MONITORING, REPORTING AND VERIFICATION PROTOCOL FOR THE NORTH COUNTRY LANDFILL GAS UTILIZATION PROJECT

MRV CBE 2005 15

Prepared for:
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a wholly owned subsidiary of
CommonWealth Resource Management Corporation

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1 Introduction

CommonWealth Bethlehem Energy LLC (CBE) is a New Hampshire based limited liability company, wholly owned by CommonWealth Resource Management Corporation (CRMC) a Massachusetts based corporation. Environmental Resources Trust, Inc. is a non-profit environmental organization specializing in market-based solutions to environmental problems.

On behalf of CBE, CRMC has commissioned this Monitoring, Reporting, and Verification Guideline (the Guideline) to provide transparency and credibility in the quantification of the greenhouse gas emission reductions, and in the allocation of corresponding property rights, generated through methane (CH_4) emission reductions at the North Country Landfill Gas Utilization Project (the "Project").

The Guideline describes a system to quantify and verify methane (CH_4) emission reductions at the North Country Landfill Gas Utilization Project.

1.1 Guideline Objectives

The primary objectives of this Guideline are to address methodology, data collection, data quality control, related to the monitoring, reporting, and verifying of methane emission reductions from a landfill gas capture project. The ultimate objective is that by following these guidelines a "true and fair" representation of the Project's net direct emissions performance, which can be verified, will result.

In order to be verified, emission reductions must meet the following criteria:

- The project must result in a reduction of direct emissions within the project's boundaries and such reductions must derive from specific and identifiable actions such as changes in equipment, technologies, processes, or operations.
- Emission reductions must be additional (i.e., surplus) to emission reductions that may be required by existing regulatory requirements.
- Ownership of the emission reductions must be clearly demonstrable by contract or written agreement. Owners of the relevant facilities, the entities paying the operational costs of the facility, and the entities that paid for or subsidized the initial and the ongoing costs of the emission reduction action must be identified.
- Emission reductions must be quantifiable by acceptable, transparent, and replicable measurement and calculation tools and techniques. Raw data must be available to verify measurements and calculations and statistical information provided to support the level of certainty/significance of the data. Baseline emissions determination must be explained and specified. The actual reduction beyond the baseline emission level must be specified.

Given those criteria, this MRV Guideline shall

- Define project boundaries
- Clearly establish ownership of the credits by clearly demonstrable contract or written

agreement. Identify the owners of the relevant facility, the entities paying the operational costs of the facility, and the entities that paid for or subsidized the initial and the ongoing costs of the emission reduction action.

- Identify emissions sources
- Address issues of additionality and leakage
- Specify a project baseline against which emission reductions will be determined
- Specify monitoring and data collection techniques and procedures
- Specify emission factors & calculation methods, where applicable
- Identify supporting data for emissions quantification
- Describe data management and quality control procedures
- Specify reporting and documentation requirements, including frequency
- Address uncertainty
- Describe procedures for verification and registration of emission reductions
- Specify an attestation statement by project operators

1.2 Applicability

This guideline is specifically applicable to methane gas emission reductions from landfill gas capture projects where:

- The captured gas is flared, or
- The captured gas is used to generate electricity or heat, but no emission reductions are claimed for avoiding emissions from other sources (e.g. if electricity generation is displaced or landfill-related transportation activities are reduced).

1.3 Periodic Reviews and Revisions

Environmental Resources Trust, Inc. (ERT) may require revisions to this Guideline to ensure that the monitoring, reporting, and verification system adequately addresses changes in the Project's activities.

An annual emissions report should be submitted by CBE to ERT and will be subject to an annual review. As a part of this review, ERT will:

- Review the report and prepare adjustments or corrections
- Verify the data by applying audit-sampling methods
- Register verified emission reductions in the GHG Registry[SM]

This MRV Guideline also specifies the frequency of other MRV activities.

2 General description of Project

CBE owns and operates the North Country Landfill Gas (“LFG”) Utilization Project (the “Project) located in the North Country Environmental Systems Inc. Landfill (the “Landfill”) at 581 Trudeau Road in the town of Bethlehem New Hampshire. Another wholly-owned subsidiary of CRMC, named CRMC Bethlehem LLC, owns the rights to the LFG from the Landfill and operates a LFG management system that extracts LFG from the Landfill and delivers all of the LFG collected at the Landfill (along with the rights in and title to all of the environmental attributes associated with the use and/or destruction of the LFG) to the CBE-owned Project.

