiency for device i. [15,16] See Appendix B for default factors	

And,

$$Q_i = \sum_t \left[LFG_{i,t} \times PR_{CH_4,t}\right]$$

Where,			Units
Q_i	=	Total quantity of landfill methane sent to destruction device i during the reporting period	m^3 / t
$LFG_{i,t}$	=	Total quantity of landfill gas fed to the destruction device i, in time interval t, at standard temperature and pressure	m^3 / t
t	=	Time interval for which LFG flow and concentration measurements are aggregated. Equal to one day for continuously monitored methane concentration and one week for weekly monitored methane concentration	
$PR_{CH4,t}$	=	Average methane fraction of the landfill gas in time interval t as measured	m^3CH_4 / m^3LFG

[15] If available, the official source tested methane destruction efficiency shall be used in place of the default methane destruction efficiency. Otherwise, project developers have the option to use either the default methane destruction efficiencies provided, or the site-specific methane destruction efficiencies as provided by a state or local agency accredited source test service provider, for each of the combustion devices used in the project case. Site-specific methane destruction efficiency testing must occur every 12 months. See Appendix C for more information.

[16] The default destruction efficiencies for enclosed flares and electricity generation devices are based on a preliminary set of actual source test data provided by the Bay Area Air Quality Management District. The default destruction efficiency values are the lesser of the twenty fifth percentile of the data provided or 0.995. These default destruction efficiencies may be updated as more source test data is made available to the Reserve.

For projects where methane was destroyed in the baseline, Equation 5.5Equation 5.8 must be applied. This equation accounts for the methane emissions calculated in Equation 5.3 which would have been destroyed in the absence of the project activity.

Any project at a landfill where methane was collected and destroyed at any time prior to the project start date – even if the prior collection and/or destruction system was removed or has been dormant for an extended period of time – must apply the pre-project deduction.

Equation 5.5. Baseline Adjustment for Destruction at the Baseline Scenario

$$Dest_{base} = (Closed_{discount} + NQ_{discount} + Dest_{max}) \times 0.717 \times 0.001 \times GWP$$

Where,			Units
$Dest_{base}$	=	Adjustment to account for the baseline methane destruction associated with a baseline destruction device. Equal to zero if there is no baseline installation	tCO_2e
$Closed_{discount}$	=	Adjustment to account for the methane that would have been combusted in the baseline flare from baseline wells at a closed landfill. Equal to zero if the project is not a flare project at a closed facility	m^3CH_4
$NQ_{discount}$	=	Adjustment to account for the methane that would have been combusted in the baseline, non-qualifying combustion device. Equal to zero if there is no non-qualifying combustion device	m^3CH_4
$Dest_{max}$	=	Destruction of the un-utilized capacity of the baseline destruction device. This deduction is to be applied only when a new destruction device is used during project activity	m^3CH_4
0.717	=	Density of methane at standard conditions, 0^oC, 1 atm	$kgCH_4 / m^3CH_4$
0.001	=	Conversion factor	$tCH_4 / kgCH_4$
GWP	=	Global Warming Potential factor of methane to carbon dioxide equivalent	tCO_2e / tCH_4

Equation 5.6. Calculating Baseline Adjustment for Destruction of a Qualifying Flare at a Closed Landfill

$$Closed_{discount} = LFG_{B1} + B_{CH_4,closed}$$

Where,

			Units
$Closed_{discount}$	=	Adjustment to account for the methane that would have been combusted in the baseline flare from baseline wells at a closed landfill. Equal to zero if the project is not a flare project at a closed facility	m^3CH_4
LFG_{B1}	=	Landfill gas from the baseline gas wells that would have been destroyed by the qualifying destruction system during the reporting period	m^3CH_4
$B_{CH4,closed}$	=	Methane fraction of landfill gas destroyed by the collection system during the reporting period	m^3CH_4 / m^3LFG

$NQ_{discount}$ may be determined using either of the following options:

1. $NQ_{discount}$ shall be equal to the measured quantity of methane recovered through an active gas collection system installed into the corresponding cell or waste mass of the landfill in which the baseline devices operated. The landfill gas flow from these active wells shall be determined using Equation 5.4 above for a minimum of one month.[17]
2. $NQ_{discount}$ shall be monitored and calculated per Equation 5.7.

Equation 5.7. Calculating Baseline Adjustment for Non-Qualifying Devices

$$NQ_{discount} = LFG_{B2} + B_{CH_4,NQ}$$

Where,

			Units
$NQ_{discount}$	=	Adjustment to account for the methane that would have been combusted in the baseline, non-qualifying combustion device. Equal to zero if there is no non-qualifying combustion device	m^3CH_4
LFG_{B2}	=	Landfill gas from the baseline gas wells that would have been destroyed by the non-qualifying destruction system during the reporting period	m^3CH_4
$B_{CH4,NQ}$	=	Methane fraction of landfill gas destroyed by non-qualifying devices in the baseline. Equal to average methane concentration over the reporting period if maximum capacity is used for LFG_{B2}	m^3CH_4 / m^3LFG

[17] For the purpose of using Equation 5.4 to determine $NQ_{discount}$, the quantity of landfill gas would be only that which is being metered from the corresponding cell or waste mass in which the baseline devices had operated, and not necessarily all of the landfill gas being destroyed by the destruction system.

Equation 5.8. Calculating Baseline Adjustment for Destruction for Qualifying Devices

$$Dest_{max} = \sum_{t}\left[\left(LFG_{B\,max,t} - LFG_{B,t}\right) \times PR_{CH_4,t}\right] \times 0.717 \times 0.001 \times GWP$$

Where,			<u>Units</u>
$Dest_{max}$	=	Deduction of the un-utilized capacity of the baseline destruction device. This deduction is to be applied only when a new destruction device is used during project activity. See Box 5.1 below for an example of the application of the $Dest_{max}$ adjustment	tCO_2e
$LFG_{Bmax,t}$	=	Maximum landfill gas flow capacity of the baseline methane destruction device (standardized at sea level according to the manufacturer specifications) in time interval t	m^3 / t
$LFG_{B,t}$	=	Actual landfill gas flow of the baseline methane destruction device in time interval t	m^3 / t
$PR_{CH4,t}$	=	Average methane fraction of the landfill gas in time interval t as measured	m^3CH_4 / m^3LFG
t	=	Time interval for which LFG flow and concentration measurements are aggregated. Equal to one day for continuously monitored methane concentration and one week for weekly monitored methane concentration	
0.717	=	Density of methane at standard conditions, 0°C, 1 atm	$kgCH_4$ / m^3CH_4
0.001	=	Conversion factor	tCH_4 / $kgCH_4$
GWP	=	Global Warming Potential factor of methane to carbon dioxide equivalent	tCO_2e / tCH_4

Box 5.1. Applying the $Dest_{max}$ Adjustment

This adjustment was designed to help differentiate system upgrades from truly new and additional projects, while encouraging project developers to use their landfill gas beneficially. In short, this methodology assumes that any gas which *could* have been destroyed in the baseline qualifying device is not additional; diversion of that gas to a new destruction device represents an upgrade. Therefore, this term deducts from calculated project reductions that portion of gas which, in the absence of the new destruction device still could have been destroyed.

Example:
An active flare with a capacity of 30 m^3/min was installed at a landfill in 2007. Therefore, because this flare was operational before August 15, 2008, the landfill gas control system is ineligible as a project under this protocol. However, in 2009, an electric generator with a 60 m^3/min capacity was installed, and all landfill gas was diverted to this device. The addition of the electric generator meets the eligibility requirements of this protocol, and therefore qualifies as a new project. Because the baseline flare is a qualifying destruction device under this protocol and is not eligible as a project due to other eligibility criteria (i.e., operational date), it must be accounted for using the $Dest_{max}$ adjustment.

In 2009, 25 m^3/min sent to generator, and 0 m^3/min was sent to the flare. In the year 2010, due to landfill expansion and installation of additional wells, the generator destroyed 40 m^3/min while the flare was non-operational. In 2011, further well expansion allowed the generator to operate at full capacity and the flare was used to destroy an additional 10 m^3/min of landfill gas.

Calculations:

Year	Generator Destruction (m^3/min)	Flare Capacity (m^3/min)	Flare Destruction (m^3/min)	Deduction (m^3/min)	Project Reductions (m^3/min)
2009	25	30	0	30	-5 (0)
2010	40	30	0	30	10
2011	60	30	10	20	40

Note: This example and the calculations are significantly simplified for illustrative purposes. The example values are calculated on a cubic meter per minute of landfill gas basis. Reporters are actually required to report the cumulative value of methane gas sent to the destruction device for each time interval t.

5.2 Quantifying Project Emissions

Certain GHG emissions may occur or increase as a result of the project activity, and therefore must be deducted from the overall project reductions. These added emissions are typically a result of the increased use of fossil-derived energy used to power project blowers, monitoring equipment, support vehicles, or gas treatment. As such, the following categories of emissions must be accounted for under this protocol:

- Total annual indirect carbon dioxide emissions resulting from consumption of electricity from the grid
- Total annual carbon dioxide emissions from the on-site destruction of fossil fuel
- Total annual carbon dioxide emissions from the combustion of supplemental natural gas
- Total annual methane emissions from the incomplete combustion of supplemental natural gas

However, unlike the emissions from incomplete destruction of supplemental natural gas, those resulting from incomplete destruction of landfill gas or the fugitive release of landfill gas do not need to be accounted for. It is assumed that these would have been released to the atmosphere in the baseline scenario as well.

Project emissions shall be calculated using Equation 5.9.

Equation 5.9. Calculating Project Emissions

$$PE = FF_{CO_2} + EL_{CO_2} + NG_{PR}$$

Where,			Units
PE	=	Project emissions during the reporting period	tCO_2e
FF_{CO2}	=	Total carbon dioxide emissions from the destruction of fossil fuel during the reporting period	tCO_2
EL_{CO2}	=	Total indirect carbon dioxide emissions from the consumption of electricity from the grid during the reporting period	tCO_2
NG_{PR}	=	Total quantity of emissions from supplemental natural gas, including both uncombusted methane and carbon dioxide emissions during the reporting period	tCO_2

Equation 5.10. Calculating Project Emissions from Fossil Fuel Use

$$FF_{CO_2} = \frac{\sum_j \left(FF_{PR,j} \times EF_{FF,j}\right)}{1000}$$

Where,			Units
FF_{CO2}	=	Total carbon dioxide emissions from the destruction of fossil fuel during the reporting period	tCO_2
$FF_{PR,j}$	=	Total fossil fuel consumed by the project landfill gas collection and destruction system during the reporting period, by fuel type j	GJ / yr
$EF_{FF,j}$	=	Fuel specific emission factor. See Appendix B	kg CO_2 / GJ fossil fuel
1000	=	Conversion factor	$kgCO_2$ / tCO_2

Equation 5.11. Calculating Project Emissions from Electricity Use

$$EL_{CO_2} = \frac{(EL_{PR} \times EF_{EL})}{1000}$$

Where,			Units
EL_{CO2}	=	Total indirect carbon dioxide emissions from the consumption of electricity from the grid during the reporting period	tCO_2
EL_{PR}	=	Total electricity consumed by the project landfill gas collection and destruction system during the reporting period	MWh
EF_{EL}	=	CO_2 emission factor for electricity used	$kgCO_2$ / MWh
1000	=	Conversion factor	$kgCO_2$ / tCO_2

