Greater New Bedford LFG Utilization Project

Dartmouth, Massachusetts

Document Prepared By: CommonWealth Resource Management Corporation
For its wholly-owned subsidiary
CommonWealth New Bedford Energy, LLC

Contact Information: Thomas Yeransian, Principal
7 Winslow Way
Mansfield, MA 02048
Tel: (508) 339-3074

Project Title	Greater New Bedford LFG Utilization Project
Version	6
Date of Issue	May 12, 2016
Prepared By	Thomas Yeransian, Principal of CommonWealth Resource Management Corporation
Contact	7 Winslow Way Mansfield, MA 02048, 508-339-3074, tyeransian@crmcx.com, www.crmcx.com

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2 PROJECT DETAILS

2.1 Summary Description of the Project

The Project is a landfill methane (*a.k.a*., "landfill gas" or "LFG") capture and utilization project located at a solid waste landfill in Dartmouth, Massachusetts. The Crapo Hill Landfill (the "Landfill") is owned by the Greater New Bedford Regional Refuse Management District (the "District"). The owner of the Project is CommonWealth New Bedford Energy, LLC ("CNBE"), a wholly-owned subsidiary of CommonWealth Resource Management Corporation ("CRMC"), a Massachusetts corporation based in Boston, Massachusetts, U.S.A. CNBE also owns the exclusive rights to all of the LFG at the Landfill, and all of the environmental attributes associated with the collection, destruction and use of all of the LFG at the Landfill.

Prior to the Project, the District had voluntarily installed a limited active LFG gas collection system and a flare to destroy the LFG (the "District Initial System"). The Project consists of a greatly expanded LFG collection system begun in January 2002 and an electric power generating facility (the "Facility") which commenced operation in November 2005. The destruction of the LFG methane generates greenhouse gas emissions reductions. The Project also sells waste heat from the power generation to an off-site entity. Although the beneficial use of the waste heat displaces fossil fuel use, no emissions reductions are being sought for this use or for the displacement of grid electricity by the Project's generated electricity. Estimated annual emissions reductions are presented in Section 1.7.

2.2 Sectoral Scope and Project Type

This Project is a landfill gas collection and combustion project, which falls under the Clean Development Mechanism Sectoral Scope 13 – Waste Handling and Disposal. This is an individual project, not a grouped project.

2.3 Project Proponent

Organization name	CommonWealth Resource Management Corporation For its wholly-owned subsidiary CommonWealth New Bedford Energy, LLC
Contact person	Thomas Yeransian
Title	Principal of CRMC
Address	199 Corey Street Boston, MA 02132
Telephone	(617) 327-8146 or (508) 339-3074
Email	tyeransian@crmcx.com

2.4 Other Entities Involved in the Project

No other entities are involved in the Project.

2.5 Project Start Date

The Project began on January 1, 2002 when the expanded landfill gas collection system installation began. Destruction of the landfill gas in the electrical plant began in November 2005.

2.6 Project Crediting Period

The first Project Credit Period was a 10-year period starting March 28, 2006 and ending March 28, 2016.

The second Project Credit Period is a 10-year period starting March 29, 2016 and ending March 28, 2026.

2.7 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	X
Large project	

Year	Estimated GHG emission reductions or removals (tCO_2e)
2016 (March 29 - December 31)	67357
2017	88437
2018	88437
2019	88437
2020	88437
2021	88437
2022	88437
2023	88437
2024	88437
2025	88437
2026 (January 1 - March 28)	21080
Total estimated ERs	884374
Total number of crediting years	10
Average annual ERs	80398

2.8 Description of the Project Activity

The Project consists of the expansion and improvement of the landfill gas collection system and the construction of an electricity generation plant to destroy the landfill gas. The Project achieves greenhouse gas emissions reductions through the collection and destruction of methane from the Landfill in either the engines or the back-up flare, which converts the methane to carbon dioxide and prevents the methane from being vented to the atmosphere. Carbon dioxide and methane emissions from the Landfill not collected by the landfill gas collection system are considered biogenic and would happen in the absence of the Project.

The expansion and improvement of the landfill gas collection system was motivated by the need for additional, higher quality gas for the electricity generation plant and would not have occurred under the voluntary collection and flaring of the landfill gas in the baseline scenario described in Section 2.4.

The District owns and operates a LFG management system that extracts LFG from the Landfill and delivers the LFG to the electricity generation plant. The LFG management system consists of (a) a network of vertical and horizontal wells, laterals and header pipes to extract the LFG that is being generated under the surface of the Landfill, and (b) a flare to combust any LFG not consumed by the Project. Two vacuum blowers pull LFG under pressure from the Landfill through the wells and pipes and through the main header to the electricity generation plant where the LFG is destroyed by combustion. The flare uses landfill gas as ignition fuel when necessary.

The electricity generation plant consists, in general terms, of the following components:

1. Piping, valves and controls for (a) conveying LFG from the District Facilities to the Project's LFG processing equipment and (b) conveying any excess or otherwise unused LFG to the District Facilities for destruction in the District's existing LFG flare
2. A LFG processing system and related ancillaries and controls for conditioning the delivered LFG by removing moisture, and other contaminants prior to use of the LFG in the Project's electric power generating equipment. The moisture and contaminants are conveyed directly to the District's discharge piping to the New Bedford waste water treatment facility.
3. Electric power generating equipment, including four Caterpillar model 3516 engine-generator sets and related ancillaries and controls for combusting the processed LFG fuel to produce mechanical energy for generating electric power
4. Switchgear, transformers, relays and related controls and equipment for delivering the electric power to the local distribution utility, Eversource Energy (formerly known as NSTAR)
5. Buildings, enclosures, foundations, access-ways, fencing and related utilities and civil structures necessarily associated with the above

The Project has the capacity to combust up to 40.2 MMBtu per hour or 1,326 scfm of LFG at 50 percent methane. Combustion of the LFG fuel in the engines creates mechanical shaft power that turns appropriately-matched electrical generators to generate up to 3.3 MW (net) of electricity. The capacity of the Project is based on the use of four Caterpillar model 3516 engine-generator sets rated nominally at 825 kW (gross) per set. Caterpillar internal combustion engine technology and its competitive analogs are widely available and have a long record of successful use in LFG applications over many decades and under a wide range of operating conditions. Electricity generated at the Project is delivered to the regional power grid via an interconnection with the local electricity distribution company, Eversource Energy (formerly known as NSTAR). Waste heat from the generation of electricity is sold to an anaerobic digestion facility off-site.

While the specific age of each piece of Project equipment varies, all electricity generation plant equipment was new and installed prior to the generation system becoming operational in November 2005. No equipment associated with the Project is scheduled to be replaced within the second crediting period based on its anticipated lifetime. Routine maintenance will be conducted in accordance with the manufacturer's recommendations.

Equipment and piping associated with the LFG collection system range in age from the District Initial System installed in 2000 to the expanded system installed between 2002-2015. Wells in older portions of the Landfill may be closed due to decreasing methane levels. If well replacement is needed, similar materials will be used and the efficiency or capacity of the well or piping will not be changed. As of 2015, 11 of the original District Initial System wells had been closed. The original flare installed in 2000 is still in operation and is expected to require only routine maintenance over the second crediting period.

Appendix 1 provides a site plan and general arrangement of the Project. The pictures below show some of its components.

Figure 1: The Project – row 1: LFG piping and Project facilities; row 2: LFG pumps and electric power generating equipment; row 3: transformer and control room

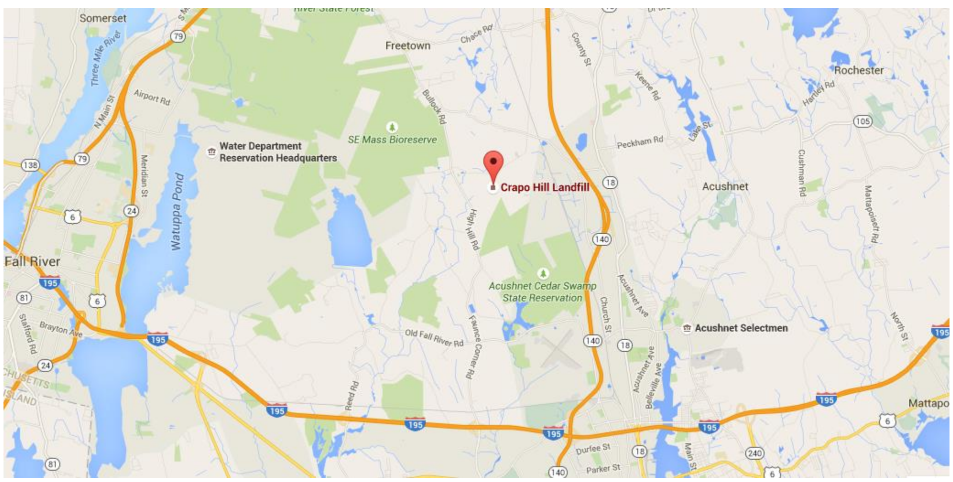
2.8.1 Landfill Description

The Landfill is owned by the District, a legislatively-created solid waste management District comprising the City of New Bedford and the Town of Dartmouth. The Landfill comprises a 152-acre parcel of land that is owned by the District and located west of Samuel Barnet Boulevard in the northeast portion of the

