Chicago Climate Exchange®

Landfill Methane Collection and Combustion Offset Project Protocol

Landfill Methane Collection and Combustion Offset Projects

The Chicago Climate Exchange (CCX®) Landfill Methane Offset Project Protocol outlines the process and requirements for Project Proponents to register greenhouse gas emission reductions resulting from the voluntary destruction of methane originating from landfills. CCX General Offsets Program Provisions, CCX Offset Project Verification Guidance Document and CCX Offset Project Protocols can be downloaded by visiting www.theccx.com. Requests for further information or comments may be directed to offsets@theccx.com.

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CHICAGO CLIMATE OFFSET PROJECT PROTOCOL

Landfill Methane Collection and Combustion Offset Projects

Updated as of 8/20/2009

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ACRONYMS, TERMS AND DEFINITIONS[1]

ANSI	American National Standards Institute
CCX	Chicago Climate Exchange
GHG	Greenhouse Gas
IPCC	Intergovernmental Panel on Climate Change
MSW	Municipal Solid Waste
WBCSD	World Business Council on Sustainable Development
WRI	World Resources Institute

Emission Guidelines (EG) for Municipal Solid Waste (MSW) Landfills:	Guidelines developed by the EPA for state regulatory plans. Emission Guidelines for MSW Landfills, codified in 40 CFR 60 Subpart Cc., regulate emissions from existing landfills with a design capacity greater than 2.5 million megagrams (2.75 million tons) that began construction or made modifications before May 30,1991 and accepted waste at any time since November 8, 1987.
Gas Collection and Control System (GCCS):	A network of wells and/or piping to create a pathway for gas migration towards a combustion or non-combustion technology to mitigate emissions, pollutants and/or odor.
Landfill Gas (LFG):	Gas generated by biological decomposition of waste material in a landfill. The gas is typically comprised of methane, carbon dioxide, other trace gases and water vapor.
New Source Performance Standards (NSPS):	Federal rules for US landfills, codified in 40 CFR Subpart WWW, that govern emissions from existing landfills with a design capacity greater than 2.5 million megagrams (2.75 million tons) that began receiving waste or began construction or made modifications after May 30, 1991.

[1] Please refer to CCX General Offsets Program Provisions for additional "Acronyms, Terms and Definitions"

1. INTRODUCTION

Chicago Climate Exchange (CCX) is the world's first and North America's only active voluntary, legally binding integrated trading system to reduce emissions of all six major greenhouse gases (GHGs), with Offset Projects worldwide. CCX Members with significant GHG emissions voluntarily enter into a legally binding agreement to reach CCX GHG Emission Reduction Commitment[2]. Upon enrollment with CCX, Exchange Allowances are issued to Members in amounts equal to their emission reduction targets. Offsets are issued to Owners or Aggregators of registered Projects on the basis of verified sequestration, destruction or reduction of GHG emissions not included under the CCX Emission Reduction Commitment. Members are required to turn in the amount of Exchange Allowances and/or Offsets equal their actual GHG emissions annually.

CCX strives to promote transparency and integrity in the carbon market. In accordance with this goal, in developing this document, CCX was guided by the fundamental principles of Project GHG accounting outlined in ISO 14064-2: *Specification with guidance at the Project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancemen*ts, Version 1. These principles include:

- Relevance
- Completeness
- Consistency
- Accuracy
- Transparency
- Conservativeness

The following sections of this Protocol discuss the Project criteria, boundaries, monitoring requirements, avoided emissions calculations and other guidelines that each Project Proponent must adhere to in order to generate Offsets from Landfill Methane Collection and Combustion Offset Projects.

2. GENERAL PROVISIONS

Projects are subject to the conditions of this Protocol, the CCX General Offset Program Provisions and determinations of the CCX Committee on Offsets. All Project Proponents should review CCX General Offset Program Provisions and CCX Offset Project Protocol for Landfill Methane and Combustion Offset Projects.

[2] http://theccx.com/content.jsf?id=72

3. ASSOCIATED DOCUMENTS

This Protocol references the use of several associated documents. These documents include:

- CCX General Offset Program Provisions
- CCX General Verification Guidance Document
- CCX Project Implementation Document (PID)
- CCX Project Specific Conflict of Interest Form
- CCX Greenhouse Gas Emission Factors Document
- CCX Project Owner Attestation

These documents are available on the Offsets section of the CCX website: www.theccx.com

4. PROJECT DEFINITION

A Landfill Methane Offset Project consists of the installation and operation of a landfill gas collection and control system (GCCS) that meets the eligibility criteria and other requirements outlined in these guidelines.