Equation 5.12. Calculating Project Emissions from the Use of Supplemental Natural Gas

$$NG_{PR} = \sum_i \left[NG_i \times NG_{CH_4} \times 0.017 \times 0.001 \times \left[\left((1 - DE_i) \times GWP \right) + \left(DE_i \times \frac{12}{16} \times \frac{44}{12} \right) \right] \right]$$

Where,			Units
NG_{PR}	=	Total emissions from supplemental natural gas during the reporting period, including both uncombusted methane and carbon dioxide emissions	tCO_2e
NG_i	=	Total quantity of supplemental natural gas delivered to the destruction device i during the reporting period	m^3
DE_i	=	Methane destruction efficiency of destruction device i. See Appendix B	
NG_{CH4}	=	Average methane fraction of the supplemental natural gas as provided for by fuel vendor	m^3CH_4 / m^3FFG
0.717	=	Density of methane	$kgCH_4$ / m^3CH_4
0.001	=	Conversion factor	tCH_4 / $kgCH_4$
GWP	=	Global Warming Potential factor of methane to carbon dioxide equivalent	tCO_2e / tCH_4
12/16	=	Carbon ratio of methane	C / CH_4
44/12	=	Carbon ratio of carbon dioxide	CO_2 / C

6 Project Monitoring

The Reserve requires a monitoring plan to be established for all monitoring and reporting activities associated with the project. The monitoring plan will serve as the basis for verifiers to confirm that the stipulations of Sections 0 and 7 have been and will continue to be met, and that consistent, rigorous monitoring and record-keeping occurs. The monitoring plan does not require ISO or any other certification but must cover all aspects of monitoring and reporting contained in this protocol and must specify how data for all relevant parameters in Table 6.1 will be collected and recorded.

At a minimum the monitoring plan must include a written account of the frequency of data acquisition; the record keeping plan (see Section 7.2 for minimum record keeping requirements); the frequency of instrument cleaning, inspection, field check and calibration activities; and the role of the individual performing each specific monitoring activity, as well as QA/QC provisions to ensure that data acquisition and meter calibration are carried out consistently and with precision. The monitoring plan shall also contain a detailed diagram of the landfill gas collection and destruction system, including the placement of all meters and equipment that affect SSRs within the GHG Assessment Boundary (see Figure 4.1).

Finally, the monitoring plan must include procedures that the project developer will follow to ascertain and demonstrate that the project at all times passes the Legal Requirement Test (Section 3.4.3).

Project developers are responsible for monitoring the performance of the project and operating the landfill gas collection and destruction system in a manner consistent with the manufacturer's recommendations for each component of the system.

6.1 Monitoring Requirements

Project developers are responsible for monitoring the performance of the project and operating the landfill gas collection and destruction system in a manner consistent with the manufacturer's recommendations for each component of the system. Methane emission reductions from landfill gas capture and control systems must be monitored with measurement equipment that directly meters:

- The flow of landfill gas delivered to each destruction device, measured continuously and recorded every 15 minutes or totalized and recorded at least daily, adjusted for temperature and pressure.

- The fraction of methane in the landfill gas delivered to the destruction device, measured continuously and recorded every 15 minutes and averaged at least daily (measurements taken at a frequency that is between daily and weekly may be used with the application of a 10% discount in Equation 5.3). Projects may not be eligible for crediting if methane concentration is not measured and recorded at least weekly.

- The operational activity of the destruction device(s), monitored and documented at least hourly to ensure landfill gas destruction.

If discontinuous CH_4 concentration monitoring is to be employed, then the project developer shall develop a prescriptive methodology for how such monitoring is to be carried out. The method should be reasonable to the circumstances of the project and shall be consistently applied throughout the reporting period. Any such methodology, and adherence to the methodology (or otherwise), should be clearly set out in the project monitoring report.

Methane fraction of the landfill gas is to be measured on a wet/dry basis, depending on the basis (i.e., measured on the same basis) of measurement for flow, temperature, and pressure. The methane analyzer and flow meter shall be installed in the same relative placement to any moisture-removing component separating the measurement of the landfill gas system, where the moisture-removing component is not separating the measurement of flow and methane fraction. The meters themselves should also operate on the same basis (i.e., if one meter internally dries the sample prior to measurement, the same should occur at the other meters). An acceptable variation to this arrangement would be in the case where flow is measured on a dry basis, while the methane concentration is measured on a wet basis. The opposite arrangement is not permissible. No separate monitoring of temperature and pressure is necessary when using flow meters that automatically correct for temperature and pressure, expressing LFG volumes in normalized cubic meters.

A single flow meter may be used for multiple destruction devices under certain conditions. If all destruction devices are of identical efficiency and verified to be operational, no additional steps are necessary for project registration. Otherwise, the destruction efficiency of the least efficient destruction device shall be used as the destruction efficiency for all destruction devices monitored by this meter.

If there are any periods when not all destruction devices measured under a single flow meter are operational, methane destruction during these periods will be eligible provided that the verifier can confirm all of the following conditions were met:

1. The destruction device efficiency of the least efficient destruction device in operation shall be used as the destruction efficiency for all destruction devices monitored by this meter; and

2. All devices are either equipped with valves on the input gas line that close automatically if the device becomes non-operational (requiring no manual intervention), or designed in such a manner that it is physically impossible for gas to pass through while the device is non-operational; and

3. For any period where one or more destruction devices within this arrangement is not operational, it must be documented that the remaining operational devices have the capacity to destroy the maximum gas flow recorded during the period. For devices other than flares, it must be shown that the output corresponds to the flow of gas.

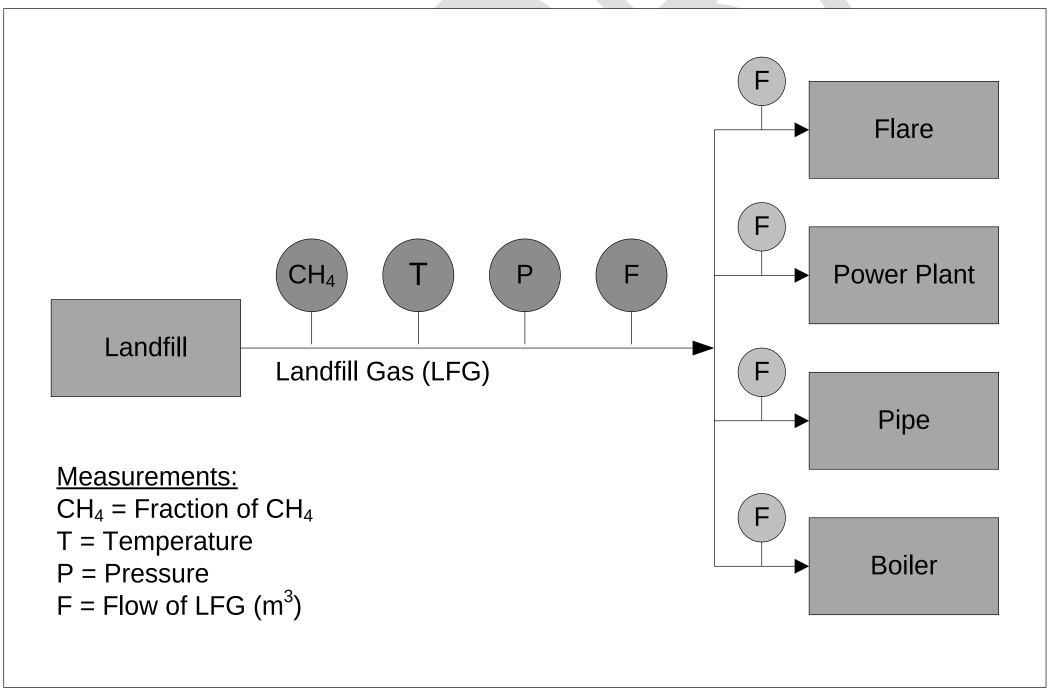
By allowing for a single device to monitor operational activity at multiple destruction devices, it shall not be construed to relax the requirement for hourly operational data for all destruction devices. Rather, this arrangement permits a specific metering arrangement during periods when one or more devices are *known* to not be operating. In order to know the operational status of a device, it must be monitored. All destruction devices must have their operational status monitored and recorded at least hourly. In other words, the project dataset will include an indication of operational status corresponding to each hour of landfill gas data. If these data are missing or never recorded for a particular device, that device will be assumed to be not operating and no emission reductions may be claimed for landfill gas destroyed by that device during the period when data are missing.

All flow data collected must be corrected for temperature and pressure at 0º C and 1 atm. If any of the landfill gas flow metering equipment does not internally correct for the temperature and pressure of the landfill gas, separate pressure and temperature measurements must be used to correct the flow measurement. The temperature and pressure of the landfill gas must be measured continuously. Corrected values must be used in all of the equations of this section. Apply Equation 5.2 only if the landfill gas flow metering equipment does not internally correct for temperature and pressure.

Often, the direct measurement instrument also uses a data recorder to store and document the landfill gas flow and methane concentration data and can be tailored to provide the amount of methane (by volume) collected from the landfill on a periodic basis as specified by the operator.

The continuous methane analyzer should be the preferred option for monitoring methane concentrations, as the methane content of landfill gas captured can vary by more than 20% during a single day due to gas capture network conditions (dilution with air at wellheads, leakage on pipes, etc.).[18] When using the alternative approach of weekly methane concentration measurement using a calibrated portable gas analyzer, project developers must account for the uncertainty associated with these measurements by applying a 10% discount factor to the total quantity of methane collected and destroyed in Equation 5.3.

Figure 6.1 represents the suggested arrangement of the landfill gas flow meters and methane concentration metering equipment.



Note: The number of flow meters must be sufficient to track the total flow as well as the flow to each destruction device. The above scenario includes one more flow meter than would be necessary to achieve this objective.
Source: Consolidated baseline methodology for landfill gas project activities, Clean Development Mechanism, Version 07, Sectoral Scope 13 (2007).

Figure 6.1. Suggested Arrangement of LFG Metering Equipment

[18] Consolidated baseline methodology for landfill gas project activities, Clean Development Mechanism, Version 07, Sectoral Scope 13 (2007).

The operational activity of the landfill gas collection system and the destruction devices shall be monitored and documented at least hourly to ensure actual landfill gas destruction. GHG reductions will not be accounted for during periods which the destruction device was not operational. For flares, operation is defined as thermocouple readings above 260°C (unless otherwise specified in manufacturer's guidance). For all other destruction devices, the means of demonstration shall be determined by the project developer and subject to verifier review. If relying on the difference between ambient temperatures and temperatures recorded by a thermocouple to demonstrate operational activity (instead of using a fixed temperature threshold), then a temperature difference of at least 93°C shall be used. If any destruction device is equipped with a safety shut off valve that prevents biogas flow to the destruction device when not operational, then demonstrating the presence and operability of the shut off valve will be sufficient to demonstrate operational activity of that device.