Town of Dartmouth, Massachusetts. The portion of the Landfill property that was permitted by the Massachusetts Department of Environmental Protection (MDEP) to be used for solid waste disposal includes 69.8 acres of the 152-acre parcel of land. The Landfill is being developed in phases. To date, 38 acres of landfill have been constructed in a series of fully lined landfill cells. The first phase, comprising a footprint of 20 acres commenced operations in 1995 and was partially filled prior to operations moving to the second phase area in 2002. Phase 1, which includes the District Initial System, was fully capped in 2010. The second phase, which consists of approximately 18 acres was constructed in two parts: an 8-acre cell that opened in 2002, and a 10-acre site that opened in 2008. Currently, an additional 6-acre cell is being constructed that should be available for disposal of solid waste in 2016. Once the 6-acre cell is completed, the Landfill will occupy 44-acres of its 69.8 acres of permitted footprint. The Landfill has been used for solid waste disposal since 1995, during which time it has received over 2,100,000 tons of solid waste for disposal. The waste stream has been composed of municipal solid waste, and construction and demolition debris. The Landfill serves member communities of the District only and is permitted to receive up to 115,000 tons of solid waste in any calendar year. Overall, the Landfill is anticipated to have the capacity to accept solid waste for disposal at current rates for the next 15 to 20 years. The District plans to develop the Landfill to continue serving the member communities for the next 15 years.

2.9 Project Location

The Project is at the Crapo Hill Landfill located west of Samuel Barnet Boulevard in the northeast portion of the Town of Dartmouth, Massachusetts (latitude and longitude are 41° 43' 28.12" N and 70° 59' 04.82").



2.10 Conditions Prior to Project Initiation

As stated earlier, the Landfill has been used for solid waste disposal since 1995. The District voluntarily installed an initial, minimal active LFG collection and flare system at the Landfill in June 2000 for the purpose of controlling odors and LFG migration. The system consisted of 21 vertical wells, collection piping and equipment and a flare. The baseline is discussed further in Section 2.4.

Because the Landfill and the methane it generates would exist with or without the Project and the Project itself generates no new greenhouse gas emissions, the Project was clearly not implemented to generate GHG emissions for the purpose of their subsequent reduction, removal or destruction.

2.11 Compliance with Laws, Statutes and Other Regulatory Frameworks

The Project is in compliance with all applicable local, state and federal regulations. The Landfill and the Project are not required to collect and destroy landfill gas as a condition of any permit or under any other local, state or federal regulations.

The Crapo Hill Landfill is not covered by the U.S. Environmental Protection Agency's (EPA's) New Source Performance Standards (NSPS) and Existing Facility Guidelines (EGs) for Landfills (40 CFR 51, 52 and 60 March 12, 1996), National Emissions Standards for Hazardous Air Pollutants (NESHAP): Municipal Solid Waste Landfills, or other local, state, or federal regulations requiring the operation of landfill gas collection system.

Under the NSPS rules landfills that commenced construction after May 30, 1991, began accepting waste on or after that date, have an approved design capacity to dispose of greater than 2.75 million tons of solid waste or 3.27 million cubic yards of solid waste, and are projected to emit more than 55 tons per year (50 megagrams per year) of Non-Methane Organic Compounds (NMOCs) without controls, are required to install and operate an active or passive LFG collection system that meets specified performance criteria and to install devices that combust and destroy at least 98 percent of the NMVOCs. The current construction approval capacity for the Crapo Hill Landfill is approximately 2 millions tons of solid waste, thus below the 2.75 million tons threshold requiring installation of LFG collection and combustion systems. A 6-acre expansion of the landfill is anticipated within the next year that would bring its overall capacity to 3.5 million tons, thus above the regulatory threshold. Even including this expansion however, projected emissions of NMOCs (in absence of intervention) would not exceed 55 tons and thus the Landfill would not be required to meet the regulatory standard. When the expansion occurs, CNBE will have to demonstrate that actual emissions remain below the regulatory thresholds.

Under the NESHAP at 40 CFR 63, landfills that have accepted waste after November 8, 1987 and are a major source of Hazardous Air Pollutants (HAPs) or co-located with a major source of HAPs, or subject to the requirement of NSPS are required to implement equivalent collection and controls under the NSPS/EGs for landfills. For these rules 'major sources of HAPs' are defined as sources with 10 tons per year of a HAP or 25 tons per year of all HAPs. Federal NESHAP regulations do not apply to the Crapo Hill Landfill because the Landfill does not classify as a 'major source of HAPs' and is not subject to the requirements of the NSPS.

The relevant state regulations are Massachusetts 310 CMR 19.0. These rules require control of LFG to prevent conditions that would cause hazards to health, safety and property. A monitoring program is required to determine the potential of such a condition. There is no specific requirement for installing and operating an active LFG collection or control system. The State of Massachusetts has not required Crapo Hill Landfill to actively collect and control LFG to satisfy applicable state regulatory criteria: i.e. to prevent conditions that would cause hazards to health, safety and property. In fact, as part of its process for permitting the Landfill, the state required that a health impact assessment be conducted under the assumption that there would be a zero percent LFG capture efficiency throughout the Landfill's active life. The assessment concluded that the Landfill would pose no such hazard.

2.12 Ownership and Other Programs

2.12.1 Right of Use

The Landfill is owned by the District, which also owns all the landfill gas generated therein. The owner of the Project is CNBE, a wholly-owned subsidiary of CRMC, a Massachusetts corporation based in Boston, Massachusetts, U.S.A. Under a landfill gas purchase and sale agreement between the District and CNBE, CNBE has the exclusive rights to (a) all of the LFG at the Landfill, and (b) all of the environmental attributes associated with the collection, destruction and use of all of the LFG at the Landfill.

The relevant contractual language is reproduced below and the sales agreement will be provided to validators upon request.

6.4 Environmental Attributes. Lessee (where Lessee is defined as CNBE) and/or its designees, successors and assigns, shall have the right, beginning on the date that the Generating Facility becomes operational and so long as this Lease Agreement is in effect thereafter, to all attributes of an environmental or other nature, known or unknown at the time of this Lease Agreement, including but not limited to allowances, certificates, RECs or other green power price premiums or similar constructs generated by or attributable to the Generating Facility by virtue of its classification as a renewable energy project under Applicable Laws, emissions credits and all other credits, offsets, tradable renewable certificates (sometimes referred to as "green tags"), and all similar rights issued, recognized, created or otherwise arising from use or disposition of the Landfill Gas delivered to Lessee, including but not limited to the generation and/or sale of electricity at the Generating Facility using Landfill Gas, the delivery and/or sale of capacity (the Generating Facility's capability to reliably generate a specific amount of electricity at a given point in time) and electricity to any purchaser thereof, the production of thermal energy or other energy products as a by-product of generating electricity at the Generating Facility, and the destruction of such Landfill Gas ("***Environmental Attributes***"). Environmental Attributes include but shall not be limited to those that are created by regulations, statutes, or other governmental action enacted before or after the Effective Date. Environmental Attributes include but shall not be limited to those that can be used to (1) claim responsibility for the reduction of emissions and/or pollutants, (2) claim ownership of emission and/or pollution reduction rights, and (3) claim reduction or avoidance of emissions or pollutants. Emissions and pollutants include, but are not limited to, acid rain precursors, carbon dioxide, carbon monoxide, chlorinated hydrocarbons, greenhouse gases, mercury, metals, methane, nitrogen oxides, nitrogen-oxygen compounds, ozone precursors, particulate matter, sulfur dioxide, toxic air pollutants, other carbon and sulfur compounds, and similar pollutants or contaminants of air, water or soil, under any governmental, regulatory or voluntary program, including but not limited to the United Nations Framework Convention on Climate Change and related Kyoto Protocol or any other program. Environmental Attributes exclude Section 45 tax credits, Section 29 tax credits and any and all other tax credits or benefits associated with the ownership or operation of the Generating Facility or production of Landfill Gas. Prior to the date that the Generating Facility becomes operational, Lessor shall have the right to any Environmental Attributes attributable to the Landfill or the LFGMS.

2.12.2 Emissions Trading Programs and Other Binding Limits

The Project is not participating in nor is required to participate in any compliance emissions trading scheme and is not located in a jurisdiction with binding greenhouse gas emissions limits. This Project does not fall under the umbrella of the Regional Greenhouse Gas Initiative program either as a regulated emitter or a credit provider.

2.12.3 Other Forms of Environmental Credit

The Project is claiming carbon credits only for the destruction of landfill methane that would otherwise have been released to the atmosphere. The Project is not claiming credits associated with the electricity produced from the landfill methane that displaces fossil–fuel-generated grid electricity. These potential carbon credits are owned by CNBE, which chooses to obtain Renewable Energy Credits (REC's) instead of the carbon credits. The Project is also choosing not to claim credits associated with the beneficial use of the waste heat, which displaces fossil fuel use by the anaerobic digestion operation.

The boundaries of this Project have been drawn to exclude the electricity and waste heat produced by the LFG-to-energy facility, which is permissible under the Verified Carbon Standard.

The Project does not and will not be required to participate in RGGI.