5. ELIGIBILITY CRITERIA

Several factors determine a Project's eligibility to generate Offsets including the Project Proponent's membership status, ownership status, Project start date, location and whether the Project meets the CCX performance benchmark.

5.1 CCX Membership

The Project Proponent(s) must be a Member or Participant Member (Offset Provider or Aggregator) of CCX. For-profit entities, cooperatives, governmental bodies and non-profit organizations may act as CCX Offset Aggregators. An Aggregator serves as an administrative representative, on behalf of Project Owners, of one or more Projects. Project Proponents should contact CCX directly for membership rules and information.

5.2 Eligibility Governing Entities with Minor Emissions

Entities with an entity-wide emissions profile greater than 10,000 metric tons of carbon dioxide equivalent (Mt CO_2e) for the most recent calendar year may register and trade CCX Offsets only if the entity is a Member of CCX and undertakes the CCX Emission Reduction Commitment. For specific guidance on this provision, Project Proponents should review CCX General Offset Program Provisions.

Entities who are unsure of their emissions profile should estimate their direct CO_2 emission using well accepted methodologies such as those available at the World Resources Institute (WRI)/World Business Council on Sustainable Development (WBCSD). CCX requires that all

entities that are not Members, including producers enrolled with Aggregators, provide an attestation relating to their direct emissions in a form provided by CCX.

Governmental entities that have Direct Emissions below 25,000 Mt CO_2e during the most recently completed calendar year are allowed to register CCX-eligible Landfill Methane Offset Projects without having to commit their Direct Emissions to the CCX Emission Reduction Schedule.[3] Governmental entities availing themselves of this provision are required to retire 10% of their registered Offsets on an annual basis, up to a maximum retirement amount of 5,000 Mt CO_2e per year. A governmental entity will be limited to the sale of CFIs representing 50,000 Mt CO_2e per Vintage. In order to sell CFIs in excess of the 50,000 Mt CO_2e, a government entity must apply and be approved as a CCX Member subject to the CCX emission reduction rules.

All CCX Project eligibility (including start dates, absence of regulatory requirement to collect the methane) and verification rules apply. The Exchange has the right to limit the number of participants under this provision.

5.3 Ownership Status

The Project Proponent must demonstrate clear ownership of the GHG mitigation rights associated with the Project in order to register Landfill Methane Offset Projects with CCX. Contract documentation may be provided by the Project Proponents to express ownership of the GHG mitigation rights. Where appropriate, an attestation of Project Ownership shall satisfy this requirement

CCX Offset Aggregators must have acquired appropriate control of the GHG mitigation rights from the Project Owner in order to execute its responsibilities on CCX pursuant to CCX General Offset Program Provisions.

Aggregators must demonstrate to the Project Verifier and CCX that they have acquired appropriate control.

5.4 Project Start Date

Projects must start on or after January 1, 2003, which corresponds with the beginning of the CCX cap and trade program.

5.5 Project Location

Landfill methane Projects shall be located either in the United States (U.S.) or in a country designated as a non-Annex I country under the Kyoto Protocol. Project Proponents with Projects in non-Annex I countries should submit the CCX Project Implementation Document (PID) to CCX for review.

[3] This provision will not apply to an entity whose Direct Emissions are less than or equal to 10,000 metric tons CO_2. If an entity experiences a material change in emissions, the entity must inform CCX and it may affect its status with respect to section 5.2.

5.6 Performance Benchmark

Landfill Methane Offset Projects are not eligible to generate Offsets in instances where the collection and destruction of landfill gas can be considered a standard business practice (i.e. business as usual) or is required by law or other legally binding framework. CCX has identified two performance criteria that Projects must meet to be considered for Offsets issuance.

5.6.1 Regulatory Criteria

In order to be eligible to receive Offsets under these guidelines, the Project shall not be required to collect and destroy landfill gas under any federal, state or local regulation or other legally binding framework. The regulatory criteria must be applied to both U.S. and non U.S. based Projects (approved Projects originating in non-Annex I Kyoto Protocol countries).

During the course of verification, the Project Proponent shall provide to the Verifier reasonable assurances necessary to prove that the Project is not required under any federal, state or local regulation or other legally binding framework and shall sign an attestation stating the same.