In "direct use" scenarios where landfill gas is delivered offsite to a third-party end user (not to a commercial natural gas transmission and distribution system or to a facility under management control of the project operator), reasonable efforts must be made to obtain data demonstrating the operational status of the destruction device(s). If it is not possible to obtain such data, the verifier must use their professional judgment to confirm that there has been no significant release of project landfill gas and that the project developer is using the destruction efficiency value appropriate for the end use. Evidence that may assist a verifier in making a determination to that effect may include, but is not limited to, one or more of the following:

- A signed attestation from the third-party operator of the destruction device that no catastrophic failure of destruction or significant release of landfill gas occurred during the reporting period, and that the safety features and/or design of the destruction equipment are such that the destruction device does not allow landfill gas to pass through it when non-operational and/or that the project developer is able to switch off the flow of landfill gas offsite in the event of emergencies (and has rigorous procedures in place to ensure such shutoff occurs immediately)

- The verifier confirming the same via a first-person interview with the third-party operator

- Examination of the safety features and/or design of the destruction equipment, such that the destruction device does not allow landfill gas to pass through it when non-operational and/or that the project developer is able to switch off the flow of landfill gas offsite in the event of emergencies (and has rigorous procedures in place to ensure such shutoff occurs immediately)

- Records that can corroborate the type and level of operation of the destruction device during the reporting period, such as engine output data, etc.

If the verifier is reasonably assured that no significant release of landfill gas has occurred offsite during the reporting period, the project can use the destruction efficiency appropriate to that offsite destruction device, despite the lack of hourly data from a monitoring device confirming operational status.

6.1.1 Indirect Monitoring Alternative

As an alternative to the direct measurement of LFG, projects may instead choose to demonstrate volumes of CH_4 destroyed using output data for their destruction device. Where the output of destruction devices (such as gensets) is measured via the use of a commercial transfer meter (i.e., a meter whose output is used as the basis for the quantification under an energy delivery contract), which is subject to regular, professional maintenance, the project may use such data as the basis for determining the volume of CH_4 destroyed. The meter output shall be subjected to an appropriate conversion methodology to calculate the volume of CH_4 destroyed during the reporting period. If using the indirect monitoring alternative, the commercial meter must be maintained by appropriately-trained professionals, in accordance with manufacturer requirements. In scenarios where projects are able to control the maintenance of such meters, the QA/QC requirements in Section 6.2 apply. In scenarios where projects are not able to control the maintenance of such meters, reasonable efforts must be made to obtain documentation demonstrating manufacturer maintenance requirements have been met during the reporting period.

The monitoring methodology to be employed must be clearly set out in the project monitoring report, it must be applied consistently throughout the reporting period, and it must be demonstrated to the satisfaction of the project's verifier and the Reserve that the use of such data and methodology is reasonable under the circumstances, and results in a conservative estimation of the volume of CH_4 destroyed.

6.2 Instrument QA/QC

The measurement equipment is sensitive for gas quality (humidity, particulate, etc.), so a strong QA/QC procedure for the calibration of this equipment should be built into the monitoring plan.[19] Monitoring instruments shall be inspected and calibrated according to the following schedule.

All gas flow meters and continuous methane analyzers must be:

- Cleaned and inspected on a regular basis, as specified in the project's monitoring plan, with activities and results documented by site personnel. Cleaning and inspection frequency must, at a minimum, follow the manufacturers' recommendations.

- Field checked for calibration accuracy by a third-party technician[20] with the percent drift documented, using either a portable instrument (such as a pitot tube) or manufacturer specified guidance, at the end of – but no more than two months prior to or after – the end date of the reporting period[21]

- Calibrated by the manufacturer or a certified third-party calibration service per manufacturer's guidance or every 5 years when calibration frequency is not specified by the manufacturer.

If a stationary meter that was in use for 60 days or more – which may span longer than one reporting period – is removed and not reinstalled during a reporting period, that meter shall either be:

- field-checked (with percent drift documented) for calibration accuracy by a properly trained individual within 2 months prior to removal; or

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[19] The monitoring plan should clarify that the QA/QC requirements are prescriptive, and it is not appropriate for the landfill staff to apply their professional judgement on whether these requirements are necessary.
[20] The verification body may conduct a third-party field check, given the field check is performed in the prescribed time frame.
[21] Instead of performing field checks, the project developer may instead have equipment calibrated by the manufacturer or a certified calibration service per manufacturer's guidance, at the end of but no more than two months prior to the end date of the reporting period to meet this requirement.

- calibrated (with percent drift documented) by the manufacturer or a certified calibration service (with as-found results recorded) prior to quantification of emission reductions for that reporting period.

If the QA/QC requirements are not performed and properly documented, no GHG credits may be generated for that reporting period.

Cleaning and Inspections

They are performed by site personnel should, at a minimum, include the following:

- Date performed;
- Condition of the meter before and after cleaning;
- Device serial number(s) and location;
- Qualitative observations of the equipment; and
- Staff member's name performing the activities.

It is recommended that project developers create a template form that is included in the project's monitoring plan for staff to complete during each cleaning and inspection. The frequency of cleanings and inspections must be clearly stated in the project's monitoring plan. Photographic evidence may be provided along with the above documentation but should not be considered sufficient without a supporting narrative.

Field Checks

A field check is an on-site validation of a meter to determine drift and assure accuracy. All flow meters and continuous methane analyzers must be field checked for calibration accuracy by a third-party technician[22] with the percent drift documented, using either a portable instrument (such as a pitot tube) or manufacturer specified guidance. A third-party technician is defined as an entity with no material interest in the project, and their only role in the project is to conduct the field check. Services may be provided by the manufacturer, a manufacturer recommended servicer, or an ISO 17025 accredited laboratory or technician. All flow meter, continuous methane analyzer, and portable methane analyzer field checks and calibrations must have "as found" and "as left" conditions[23] documented and percent drift calculated and recorded. The percent drift must be assessed relative to the expected reading rather than the full scale reading of the device.

Continuous methane analyzers must be field checked against a known reference gas at a range of conditions expected at the project. For example, if the methane concentration of the landfill gas is typically in the 45-60% methane range, then a methane analyzer can be field checked against a known 50% methane concentration sample. Each field check must have the meter's reading before (i.e., "as found") any calibration and/or cleaning must be documented. A meter is tested against a known sample of 50% methane concentration prior to cleaning and the result of the device's reading is considered the "as found" condition. The technician will then clean and/or calibrate the meter before conducting the test again against the same known sample, recording the "as left" condition. The percent drift is calculated relative to the known sample (i.e., 50%), as opposed to the manufacturer's defined full scale reading.

[22] The verification body may conduct a third-party field check, given the field check is performed in the prescribed time frame.
[23] "As found" condition is defined as the accuracy of the device before it has been cleaned or calibrated, and the "as left" condition is the accuracy of the device after it has been cleaned or calibrated. This is quantitative documentation of the accuracy of the meter as opposed to qualitative descriptions.

Field checks for flow meters must be conducted against volumetric flow. Similarly to continuous methane analyzers described above, a field check for a flow meter must assess the “as found” and “as left” conditions and document percent drift relative to the expected conditions present at the project site.

At a minimum, field checks must occur at the end of – but no more than two months prior to or after – the end date of the reporting period. For example, if the reporting period follows the calendar year ending on December 31st, then a field check must be completed in the 4-month window between November and February each year as shown in the figure below.

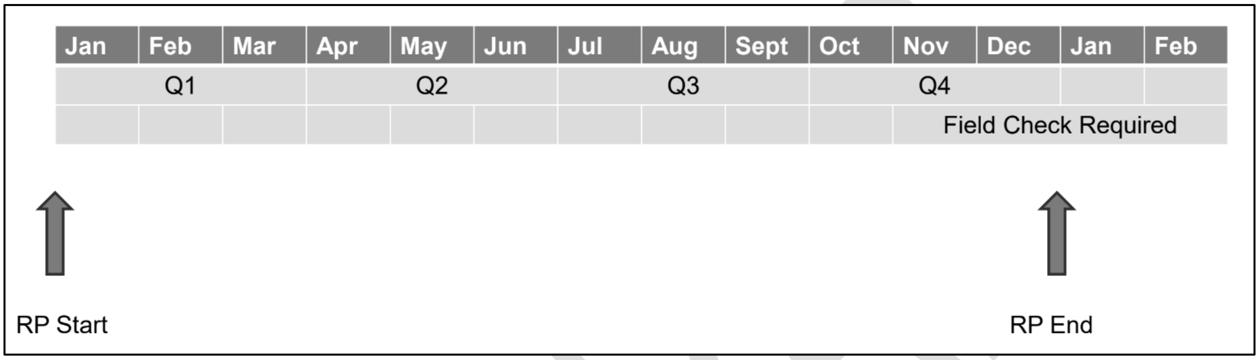

Figure 6.2. Timeline for annual field check requirement

A project may conduct field checks more frequently than required by the protocol. Additional field checks carried out during the reporting period at the project developer’s discretion may be performed by an individual that is not a third-party technician. In this case, the competency of the individual and the accuracy of the field check procedure must be assessed and approved by the verification body. If a field check identifies a reading accuracy outside of a +/- 5% threshold for accuracy, the data must be adjusted for the period beginning with the last successful field check or calibration event up until the meter is confirmed to be in calibration. Thus, more frequent field checks will reduce the amount of data required to be adjusted, as prescribed below.

In order to provide flexibility in verification, data monitored up to two months after a field check may be verified. As such, the end date of the reporting period must be no more than two months after the latest successful field check.

If the meter is found to be measuring outside of a +/- 5% threshold for accuracy, the data must be adjusted for the period beginning with the last successful field check or calibration event up until the meter is confirmed to be in calibration (unless the last event occurred during the prior reporting period, in which case adjustment is made back to the beginning of the current reporting period). If, at the time of the failed field check, the meter is cleaned and checked again, with the “as-left” condition found to be within the accuracy threshold, a full calibration is not required for that piece of equipment. This shall be considered a failed field check, followed by a successful field check. The data adjustment shall be based on the percent drift recorded at the time of the failed field check. However, if the “as-left” condition remains outside of the +/- 5% accuracy threshold (whether or not additional cleaning and accuracy testing occurs), calibration by the manufacturer or a certified service provider is required for that piece of equipment.

Calibrations

All meters must be calibrated per manufacturer's guidance or every 5 years when calibration frequency is not specified by the manufacturer. Calibrations may be performed by the manufacturer, by a laboratory recommended by the manufacturer, or by an ISO 17025[24] accredited laboratory. Having a representative from an accredited or approved calibration service come on site to conduct the calibration is also permissible for this protocol.

Flow meter calibrations shall be documented to show that the meter was calibrated to a range of flow rates corresponding to the flow rates expected at the landfill. Methane analyzer calibrations shall be documented to show that the calibration was carried out to the range of conditions (temperature and pressure) corresponding to the range of conditions as measured at the landfill.

Conformance with the factory calibration requirement is only required during periods of time where data gathered by the meter are used for emission reduction quantification. Periods where the meter did not meet this requirement will not cause the project to fail this requirement, provided the meter was not being used for project emission reduction quantification during such periods, and provided the meter was brought back into conformance before being employed to gather project data. Periods while the meter is not in use must still be considered when determining when to calibrate the device. For example, a continuous flow meter was calibrated on January 1, 2015 and the manufacturer requires the device to be calibrated every 5 years. The meter was in use beginning February 1, 2015 and was removed on December 31, 2016, and then re-installed February 1, 2020. The flow meter must be calibrated by January 1, 2020 in order to be in conformance with the manufacturer specifications.