2.12.4 Participation under Other GHG Programs

The only other active GHG Program under which the Project is registered is the American Carbon Registry – Project ID of ACR 113. The Project has neither verified emissions reductions under nor requested issuance of credits under ACR since 2008's emission reductions and does not plan to do so during its second crediting period under VCS.

2.12.5 Projects Rejected by Other GHG Programs

The Project has not been rejected under any program.

2.13 Additional Information Relevant to the Project

Eligibility Criteria

This is not a group project so this section is not relevant.

Leakage Management

This Project does not require a leakage management plan per ACM0001.

Commercially Sensitive Information

The full text of the gas sales agreement is considered commercially sensitive and as such will not be included in the PDD. Full copies will be made available to validators upon request.

Further Information

The PDD contains all necessary information in other sections.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

Approved consolidated baseline methodology ACM0001, Version 16, “Large-scale Consolidated Methodology – Flaring or use of landfill gas”.

3.2 Applicability of Methodology

The ACM001 methodology is applicable under the following conditions:

- 3(b) An investment in an existing LFG capture system to increase the recovery rate or change the use of the captured LFG
- 3(c) Flare the LFG and/or use the captured LFG in any combination of the following ways:
    - Generating electricity.
- 4(a) the most plausible baseline scenario is the atmospheric release of the LFG or the capture of LFG and destruction through flaring to address safety and odor concerns
- 4(b) the most plausible baseline scenario for the electricity generation is that electricity would be generated in the grid

The Project activity is the expansion of an existing LFG collection system to greatly increase the recovery rate and use of captured gas to generate electricity or be flared. The most plausible baseline scenario is the continued operation of the District Initial System and that electricity produced by the Project would have been generated by the grid. Therefore, this methodology is applicable.

3.3 Project Boundary

The Project boundary includes the LFG gas collection system, the flare, and the LFGTE plant. A site plan is provided in Appendix 1. Appendix 1 includes a well field map showing the District Initial System and the Project expansion.

Source		Gas	Included?	Justification/Explanation
Baseline	Emissions from decomposition of waste at the SWDS site	CO_2	No	CO_2 emissions from decomposition of organic waste are not accounted since the CO_2 is also released under the Project activity.
		CH_4	Yes	The major source of emissions in the baseline.
		N_2O	No	This is excluded because the emissions are very small compared to the methane. This is conservative.
	Emissions from electricity generation and heat generation	CO_2	No	The Project is not claiming emissions reductions from the displacement of grid electricity or heat generation, so these are not included.
		CH_4	No	
		N_2O	No	
	Emissions from use of natural gas	CO_2	No	The Project does not include the use of natural gas, so these are not included.
		CH_4	No	
		N_2O	No	

Source		Gas	Included?	Justification/Explanation
Project	Emissions from fossil fuel consumption for purposes other than electricity generation or transportation due to the project activity	CO_2	Yes	This may be an important emissions source.
		CH_4	No	This emissions source is expected to be very small and is excluded for simplicity.
		N_2O	No	This emissions source is expected to be very small and is excluded for simplicity.
	Emissions from electricity consumption due to project activity	CO_2	Yes	This may be an important emissions source.
		CH_4	No	This emissions source is expected to be very small and is excluded for simplicity.
		N_2O	No	This emissions source is expected to be very small and is excluded for simplicity.
	Emissions from flaring	CO_2	No	This emissions source is expected to be very small and is excluded for simplicity.
		CH_4	Yes	This may be an important emissions source.
		N_2O	No	This emissions source is expected to be very small and is excluded for simplicity.
	Emissions from distribution of LFG using trucks	CO_2	No	This project does not include distribution of LFG in trucks, so these are not included.
		CH_4	No	
		N_2O	No	

When calculating the baseline emissions from the District Initial System, the Project is not including the pre-Project emissions sources electricity consumed and emissions from incomplete combustion at the flare. This is conservative because using the ACM0001 formulas, including these emissions sources would reduce the calculated amount of methane destroyed pre-Project and therefore increase the total amount of credits generated by the Project. It is instead assumed that 100% of the landfill gas sent to the flare pre-Project was destroyed.

This Project has a single end use for the LFG collected: electricity generation. This use was not in operation prior to the implementation of the Project activity so ACM001 does not require an end of the remaining lifetime analysis.

3.4 Baseline Scenario

The previously validated baseline scenario and additionality analysis are presented in the original PDD and discussed in Section 3.5. The CDM Tool, “Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period”, Version 3.0.1 is used below to assess the validity of the original baseline. The original baseline was found to be the continued operation of the District Initial System (LFG collection system comprised of 21 vertical and horizontal wells, piping, blower, and flare).

<u>Step 1</u>: Assess the validity of the current baseline for the next crediting period

<u>Step 1.1</u>: Assess compliance of the current baseline with relevant mandatory national and/or sectoral policies
The baseline continues to be compliant with relevant mandatory national and/or sectoral policies. There are no new local, regional or national requirements that would alter the continued implementation of the baseline scenario. A discussion of the relevant regulations is presented in Section 1.11.

<u>Step 1.2</u>: Assess the impact of circumstances
The baseline is not affected by any changes to market conditions such as raw material, electricity or other price fluctuations given the nature of the most plausible baseline scenario. The District Initial System was implemented solely to mitigate potential odor complaints. This driver would prompt the District to continue the system but not to expand or improve it over time as demonstrated in the initial validated baseline analysis.

<u>Step 1.3</u>: Assess whether the continuation of use of current baseline equipment(s) or an investment is the most likely scenario for the crediting period for which renewal is requested.
The District Initial System has not had any portions replaced during the initial Project crediting period and it is not anticipated to replace any equipment during the second crediting period. There would be no motivation for the District to replace functioning equipment with different models in a voluntary system that was performing well. Therefore the use of current baseline equipment is the most likely scenario for the second crediting period.

<u>Step 1.4:</u> Assessment of the validity of the data and parameters
Since the original validation, the applicable methodology, ACM001, has been revised numerous times and now uses different formulas. As such, the data and parameters collected for the Project should be updated to reflect the latest version of the methodology as required by the VCS Standard.

<u>Step 2:</u> Update the current baseline and the data and parameters
The current baseline and data and parameters have been updated and the changes are reflected in the emissions reductions estimates and Sections 3 and 4 of this document.

This analysis concludes that the baseline remains valid for the second crediting period. The methodology used to quantify the emissions reductions from the Project will be updated to reflect the latest available methodology and tools.

3.5 Additionality

In accordance with VCS Standard Section 3.8.5.1, a full additionality review is not required for the renewal of the crediting period. Only regulatory surplus need be demonstrated again and this is presented in Section 1.11. The Project is not required to collect and destroy LFG by any local, regional or national regulation.

3.6 Methodology Deviations

The following methodology deviations were previously validated and approved for the Project:

- The SCADA system was programmed to calculate the methane gas flow in units of million British thermal units (MMBtu) using standardized gas flow (at 68°F and one atmosphere of pressure), methane concentration, the gross heat content (higher heating value) of methane, and the actual temperature and pressure. CNBE determines the volume of methane destroyed by converting the MMBtu values to total methane gas flow in standard cubic feet. This deviation from the monitoring methodology was previously approved by independent verifiers and had a conservative impact on the quantification of GHG emissions reductions.
- The Project reference conditions are 20 degrees Centigrade and 1 atmosphere rather than ACM0001 reference conditions of 0 degrees Centigrade and 1 atmosphere.

Additional deviations from the latest methodology are:

1. A separate LFG meter is not present on each of the four combustion engines. A single meter is used immediately before the piping splits to each engine. This meter is continuously recording data. Operating data is tracked for each engine so it is possible to calculate the flow destroyed by each engine and to ensure that LFG is destroyed. Flow controls are in place to ensure no LFG is sent to an engine that is not operating. This does not affect the conservativeness of the emissions reductions claimed.
2. Ex-ante emissions reductions calculations use historic Project specific data as the basis for projecting future emissions rather than the required CDM estimation tools. Using real data allows the estimations to be more accurate and reflect actual Project operating conditions. his does not affect the conservativeness of the emissions reductions claimed but increases the accuracy of the ex-ante projections ensuring the project is forecasting obtainable, appropriate emissions reductions.
3. There is no flow meter installed on the collection pipe from the District Initial System to separately monitor the contribution of the original baseline system. Given the collection system design and meter requirements, installing a meter at this location would not produce reliable, meaningful results. Instead, well-head flow measurements are collected manually two times each month. These results are used to calculate the relative contribution of the District Initial System to the overall flow of LFG destroyed by the engines. This portion of the total flow represents $F_{CH4,BL,y}$ and will be calculated on a monthly basis and subtracted from the total flow to account for the amount of methane destroyed in the baseline scenario. This approach represents an accurate measurement of the flow because (a) the portion of the landfill that includes the District Initial System (Phase 1) is capped so no landfill gas can be passively emitted to the atmosphere, and (b) the remaining active wells from the District Initial System are located in such a way as to enable capture of all LFG generated within the sphere of influence of the District Initial System. This deviation decreases the conservativeness of the emissions reductions claimed but significantly increases the accuracy of the calculations as is allowable under VCS Standard v3.5, Section 3.5.1.
4. The Project uses the eGrid electricity emissions factor rather than the default emissions factor provided in the CDM tool as explained in the project emissions section. This deviation decreases the conservativeness of the emissions reductions claimed but significantly increases the accuracy of the calculations as is allowable under VCS Standard v3.5, Section 3.5.1.