5.6.2 Common Practice Criteria

According to the GHG Protocol for Project Accounting, "*Common practice refers to the predominant technologies or practices in a given market, as determined by the degree to which those technologies or practices have penetrated the market.*"[4] CCX reviewed information regarding the prevalence of GCCSs at unregulated landfills in the United States. The U.S. EPA Landfill Methane Outreach Program (LMOP) gathers information on landfills in the U.S. and their gas management systems. Based on this review, only 21% of non-NSPS regulated landfills have installed a GCCS. Since some of these landfills have state, local or other requirements to install and operate a GCCS, the percentage of voluntarily installed GCCSs is likely even lower. The table below provides the summary information.

Table 1: Profile of US Landfills by Type and Quantity[5]

Non-NSPS/EG landfills	Number of landfills	Percent of landfills
Flares	161	13.9
Electricity Projects	55	4.8
Other Gas Projects	24	2.1
Subtotal	**240**	**21**
No gas recovery and combustion	915	79
Total	**1,155**	**100**

[4] World Resources Institute and World Business Council for Sustainable Development. 2005. *The Greenhouse Gas Protocol for Project Accounting.* WRI/WBCSD, Washington, D.C.
[5] EPA Climate Leaders *Draft Offset Protocol.* October 2006. Accessed online at http://www.epa.gov/stateply/documents/resources/draft_landfill_Offset_protocol.pdf on October 15, 2008.

Given the common practice definition above, voluntary gas collection and destruction at unregulated landfills in the U.S. is clearly not common practice. Therefore, a Project that meets the regulatory criteria above and installs a GCCS can be considered beyond business as usual. For Projects in non-Annex 1 countries of the Kyoto Protocol, the Project Proponent must similarly demonstrate that the Project activity is beyond business as usual.

CCX will periodically review this data to assess whether the performance benchmark has changed and may implement modifications in the future based on the review. Once a Project is registered with CCX, it is not affected by changes to the common practice criteria for the market period in which it registers. The current market period is from January 1, 2003 through December 31, 2010.

6. PROJECT BOUNDARY

A clearly defined boundary is vital to accurately assessing emission reductions due to the installation of a GCCS. Although the destruction method may vary, the Project Boundary for landfill methane Projects will include the LFG collection system, equipment used for upgrading the collected gas, monitoring and recording equipment and destruction device(s).

6.1 Identification of GHG Sources, Sinks and Reservoirs

The following table identifies relevant GHG Sources and whether each is to be included within the Project's Boundary.

Table 2 – Relevant GHG Sources to be Included within Project Boundary

GHG Source Category	GHG Source	GHG	Included in Project Boundary	Comment[6]
Landfill Methane Collection and Upgrading Systems	Emissions resulting from fossil fuel derived energy used by, inter alia, compressors, blowers, and monitoring system	CO_2	Yes	All CO_2 emissions (direct and indirect) due to fossil fuel combustion are required to be included.[7]
		CH_4	No	Excluded, as this emission source is assumed to be very small.
		N_2O	No	Excluded, as this emission source is assumed to be very small.
Landfill Gas Destruction Device	Emissions resulting from the destruction of landfill gas	CO_2	No	Biogenic emissions are excluded.
		CH_4	Yes	Dependent on efficiency of the destruction device.

[6] Based on emissions factors found in Volume 2, Table 2.2 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, all CH_4 and N_20 emissions are excluded (with the exception of CH_4 emissions from landfill gas destruction), as emissions will be small in comparison to CO_2 emissions.

[7] See Project Emissions discussion in this section for exceptions to the inclusion of indirect emission sources.

		N_2O	No	Excluded, as this emission source is assumed to be very small.
	Emissions resulting from the combustion of fossil fuel in the destruction device	CO_2	Yes	All CO_2 emissions (direct and indirect) due to fossil fuel combustion are required to be included.
		CH_4	No	Excluded, as this emission source is assumed to be very small.
		N_2O	No	Excluded, as this emission source is assumed to be very small.

The GHG Sink(s) will be the combustion process and associated destruction device(s) used by the Project. No reservoirs are anticipated in Landfill Methane Offset Projects and therefore are not discussed at greater length below.

ISO 14064-2 requires that the Project's GHG Sources and Sinks be categorized as controlled by the Project Proponent, related to the Project, or affected by the Project. These are discussed below.