Portable Instruments

If a portable instrument either:

1. acquires project data (e.g., a handheld methane analyzer is used to take weekly methane concentration measurements), or

2. is used to field check the calibration accuracy of equipment that acquires project data and the portable instrument produces a data output that is or could be used in emission reduction calculations (i.e., flow or concentration); then,

the portable instrument shall be maintained and calibrated per the manufacturer's specifications, and calibrated at least annually by the manufacturer, by a laboratory recommended by the manufacturer, or by an ISO 17025 accredited laboratory[25] or servicer. Other pieces of equipment used for QA/QC of monitoring instruments shall be maintained according to the manufacturer's specifications, including calibration where specified. Portable methane analyzers must also be field calibrated to a known sample gas prior to each use.

Scaling Procedures for Meters Outside of the Accuracy Threshold

For the interval between the last successful field check and any calibration event confirming accuracy below the +/- 5% threshold, all data from that meter or analyzer must be scaled

[24] An alternative accreditation may be accepted pending Reserve approval.
[25] The International Organization for Standardization establishes general requirements for the competence of testing and calibration laboratories under ISO 17025, ensuring that the organization can generate valid results.

according to the following procedure. These adjustments must be made for the entire period from the last successful field check until such time as the meter is properly calibrated.

1. For calibrations that indicate under-reporting (lower flow rates, or lower methane concentration), the metered values must be used without correction.

2. For calibrations that indicate over-reporting (higher flow rates, or higher methane concentration), the metered values must be adjusted based on the greatest calibration drift recorded at the time of calibration.

For example, if a project conducts field checks quarterly during a year-long reporting period, then only three months of data will be subject at any one time to the penalties above. However, if the project developer feels confident that the meter does not require field checks or calibration on a greater than annual basis, then failed events will accordingly require the penalty to be applied to the entire year's data. Frequent calibration may minimize the total accrued drift (by zeroing out any error identified), and result in smaller overall deductions. Additionally, strong equipment inspection and cleaning practices that include checking all probes and internal components will minimize the risk of meter and analyzer inaccuracies and the corresponding deductions. If it is not possible to determine the accrued drift and/or an appropriate method for scaling the data (e.g., drift is recorded in milliwatts, which cannot be directly translated into a drift percentage), the project developer should seek guidance from the instrument manufacturer to confirm when the 5% drift threshold has been reached and how to appropriately scale the relevant data. Such guidance should be provided to the verifier and the Reserve.

If the required on-site cleaning, inspection, calibration, or testing is not properly performed and documented, GHG credits cannot be generated for that reporting period.

6.3 Missing Data

In situations where the flow rate or methane concentration monitoring equipment is missing data, the project developer shall apply the data substitution methodology provided in Appendix C. If for any reason the destruction device monitoring equipment is inoperable (for example, the thermal coupler on the flare), then no emission reductions can be registered for the period of inoperability.

6.4 Monitoring Parameters

Prescribed monitoring parameters necessary to calculate baseline and project emissions are provided in Table 6.1.

Table 6.1. Project Monitoring Parameters

Eq. #	Parameter	Description	Data Unit	Measurement Frequency	Calculated (c) Measured (m) Reference (r) Operating Records (o)	Comment
Qualitative Monitoring Parameters						
		Legal Requirement Test	Project developer attestation of voluntary implementation	Each reporting period		Must be monitored and determined for each reporting period. The project shall document all federal, state, and local regulations, ordinances, and permit requirements (and compliance status for each) that apply to the GHG reduction project. The project developer shall provide a signed attestation of voluntary implementation of the project.
		Regulatory Compliance	Project developer attestation to compliance with regulatory requirements relating to landfill gas project	Each reporting period		Must be monitored and determined for each project period. The project developer shall document all federal, state, and local regulations, ordinances, and permit requirements (and compliance status for each) that apply to the GHG reduction project. The project developer shall provide a signed attestation to their compliance status for the above-mentioned federal, state, and local regulations, ordinances, and permit requirements
		Operation of destruction device		Hourly	o	Required for each destruction device. For flares, operation is defined as thermocouple readings above 260°C
Quantitative Monitoring Parameters						
Equation 5.1	ER	GHG emission reductions during the reporting period	tCO_2e		c	

Eq. #	Parameter	Description	Data Unit	Measurement Frequency	Calculated (c) Measured (m) Reference (r) Operating Records (o)	Comment
Equation 5.1 Equation 5.3	BE	Baseline emissions during the reporting period	tCO_2e		c	
Equation 5.1 Equation 5.9	PE	Project emissions during the reporting period	tCO_2e		c	
Equation 5.2 Equation 5.4	$LFG_{i,t}$	Total quantity of landfill gas fed to the destruction device I, in time internal t, at standard temperature and pressure	scf	Continuous	m/c	Measured continuously by a flow meter and recorded at least once every 15 minutes. Data to be aggregated by time interval t (this parameter is calculated in cases where the metered flow must be corrected for temperature and pressure)
Equation 5.2	$LFG_{unadjusted}$	Unadjusted volume of landfill gas collected for the given time interval	acf	Continuous	m	Used only in cases where the flow meter does not automatically correct to 0°C and 1 atm
Equation 5.3 Equation 5.4	CH_4Dest_{PR}	Total methane destroyed by the project landfill gas collection and destruction system during the reporting period	tCH_4		c	
Equation 5.3	DF	Discount factor to account for uncertainties associated with the monitoring equipment	0, 0.10, 0.2		r	Equal to zero if using continuous methane monitor.
Equation 5.3	OX	Factor for the oxidation of methane by soil bacteria	0, 0.10		r	Equal to 0.10 for all landfills except those that incorporate a synthetic liner throughout the entire area of the final cover systems where OX = 0

Eq. #	Parameter	Description	Data Unit	Measurement Frequency	Calculated (c) Measured (m) Reference (r) Operating Records (o)	Comment
Equation 5.3 Equation 5.5 Equation 5.8 Equation 5.12	GWP	100-year global warming potential for CH_4	tCO_2e / tCH_4	Per reporting period	r	Refer to the Reserve Offset Program Manual and policy memos for updated values.
Equation 5.3 Equation 5.5	$Dest_{base}$	Adjustment to account for the baseline methane destruction associated with a baseline destruction device	tCO_2e		c	Equal to zero if no baseline LFG destruction system is in place prior to project implementation
Equation 5.4	CH_4Dest_i	The net quantity of methane destroyed by destruction device i during the reporting period	m^3CH_4		c	
Equation 5.4	Q_i	Total quantity of landfill methane sent to destruction device i during the reporting period	m^3 CH_4	Daily/Weekly	c	Calculated daily if methane is continuously metered or weekly if methane is measured weekly

Eq. #	Parameter	Description	Data Unit	Measurement Frequency	Calculated (c) Measured (m) Reference (r) Operating Records (o)	Comment
Equation 5.4	DE_i	Default methane destruction efficiency for device i	%	Once	r/m	Project developers have the option to use a state or local agency accredited source test service provider to test the actual methane destruction efficiency of each of the destruction devices used in the project case. If using source test data for destruction efficiencies in Equation 5.2, all source test documentation shall be provided to the verifier. See Appendix B for default values
Equation 5.4	*t*	Time interval for which LFG flow and concentration measurements are aggregated	Week, day, or smaller interval	Continuous/ Daily/Weekly	r	Projects employing continuous methane concentration monitoring may use the interval of their data acquisition system. Otherwise, this parameter is equal to one day for continuously monitored methane concentration and one week for weekly monitored methane concentration
Equation 5.4 Equation 5.8	$PR_{CH4,t}$	The average methane fraction of the landfill gas in time interval t	m^3CH_4 / m^3LFG	Continuous/ Weekly	m	Measured by continuous gas analyzer or a calibrated portable gas analyzer. Data to be averaged by time interval t
Equation 5.6	$Closed_{discount}$	Adjustment to account for the methane which would have been combusted in the baseline flare from baseline wells at a closed landfill	m^3CH_4	Yearly	C	Calculated per year, but may be scaled for project reporting periods less than one year

Eq. #	Parameter	Description	Data Unit	Measurement Frequency	Calculated (c) Measured (m) Reference (r) Operating Records (o)	Comment
Equation 5.7	$NQ_{discount}$	Adjustment to account for the methane which would have been combusted in the baseline, non-qualifying combustion device	$m^3 CH_4$	Yearly	C	Calculated per year, may be scaled for project reporting periods less than one year
Equation 5.8	$Dest_{max}$	Deduction of the un-utilized capacity of the baseline destruction device	$m^3 CH_4$	Weekly, Monthly, or per reporting period (no more than weekly)	C	This deduction is to be applied only when a new destruction device is used during project activity
Equation 5.8	$LFG_{B,t}$	Actual landfill gas flow of the baseline methane destruction device in time interval t	m^3/t	Yearly	c	Calculated per Section 5. Calculated per year, but may be scaled for project reporting periods less than one year
Equation 5.6	$B_{CH4,\ closed}$	Methane fraction of landfill gas destroyed by baseline flares at a closed landfill	$m^3 CH_4$ / $m^3 LFG$	Continuously/ Other	m	Measured by continuous gas analyzer or calibrated portable gas analyzer
Equation 5.7	LFG_{B2}	Landfill gas that would have been destroyed by the original, non-qualifying destruction system during the reporting period	$m^3 LFG$ / year	Yearly	C	Calculated per Section 5, or according to guidance provided in Appendix C. Calculated per year, but may be scaled for project reporting periods less than one year
Equation 5.7	$B_{CH4,NQ}$	Methane fraction of landfill gas destroyed by non-qualifying devices in the baseline	$m^3 CH_4$ / $m^3 LFG$	Continuously/ Other	m	Measured by a continuous gas analyzer or a calibrated portable gas analyzer

Eq. #	Parameter	Description	Data Unit	Measurement Frequency	Calculated (c) Measured (m) Reference (r) Operating Records (o)	Comment
Equation 5.8	$LFG_{Bmax,t}$	The maximum landfill gas flow capacity of the baseline methane destruction device in time interval t	m^3/t	At beginning of first reporting period	c	Calculated based on manufacturer's and/or engineers' specifications for the destruction device and blower system. The maximum capacity of the limiting component, either the destruction device or blower, shall be used
Equation 5.8	$LFG_{B,t}$	The actual landfill gas flow of the baseline methane destruction device in time interval *t*	m^3	Continuous	m	Measured continuously by a flow meter and recorded at least once every 15 minutes
Equation 5.9 Equation 5.10	FF_{CO2}	Total carbon dioxide emissions from the destruction of fossil fuel during the reporting period	tCO_2	Yearly	c	
Equation 5.10	$FF_{PR,j}$	Total fossil fuel consumed by the project landfill gas collection and destruction system during the reporting period, by fuel type j	GJ/yr	Monthly	o	Calculated from monthly record of fossil fuel purchased and consumed
Equation 5.10	$EF_{FF,j}$	Fuel specific emission factor	$kgCO_2$ / GJ fossil fuel	Annually	r	See Appendix B