These deviations only apply to the monitoring and measurement portions of the Project.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

The following equation is used to determine baseline emissions per ACM0001:

$BE_y = BE_{CH4,y} + BE_{EC,y} + BE_{HG,\ y} + BE_{NG,y}$ (Eq. 1)

Where:
BE_y = Baseline emission in year y (tCO2e/yr)
$BE_{CH4,y}$ = Baseline emissions of methane from the SWDS in year y (tCO2e/yr)
$BE_{EC,y}$ = Baseline emissions associated with electricity generation in year y (tCO2e/yr)
$BE_{HG,y}$ = Baseline emissions associated with heat generation in year y (tCO2e/yr)
$BE_{NG,y}$ = Baseline emissions associated with natural gas use in year y (tCO2e/yr)

Baseline emissions associated with electricity generation and heat generation are excluded as the Project is not seeking carbon credits for the displacement of grid electricity or the beneficial reuse of the Project's waste heat. The Project is only seeking credits for emissions reductions resulting from the destruction of methane collected from the Landfill. The Project does not include natural gas replacement so the final parameter is also not relevant. The equation simplifies to:

$BE_y = BE_{CH4,y}$ (Project modified Eq.1)

Where:
BE_y = Baseline emission in year y (tCO2e)
$BE_{CH4,y}$ = Baseline emissions of methane from the SWDS in year y (tCO2e)

Baseline emissions of methane from the SWDS in year y are found as follows:

$BE_{CH4,y} = ((1-OX_{top\_layer}) \times F_{CH4,PJ,y} – F_{CH,BL,y}) \times GWP_{CH4}$ (Eq. 2)

Where:
$BE_{CH4,y}$ = Baseline emissions of methane from the SWDS in year y (tCO2e/yr)
OX_{top_layer} = Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (dimensionless)
$F_{CH4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used in the project activity in year y (tCH_4/yr)
$F_{CH,BL,y}$= Amount of methane in the LFG that would be flared in the baseline in year y (tCH_4/yr)
GWP_{CH4} = Global warming potential of CH_4 (tCO_2e / tCH_4)

For this Project, $F_{CH4,PJ,y}$ is the sum of the quantities of methane flared and used in power generation during the year. This term is calculated as follows according to Equation 3 from the methodology, modified to remove the heat generation and natural gas distribution terms, which are not applicable to this Project.

$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$ (modified Eq. 3)

Where:
$F_{CH4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used in the project activity in year y (tCH_4/yr)
$F_{CH4,flared,y}$ = Amount of methane in the LFG which is destroyed by flaring in year y (tCH_4/yr)
$F_{CH4,EL,y}$ = Amount of methane in the LFG which is used for electricity generation in year y (tCH_4/yr)

As described in the deviation section, the Project's SCADA system is programmed to calculate the methane gas flow in units of million British thermal units (MMBtu) using the real time standardized gas flow (at 68°F and one atmosphere of pressure), methane concentration, the gross heat content (higher heating value) of methane, and the actual temperature and pressure. CNBE determines the volume of methane destroyed by converting the MMBtu values to total methane gas flow in standard cubic feet. The total methane flow in standard cubic feet is then translated into metric tons of methane using the Universal Gas constant, the molecular weight of methane and a standard unit conversion factor. This result provides $F_{CH4,EL,y}$.

The flare is available to destroy landfill gas if the energy system is not operating. However, it has not been used in several years. The flaring equations are included for completeness in case it is needed. The following equation determines the amount of methane, which is destroyed in flaring.

$$F_{CH4,flared,y} = F_{CH4,sent\_flare,y} - PE_{flare,y} / GWP_{CH4}$$

Where:
$F_{CH4,flared,y}$ = Amount of methane in the LFG which is destroyed by flaring in year y (tCH_4/yr)
$F_{CH4,sent\_flare,y}$ = Amount of methane in the LFG which is sent to the flare in year y (tCH_4/yr)
$PE_{flare,y}$ = Project emissions from flaring of the residual gas stream in year y (tCO_2e/yr) determined following the procedure described in the tool “Project emissions from flaring”
GWP_{CH4} = Global warming potential of CH_4 (tCO_2e / tCH_4)

$F_{CH4,sent\_flare,y}$ is determined in the same manner as $F_{CH4,EL,y}$ described above.

Baseline Emissions Reductions ($F_{CH,BL,y}$)

Per ACM0001, this Project falls under the requirements of Case 3 for the baseline system: No requirement to destroy the methane and an existing LFG capture and destruction system.

Because “the amount of methane captured with the existing system can be monitored separately from the amount captured under the Project, and the efficiency of the existing system is not impacted on by the Project system during the crediting period”, the amount of methane that would be flared in the baseline is equivalent to that collected and destroyed from the District Initial System.

$F_{CH4,BL,y} = F_{CH4,BL,sys,y}$ (Eq. 11)

$F_{CH4,BL,sys,y} = F_{CH4,destroyed,y}$ (modified Eq.12)

Where:
$F_{CH4,BL,sys,y}$ = Amount of methane in LFG that would be flared in the baseline for year y for the case of an existing LFG capture system (t CH_4/yr)
$F_{CH4,destroyed,y}$ = Amount of methane in the LFG which is destroyed in year y (t CH_4/yr)

The subscript in the second half of Equation 12 has been modified to reflect the fact that the LFG is not flared in the Project. Because electricity generation has a higher destruction efficiency than a flare, this is a conservative modification that reflects actual Project operations.

As described in the deviation section, there is no flow meter installed on the collection pipe from the District Initial System. Given the collection system design and meter requirements, installing a meter at this location would not produce reliable, meaningful results. Instead, well-head flow measurements are collected manually two times each month. These results are used to calculate the relative contribution of the District Initial System to the overall flow of LFG destroyed by the engines. This portion of the total flow represents $F_{CH4,BL,y}$ and will be calculated on a monthly basis and subtracted to account for the amount of methane destroyed in the baseline scenario.

Ex Ante Estimate of Emission Reductions

Per ACM0001, Section 5.7, each project must estimate the amount of emissions reductions by projecting the future greenhouse gas emissions of the landfill. ACM0001 requires the use of Equation 5 and the tool "Emissions from solid waste disposal sites". The Project has elected to use more accurate, Project specific data that is available from the first crediting period to estimate emissions reductions for the second crediting period. Data from the last monitoring period will be used to estimate emissions reductions moving forward. Using data from the last monitoring period also captures typical system collection efficiencies, down time and other variables that will affect the emissions reductions. Therefore, this provides the most accurate model for future reductions. While there is a plan to expand the footprint of the Landfill in the next year, it will be many years before sufficient waste is in place to consider an expansion of the landfill gas collection system and as such no expansion is included in the projections.

4.2 Project Emissions

According to ACM0001 Project emissions are defined by the following equation:

$$PE_y = PE_{EC,y} + PE_{FC,j,y} + PE_{DT,y} \quad (22)$$

Where:
$PE_{EC,y}$ = Emissions from consumption of electricity due to the Project activity, in year *y* (t CO2/yr)
$PE_{FC,j,y}$ = Emissions from consumption of fossil fuels due to the Project activity, for purpose other than electricity generation, in year *y* (t CO2/yr)
$PE_{DT,y}$ = Emissions from the distribution of compressed/liquefied LFG using trucks, in year *y* (t CO2/yr)

All of the electric power used to power Project activities, including lighting, operations, compressors, blowers and the LFG collection system is provided by the electric power generated by the Project, which is considered a biogenic source and therefore contributes no Project emissions. On rare occasions, when the Plant is not operating, Project activities utilize electricity from the grid or a diesel back-up generator. Emissions from the generator are discussed later in this section. Emissions from grid electricity use are included and will be calculated following the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (Version 01) as required by ACM0001.

For determination of the emission factor for electricity generation ($EF_{EL,j,y}$) the methodology presents a number of options. In this case the electricity consumed is purchased from the regional grid and the applicable options are Option A1 and Option A2.

Option A1 is the calculation of a grid emission intensity factor following the methodology outlined in the "Tool to calculate the emission factor for an electricity system" Version 01.1. However, this process requires much additional data and is a detailed, complex process which is not appropriate given the relative value of this emissions source.

Option A2 allows a default value to be used instead. Following ACM0001 only Project emissions from electricity consumption are calculated, therefore a default value of 1.3 tonnes CO2 per MWh would be applied. However this does not seem in line with the emissions factors published by the United States environmental Protection Agency for the region. The Project falls under region NEWE (NPCC New England) which has a 2012 emissions factor of 637.90 lbs CO2/MWh according to eGrid2012 data. The Project will use this factor instead of the CDM default factor. Emissions are then calculated as follows:

$PE_{EC,y} = EC_{PJ,Grid,y} * EF_{EL,Grid,y} * (1 + TDL_{Grid,y})$ (Eq 1 in the electricity tool)
Where:
$PE_{EC,y}$ = Project emissions from electricity consumption in year y (tCO2/yr)
$EC_{PJ,Grid,y}$ = Quantity of electricity consumed by the Project from the regional grid in year y (MWh/yr)
EFELGridj,y = Emission factor for electricity generation from the regional grid in year y (tCO2/MWh)
TDLGrid,y = Average technical transmission and distribution losses for the regional grid in year y

Equations (2) and (3) of the electricity tool are omitted as calculation of the baseline and leakage electricity consumption are not required by ACM0001. Equations (4), (5), (6), (7) and (8) of the CDM tool are omitted as these are not relevant to the Project.