6.1.1 Controlled GHG Sources and Sinks

Controlled GHG Sources and Sinks for Landfill Methane Offset Projects are those that occur on-site. Therefore, controlled GHG Sources and Sinks for Landfill Methane Offset Projects refer to those that are part of the landfill methane collection and upgrading systems and the landfill methane destruction device.

6.1.2 Related GHG Sources and Sinks

Related GHG Sources and Sinks for Landfill Methane Offset Projects refer to those that have material or energy flows into or out of the Project. Therefore, related GHG Sources and Sinks are the electricity grid that supplies electricity to the Project (if applicable) and the natural gas pipeline that conveys upgraded landfill gas to an end user's destruction device (if applicable).

6.1.3 Affected GHG Sources and Sinks

Affected GHG Sources and Sinks are those that are influenced by the Landfill Methane Offset Project and result in new or changed activities outside the Project Boundary that actually increase GHG emissions. This concept is commonly referred to as leakage. CCX does not expect Landfill Methane Offset Projects to result in new or changed activities that increase GHG emissions outside of the Project Boundary and, therefore, no Project-specific leakage assessment is required.

6.2 Determining the Baseline Scenario

In accordance with the process outlined in ISO 14064-2, possible baseline scenarios were evaluated for landfill gas Projects. CCX identified two plausible baselines for new landfill methane Projects:

1) The unmitigated release of methane to the atmosphere, and;
2) The voluntary installation of a GCCS without the generation of revenue from Offsets.

Based on the information presented in Section 5, the most likely baseline scenario in the absence of regulation or other requirement mandating installation is the unmitigated release of methane to the atmosphere. The GHG Sources, Sinks and Reservoirs identified in this baseline are limited to the GHG emissions from the landfill.

6.3 Project Emissions

In cases where Project emissions *are not* included in a legally binding emission reduction program (e.g. CCX), they shall be included as Project emissions and subtracted from Project emission reductions as provided in section 8 below. Where Project emissions *are* included within a legally binding emissions reduction program, they may be omitted from the Project emissions calculation. Only those specific sources included under the capped portion of an emissions reduction program may be omitted. All other sources must be included.

Project emissions sources include, but are not limited to, the use of electricity from the grid, the consumption of purchased steam or heat, and the combustion of fossil fuel by the collection equipment or destruction device. Emissions associated with the preparation of landfill gas for injection to a natural gas pipeline are included within the Project Boundary and shall be counted as a Project emissions source. Since carbon dioxide emissions from these sources are of much greater magnitude than emissions of other GHGs, only carbon dioxide emissions shall be included as Project emissions.

7. MONITORING REQUIREMENTS

The Project Proponent shall develop and maintain a monitoring plan with procedures for obtaining, recording, compiling and analyzing data and information required for quantifying and reporting GHG emission reductions.

Landfill methane Project monitoring and recording includes the following parameters:

- Continuous monitoring of landfill gas flow, temperature and pressure to each combustion device[8].
- Methane content analysis using a continuous gas analyzer or a portable gas analyzer, or gas sampling for independent laboratory analysis according to ASTM D-1946 or other appropriate standard.
- Electricity production.
- Destruction device operating hours.
- Project-related emissions.

Section 8 presents two alternatives for calculating the GHG emission reductions for a Landfill Methane Offset Project. In the first alternative, landfill gas flow and methane

[8] Separate monitoring of temperature and pressure is not required when using flow meters that standardize based on temperature and pressure and present flow rate in standard cubic feet per minute (SCFM).

content data are used while in the second, electricity production data is used to calculate the amount of methane destroyed[9]. Monitoring data shall be maintained to support the calculation to be used by the Project.

7.1 Flow Monitoring and Recording

Landfill gas flow shall be continuously monitored and recorded using an acceptable flow meter. Continuous monitoring and recording is defined as one data point at least every 15 minutes.

CCX requires the flow meter to be installed downstream of the blower and upstream of the control device or upstream of the blower and downstream of the moisture separator.

7.1.1 Flow Meter Performance Standard

The following information regarding flow meter performance shall be maintained:

- Manufacturer specifications of flow meter accuracy should be +/- 5% of reading.
- Proof of initial calibration.
- Capability to record flow, at least, every 15 minutes.
- Means to correct for temperature and pressure.