Eq. #	Parameter	Description	Data Unit	Measurement Frequency	Calculated (c) Measured (m) Reference (r) Operating Records (o)	Comment
Equation 5.9 Equation 5.11	EL_{CO2}	Total indirect carbon dioxide emissions from the consumption of electricity from the grid during the reporting period	tCO_2		c	
Equation 5.11	EF_{EL}	Carbon emission factor for electricity used	$kgCO_2$/ MWh	Annually	r	
Equation 5.11	EL_{PR}	Total electricity consumed by the project landfill gas collection and destruction system during the reporting period	MWh		m/o	Obtained from either on-site metering or utility purchase records. Required to determine CO_2 emissions from use of electricity to operate the project activity
Equation 5.9 Equation 5.12	NG_{PR}	Total quantity of emissions from supplemental natural gas used during the reporting period	tCO_2	Annually	c	Includes both uncombusted methane and carbon dioxide emissions
Equation 5.12	NG_i	Total quantity of supplemental natural gas delivered to the destruction device i during the reporting period	m^3	Continuous	m	Metered prior to delivery to destruction device

Eq. #	Parameter	Description	Data Unit	Measurement Frequency	Calculated (c) Measured (m) Reference (r) Operating Records (o)	Comment
Equation 5.12	NG_{CH4}	Average methane fraction of the supplemental natural gas as provided for by fuel vendor	m^3CH_4 / m^3FFG		r	Refer to purchase records
Equation 5.2	T	Temperature of the landfill gas	°C	Continuous	m	No separate monitoring of temperature is necessary when using flow meters that automatically adjust flow volumes for temperature and pressure, expressing LFG volumes in normalized cubic feet
Equation 5.2	P	Pressure of the landfill gas	atm	Continuous	m	No separate monitoring of pressure is necessary when using flow meters that automatically measure adjust flow volumes for temperature and pressure, expressing LFG volumes in normalized cubic feet

7 Reporting Parameters

This section provides guidance on reporting rules and procedures. A priority of the Reserve is to facilitate consistent and transparent information disclosure among project developers. Project developers must submit verified emission reduction reports to the Reserve annually at a minimum.

7.1 Project Submittal Documentation

Project developers must provide the following documentation to the Reserve in order to list a landfill project.

- Project Submittal form
- Pre-Project diagram(not public)
- Project diagram (not public)

Project developers must provide the following documentation each reporting period in order for the Reserve to issue CRTs for quantified GHG reductions.

- Project diagram – only if there has been a change since the previous reporting period
- Project Monitoring Plan (not public)
- Social and Environmental Safeguards Evaluation Form
- Sustainable Development Goals (SDG) Tool
- Project Data Report
- Verification Report
- Verification Statement
- List of Findings
- Signed Attestation of Title form
- Signed Attestation of Regulatory Compliance form
- Signed Attestation of Voluntary Implementation form
- Signed Attestation of No Conflicts form

At a minimum, the above project documentation will be available to the public via the Reserve's online registry. Further disclosure and other documentation may be made available on a voluntary basis through the Reserve. Project submittal forms can be found on the protocol webpage.

7.2 Record Keeping

For purposes of independent verification and historical documentation, project developers are required to keep all information outlined in this protocol for a period of 10 years after the information is generated or 7 years after the last verification. This information will not be publicly available but may be requested by the verifier or the Reserve.

Social and Environmental Safeguards

- Documentation of Free, Prior, and Informed Consent presented to the landfill livestock operator and/or relevant stakeholders at the project livestock operation site.
- Historical records and ongoing monitoring and reporting of safeguards through data recording of physical measurements, online sources, and government data.
- Executed declaration of absence of conflicts

System information the project developer should retain includes:

- All data inputs for the calculation of the GHG reductions
- Copies of all solid waste, air, water, and land use permits, Notices of Violations (NOVs), and any administrative or legal consent orders dating back at least 3 years prior to the project start date, and for each subsequent year of project operation
- Project developer attestation of compliance with regulatory requirements relating to the landfill gas project
- Collection and control device information (installation dates, equipment list, etc.)
- LFG flow meter information (model number, serial number, manufacturer's calibration procedures)
- Methane monitor information (model number, serial number, calibration procedures)
- Destruction device monitor information (model number, serial number, calibration procedures)
- LFG flow data (for each flow meter)
- LFG flow meter calibration data (for each flow meter)
- Methane monitoring data
- Methane monitor calibration data
- Destruction device monitoring data (for each destruction device)
- Destruction device monitor calibration data (for each destruction device)
- CO_2e monthly and annual tonnage calculations
- Initial and annual verification records and results
- All maintenance records relevant to the LFG control system, monitoring equipment, and destruction devices
- Operational records of the landfill relating to the amount of waste placed onsite (scalehouse records, etc.), or most recent documented WIP report accepted by a regulatory agency

Calibrated portable gas analyzer information that the project developer should retain includes:

- Date, time, and location of methane measurement
- Methane content of LFG (% by volume) for each measurement
- Methane measurement instrument type and serial number
- Date, time, and results of instrument calibration
- Corrective measures taken if the instrument does not meet performance specifications

7.3 Reporting Period and Verification Cycle

7.3.1 Reporting Periods

The reporting period is the length of time over which GHG emission reductions from project activities are quantified. Project developers must report GHG reductions resulting from project activities during each reporting period. A reporting period may not exceed 12 months in length, except for the initial reporting period, which may cover up to 24 months.
The Reserve will accept verified emission reduction reports on a sub-annual basis, should the project developer choose to have a sub-annual reporting period and verification schedule (e.g., monthly, quarterly, or semi-annually). Reporting periods must be contiguous; there may be no time gaps in reporting during the crediting period of a project once the first reporting period has commenced.

7.3.2 Verification Periods

The verification period is the length of time over which GHG emission reductions from project activities are verified. The initial verification period for a landfill project is limited to one reporting period of up to 24 months of data. Subsequent verification periods may cover up to two reporting periods, with a maximum of 24 months of data (i.e., 12 months of data per reporting period). CRTs will not be issued for reporting periods that have not been verified. For any reporting period that ends prior to the end of the verification period (i.e., year 1 of a 2-year verification period), an interim monitoring report must be submitted to the Reserve no later than six months following the end of the relevant reporting period. The interim monitoring report shall contain a summary of emission reductions, description of QA/QC activities, and description of any potential nonconformances, data errors, metering issues, or material changes to the project.[26] All mandatory sections of interim monitoring reports must be verified in the subsequent verification.

To meet the verification deadline, the project developer must have the required verification documentation (see Section 7.1 submitted within 12 months of the end of the verification period. The end date of any verification period must correspond to the end date of a reporting period.

7.3.3 Verification Site Visit Schedule

A site visit must occur during the initial verification, and at least once every two reporting periods thereafter. A reporting period may be verified without a new site visit if the following requirements are met:

1. A new site visit occurred in conjunction with the verification of the previous reporting period;
2. The current verification is being conducted by the same verification body that conducted the site visit for the previous verification; and
3. There have been no significant changes in data management systems, equipment, or personnel since the previous site visit.

The above requirements apply regardless of whether the verification period contains one or two reporting periods. The Reserve maintains the discretion to require a new site visit for a reporting period despite satisfaction of the above requirements. For example, the approval of a significant variance during the reporting period could be considered grounds for denial of the option to forego a site visit for the verification.

[26] A template monitoring report is available at: http://www.climateactionreserve.org/how/program/documents/.

8 Verification Guidance

This section provides verification bodies with guidance on verifying GHG emission reductions from landfill gas projects developed to the standards of this protocol. This verification guidance supplements the Reserve's Verification Program Manual and describes verification activities in the context of landfill gas destruction projects in Argentina.

Verification bodies trained to verify landfill projects in Argentina must be familiar with the following Climate Action Reserve documents:

- Reserve Offset Program Manual
- Reserve Verification Program Manual
- Reserve Argentina Landfill Protocol (this document)

The Reserve Offset Program Manual, Verification Program Manual, and project protocols are designed to be compatible with each other and are available on the Reserve's website at http://www.climateactionreserve.org.

In cases where the Reserve Offset Program Manual and/or Verification Program Manual differ from the guidance in this protocol, this protocol takes precedent.

ISO-accredited verification bodies trained by the Reserve for this project type are eligible to verify landfill project reports. Verification bodies approved under other Reserve or California Air Resources Board waste handling and methane destruction protocols are also permitted to verify landfill projects. Information about verification body accreditation and Reserve project verification training can be found on the Reserve website at https://www.climateactionreserve.org/how/verification/.

8.1 Standard of Verification

The Reserve's standard of verification for landfill projects in Argentina is the Argentina Landfill Protocol (this document), the Reserve Offset Program Manual, and the Verification Program Manual. To verify a landfill project developer's project report, verification bodies apply the guidance in the Verification Program Manual and this section of the protocol to the standards described in Section 2 through 7 of this protocol. Sections 2 through 7 provide eligibility rules, methods to calculate emission reductions, performance monitoring instructions and requirements, and procedures for reporting project information to the Reserve.

8.2 Monitoring Plan

The monitoring plan serves as the basis for verification bodies to confirm that the monitoring and reporting requirements in Section 0 and Section 7 have been met, and that consistent, rigorous monitoring and record-keeping is ongoing at the project site. Verification bodies shall confirm that the monitoring plan covers all aspects of monitoring and reporting contained in this protocol and specifies how data for all relevant parameters in Table 6.1 are collected and recorded.

8.3 Verifying Project Eligibility

Verification bodies must affirm a landfill project's eligibility according to the rules described in this protocol. The table below outlines the eligibility criteria for a landfill project. This table does not represent all criteria for determining eligibility comprehensively; verification bodies must also look to Section 3 and the verification items list in Table 8.2.

Table 8.1. Summary of Eligibility Criteria

Eligibility Rule	Eligibility Criteria	Frequency of Rule Application
Location	Argentina	Once during first verification
Start Date	Project start date must be no more than 90 days after landfill gas is first destroyed by project destruction device. Projects must be submitted for listing within 12 months of the project start date	Once during first verification
Project Crediting Period	Ensure the project is within its first, second, or third crediting period	Once during each crediting period
Performance Standard	Installation of a qualifying destruction device where not required by law (see Section 3.4.1 for other requirements)	Once during first verification
Legal Requirement Test	Signed Attestation of Voluntary Implementation form and monitoring procedures that lay out procedures for ascertaining and demonstrating that the project passes the Legal Requirement Test	Every verification
Regulatory Compliance Test	Signed Attestation of Regulatory Compliance form and disclosure of all non-compliance events to verifier; project must be in material compliance with all applicable laws	Every verification
Exclusions	▪ Bioreactors ▪ Landfills which re-circulate a liquid other than leachate in a controlled manner ▪ Indirect emissions from the displacement of grid electricity or natural gas	Every verification
Social Safeguard 1 - FPIC	Signed documentation demonstrating compliance with SS 1 FPIC.	Once during first verification
Social Safeguard 2 - Ongoing notification, participation and documentation	Signed documentation demonstrating compliance with SS 2	Every verification
Social Safeguard 3 – Work & Safety	Signed compliance declaration form certifying material compliance with all applicable laws, including labor and safety laws.	Every verification

Social Safeguard 4 – Absence of Disputes	Signed certificate of absence of conflicts attesting that there are no land tenure disputes affecting the project boundaries, including all landfill facilities directly associated with the carbon project.	Every verification
Environmental Safeguard 1 – Air & Water Quality	Signed Regulatory Compliance Declaration form certifying compliance with all applicable laws, including those relating to air and water quality.	Every verification
Environmental Safeguard 2 – Pollutants mitigation	Historical records and ongoing monitoring and reporting through recording data from physical measurements, online sources, and government data to demonstrate that the project has been designed and implemented to mitigate potential emissions of pollutants that may cause degradation of soil, air, surface and groundwater quality, and that project developers have obtained appropriate local permits prior to installation to avoid violation of all applicable laws.	Every verification

8.4 Core Verification Activities

The Argentina Landfill Project Protocol provides explicit requirements and guidance for quantifying GHG reductions associated with the destruction of landfill methane. The Verification Program Manual describes the core verification activities that shall be performed by verification bodies for all project verifications. They are summarized below in the context of a landfill project, but verification bodies shall also follow the general guidance in the Verification Program Manual.