The flare uses landfill gas as an ignition source when necessary,

Fossil fuels used by Project activities include fuel used by landfill vehicles and diesel used in the emergency generator. Landfill vehicle use has not grown as a result of Project activities as was confirmed during the first validation and can also be conservatively excluded.

The emergency generator is a diesel powered 150kW generator. It is periodically tested and is used only when the Plant is not operating and no grid electricity is available. Project emissions from the use of the generator will be calculated using the formulas required in the "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion v2" as required by the methodology.

$PE_{FC,j,y} = \Sigma\, FC_{i,j,y} \times COEF_{i,y}$ (Eq 1 in the Tool)

Where:
$PE_{FC,j,y}$ = Are the CO_2 emissions from fossil fuel combustion in process j during the year y (tCO_2/yr);
$FC_{i,j,y}$ = Is the quantity of fuel type i combusted in process j during the year y (mass or volume unit/yr);
$COEF_{i,y}$ = Is the CO_2 emission coefficient of fuel type i in year y (tCO_2/mass or volume unit)
i = Are the fuel types combusted in process j during the year y

Because the fuel type in this project is diesel and it is only used in one process, Equation 1 becomes:

$PE_{FC,y} = (FC_{diesel,y} \times COEF_{diesel,y})$

The CO2 emission coefficient $COEF_{diesel,y}$ is then calculated based on the net calorific value and CO2 emission factor of the diesel (Option B), as follows:

$COEF_{Diesel,y} = NCV_{Diesel,y} * EF_{CO2,\ Diesel,y}$ (Eq 4 in the fossil fuel tool)
Where:
$COEF_{Diesel,y}$ = the CO2 emission coefficient of diesel used (tCO2/gallon);
$NCV_{Diesel,y}$ = the weighted average net calorific value of diesel (MMBtu/gallon)
$EF_{CO2,\ Diesel,y}$ = the weighted average CO2 emission factor of diesel (tCO2/MMBtu)

Data used to determine $COEF_{Diesel,y}$ was obtained from the Draft 2011 US Greenhouse Gas Report: US EPA Inventory of US Greenhouse Gas Emissions and Sinks to provide a national factor. Results were compared to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories to ensure consistency as required by the tool.

The Project does not use trucks to distribute compressed or liquefied LFG.

Therefore, under normal operating conditions, the Project has only grid electricity and emergency generator use as Project emissions to quantify. If a landfill gas expansion does occur, the emissions associated with the construction event will be calculated in accordance with the "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion".

4.3 Leakage

Per ACM0001, no leakage effects need to be accounted.

4.4 Net GHG Emission Reductions and Removals

GHG Emissions reductions are calculated by subtracting the Project emissions from the baseline emissions removals.

$ER_y = BE_y – PE_y$ (17)

Where:
ER_y = Emission reductions in year y ($tCO2e/yr$)
BE_y = Baseline emissions in year y ($tCO2e/yr$)
PE_y = Project emissions in year y ($tCO2/yr$)

Estimated emissions reductions are provided below and the calculation spreadsheet is provided in Appendix 2.

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
2016 (March 29 - December 31)	67360	3	0	67357
2017	88441	4	0	88437
2018	88441	4	0	88437
2019	88441	4	0	88437
2020	88441	4	0	88437
2021	88441	4	0	88437
2022	88441	4	0	88437
2023	88441	4	0	88437
2024	88441	4	0	88437
2025	88441	4	0	88437
2026 (January 1 - March 28)	21081	1	0	21080
Total	884414	40	0	884374

5 MONITORING

5.1 Data and Parameters Available at Validation

Data / Parameter	OX_{top_layer}
Data unit	Dimensionless
Description	Fraction of methane that would be oxidized in the top layer of the SWDS in the baseline
Source of data	Consistent with how oxidation is accounted for in the methodological tool “Emissions from solid waste disposal”
Value applied:	0.1
Justification of choice of data or description of measurement methods and procedures applied	In accordance with requirements of ACM0001
Purpose of Data	Calculation of baseline emissions
Comments	No comments

Data / Parameter	GWP_{CH4}
Data unit	T CO_2e / t CH_4
Description	Global warming potential of methane
Source of data	IPCC – Second Assessment Report
Value applied:	21
Justification of choice of data or description of measurement methods and procedures applied	Value required by VCS. Shall be updated to 25 or the latest UNFCCC approved value as required by ACM0001 when permitted by VCS.
Purpose of Data	Calculation of baseline emissions
Comments	No comments

Data / Parameter	Regulatory requirements
Data unit	Not applicable
Description	Regulatory requirements applicable to the Landfill and Project
Source of data	Publicly available information on local, regional and national regulations
Value applied:	Not applicable

Justification of choice of data or description of measurement methods and procedures applied	Not applicable
Purpose of Data	To ensure continued compliance and regulatory additionality
Comments	This information is summarized in the PDD and will be monitored during the crediting period for any applicable changes.

Data / Parameter	Methane oxidation efficiency for electricity generation
Data unit	Percent
Description	Quantity of methane oxidized during combustion for electricity generation
Source of data	CDM Methodologies and Tools
Value applied:	100
Justification of choice of data or description of measurement methods and procedures applied	Appropriate for this type of destruction
Purpose of the data	Calculation of baseline emissions
Comments	None

Data / Parameter	Fuel Use by the Emergency Generator
Data unit	Gallons/hour
Description	Average consumption of a 150kW generator operating at ¾ load to be used to calculate fuel consumed annually
Source of data	Diesel Service and Supply Company
Value applied:	8.4 gallons/hour
Justification of choice of data or description of measurement methods and procedures applied	Conservative for this piece of equipment given output needed vs total capacity
Purpose of the data	Calculation of project emissions
Comments	None

5.2 Data and Parameters Monitored

Data Unit / Parameter:	Methane content of gas (LFG and biogas)
Data unit:	Percent methane content of gas (LFG and biogas)
Description:	Methane content of gas (LFG and biogas)
Source of data:	SCADA System at Facility
Description of measurement methods and procedures to be applied:	Non-dispersive infrared
Frequency of monitoring/recording:	Continuous, hourly, daily
Value monitored:	Methane concentration, %
Monitoring equipment:	California Analytical 602P, Serial # S07002
QA/QC procedures to be applied:	Field calibrated once per week. A zero check and value check is performed by comparison with standard certified gas.
Purpose of the data	Calculate baseline and emissions reductions.
Calculation method:	Used in calculation to obtain heat value of gas (LFG and biogas) in Btu per scf of gas (LFG and biogas)
Any comment:	CO2 and O2 are also continuously monitored using the same instrument.

Data Unit / Parameter:	Volume of gas (LFG and biogas) to engines
Data unit:	Actual cubic feet per minute
Description:	Quantity of gas (LFG and biogas) used to fuel engines
Source of data:	SCADA System at Facility
Description of measurement methods and procedures to be applied:	Differential pressure measured across orifice plate
Frequency of monitoring/recording:	Continuous, hourly, daily
Value monitored:	Differential pressure
Monitoring equipment:	Oripac Model 4150, Serial #30154
QA/QC procedures to be applied:	Field calibrated once per month.
Purpose of the data	Calculate baseline and emissions reductions.
Calculation method:	Fluid flow equation (Bernoulli) calculates actual cubic feet per minute of gas (LFG and biogas).
Any comment:	None

Data Unit / Parameter:	Temperature of gas (LFG and biogas) to engines
Data unit:	Degrees Fahrenheit
Description:	Temperature of gas (LFG and biogas)
Source of data:	SCADA System at Facility
Description of measurement methods and procedures to be applied:	Thermocouple
Frequency of monitoring/recording:	Continuous
Value monitored:	Temperature
Monitoring equipment:	Thermocouple, Omega or equivalent
QA/QC procedures to be applied:	Field calibrated using thermometer.
Purpose of the data	Calculate baseline and emissions reductions.
Calculation method:	Used in fluid flow equation (Bernoulli) to calculate standard cubic feet per minute from actual cubic feet per minute of gas (LFG and biogas).
Any comment:	None

Data Unit / Parameter:	Pressure of gas (LFG and biogas) to engines
Data unit:	PSIG
Description:	Pressure of gas (LFG and biogas)
Source of data:	SCADA System at Facility
Description of measurement methods and procedures to be applied:	Pressure transducer
Frequency of monitoring/recording:	Continuous
Value monitored:	Static pressure
Monitoring equipment:	Pressure transducer, Omega or equivalent
QA/QC procedures to be applied:	Field calibrated using pressure gauge.
Purpose of the data	Calculate baseline and emissions reductions.
Calculation method:	Used in fluid flow equation (Bernoulli) to calculate standard cubic feet per minute from actual cubic feet per minute of gas (LFG and biogas).
Any comment:	None