7.1.2 Flow Meter Calibration

It is essential that flow meters operate properly in order to accurately quantify GHG emission reductions. To ensure proper flow meter function, annual calibration of the flow meter shall be performed unless otherwise specified by the manufacturer. Flow meter calibrations must meet the following conditions:

- Calibrations must be performed in accordance with manufacturer's specifications and methodologies.
- Calibrations must be performed by the manufacturer or an ISO 17025 certified calibration and testing organization, or other.
- All records of calibration reports and methodologies must be documented and made available for review during the verification process.

If manufacturer specifications state that the flow meter must be calibrated more often than annually, then the calibration schedule as recommended by the manufacturer shall be followed and the above conditions applied.

7.1.3 Flow Meter Location

The flow meter shall be installed at a location that provides a straight section of pipe sufficient to establish laminar gas flow as turbulent flow resulting from bends, obstructions, or constrictions in the pipe can cause interference with flow measurements that rely on

[9] This methodology is employed by the USEPA in the Inventory of U.S. Greenhouse Gas Emissions and Sinks (1990-2007) to estimate methane emissions avoided through landfill gas-to-energy Projects.

differential pressure. Alternatively, a flow meter may be installed where there is not laminar flow, provided the technology is proven to be accurate under such conditions and the location of the installation has been specifically approved by a professional engineer to provide accurate flow meter readings. Flow meters shall be located such that the quantity of landfill gas being consumed by each destruction device can be continuously and accurately measured.

7.2 Methane Content Measurement and Recording

Continuous monitoring and recording of the methane fraction in the landfill gas is preferred. However as an alternative, methane content measurements may be taken and recorded on at least a weekly basis using a portable gas analyzer or by laboratory analysis of sampled gas.

7.2.1 Gas Analyzer Performance Standard

The gas analyzer used shall meet the following performance standards:

- Precision: Methane measurements are to be to the nearest 0.1 percent.
- Accuracy: Methane measurement accuracy decreases with increasing methane concentration but must be within +/- 5% of reading, as specified by the manufacturer.

Alternate instruments, including gas chromatographs or thermal conductivity detectors shall meet similar standards.

7.2.2 Gas Analyzer Calibration

Continuous gas analyzers shall be calibrated according to manufacturer specifications. Records of these calibrations shall be maintained.

For weekly measurements, portable gas analyzers shall be calibrated against a gas sample with a known methane concentration prior to each use. Records of these calibrations shall be maintained according to the Project's monitoring plan and shall be conducted by appropriately trained personnel.

7.3 Electricity Production

Where an engine is serving as a destruction device, the following information shall be maintained regarding the measurement of methane combustion:

- Type, make, and model number of combustion unit(s).
- Copy of the summary table from the most recent source test (source test shall have be taken within 3 years of the period for which the calculation is being made) showing the measured heat rate of combustion device(s). When this not been measured, the Proponent many use the manufacturer specified heat rate.
- Summary tables showing kWh of electricity produced from landfill gas per month over the relevant period.
- Type of electrical metering device.

- Accuracy, precision, and proof of calibration of the electrical metering device per manufacturer specifications (this parameter is only required if the purchasing utility's sales meter is not used as these meters must already meet stringent requirements).

7.4 Destruction Device Operating Hours

The operating hours for each destruction device must be monitored to ensure that methane destruction is claimed only during periods when the destruction device(s) was operational. Offsets will not be issued for time periods where the destruction device(s) is not operating. Operating hours must be continuously monitored and recorded, at least, every 15 minutes. In general, operating hours for a flare are tracked through the use of a thermocouple which monitors the presence and temperature of the flame. Operating hours for other destruction devices such as engines can be tracked through operator logs and other appropriate procedures.

Projects shall provide evidence of alarms, valves or other methods (a GCCS often incorporates one or more of these methods so that the system can be shut down when it is not functioning properly) that ensure that the landfill gas destruction device does not simply vent LFG to the atmosphere. Projects that treat landfill gas and inject it into a natural gas pipeline shall only provide evidence of the quantity of gas delivered to the pipeline and are not required to provide evidence of landfill methane destruction.