Verification is a risk assessment and data sampling effort designed to ensure that the risk of reporting error is assessed and addressed through appropriate sampling, testing, and review. The three core verification activities are:

1. Identifying emission sources, sinks and reservoirs
2. Reviewing GHG management systems and estimation methodologies
3. Verifying emission reduction estimates

Identifying emission sources, sinks, and reservoirs
The verification body reviews for completeness the sources, sinks, and reservoirs identified for a project, such as system energy use, fuel consumption, combustion and destruction from various qualifying and non-qualifying destruction devices, and soil oxidation.

Reviewing GHG management systems and estimation methodologies
The verification body reviews and assesses the appropriateness of the methodologies and management systems that the landfill project uses to gather data on methane collected and destroyed and to calculate baseline and project emissions.

Verifying emission reduction estimates
The verification body further investigates areas that have the greatest potential for material misstatements and then confirms whether or not material misstatements have occurred. This involves site visits to the project to ensure the systems on the ground correspond to and are

consistent with data provided to the verification body. In addition, the verification body recalculates a representative sample of the performance or emissions data for comparison with data reported by the project developer in order to double-check the calculations of GHG emission reductions.

8.5 Argentina Landfill Project Verification Items

The following tables provide lists of items that a verification body needs to address while verifying a landfill project in Argentina. The tables include references to the section in the protocol where requirements are further described. The table also identifies items for which a verification body is expected to apply professional judgment during the verification process. Verification bodies are expected to use their professional judgment to confirm that protocol requirements have been met in instances where the protocol does not provide (sufficiently) prescriptive guidance. For more information on the Reserve's verification process and professional judgment, please see the Verification Program Manual.

Note: These tables shall not be viewed as a comprehensive list or plan for verification activities, but rather guidance on areas specific to landfill projects that must be addressed during verification.

8.5.1 Project Eligibility and CRT Issuance

Table 8.2 lists the criteria for reasonable assurance with respect to eligibility and CRT issuance for landfill projects in Argentina. These requirements determine if a project is eligible to register with the Reserve and/or have CRTs issued for the reporting period. If any one requirement is not met, either the project may be determined ineligible or the GHG reductions from the reporting period (or sub-set of the reporting period) may be ineligible for issuance of CRTs, as specified in Sections 2, 3, and 6.

Table 8.2. Eligibility Verification Items

Protocol Section	Eligibility Qualification Item	Apply Professional Judgment?
2.1	Verify that the project meets the definition of a landfill project and is properly defined	No
2.1, 4	Confirm all baseline qualifying devices have been properly accounted for within project's GHG Assessment Boundary	No
2.2	Verify ownership of the reductions by reviewing Attestation of Title	No
2.2, 2.3	For direct use agreements between the project developer and the end user of the landfill gas (i.e., an industrial client purchasing the landfill gas from the project developer), verify that a legally binding mechanism is built into the agreement language to assure that the GHG offset credits will not be double counted	No
3.2	Verify eligibility of project start date	No
3.2	Verify accuracy of project start date based on operational records	Yes
3.3	Verify that project is within its first, second, or third 10-year crediting period	No
3.4.1	Verify that the project meets the appropriate Performance Standard Test for the project type	No
3.4.2	Confirm execution of the Attestation of Voluntary Implementation form to demonstrate eligibility under the Legal Requirement Test	No
3.5	Verify that the project activities comply with applicable laws by reviewing any instances of non-compliance provided by the project	Yes

Protocol Section	Eligibility Qualification Item	Apply Professional Judgment?
	developer and performing a risk-based assessment to confirm the statements made by the project developer in the Attestation of Regulatory Compliance form	
6	Verify that the project monitoring plan contains procedures for ascertaining and demonstrating that the project passes the Legal Requirement Test at all times	Yes
6	Verify that monitoring meets the requirements of the protocol. If it does not, verify that a variance has been approved for monitoring variations	No
6	Verify that the landfill gas control system operated in a manner consistent with the design specifications	Yes
6	Verify that there is an individual responsible for managing and reporting GHG emissions, and that individual is properly trained and qualified to perform this function	Yes
6.2	Verify that all gas flow meters and methane analyzers adhered to the inspection, cleaning, and calibration schedule specified in the protocol. If they do not, verify that a variance has been approved for monitoring variations or that adjustments have been made to data per the protocol requirements	No
6.2	If any piece of equipment failed a calibration check, verify that data from that equipment was scaled according to the failed calibration procedure for the appropriate time period	No
6.3	If used, verify that data substitution methodology was properly applied	No
7.1, 7.2	Verify that appropriate documents are created to support and/or substantiate activities related to GHG emission reporting, and that such documentation is retained appropriately	Yes
	If any variances were granted, verify that variance requirements were met and properly applied	Yes
	If any zero-credit reporting periods were taken, verify that zero-credit reporting period requirements were met	Yes

8.5.2 Quantification of GHG Emission Reductions

Table 8.3 lists the items that verification bodies shall include in their risk assessment and re-calculation of the project's GHG emission reductions. These quantification items inform any determination as to whether there are material and/or immaterial misstatements in the project's GHG emission reduction calculations. If there are material misstatements, the calculations must be revised before CRTs are issued.

Table 8.3. Quantification Verification Items

Protocol Section	Quantification Item	Apply Professional Judgment?
4	Verify that SSRs included in the GHG Assessment Boundary correspond to those required by the protocol and those represented in the project	No
5	Verify that the project developer correctly quantified and aggregated electricity use	Yes

Protocol Section	Quantification Item	Apply Professional Judgment?
5	Verify that the project developer correctly quantified and aggregated fossil fuel use	Yes
5	Verify that the project developer applied the correct emission factors for fossil fuel combustion and grid-delivered electricity	No
5.1	Verify that the project developer correctly accounted for baseline methane destruction in the baseline scenario	No
5.2	Verify that the project developer correctly monitored, quantified, and aggregated the amount of methane collected from the landfill and destroyed by the project landfill gas control system	No
5, Appendix B	Verify that the project developer applied the correct methane destruction efficiencies	No
Appendix B	If the project developer used source test data in place of the default destruction efficiencies, verify accuracy and appropriateness of data and calculations	Yes

8.5.3 Risk Assessment

Verification bodies will review the following items in Table 8.4 to guide and prioritize their assessment of data used in determining eligibility and quantifying GHG emission reductions.

Table 8.4. Risk Assessment Verification Items

Protocol Section	Item that Informs Risk Assessment	Apply Professional Judgment?
0	Verify that the project monitoring plan is sufficiently rigorous to support the requirements of the protocol and proper operation of the project	Yes
0	Verify that the individual or team responsible for managing and reporting project activities are qualified to perform this function	Yes
0	Verify that appropriate training was provided to personnel assigned to greenhouse gas reporting duties	Yes
0	Verify that all contractors are qualified for managing and reporting greenhouse gas emissions if relied upon by the project developer. Verify that there is internal oversight to assure the quality of the contractor's work	Yes
6.1	Verify that appropriate monitoring equipment is in place to meet the requirements of the protocol	No
6.2	Verify that the methane destruction equipment was operated and maintained according to manufacturer specifications	Yes
7.2	Verify that all required records have been retained by the project developer	No

8.6 Completing Verification

The Verification Program Manual provides detailed information and instructions for verification bodies to finalize the verification process. It describes completing a Verification Report, preparing a Verification Opinion, submitting the necessary documents to the Reserve, and notifying the Reserve of the project's verified status.

9 Glossary of Terms

Accredited verifier	A verification firm approved by the Climate Action Reserve to provide verification services for project developers.
Additionality	Landfill management practices that are above and beyond business-as-usual operation, exceed the baseline characterization, and are not mandated by regulation.
Anaerobic	Pertaining to or caused by the absence of oxygen.
Anthropogenic emissions	GHG emissions resultant from human activity that are considered to be an unnatural component of the Carbon Cycle (i.e., fossil fuel destruction, de-forestation, etc.).
Biogenic CO_2 emissions	CO_2 emissions resulting from the destruction and/or aerobic decomposition of organic matter. Biogenic emissions are considered to be a natural part of the Carbon Cycle, as opposed to anthropogenic emissions.
Bioreactor	Any landfill which: a. Meets the EPA definition of a bioreactor: “a MSW landfill or portion of a MSW landfill where any liquid other than leachate (leachate includes landfill gas condensate) is added in a controlled fashion into the waste mass (often in combination with recirculating leachate) to reach a minimum average moisture content of at least 40 percent by weight to accelerate or enhance the anaerobic (without oxygen) biodegradation of the waste.”[27] b. Has been designated by local, state, or federal regulators as a bioreactor. c. Has received grants or funding to operate as a bioreactor.
Carbon dioxide (CO_2)	The most common of the six primary greenhouse gases, consisting of a single carbon atom and two oxygen atoms.
Clean Development Mechanism (CDM)	One of the three flexible mechanisms established by the Kyoto Protocol. CDM is the market instrument in which certified emissions reductions can be achieved from a project developed in a “non-Annex I” country (developing country) with the assistance of an “Annex I” country (industrialized country). These reductions are accrued to the reduction commitment of the “Annex I” party (Art. 12 of the Kyoto Protocol) in the Kyoto Protocol’s first commitment period (2008-2012).
CO_2-equivalent (CO_2e)	The quantity of a given GHG multiplied by its total Global Warming Potential. This is the standard unit for comparing the degree of warming which can be caused by different GHGs.
Direct emissions	Greenhouse gas emissions from sources that are owned or controlled by the reporting entity.
Eligible landfill	A landfill that: 1. Is not subject to regulations or other legal requirements requiring the destruction of methane gas

[27] 40 CFR 63.1990 and 40 CFR 258.28a.