Data Unit / Parameter:	Methane content of biogas
Data unit:	Percent methane content of biogas
Description:	Methane content of biogas

Data Unit / Parameter:	Methane content of biogas
Source of data:	CRMC Bioenergy Facility (anaerobic digester system) tied to SCADA System at Facility
Description of measurement methods and procedures to be applied:	Infra-Red Gas Analyzer
Frequency of monitoring/recording:	Continuous and at totalization of biogas volume
Value monitored:	Methane concentration, %
Monitoring equipment:	Hitech Model: IR600 Infra-Red Gas Analyzer
QA/QC procedures to be applied:	Field calibrated periodically. A value check is performed by comparison with standard certified gas.
Purpose of the data	Calculate emissions reductions.
Calculation method:	Used in calculation to obtain heat value of biogas in Btu per scf of biogas
Any comment:	None

Data Unit / Parameter:	Volume of biogas
Data unit:	Standard cubic feet per minute
Description:	Quantity of biogas added to LFG, both used to fuel engines
Source of data:	CRMC Bioenergy Facility (anaerobic digester system) tied to SCADA System at Facility
Description of measurement methods and procedures to be applied:	Differential pressure measured across a pitot tube
Frequency of monitoring/recording:	Continuous and at totalization of biogas volume
Value monitored:	Differential pressure
Monitoring equipment:	Dwyer Series DS-300 Flow Sensor, which is an averaging pitot tube
QA/QC procedures to be applied:	Field calibrated once per month.
Purpose of the data	Calculate emissions reductions.
Calculation method:	Fluid flow equation (Bernoulli) calculates actual cubic feet per minute of gas.
Any comment:	None

Data Unit / Parameter:	Temperature of biogas
Data unit:	Degrees Fahrenheit
Description:	Temperature of gas
Source of data:	CRMC Bioenergy Facility (anaerobic digester system) tied to SCADA System at Facility
Description of measurement methods and procedures to be applied:	Thermocouple
Frequency of monitoring/recording:	Continuous monitoring
Value monitored:	Temperature
Monitoring equipment:	Thermocouple, Omega or equivalent
QA/QC procedures to be applied:	Field calibrated using thermometer.
Purpose of the data	Calculate emissions reductions.
Calculation method:	Used in fluid flow equation (Bernoulli) to calculate standard cubic feet per minute from actual cubic feet per minute of gas.
Any comment:	None

Data Unit / Parameter:	Pressure of biogas
Data unit:	PSIG
Description:	Pressure of gas
Source of data:	SCADA System at Facility
Description of measurement methods and procedures to be applied:	Pressure transducer
Frequency of monitoring/recording:	Continuous
Value monitored:	Static pressure
Monitoring equipment:	Pressure transducer, Omega or equivalent
QA/QC procedures to be applied:	Field calibrated using pressure gauge.
Purpose of the data	Calculate baseline and emissions reductions.
Calculation method:	Used in fluid flow equation (Bernoulli) to calculate standard cubic feet per minute from actual cubic feet per minute of gas.
Any comment:	None

Data Unit / Parameter:	Volume of LFG to the flare
Data unit:	Standard cubic feet per minute

Data Unit / Parameter:	Volume of LFG to the flare
Description:	Quantity of landfill gas combusted in flare
Source of data:	Flare station
Description of measurement methods and procedures to be applied:	Differential pressure measured across orifice plate
Frequency of monitoring/recording:	Continuous, hourly, daily
Value monitored:	Standard cubic feet per minute
Monitoring equipment:	Omega PDF65 sqrt, Serial #57493
QA/QC procedures to be applied:	Field calibrated as required when operating.
Purpose of the data	Calculate baseline and emissions reductions.
Calculation method:	Fluid flow equation (Bernoulli) calculates standard cubic feet per minute of LFG.
Any comment:	None

Data / Parameter	Fraction of total LFG collected attributable to District Initial System
Data unit	Percentage
Description	Amount of LFG collected from the District Initial System that would have been destroyed in the baseline scenario
Source of data	Well-head measurements
Description of measurement methods and procedures to be applied	Measurements at each well-head using a hand-held instrument
Frequency of monitoring/recording	Twice a month (approximately every two weeks)
Value applied:	6% was used in the ex-ante calculation based on two years of data (June 2013 – June 2015)
Monitoring equipment	Landtec GEM 2000 and GEM 5000
QA/QC procedures to be applied	Calibrations will be conducted prior to each set of measurements and documented.
Purpose of data	Calculation of the baseline emissions
Calculation method	LFG flows from District Initial System/Total LFG flow from all wells
Comments	None

Data Unit / Parameter	$EF_{EL,Grid,y}$

Data unit	tonnes CO2/MWh
Description	Emission factor for electricity generation in year y
Source of data	US EPA eGRID data
Description of measurement methods and procedures to be applied	This value converted from the pounds CO2/MWh provided by the US EPA.
Frequency of monitoring/recording	The eGRID data will be reviewed each year to ensure that the most current value is used.
Value applied	0.289955 tonnes CO2/MWh
Monitoring equipment	None
QA/QC procedures to be applied	None
Purpose of data	Calculation of project emissions
Calculation method	637.90 lbs CO2/MWH*0.454545455 kg/lbs*0.001 tonnes/kg = 0.289955 tonnes CO2/MWh
Any comment:	None

Data Unit / Parameter	TDL Grid,y
Data unit	--
Description	Average technical transmission and distribution losses for grid in year y
Source of data	Energy Information Administration (EIA) Department of Energy (DOE) Annual Energy Review 2011: Chapter 2 Energy Consumption by Sector. P. 66
Description of measurement methods and procedures to be applied	None
Frequency of monitoring/recording	This data will be reviewed each year to ensure that the most current value is used.
Value applied	0.07
Monitoring equipment	None
QA/QC procedures to be applied	None
Purpose of data	Calculation of project emissions
Calculation method	None
Any comment	None

Data Unit / Parameter	EC Grid,y
Data unit	MWh
Description	Amount of grid electricity consumed by the project

Source of data	Bills
Description of measurement methods and procedures to be applied	CNBE staff will compile the data.
Frequency of monitoring/recording	Data will be compiled annually.
Value applied	Ex Ante Calculation: 6.3 MWh/year based on 2014 usage
Monitoring equipment	None
QA/QC procedures to be applied	None
Purpose of data	Calculation of project emissions
Calculation method	None
Any comment	None.

Data Unit / Parameter:	$FC_{Diesel,y}$
Data unit:	Gallons/year
Description:	Amount of diesel consumed by the emergency generator
Source of data:	Run time log
Description of measurement methods and procedures to be applied:	Plant operator will log the run time of the engine each time it is used
Frequency of monitoring/recording:	Data will be compiled annually.
Value applied:	Ex Ante Calculation: Based on 2014-2015 usage, the engine ran for 19 hours. Using a conservative assumption that the engine operated at ¾ load, it was assumed that the engine uses 8.4 gallons of diesel per hour run. (Technical specifications provided to validator. See Parameter in Section 5.1 of PD)
Monitoring equipment:	None
QA/QC procedures to be applied:	None
Purpose of data:	Calculation of project emissions
Calculation method:	The total run time will be multiplied by 8.4 gallons/hour to determine the total amount of diesel consumed in the year.
Any comment:	None.

Data Unit / Parameter:	NCV_{diesel}
Data unit:	MMBtu/ gallon
Description:	Energy content of the diesel

Source of data:	Draft 2011 US Greenhouse Gas Inventory Report
Description of measurement methods and procedures to be applied:	This was converted from the MMBtu/barrel data provided by the USEPA. 5.809 MMBtu/barrel
Frequency of monitoring/recording:	Annual
Value applied:	0.13831 MMBtu/ gallon See ExAnteEstimate or Annual Calculation Workbooks for conversion
Monitoring equipment:	None
QA/QC procedures to be applied:	None
Calculation method:	None
Any comment:	Values provided by the EPA will be reviewed annually to ensure this value is the most up to date value available. This value is higher than the range provided by the IPCC in its 2006 Guidelines for National Greenhouse Gas Inventories and is therefore conservative.

Data Unit / Parameter:	EF CO2,Diesel,y
Data unit:	t CO2 /MMBtu
Description:	CO2 emissions factor for diesel
Source of data:	Draft 2011 US Greenhouse Gas Inventory Report
Description of measurement methods and procedures to be applied:	This was converted from the Tg C/Qbtu data provided by the US EPA. See ExAnteEstimate or Annual Calculation Workbooks for conversion
Frequency of monitoring/recording:	Annual
Value applied:	0.073957 t CO2 /MMBtu
Monitoring equipment:	N/A
QA/QC procedures to be applied:	N/A
Calculation method:	N/A
Any comment:	Values provided by the EPA will be reviewed annually to ensure this value is the most up to date value available.

5.3 Monitoring Plan

5.3.1 Data Collection

At the Facility, the Supervisory Control and Data Acquisition (SCADA) system measures and records methane content and gas (LFG and biogas) volume to the engines and flare once per minute, and then calculates methane quantities each minute. The results are then accumulated to provide hourly and daily totals in units of million British thermal units on a higher heating value basis [MMBtu (HHV)] and thousand standard cubic feet (KSCF) of LFG. This data point provides information regarding the mixed landfill gas and biogas from the CRMC Bioenergy Facility (anaerobic digester system).