7.5 Destruction Device Efficiency

CCX reviewed available literature on destruction efficiency values from a variety of sources. Based on this review, CCX determined that 98% default destruction efficiency is conservative and shall be applied where Project Proponents have not conducted source tests or have manufacturer data. In situations where a source test has been conducted, the destruction efficiency value obtained during this source test shall be utilized rather than the default destruction efficiency value provided herein.[10]

7.6 Project-Related Emissions

Project-related emissions may result from the importation of electricity or from the use of fossil fuels. Information related to electricity usage and relevant fossil fuel consumption may be obtained from sources such as on-site electricity meters, utility invoices, and fuel purchase

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[10] Seebold et al. (2003) *Reaction Efficiency of Industrial Flares: The Perspective of the Past.*

[10] The Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories gives a standard value for the fraction of carbon oxidized for gas combustion 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 118,000kgCH4/PJ on the basis of gas consumption, which is 0.6%. Leakage in the residential and commercial sectors is stated to be 0 to 87,000kgCH4/PJ, which equates to 0.4%, and in industrial plants and power station the losses are 0 to 175,000kg/CH4/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% * 99.4% * 99.6%) 98.5% for residential and commercial sector users, and (99.5% * 99.4% * 99.2%) 98.1% for industrial plants and power stations.

records. Project emissions may be omitted if the Project related emissions source is included in a legally binding emission reduction program for the period in question.

8. QUANTIFYING GHG EMISSION REDUCTIONS

Emission reductions are assumed to be the amount of methane that would be emitted during the crediting period in the absence of the landfill methane Project (minus Project emissions).

8.1 Calculations for Metered Methane Destruction

Tabulated records of total daily landfill gas flows (in standard cubic feet per day) shall be matched with either the continuous methane content data or with the associated weekly methane content reading using Equation 1:

Equation 1a: CH_4 Recovered

$$\mathbf{CH_{4recovered} = LFG_{recovered} \times \%CH_4}$$

Where:

$\mathbf{CH_{4recovered}}$	Methane recovered per day (as measured in standard ft^3/day)
$\mathbf{LFG_{recovered}}$	LFG recovered per day (as measured in standard ft^3/day)
$\mathbf{\%CH_4}$	Methane content of LFG

Methane flows shall be tabulated and summed on a monthly basis using the continuous daily readings for flow and the appropriate methane content readings.

Equation 1b: Alternative CH_4 Recovery Method

Energy generation facilities that use landfill methane as a fuel to generate electricity typically have detailed records of electrical generation rates in kilowatt-hours (kWh) that can be used to calculate methane recovery. Information on the heat rate of the combustion unit in BTU per kilowatt hour (BTU/kWh) can be used to calculate the amount of methane combusted. The calculation is summarized in Equation 3:

$$CH_{4recovered} = (kWh \times [BTU/kWh]) / 1012$$

Where:

$CH_{4recovered}$	Total CH_4 recovered (ft^3)
kWh	Total kWh of electricity produced from the LFG fuel
BTU/kWh	Heat rate of engine
1012	HHV of methane (as measured in Btu/ft^3)[11]

To estimate annual methane combustion rates, the Project shall use the amount of electricity generated over a one-year period in the equation above. The heat rate used in the calculation shall be from the most recent source test for the combustion device or the manufacturer specified heat rate

Equation 2: CH_4 Combusted

In order to estimate the amount of methane combusted in metric tons per year (Mg/yr), the annual methane recovery rate in cubic feet per year needs to be converted to weight using Equation 2:

$$CH_{4combusted} = (CH_{4recovered} \times 16.04 \times [1/10^6] * [1/24.04] \times 28.32) * DE$$

Where:

$CH_{4combusted}$	Annual methane combusted (as measured in Mg/yr)
$CH_{4recovered}$	Annual methane recovered (as measured in ft^3/yr)
16.04	molecular weight of CH_4
$1/10^6$	Conversion to metric tons (Mg/g)
1/24.04	Gas constant (mol/L – measured at standard temperature and pressure – defined as 68F and 14.7psi)[12]
28.32	Conversion factor (L/cf)
DE	Destruction efficiency of the destruction device (default value of 98%)

9. QUANTIFYING PROJECT GHG EMISSIONS

Depending on Project-specific circumstances, certain emissions sources may need to be subtracted from total Project emission reductions using the equations below.

[11] Where the engine heat rate is specified in lower heating value, the Project Proponent shall make the appropriate adjustment.

[12] The appropriate adjustment factor should be applied if the Project flow meter(s) apply a different standard temperature and/or pressure.