Both (a) the LFG management system at the Landfill, and (b) the LFG utilization and destruction system which constitutes the Project, have been developed in phases. In the Project’s first phase, from the commencement of commercial operations in April, 2001 until April, 2007, the Project utilized LFG to thermally treat both leachate and condensate, which are wastewaters associated with landfill disposal operations and LFG collection. From April, 2007 and through to at least the issue date of the MRV Guideline MRV CBE 2005 15**,** a second phase of Project operations has involved removal of condensate from the LFG for proper disposal by the Landfill owner, and thermal destruction of all of the recovered, dewatered LFG.. Concurrent with those on-going condensate removal and LFG destruction activities, the Project owners have been engaged in the siting and permitting of a power production facility that will use the LFG as a fuel to generate electricity for delivery to the regional power grid. Operation of that facility would constitute the third phase of the Project. Changes in the nature of Project operations across phases have no effect, in and of themselves, on the quantities of LFG collected from the Landfill and thermally destroyed. Additional information about the development and operation of the LFG management system and the Project is provided in Sections 2.2 and 2.3 of this MRV, below.

2.1 Landfill description

The Landfill is owned by a North Country Environmental Systems Inc (NCES), a subsidiary of Casella Waste Systems, Inc. The Landfill comprises a 92-acre parcel of land that is owned by NCES. The portion of the Landfill property that was permitted by the New Hampshire Department of Environmental Services (NHDES) to be used for solid waste disposal includes 42 acres of the 92-acre parcel of land. The Landfill, which commenced operations in 1987, is being developed in stages (see Appendix II **-** Existing Conditions Plan, and photos below)**.** The permitted and constructed stages of the Landfill, comprising a footprint of 34 acres, have an approved design capacity of approximately 2.8 millions tons of solid waste. Stage 1 was closed and capped in 1997. Stages 2 and 3 have been closed with intermediate cover but areas that have experienced settlement are actively being filled to closure grades. Stage 4, Phase 1 is actively being filled and together with Stages 2 and 3 are expected to be full and closed during 2010. During 2008 and 2009, NCES sought approvals from the NHDES to vertically expand areas

within Stages 1 through 3 and Stage 4, Phase 1, which would expand the Landfill by an additional 0.8 million tons of waste disposal capacity. NHDES has denied the NCES expansion requests, pending the outcome of litigation.   . The Stage 4, Phase 2 expansion is not constructed and will not be constructed until pending litigation resolves the approval status. Approval of Stage 4, Phase 2 would expand the landfill footprint from 34 acres to 42 acres and would provide an additional 1.0 million tons of design capacity. With the capacity expansion planned with Stage 4, Phase 2 the Landfill would reach an overall 3.8 million tons of waste disposal capacity. The solid waste that has been accepted at the Landfill is primarily municipal solid waste, with some construction and demolition debris. The waste disposal fill rate at the Landfill has ranged from approximately 77,000 to 160,000 tons per year.

Figure 1: Landfill plant. From left to right, top to bottom: Picture 1: Synthetic lining and wastewater treatment plant. Picture 2: Landfill gas extraction well. Picture 3: active landfill area. Picture 4: Stage 4 extension

The Landfill was designed and constructed in accordance with stringent environmental standards currently in effect in New Hampshire, and incorporates features such as a double-synthetic lined bottom, a double leachate collection system, and a flexible geo-synthetic liner and earthen cap on closed areas.

2.2 LFG management system

Landfill gas is the natural byproduct of the actions of anaerobic bacteria that cause the organic matter that exists within a landfill to decompose. Undiluted landfill gas typically has a composition of between 40 and 60 percent methane and roughly 45 percent carbon dioxide with lesser amounts of hydrogen, oxygen, nitrogen and minute concentrations of other gases. The emission of landfill gas is a major contributor to the buildup of methane in the atmosphere. The migration of the landfill gas underground can also cause groundwater contamination or has the potential to build up in a closed area or a building and become an explosive hazard. The removal of the landfill gas has other benefits, such as odor control.