2. Is not a bioreactor
3. Does not add any liquid other than leachate into the waste mass in a controlled manner

Emission factor (EF)	A unique value for determining an amount of a greenhouse gas emitted for a given quantity of activity data (e.g., metric tonnes of carbon dioxide emitted per barrel of fossil fuel burned).
Emission Guidelines (EG)	Guidelines for state regulatory plans that have been developed by the U.S. EPA. For landfills, emission guidelines are codified in 40 CFR 60 Subpart Cc.
Flare	A destruction device that uses an open flame to burn combustible gases with combustion air provided by uncontrolled ambient air around the flame.
Fossil fuel	A fuel, such as coal, oil, and natural gas, produced by the decomposition of ancient (fossilized) plants and animals.
Greenhouse gas (GHG)	Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), or perfluorocarbons (PFCs).
Global Warming Potential (GWP)	The ratio of radiative forcing (degree of warming to the atmosphere) that would result from the emission of one unit of a given GHG compared to one unit of CO_2.
Indirect emissions	Emissions that are a consequence of the actions of a reporting entity but are produced by sources owned or controlled by another entity.
Landfill	A defined area of land or excavation that receives or has previously received waste that may include household waste, commercial solid waste, non-hazardous sludge and industrial solid waste.
Landfill gas (LFG)	Gas resulting from the decomposition of wastes placed in a landfill. Typically, landfill gas contains methane, carbon dioxide, and other trace organic and inert gases.
Landfill gas project	Installation of infrastructure that in operating causes a decrease in GHG emissions through destruction of the methane component of landfill gas.
Liquefied petroleum gas (LPG)	Fuel obtained from oil distillation and after processing the natural gas liquids. It mainly consists on propane, butane or a mixture of both.
Metric ton or “tonne” (MT)	A common international measurement for the quantity of GHG emissions, equivalent to about 2204.6 pounds or 1.1 short tons.
Methane (CH_4)	A potent GHG with a GWP of 28, consisting of a single carbon atom and four hydrogen atoms.
MMBtu	One million British thermal units.
Mobile combustion	Emissions from the transportation of materials, products, waste, and employees resulting from the combustion of fuels in company owned or controlled mobile combustion sources (e.g., cars, trucks, tractors, dozers, etc.).
Nitrous oxide (N_2O)	A GHG consisting of two nitrogen atoms and a single oxygen atom.

Non-methane organic compounds (NMOC)	Non-methane organic compounds as measured according to the provisions of 40 CFR 60.754.
Non-qualifying destruction device	A passive flare or other combustion system that results in the destruction of methane, but which cannot serve as the primary destruction device for a methane destruction project under this protocol.
Project baseline	A business-as-usual GHG emission assessment against which GHG emission reductions from a specific GHG reduction activity are measured.
Project developer	An entity that undertakes a project activity, as identified in the Argentina Landfill Project Protocol. A project developer may be an independent third party or the landfill operating entity.
Reporting period	Specific time period of project operation for which the project developer has calculated and reported emission reductions and is seeking verification and issuance of credits. The reporting period must be no longer than 12 months.
Stationary combustion source	A stationary source of emissions from the production of electricity, heat, or steam, resulting from combustion of fuels in boilers, furnaces, turbines, kilns, and other facility equipment.
Verification	The process used to ensure that a given participant's greenhouse gas emissions or emission reductions have met the minimum quality standard and complied with the Reserve's procedures and protocols for calculating and reporting GHG emissions and emission reductions.
Verification body	A Reserve-approved firm that is able to render a verification opinion and provide verification services for operators subject to reporting under this protocol.

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Appendix A Regulatory Framework review

A.1. National Regulation

The framework in Argentina regulating solid waste and landfills involves both federal and national governance. This system is articulated mainly through the Household Waste Management Law and the General Environmental Law. At the national level, the Secretariat of Tourism, Environment and Sports is responsible for policy definition, technical assistance and co-financing of investments in the waste sector.

At the national level, Argentina has the National Environmental Policy Act No. 25,675[28], also known as General Environmental Law, that establishes the minimum budgets for achieving sustainable and adequate management of the environment, the preservation and protection of biological diversity, and the implementation of sustainable development in Argentina. Likewise, it establishes a general framework on information and participation in environmental matters, responsibility for environmental damage and environmental education. This law also introduces the obligation to carry out Environmental Impact Assessments (EIA) for projects that may have significant effects on the environment, such as landfills or final disposal sites.

Law 25.916 Household Waste Management (August 4, 2004)[29] establishes minimum environmental protection budgets for the comprehensive management of household waste, general provisions, competent authorities, generation and initial disposal, collection and transportation, treatment, transfer and final disposal, interjurisdictional coordination, enforcement authority, infractions and sanctions, and complementary provisions. Article 18 states that the applicable agencies must establish the necessary requirements for the authorization of final disposal centers, based on the characteristics of the household waste, the technologies to be used, and the local environmental characteristics. To comply with Law No. 25,675, these centers must have an approved EIA prior to becoming fully operational, which includes the execution of a Monitoring Plan for the main environmental considerations during the operation, closure, and post-closure phases.

Article 22 establishes the Federal Council of the Environment (Spanish abv. COFEMA), which ensures interjurisdictional coordination of the implementation and compliance of the Federal Environmental Pact. COFEMA's main objectives are to agree on comprehensive household waste management policies, technical and environmental criteria to be used in the different stages of comprehensive management, and, in conjunction with the Secretariat of Tourism, Environment and Sports , determine targets for the recovery of household waste.

A.2. Provincial Laws and Municipal Regulations

The provinces are responsible for forming and managing provincial waste policy, which has various regulations to govern different aspects of municipal solid waste disposal systems. Several regulations are highlighted below, but they should not be considered an exhaustive list.

In the Province of Buenos Aires, Resolution 1143/02 (August 13, 2022), establishes the suggested guidelines for the Disposal of Urban Solid Waste in Landfills. This resolution includes

[28] https://www.magyp.gob.ar/sitio/areas/d_recursos_humanos/concurso/normativa/_archivos//000001_Leyes/000000_LEY%2025.675%20Pol%C3%ADtica%20Ambiental%20Nacional.pdf
[29] https://www.argentina.gob.ar/normativa/nacional/ley-25916-98327/texto

criteria according to the level of waste collected (with a limit of 50 tons per day), as well as characteristics of the location, design, operation, closure and maintenance of landfills.

In the Province of Córdoba, under the Ministry of Environment and Circular Economy, Resolution No. 372/01 defines the general guidelines for final waste disposal sites. In addition, landfill projects must have the corresponding Environmental License.

Article 40 of Law 13055 in the Province of Santa Fe describes the characteristics of landfills that must respond to the guidelines described on design, operation, and monitoring. It also establishes regulations to reduce the amount of waste disposed in landfills by 2030.

Law 7,076 on the Final Disposal Regime of Urban Solid Waste (October 23, 2000) in Tucumán describes the characteristics for the final disposal of municipal solid waste and the minimum technical requirements for the installation and operation of landfills.

Appendix B Development of the Performance Standard Threshold

The purpose of a performance standard is to establish a threshold that is significantly better than average GHG production for a specified service, which, if met or exceeded by a project developer, satisfies the criterion of "additionality." The Reserve's protocol focuses on the capture and combustion of methane from landfills located in Argentina.

The analysis to establish the performance standard evaluated Argentina-specific data on waste management practices. Ultimately, it recommended a practice-change threshold that focuses on the baseline scenario and changes made in the project scenario. The summary of the performance standard analysis includes the following sections:

- Waste management practices in Argentina;
- Participation in the carbon market; and
- Recommendation for a performance standard

B.1 Waste management Practices in Argentina

According to the 2021 State of the Environment Report[30], approximately 90% of the population is concentrated in urban areas with waste disposal infrastructure. It is estimated that around 65% of the Municipal Solid Waste (MSW) produced throughout the country is disposed of in waste treatment centers designed for safe waste disposal with built in measures to protect the surrounding environment. The rest of the MSW is disposed of in controlled dumps or open-air dumps (common in most municipalities). These modes of disposal lack the more holistic management and waste treatment involved with an engineered landfill. The existence of nearly 5,000 open air dumps throughout the country entails negative environmental and social impacts, along with health risks. The table below shows the waste disposal distribution in the country.

Table B.1. Final disposal Method (percent disposed waste) in Argentina 2021

Open-Air Dump Site	Controlled Dumps	Landfill
24.5%	9.9%	65.6%

Source: Roadmap for the progressive closure of landfills in Latin America and the Caribbean (2021). PNUMA.[31]

The Integrated Management of Urban Solid Waste (Spanish abv. ISWM) was established by the Argentinian government to reduce the waste, improve processes for collection, transport and treatment of waste, as well as to provide guidance to implement collection and control systems for liquid and gas emissions.[32] Between 2017and 2020 the Undersecretariat of the Environment of the Nation, together with the United Nations Development Program (UNDP), implemented the GEF project Sustainable Business Models to produce biogas from organic urban solid waste. The project planned to demonstrate the potential of biogas, with emphasis on landfill gas, for the generation of energy from organic municipal solid waste in medium-sized urban centers in Argentina. Then, demonstrative pilot projects were implemented in three selected

[30] Ministry of Environment and Sustainable Development (2022). Available at: https://informe.ambiente.gob.ar/Informe_del_estado_del_ambiente_2022.pdf
[31] https://wedocs.unep.org/bitstream/handle/20.500.11822/34919/Roadmap_ES.pdf?sequence=8
[32] https://www.argentina.gob.ar/interior/ambiente/control/rsu/etapas

municipalities.[33] However, after the implementation of the project, no significative increase in landfill gas capture and destruction/use at in-country facilities was observed..

The installation and operation of landfills in Argentina are mainly coordinated by the governments, however, there is a concession system that allows the participation of private or public-private actors in the start-up and operation. Below is a list of the country's landfills according to 2015 World Bank Assessment of the Integrated Management of Urban Solid Waste in Argentina. [34] There are no published national statistics on the generation and management (including recovery) of MSW in Argentine municipalities, which are responsible for waste management.

Table B.2. Existing landfills in Argentina, by province (2015).