Equation 3a: CO_2 Emissions from Fossil Fuel Combustion

$$\mathbf{Dest_{CO2}} = \sum_y (\mathbf{FF_y} * \mathbf{EF_y})$$

Where:

$Dest_{CO2}$	CO_2 emissions from fossil fuel used in methane destruction process (tCO_2)
FF_y	Total quantity of fossil fuel, y, consumed (as measured in volume of fuel)
EF_y	Fuel specific emission factor for fuel, y (as measured in t_{CO2}/fuel quantity - values should be taken from the CCX GHG Emissions Factors online document[13])

Equation 3b: CO_2 Emissions from Project Specific Electricity Consumption

$$\mathbf{Elec_{CO2}} = (\mathbf{EL_{total}} * \mathbf{EF_{EL}})/2204.62$$

Where:

$Elec_{CO2}$	Project specific electricity emissions (tCO_2)
EL_{total}	Total grid connected electricity consumption (as measured in MWh)
EF_{EL}	Carbon emission factor for grid electricity (taken from the most recent region specific eGrid values – measured in $lbCO_2$/MWh)
2204.62	$lbCO_2/tCO_2$

9.1 Calculation of Project Emission Reductions

Equation 4: GHG Emission Reductions

$$\mathbf{ER} = [\mathbf{CH_{4combusted}} * 21 * (1\text{-}\mathbf{OF})] - \mathbf{PE}$$

Where:

ER	Total Emission Reductions (tCO_2e)
$CH_{4combusted}$	Annual methane combusted (as measured in Mg/yr)
21	Global warming potential of methane
OF	Oxidation factor (a value of 0.1 should be applied to landfills without a synthetic cover system and 0 for landfills with a synthetic cover system)[14]
PE	If applicable, Project emission sources should be subtracted using Equations 3a and 3b

[13] Relevant GHG emission factors can be found here: http://theccx.com/docs/misc/GHG_Emission_Factors.pdf
[14] This oxidation factor only applies to landfills that do not have a synthetic cover system. For landfills with a synthetic cover system, the relevant baseline is the unmitigated release of methane to the atmosphere. *See*: Volume 5, Chapter 3, Table 3.2 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

10. REPORTING AND RECORD-KEEPING REQUIREMENTS

The Project Proponent must maintain all relevant data and documentation as required in Section 7 above. All relevant Project documentation shall be kept for a minimum of 2 years beyond each verification time-period.

11. VALIDATION AND VERIFICATION REQUIREMENTS

11.1 Validation

CCX Projects utilizing these guidelines are validated one of two ways. All Projects must submit a PID to CCX Staff for review. Projects that adhere strictly to the requirements of this protocol are validated by CCX staff and do not require a separate Validation by CCX Offsets Committee. For all Projects seeking to deviate from specific components of this protocol, the Project Proponent is required to complete the deviation request section of the PID for review and approval by the CCX Offsets Committee. Upon receipt and review of the deviation request, the CCX Offsets Committee will review the feasibility and appropriateness of the requested deviation(s) and, as needed, seek guidance from appropriate technical experts. Under either approach, the Project Proponents will be notified of the Project or Deviation approval by notification letter.

11.2 Verification

Prior to undertaking verification, the prospective Verifier must conduct a Project specific conflict of interest process. The prospective Verifier must complete and submit the CCX Project Specific Conflict of Interest form to CCX for approval prior to the commencement of verification activities.

Projects seeking to register Offsets shall be verified by a CCX-Approved Verifier[15] in accordance with CCX General Offsets Program Provisions, CCX Verification Guidance Document and the Project Protocols. A checklist list of verification requirements is contained in Appendix A. Independent verification is critical to ensure that the requirements of this Protocol are correctly applied. Projects shall be verified on an annual basis at minimum.

To ensure impartiality, completeness and consistency in the verification report review process an additional independent review of the submitted verification reports is conducted by the CCX Provider of Regulatory Services. Further information about the roles and responsibilities of Verifiers and the roles and responsibility of Members during verification are discussed in detail in *Chicago Climate Offset Program Verification Guidance Document* available on the CCX webpage: www.theccx.com.