The Landfill was originally designed and permitted to incorporate passive gas vents in order to allow methane generated in subsurface areas of waste deposition to be emitted to the atmosphere uncontrolled. The purpose of such gas vents was to prevent the methane from building up pressure, thereby avoiding lateral migration of the methane underground and reducing the potential for underground fires or explosions. Passive gas vents continue to be utilized to vent methane to the atmosphere from certain sections of the Landfill . In addition, an active LFG collection system has been voluntarily installed at the Landfill in increments, as the Landfill has expanded and as dictated by the quantity of waste in place. The active collection system consists of 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. Two vacuum blowers pull LFG under pressure from the Landfill through the wells and pipes and through the main header to the Project where the LFG is destroyed by combustion. (See the attached engineering drawings at Appendix VII that show the design of the LFG extraction wells). Over the years, the volume of LFG pulled through the active system has ranged from1,400 to 1,700 standard cubic feet per minute (corrected to 50 percent methane). Actual methane concentrations in the LFG have ranged between 30 to 55 percent.

Appendix VIII, attached, shows the build out of the active collection system over the years. As shown in Appendix VIII, the initial elements of the active collection system were first installed and began operating in 1998. That initial system was comprised of 11 gas extraction points and 1,521 linear feet of screened pipe. As of the end of calendar 2008, the system was comprised of 123 gas extraction points and 16,899 linear feet of screened pipe, 92 percent of which screened piping was installed after January 1, 2000, and 83 percent of which was installed after January 1, 2002.

2.3 Project description

Methane, the major component of the landfill gas, is the principal constituent of natural gas and, therefore, landfill gas is an alternative fuel to natural gas, fuel oil or coal. This waste product can be put to a productive use as fuel for the generation of electrical or heat energy. This particular Project was designed initially to utilize the landfill gas to produce heat energy to evaporate certain wastewaters from the Landfill, including leachate collected via a leachate collection system and condensate removed from the LFG itself.

The Project uses LFG in one enclosed and one open flare that are specially designed for combustion of LFG. Each flare has the capacity to combust up to 52.50 MMBtu per hour or 1,750 scfm of LFG at 50 percent methane. Combustion of the LFG fuel in the enclosed flare creates heat energy. Combustion temperatures in the enclosed flare are controlled and maintained at approximately 1700 to 1800 degrees Fahrenheit. The enclosed flare recovers energy that, in the Project's first phase, was used to evaporate and destroy leachate and/or condensate at a rate up to 5 gallons per minute that would have otherwise be transported by truck off-site to waste water treatment facilities. As of April, 2007, the Project had evaporated over 10 million gallons of landfill wastewaters. The byproducts of the wastewater evaporation process were non-hazardous solid residues, comprised primarily of minerals, salts and metals, that were permitted to be disposed of in the Landfill.

During the second phase of Project operations, when wastewater has not being delivered to the enclosed flare, the Project has been operated continuously to remove condensate from the LFG prior to its combustion, and then to combust the LFG in the enclosed flare and open flare, destroying the methane, volatile organic compounds, and other combustible constituents in the gas. Two centrifugal blowers extract LFG from the Landfill and deliver it to the flares. Each blower is driven by a 40 HP motor controlled by a variable frequency drive.

The enclosed flare measures eight feet in diameter and 40 feet high. The open flare measures 10 inches in diameter and 30 feet high. The open flare serves as a back-up, operating to combust LFG only when the enclosed flare is unavailable for any reason or excess combustion capacity is required for any reason. Operations are continuously monitored and controlled through a Programmable Logic Controller.

Figure 2: Operating flares at the Landfill

2.4 Starting date of the Project activity

As set forth in greater detail in Section 2.2, above, the initial components of the active landfill gas collection system were installed in 1998, along with the open flare that serves as a back-up. The open flare was replaced with the larger, enclosed flare system in 2000. The equipment that has supported the Project's combined LFG combustion and wastewater treatment capabilities became operational in 2001. Construction of the power production facility is expected to occur late in calendar 2009 or early in 2010.

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2.5 Project boundaries and emission sources

The Project and system boundaries comprise all elements of the flaring and wastewater treatment system. GHG emissions included in the Project boundaries consist of: direct on-site emissions associated with the flaring of landfill gas and with the generation of heat (used for wastewater treatment) from landfill gas. It does not include emissions from activities that may be associated with the Landfill but that occur off of the Landfill site -- e.g.., it does not include incidental emissions from mobile source fuel combustion.

The Project includes the following emission pathways:

- Fugitive methane emissions from the flaring and wastewater treatment system

- Carbon dioxide (CO_2) from flare
- CO_2 from landfill gas combustion in wastewater treatment equipment

The CO_2 emissions from the Project, however, are assumed to be from biogenic-based carbon. As for standard GHG accounting convention, these emissions are therefore assumed not to lead to a net addition of carbon to the atmosphere[1].