Province	Landfill*	Municipalities	Tons disposed per day**
Ciudad de Buenos Aires	CEAMSE-Norte III	City of Buenos Aires and 34 districts of the Province of Buenos Aires	13,942
Buenos Aires	CEAMSE – Gonzales Catán		
	CEAMSE - Ensenada		628
	Bahía Blanca	Bahía Blanca	230
	Mar de Plata	Gral. Pueyrredón	1,100
	Olavarría (first CDM Project in Argentina)	Olavarría	100
	Tandil	Tandil	100
	Laprida	Laprida	2.5
	San Nicolás	San Nicolás	120
Santa Fe	Ricardone	10 municipalities from El Gran Rosario	1,500
	Rafaela	Rafaela	120
	Santa Fe	Santa Fe capital and small municipalites (San José del Rincón, Arroyo Leyes and Santa Rosa de Calchines)	500
Córdoba	6 Landfills	Including Gran Córdona (The city of Córdoba and other 17 municipalities) Villa Dolores and Cruz del eje	2,300
La Pamapa	Santa Rosa	Santa Rosa	140
Entre Ríos	Galeguaychú	Galeguaychú	104
Mendoza	Malargue	Malargue	22
	Alvear	Alvear	42
	Zona Este	Rivadavia, San Martín, Santa Rosa y Junín	180
San Luis	San Luis capital	San Luis capital	20
	Donovan	The metropolitan area of the capital and small towns located in the mountain area (Juana Koslay, Potrero, La Punta, San Gerónimo,	32

[33] https://www.undp.org/es/argentina/proyectos/modelos-de-negocios-para-la-produccion-de-biogas
[34] *World Bank 2015 - Diagnosis of the Integrated Management of Urban Solid Waste in Argentina. Data collection, generation and analysis - Collection, sweeping, transfer, treatment and final disposal of Urban Solid Waste.*

		Balde, El Volcán, Estancia Grande, Trapiche, Nogolí, Villa de la Quebrada)	
	Villa Mercedes	Villa Mercedes, Justo Darac, Juan Jorba y Fraga	120
	Carpintería	Villa de Merlo, Carpintería, Los Molles, Cortaderas, Villa Larca, Villa del Carmen, Papagayos, Concarán, Naschel, San Pablo, Santa Rosa de la Conlara, Renca y La Punilla.	50
	La toma	La Toma, Juana Llerena, Paso Grande, el Morro, Saladillo.	9
Tucumán	San Felipe	Municipalities from Gran San Miguel de Tucumán	900
Salta	San Javier	Salta capital and municipalities from Gran Salta	750
	Manual Landfills	The province worked on the installation of manual landfills with several small and medium-sized towns, including: Tolar Grande, la Puna, Valles Calchaquíes, Iruya and Coronel Moldes.	10
La Rioja	Villa Unión	Villa Unión	15
Santiago del Estero	Río Hondo	Río Hondo	33
Misiones	The entire province is regionalized and has 25 transfer stations and two landfills operated by the private company Aesa.	The entire Province	800
Neuquén	Neuquén	Neuquén	300
	Junin de los andes	Junín de los andes and San Martín de los Andes	58
Río Negro	El Bolson	El Bolsón	25
	General Roca	General Roca	80
Chubut	Ex Torre Omega	Puerto Madryn, Trelew, Dolavon, Gaiman and Rawson	350
	Esquel- Trevelin	Esquel- Trevelin	55
Tierra de Fuego	Ushuaia	Ushuaia	120
Total municipal waste disposed of in landfills (tons/day)			25,150
*Total Municipal waste generation (tons/day)****			49,070
Total Landfill disposal capacity over municipal solid waste generation			51,25%
Percentage of disposal capacity in landfill over total MSW generation (not considering CEAMSE landfills)			30.67%

*The disposal site is considered to be a landfill if the gases and leachate generated are properly managed and regular compaction and covering (preferably on a daily basis) is performed.
**Information obtained from landfill managers or official websites, based on records from the disposal site.
***Considers 1.15 kg/person*day of municipal solid waste generation (EVAL 2010) and 42,669,500 inhabitants (2014 projection, 2010 Census).

B.2 Participation in the Carbon Market

After the adoption of the Kyoto Protocol, the Clean Development Mechanism (CDM) incentivized several landfills to install a gas collection and control system in Argentina. Of the 48 CDM projects located in Argentina, 11 were landfill gas collection and control systems. The program issued over 7.3 million Certified Emission Reductions (CERs) from 7 projects; however, these projects ceased crediting after the end of the CDM. In addition to CDM-accredited landfills, there is one proposed project listed with Verra (formerly VCS).

Table B.3. Landfills in Argentina Listed with the CDM

Province	Number of Projects	CERs Issued
Buenos Aires	7	7,035,897
Santa Fe	1	243,288
Mendoza	1	37,868
Salta	1	-
Misiones	1	-
Total:	11	7,317,053

Source: Clean Development Mechanism, accessed January 2025

Based on the emission reductions achieved under the CDM, the implementation of landfill gas collection and control systems are possible in Argentina, however, according to studies[35] the transfer was not easy or complete. A majority of the projects failed to reach the estimated level of CERs, indicating systemic problems in technology implementation and knowledge utilization. The revitalization of the voluntary carbon market can provide the incentive necessary to reduce emissions in the sector.

B.3 Recommendation for Performance Standard

There were 7 actively reporting landfill projects during the height of the CDM but ceased crediting after the widespread decline in participation in the program. Since, there has been little activity from landfills in the carbon market, signaling the need for incentives to control emissions. Based on the determination that landfill gas collection and control systems are not common practice in the jurisdiction, the Reserve recommends a practice-change threshold that focuses on the baseline scenario and changes made in the project scenario.

[35] The Argentine garbage boom: two successful cases of Technology Transfer in the CDM. Quintín Barnes (2015).

Appendix C Emission Factor Tables

Table C.1. Fuel Emission Factor for Stationary and Mobile Combustion

Fuel	**Emission Factors [kg CO_2/GJ]**
Stationary Combustion [a]	
Crude oil	73.30
Natural gas liquids	64.20
Gasoline	69.30
Kerosene	71.90
Diesel	74.10
Residual fuel oil	77.40
Liquefied petroleum gas (LPG)	63.10
Naphtha	73.30
Lubricants	73.30
Petroleum coke	97.50
Coking coal	94.60
Bituminous coal	94.60
Sub-bituminous coal	96.10
Natural gas	56.10
Waste oils	73.30
Mobile combustion [b]	
Gasoline vehicles	69.3
Gasoline/Diesel Vehicles	74.1
Liquefied Petroleum Gas (LPG) Vehícles	70.07
LPG vehicles	63.1
Compressed Natural Gas (CNG) Vehicles	56.10
Liquefied Natural Gas Vehicles	56.10
Aircraft (Kerosene)	71.90

[a] IPCC, 2006. IPCC Guidelines for National Greenhouse Gas Inventories, Volumen 2, Chapter 2, Stationary Combustion, Table 2.5, pages 2.22-2.23.
[b] IPCC, 2006. IPCC Guidelines for National Greenhouse Gas Inventories, Volumen 2, Chapter 3, Mobile combustion, Table 3.2.1, pages 3.16. No se hicieron correcciones en el Refinamiento del IPCC de 2019

Table C.2. Fossil Fuels Lower Calorific Values

Fuel	Lower calorific value[36]	
Solid fuels	**Kcal/kg**	**GJ/metric ton**
National coal	5900	22.3944
Imported coal	7200	27.3287
San Nicolas Coal	5400	20.4965
Coke	6800	25.1049
Residual Coal coke	7600	28.8470
Fuel Oil [0.945kg/L]	9800	37.1974
Liquid fuels [a]	**Kcal/litre**	**GJ/litre**
Crude oil	8900	0.03723
Gasoline	7280	0.03045
Kerosene	8400	0.03514
Diesel Oil	9064	0.03792
Liquefied petroleum gas (LPG)	8618	0.03605
Naphtha	7844	0.03281
Lubricants	7560	0.03163
Gaseous fuels		
Natural gas		

[a] 1 barrel = 158.9873 liters
Source: National Energy Balance Methodological Document (2015). Ministry of Energy and Mining. Available at: https://www.energia.gob.ar/contenidos/archivos/Reorganizacion/informacion_del_mercado/publicaciones/energia_en_gral/balances_2016/documento-metodologico-balance-energetico-nacional-final-2015.pdf

[36] Argentina has historically used the lower calorific value for its Energy Statistics. The National Energy Balance 2015 uses Lower calorific values.

Destruction Efficiencies for Combustion Devices

If available, the official source tested methane destruction efficiency shall be used in place of the default methane destruction efficiency. Project developers have the option to use either the default methane destruction efficiencies provided, or the site specific methane destruction efficiencies as provided by a state or local agency accredited source test service provider, for each of the combustion devices used in the project, performed every 12 months.

Table C.3. Default Destruction Efficiencies for Combustion Devices

Destruction Device	Destruction Efficiency
Open flare	0.96
Enclosed flare	0.995
Lean-burn internal combustion engine	0.936
Rich-burn internal combustion engine	0.995
Boiler	0.98
Microturbine or large gas turbine	0.995
Upgrade and use of gas as CNG/LNG fuel	0.95
Upgrade and injection into natural gas transmission and distribution pipeline	0.98*
Off-site use of gas under direct-use agreement	Per corresponding destruction device factor (not pipeline)

Source: The default destruction efficiencies for enclosed flares and electricity generation devices are based on a preliminary set of actual source test data provided by the Bay Area Air Quality Management District. The default destruction efficiency values are the lesser of the twenty fifth percentile of the data provided or 0.995. These default destruction efficiencies may be updated as more source test data is made available to the Reserve.

***** The Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories gives a standard value for the fraction of carbon oxidized for gas destroyed of 99.5% (Reference Manual, Table 1.6, page 1.29). It also gives a value for emissions from processing, transmission and distribution of gas which would be a very conservative estimate for losses in the pipeline and for leakage at the end user (Reference Manual, Table 1.58, page 1.121). These emissions are given as 118,000kgCH_4/PJ on the basis of gas consumption, which is 0.6%. Leakage in the residential and commercial sectors is stated to be 0 to 87,000kgCH_4/PJ, which equates to 0.4%, and in industrial plants and power station the losses are 0 to 175,000kg/CH_4/PJ, which is 0.8%. These leakage estimates are compounded and multiplied. The methane destruction efficiency for landfill gas injected into the natural gas transmission and distribution system can now be calculated as the product of these three efficiency factors, giving a total efficiency of (99.5% x 99.4% x 99.6%) = 98.5% for residential and commercial sector users, and (99.5% x 99.4% x 99.2%) = 98.1% for industrial plants and power stations. [37]

[37] GE AES Greenhouse Gas Services, Landfill Gas Methodology, Version 1.0 (July 2007).

Appendix D Data Substitution Guidelines

This appendix provides guidance on calculating emission reductions when data integrity has been compromised due to missing data points. No data substitution is permissible for equipment such as thermocouples which monitor the proper functioning of destruction devices. Rather, the methodologies presented below are to be used only for the methane concentration and flow metering parameters.

The Reserve expects that projects will have continuous, uninterrupted data for the entire verification period. However, the Reserve recognizes that unexpected events or occurrences may result in brief data gaps.

The following data substitution methodology may be used only for flow and methane concentration data gaps that are discrete, limited, non-chronic, and due to unforeseen circumstances. Data substitution can only be applied to methane concentration *or* flow readings, but not both simultaneously. If data is missing for both parameters, no reductions can be credited.

Further, substitution may only occur when two other monitored parameters corroborate proper functioning of the destruction device and system operation within normal ranges. These two parameters must be demonstrated as follows:

1. Proper functioning can be evidenced by thermocouple readings for flares, energy output for engines, etc.
2. For methane concentration substitution, flow rates during the data gap must be consistent with normal operation.
3. For flow substitution, methane concentration rates during the data gap must be consistent with normal operations.

If corroborating parameters fail to demonstrate any of these requirements, no substitution may be employed. If the requirements above can be met, the following substitution methodology may be applied:

Duration of Missing Data	Substitution Methodology
Less than six hours	Use the average of the four hours immediately before and following the outage
Six to 24 hours	Use the 90% lower or upper confidence limit of the 24 hours prior to and after the outage, whichever results in greater conservativeness
One to seven days	Use the 95% lower or upper confidence limit of the 72 hours prior to and after the outage, whichever results in greater conservativeness
Greater than one week	No data may be substituted and no credits may be generated

The lower confidence limit should be used for both methane concentration and flow readings for landfill projects, as this will provide the greatest conservativeness.

For weekly measured methane concentration, the lower of the measurement before and the measurement after must be used. This substitution may only be used to substitute data for one consecutive missing weekly measurement.