The same calculation is made using data from the biogas feed pipe. The difference between the total Btus entering the engines and the total Btus received from the biogas facility is the quantity attributed to the LFG collected and is used in the calculations described previously in the PDD. Because the calculations for this project are based on the use of Btus rather than metric tonnes of methane as discussed in the deviation section, the value obtained by this approach is not skewed by the mixing of the gases prior to the measurement of the gas entering the engines.

Flow Measurements

The flow meters are located directly upstream of the destruction devices. One flow meter serves as the unit for flow meter measurements to the four engines, one unit for flow measurement of the biogas, and one unit for flow meter measurements to the flare. Each flow meter is equipped with a totalizer that indicates the cumulative actual cubic feet of gas that have passed through that flow meter.

The Project uses an orifice plate flow meter purchased directly from its manufacturer, Lambda Square Inc for the engine measurements. The orifice plate flow meter is an Oripac® Model 5300 that determines flow based on pressure differentials measured across a 5-inch diameter bore pressure differential plate installed in the Project's 8-inch diameter LFG pipe. The design data for the instrument specifies an accuracy of ± 0.6 percent of full scale and the capability of measuring flows from 0 to 1,600 actual cubic feet per minute. The performance of the instrument in the field is assured by the manufacturer on the basis of bench scale testing in accordance with applicable design and methodologies prescribed by the International Standards Organization (ISO) and the American Society of Mechanical Engineers (ASME).

The Project uses an Omega PDF65 flow meter for measuring flow to the flare and a Dwyer Series DS-300 Flow Sensor, which is an averaging pitot tube, for measuring flow of the biogas.

Methane Measurements

The methane content of the gas (LFG and biogas), on a percent volume basis, is measured at a sampling port in the main header pipe near the flow meter with the use of a California Analytical Instrument Non-dispersive infrared (NDIR) analyzer. The readings are also logged by the SCADA system once per minute.

The methane content of the biogas is measured using a Hitech Model: IR600 Infra-Red Gas Analyzer.

Wellfield Measurements

At least twice a month, a trained operator balances the landfill gas collection wellfield. In the course of balancing the system, the operator measures and records the methane content, carbon dioxide content, oxygen content, landfill gas flow rate, landfill gas temperature, static pressure, and balance gas content. These results are logged in an electronic file to document system performance as well as to determine the percent contribution of LFG from the District Initial System.

Meter Calibrations

On installation, CNBE performed initial calibrations of the instruments, under actual field conditions using the USEPA Protocols described below. As a back-up to the flowmeter measurements, actual quantities of LFG destroyed in the Project engine-generators can be accurately calculated based on (a) the known engine heat rate (the number of British Thermal Units (Btus) required to produce a kilowatt hour electric power, (b) the measured heat content of the LFG fuel, and the metered electric power output of the Project.

CNBE performs calibration of the orifice plate flow meter at least quarterly and often monthly. CNBE follows the USEPA-promulgated test methods (USEPA Protocols) for determining flow rates of gas through pipes at 40 CFR 60 Appendix A, including (a) Method 1a - sample and velocity traverses for stationary sources with small stacks or ducts, and (b) Method 2c - determination of gas velocity and volumetric flow rate in small stacks or ducts (standard pitot tube) . The USEPA Protocols were established by the USEPA to accurately determine the volumetric flow rates of gases through pipes at industrial facilities to determine compliance with permit limitations on process and exhaust gases.

The calibration is performed by measuring the flow at a point in close proximity to the orifice flow meters. A pitot tube attached to a manometer measures the flow. The pitot tube is inserted into the pipe and several points are measured across the full diameter of the pipe. The measurements taken by the pitot tube and manometer include velocity pressure and static pressure. Other measurements taken during calibration include gas temperature and barometric pressure.

Each week or more frequently as necessary, CNBE calibrates methane concentration measured on an automated basis by a California Instruments NDIR Analyzer installed at the Project, and any hand-held instrument that may be used in addition to the NDIR Analyzer is calibrated prior to its use. CNBE has found that weekly calibrations are sufficient to provide accurate measurements because of the reliable performance of the instrument, and the stringent dependence of engine operations on the accuracy of the methane measurements. CNBE typically experiences a weekly variance in the accuracy of methane content readings of one percent or less, which readings are measured by the California Instruments NDIR Analyzer and compared to readings from a certified standard gas containing a known methane concentration.

Another performance measure that is a further check and balance of methane content is the calculation of efficiency of the operating engine-generator sets, which is calculated daily and does not vary by more than approximately five percent during normal operations.

Biogas meters are calibrated as outlined in the relevant parameters.

5.3.2 Organizational structure, responsibilities and competencies

CNBE owns and manages the operations of the Facility and is responsible for oversight of operations and data collection, calculating emissions reductions and ensuring proper Project documentation. CNBE personnel have extensive experience in all of these areas. They have successfully implemented the Project over many years and have had no employee turnover.

CNBE contracts an operating company to conduct the operations and maintenance of the Facility. The operating company employs a full time operator to conduct operations, maintenance, inspections, calibrations, monitoring and record-keeping at the facility. The operator receives training on the necessary tasks and has a task reminder calendar to ensure duties are performed at the appropriate time.

5.3.3 Recordkeeping

The SCADA system creates a Microsoft Excel file that contains the hourly and daily totals of landfill gas flow, landfill gas heat value, landfill gas methane content, operating hours of each engine, gross power output of each engine, gross and net power output of the facility. This file is created each day at mid-night for the prior 24-hour period. The file is automatically stored on the SCADA system computer. This file can be accessed remotely or at the facility. The file is manually copied from in its entirety and pasted into the monthly quantification excel spreadsheet. No individual pieces of data are manually entered. The files are backed up at the Facility and off-site.

The SCADA systems also records all biogas data which is also transferred in its entirety and used in calculating the landfill gas values for determining Project emissions reductions.

Operator records including the Facility operation logs, maintenance logs and manually recorded data logs are maintained at the Facility. Operator records also include the log noting the run time of the emergency generator.

5.3.4 Internal Review

The Project uses several layers of review to ensure proper operations, data collection and quantification of emissions reductions.

The monthly quantification spreadsheet calculates several key performance parameters each day that are compared a few times per week to the expected performance range of each parameter. If the calculations show a significant deviation, corrective actions are taken. Corrective actions involve repairing equipment that is performing outside its normal range or correcting data that may have been reported in error. Equipment problems and corrective actions are noted in the "Service Section" of the monthly reports. CNBE includes notes to fully explain the problem and corrective action to the extent necessary. This information also identifies any deviations from this monitoring plan which can then be recorded in the verified Monitoring Report.

CNBE has established monthly operations meetings at the Facility between CNBE's contract operator and the owners of CNBE. During each monthly meeting CNBE and the operator review the prior month operations performance including the production reports, work order list, unscheduled repairs and maintenance, and routine maintenance; the current month's additions to the work orders that would prevent and correct deficiencies discovered and make overall improvements in performance of the Facility; review reports including monthly outage report, methane calibration logs, exhaust gas oxygen logs, lubricating oil logs, spare parts inventory report and others that may be relevant. In addition, CNBE meets with the District to review the status of the LFG collection system performance and work required to prevent and correct deficiencies discovered and make overall improvements in performance of the system.

CNBE annually calculates the project emissions from electricity use and emergency generator use as outlined in this PD.