2.6 Additionality

The primary test as to whether a landfill gas capture project leads to additional (i.e., surplus) emission reductions relates to the existing federal, state, or local regulatory requirements on the Landfill to capture and/or treat landfill gas. Neither the Landfill owner nor CBE are presently required, pursuant to any applicable law to collect and destroy methane, hazardous air pollutants or any other component of landfill gas from the Landfill. ERT must be informed of any changes to the regulatory status of the facility that may affect the additionality test—i.e., at such time that the Landfill owner or operator is required under any applicable federal or state law or regulation to capture and destroy methane, hazardous air pollutants or any other component of landfill gas, CBE will advise ERT and the buyer of emission reductions in writing. The status of the Landfill relative to existing, potentially applicable federal and state laws and regulations regarding the capture and destruction of LFG is described below.

Federal Law and Regulation.

The principal federal regulations potentially applicable to the management of LFG at landfills in the U.S. are the New Source Performance Standards ("NSPS") and Existing Facility Guidelines ("Guidelines") for Landfills (40 CFR 51, 52 and 60), and the National Emissions Standards for Hazardous Air Pollutants ("NESHAP"): Municipal Solid Waste Landfills (40 CFR Part 61 and 63). The NSPS, the Guidelines, and the NESHAP were each issued pursuant to the federal Clean Air Act. As set forth below, the Landfill is not subject to these or any other federal laws or regulations that would require the installation and operation of a landfill gas collection system.

Under the NSPS rules, landfills that (i) commenced construction after May 30, 1991, (ii) began accepting waste on or after that date, (iii) 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 (iv) are projected at the start of any operating year to emit more than 55 tons (50 Megagrams) of Non-Methane Organic Compounds (NMOCs) without controls during that operating year, 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 NMOCs. As of April, 2009, the approved design capacity for the Landfill is 2.8 millions tons of

[1] It is the convention in project-level greenhouse gas emissions accounting that CO_2 emissions from biogenic-based carbon are not treated as a net source of carbon to the atmosphere. This convention is based on the assumption that the carbon in the materials that are oxidized—in this case waste materials—is replaced by new growth of plant matter after the original biomass is harvested. National level GHG inventories, account for changes in the stocks of carbon stored in terrestrial ecosystems to measure net biogenic-based carbon emissions.

solid waste, slightly above the 2.75 million ton NSPS capacity threshold. However, emissions of NMOCs do not exceed 55 tons and thus the Landfill is not be required to meet the regulatory standard for controls. If and when Stage 4, Phase 2 expansion occurs, CBE would have to demonstrate that actual Landfill capacity and emissions of NMOCs remain below the regulatory thresholds. However, CBE projects that NMOC emissions will be below the 55 ton NSPS threshold, even if the Stage 4, Phase 2 expansion is constructed.

Under the NESHAP at 40 CFR 63, landfills that (i) have accepted waste after November 8, 1987 and are a major source of Hazardous Air Pollutants ("HAPs") or (ii) are co-located with a major source of HAPs, or (iii) are subject to the requirement of NSPS, are required to implement equivalent collection and controls as would otherwise be applicable under the NSPS or the Guidelines. For purposes of the NESHAP, '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 Landfill because the Landfill (a) is not classified as a 'major source of HAPs' and (b) is not otherwise subject to the requirements of the NSPS.

The Landfill is not subject to the Existing Facility Guidelines due to the date of its initial construction.

State Law and Regulation.

The state of New Hampshire regulates landfills through the New Hampshire Code of Administrative Rules, Chapter Env-Sw 800: Landfill Requirements. The Rules are largely an adaptation of the Code of Federal Regulations at 40 CFR 258, implementing certain provisions of the federal Resource Conservation and Recovery Act and the Clean Water Act. Requirements for LFG management in the Rules are addressed at Part Env-Sw 806 (formerly Part Env WM 2506): Operating Requirements. The Rules require that LFG concentrations at a landfill be monitored to determine whether the gas poses a hazard to health, safety or property. If the monitoring program determines that hazardous conditions exist, the Rule requires that the LFG be controlled. However, there is no specific requirement for installing and operating an active LFG collection and flaring system as the means of control, and numerous approaches to control, other than gas destruction, may be considered.