[15] A list of CCX-Approved Verifiers is found on the CCX website: www.theccx.com

APPENDIX A: VERIFICATION CHECKLIST

CCX Requirement	Assessment Criteria	Verifiers Comments
Validation	CCX Project Approval Letter.	
Verification: Conflicts of Interest	Complete a conflicts of interest assessment.	
Monitoring Plan	Confirmation that the Project developer has a Project data monitoring plan.	
Project Definition	Confirm the Project meets the definition and/or it has been specifically approved by the CCX Offsets Committee via a deviation request approval.	
CCX Membership	Confirm that the Project Proponent is a CCX Member or Participant Member (Offset Aggregator or Provider).	
Eligibility Governing Entities with Minor Emissions	Confirm that the Project Proponent is a small emitter as defined in Section 5.2 and rule 9.7.1.1 of the Project Protocol. If the Project Proponent is not a small emitter they must be a CCX Member.	
Ownership Status	Confirm the Project Proponent has title to the CO_2 emission reductions and, if applicable, that the Offset Aggregator has the right to market them on CCX.	
Project Start Date	Confirm the Project began on or after January 1, 2003 or that it is a Project grandfathered by CCX.	
Project Location	Confirm Project is located in the U.S. or a Kyoto Protocol non-Annex 1 country.	
Regulatory Criteria	Confirm the Project is not required by federal, state, local law or other legally binding framework.	
Common Practice Criteria	Confirm that the Project Proponent has demonstrated that the Project activity is beyond business as usual for its country of origin.	
Identification of GHG Sources, Sinks and Reservoirs	Confirmation of the identification of all GHG Sources, Sinks and Reservoirs.	

Project Emissions	Confirmation of whether Project emissions have been properly included as per the Project accounting methods described in the Protocol.	
Monitoring Requirements	Confirm existence of a Project data monitoring plan with procedures for obtaining, recording, compiling and analyzing data and required information.	
Flow Monitoring	Confirmation of continuous flow monitoring requiring measurement and recording, at least, every 15 minutes.	
	Confirmation the flow meter is installed in a location which allows for laminar flow or appropriate technology and professional engineering assessment of meter accuracy.	
Flow Meter Performance Standard	Confirmation of manufacturer's specification that the flow meter accuracy is +/- 5% of reading.	
	Proof of initial calibration.	
	Confirmation of capability to record flow, at least, every 15 minutes.	
	Confirm the flow meter has a means to correct for temperature and pressure, where applicable.	
Flow Meter Calibration	Confirm annual (or more frequent) flow meter calibration unless otherwise specified by the manufacturer.	
	Confirm calibration performed and documented to be in accordance with manufacturers specifications and methodologies.	
	Confirm that the calibration and testing organization was either the manufacturer, an ISO 17025 certified entity, or a manufacturer approved vendor.	
	Confirm records of calibration and calibration methodologies are documented and reviewed.	
Flow Meter Location	Confirm location provides for proper laminar flow or has been approved by professional engineer.	

Methane Content Analysis	Confirm frequency of methane fraction recording to be continuous or, at least, weekly.	
	Confirm device or approach used to determine methane fraction is conducted with a portable gas analyzer or by laboratory analysis of sampled gas.	
Gas Analyzer Performance Standard	Confirm the precision of the recordings to be to the nearest 0.1 percent.	
	Confirm measurement device is specified by the manufacturer to provide results that are +/- 10% of the actual reading.	
	Confirm alternative approach to determining methane quality meets the requirements that readings are +/- 10% of the actual reading.	
Gas Analyzer Calibration	Confirm calibration has been performed in accordance with the manufacturer's specification.	
Electricity Production	If applicable, confirm the items provided in the cells below:	
	Type, make and model number of the engine.	
	Copy of most recent source test or manufacturer specified heat rate.	
	Monthly electricity production records.	
	Type of electrical metering device	
	Proof that calibration of metering device is in accordance with the manufacturers specification, if applicable	
Destruction Device Operating Hours	Confirmation of continuous monitoring of operating hours of the destruction device	
	Confirmation of existence of alarms, valves or other methods to ensure against venting to atmosphere	
Destruction Device Efficiency	Confirmation of the use of the default value or the value specified by the manufacturer, if lower	
Project Related Emissions	Confirmation of monitoring of Project related emissions	
Calculation of Metered Methane	Confirmation of tabulated daily landfill gas flows in scf/day	

Destruction	Confirmation of, at least, weekly methane content readings	
	Confirmation of monthly methane flows by combining landfill gas flows and methane content	
	Confirmation of alternative calculation of methane destruction, if applicable	
Calculation of Project Emissions	Confirmation of Project emissions calculations	
Calculation of Project Emission Reductions	Confirmation of Project emission reduction calculations	
Reporting and Record Keeping Requirements	Confirmation of procedures to retain relevant Project records for, at least, 2 years beyond the verification date	