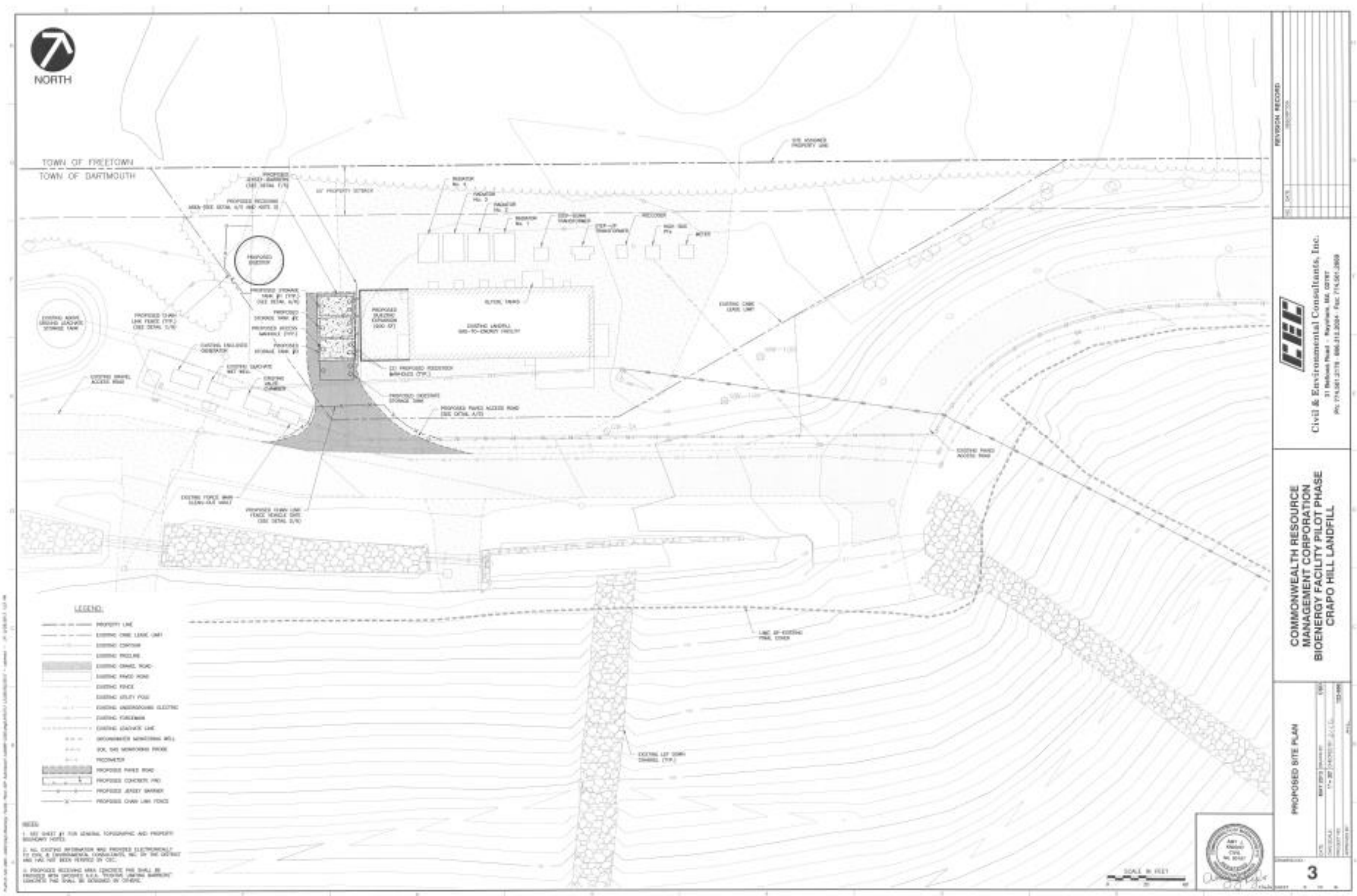
6 ENVIRONMENTAL IMPACT

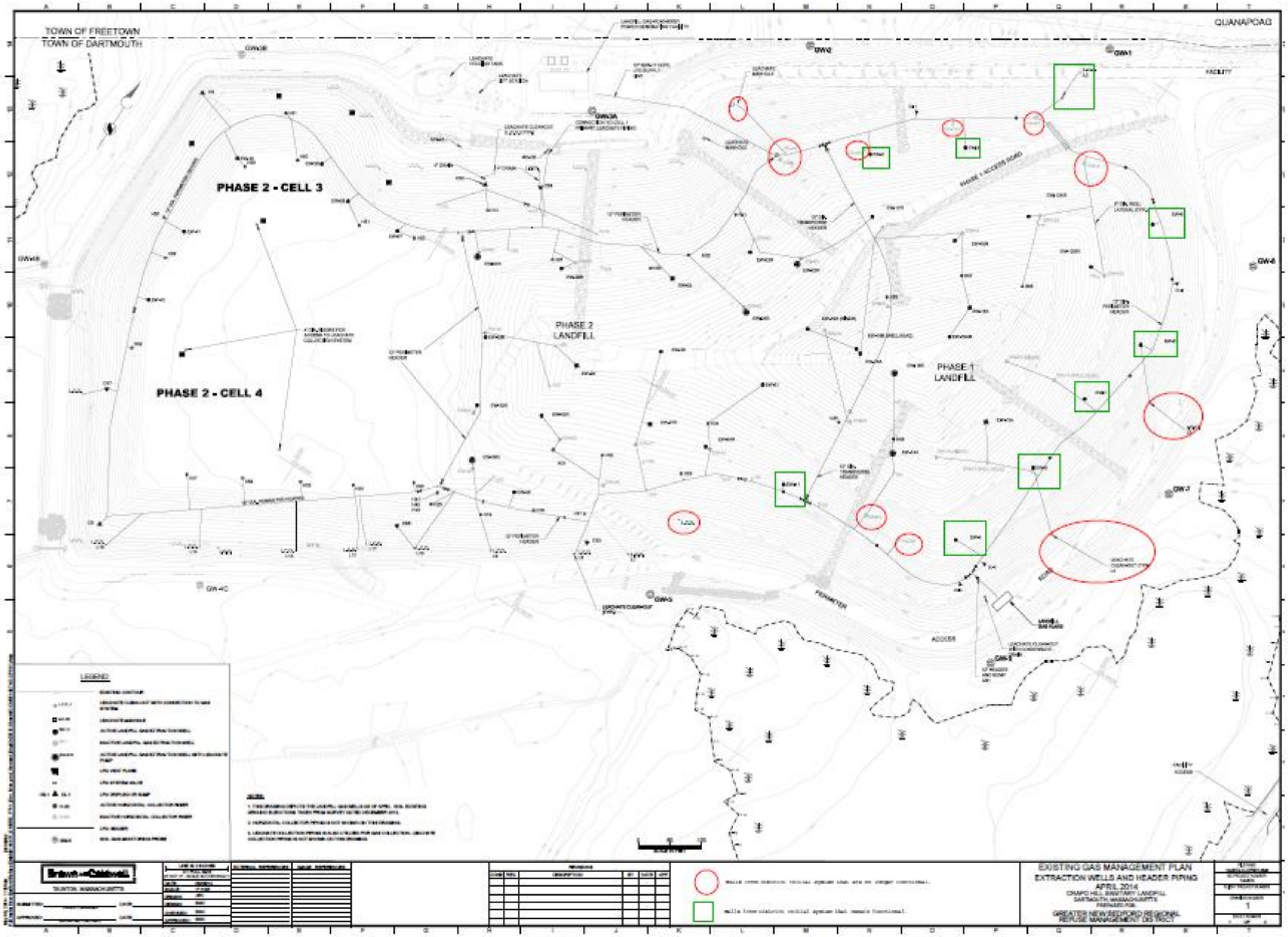
In accordance with the requirements of the Massachusetts Environmental Policy Act ("MEPA"), prior to construction of the Project and as a pre-requisite to Project permitting, CNBE submitted an Environmental Notification Form ("ENF") to the Massachusetts Secretary of Environmental Affairs to enable the Secretary, acting through the MEPA Office (the state agency responsible for assessing the potential environmental impact of proposed projects pursuant to MEPA) to determine whether and to what extent any detailed environmental impact assessment of the Project should be required. Based on its review of the ENF, in February 2004 the MEPA Office determined and the Secretary certified that no Environmental Impact Report for the Project would be required.

7 STAKEHOLDER COMMENTS

The Project stakeholders are the District and CNBE. There are no other investment group or public groups involved in the Project. Therefore, no formal stakeholder consultations are required. However, the District does have a formal process for receiving comments or complaints available to the public via email or telephone. No comments regarding this Project have been received. In addition, the District Committee, which is an oversight committee comprised of representatives of the District's member communities and which makes strategic decisions for the District, meets once per month and the meetings are open to the public.

APPENDIX 1: SITE PLAN





TOWN OF FREETOWN
TOWN OF DARTMOUTH
QUANAPOAG
PHASE 2 - CELL 3
PHASE 2 - CELL 4
PHASE 2
LANDFILL
PHASE 1
LANDFILL
LEGEND
EXISTING GAS MANAGEMENT PLAN
EXTRACTION WELLS AND HEADER PIPING
APRIL 2014
CRAPO HILL SANITARY LANDFILL
DARTMOUTH, MASSACHUSETTS
GREATER NEW BEDFORD REGIONAL
REFUSE MANAGEMENT DISTRICT

APPENDIX 2: EX ANTE ESTIMATED EMISSIONS REDUCTIONS SPREADSHEET

	Formula variables	Value used	Units	Source if appropriate
$ER_y = BE_y - PE_y$				
	BE_y	see below	tCO2e/yr	
88437	PE_y	3.59	tCO2e/yr	See Electricity Tab + Emergency Generator Tab
$BE_y = BE_{CH4,y}$				
	$BE_{CH4,y}$	see below	tCO2e/yr	
88441				
$BE_{CH4,y} = ((1\text{-}OX_{top\_layer}) \times F_{CH4,PJ,y} - F_{CH,BL,y}) \times GWP_{CH4}$				
	OX_{top_layer}	0.1		ACM001 Methodology value
88441	GWP_{CH4}	21	tCO2e / tCH4	IPCC Value – 2nd Assessment
	$F_{CH4,PJ,y}$	see below	t CH4/yr	
	$F_{CH,BL,y}$	see below	t CH4/yr	
$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$				
	$F_{CH4,flared,y}$	0	t CH4/yr	See Assumptions tab
5014	$F_{CH4,EL,y}$	5014	t CH_4/yr	See Engine Flow tab
$F_{CH4,BL,y} = F_{CH4,BL,sys,y}$				
$F_{CH4,BL,sys,y}$ = %DistrictInitialSystem X $F_{CH4,PJ,y}$	%DistrictInitial System	6		See DistrictInitialSystemTab
	$F_{CH4,PJ,y}$	see above	t CH4/yr	
301				