Prior to the implementation of the Project, the Landfill owner routinely implemented measures for control of LFG that did not involve collection and destruction of landfill methane, such as passive venting and area spraying of a deodorizing agent. However, the existence of the Project has allowed the Landfill owner to rely on the Project's landfill gas collection and destruction system, rather than passive venting and area spraying, to prevent conditions that would cause hazards to health, safety and property going forward. Accordingly, as the Landfill has expanded, the Landfill owner has sought and received successive regulatory approvals for expansion of the existing, voluntarily installed LFG collection system as the appropriate means of control. In the absence of the Project, however, the Landfill owner might have continued to rely on the previous methods of control, which satisfy all legal requirements.

Note that state permits have been and will continue to be required to construct and operate the Project, the LFG management system and any expansions or modifications thereto. However, the requirement to obtain permits from the state for the Project and the LFG management system does not mean that those particular activities are mandated by state regulation. Rather, the implementation of any material modification to a landfill, whether required or not by regulation, requires state approval prior to installation and operation.

2.7 Leakage

There are no significant sources of leakage (i.e., indirect increases in greenhouse gas emissions outside of the Project's boundaries).

The Project causes two main changes in GHG emissions outside its boundaries. Both such changes are associated with the on-site treatment of the Landfill's wastewater:

- ⇒ The Project enables the reduction of the truck trips, and associated GHG emissions, previously needed to transport wastewater from the Landfill to waste treatment plants (located about 100 miles from the Landfill). Thus the Project results in GHG emission reductions outside its boundaries ('positive externality/leakage').
- ⇒ By changing the specific treatment technique used for the Landfill's wastewater (on-site evaporation vs. off-site treatment) the Project results in a change in GHG emissions from the off-site water treatment plant.

These changes, however, are estimated to be immaterial.

2.8 Baseline determination

Traditionally a project baseline takes into account historic trends, technology developments, regulatory requirements, and investments/divestures/other structural adjustments in operational control of entity. In the case of this Landfill, the applicable baseline scenario is the continued uncontrolled release of landfill gas to the atmosphere, as this site does not fall under any regulatory requirements to control the methane gas.

Consistently with the Project boundaries (see section 2.5) the Project baseline does not include the GHG emissions generated by:

- ⇒ the trucks used to transport landfill wastewater to waste water treatment plants
- ⇒ the GHG emissions deriving from the treatment activities in the waste water treatment plants

2.9 Ownership

CRMC Bethlehem LLC owns the rights over the landfill gas generated in the Landfill and has contractually transferred all rights to emission reductions from the Landfill to CommonWealth Bethlehem Energy LLC. The relevant contractual language is reproduced below.

> "12.16 Emission Credits. For the term of this Agreement, Buyers and its affiliates, successors and assigns shall be entitled, *vis-à-vis* Seller and its affiliates, successors and assigns to claim the value of any emissions credits or values (including but not limited to environmental credits, "green tags" or similar credits; but excluding Section 29 Credits) which arise or are allocable to the generation, collection, production, sale, destruction or use in any process, by any person, of Landfill Gas from the Landfill. " Landfill Gas Sale and Purchase Agreement dated as of September 8, 2000 by and between CRMC Bethlehem LLC (Seller) and CommonWealth Bethlehem Energy LLC (Buyer), Section 12.16.

Environmental Resources Trust, Inc. recognizes that emission reductions may be achieved offsite related to the displacement of fossil fuel generation as a result of a reduced need for transportation of the landfill wastewaters to a wastewater treatment plant. However, ownership rights to these reductions cannot be assigned a priori to either CBE or others at this time.

In the future, if renewable energy facilities were added to the Project, tradable Renewable Energy Certificates can be generated from this site and a marginal generation analysis can be developed to quantify any emissions that may be reduced (i.e., "backed down") as a result of on-site generation.

3 Calculation Methodology

For landfill methane gas capture projects such as this one, it is essential to accurately and transparently measure the methane combusted in flares and generators (i.e. the emission reduction attributable to the Project).

The emissions not released to the atmosphere can be directly monitored. It is assumed that every ton of methane collected and destroyed equals one ton of methane not released to the atmosphere and thus one ton of methane emissions reduced.

This Project reduces emissions of methane through the following combustion reaction:

$$CH_4 + O_2 \Rightarrow CO_2 + 2\ H_2O$$

The combustion reaction, which occurs under controlled conditions in the flare, involves the combination of methane (CH_4) with oxygen (O_2) to create carbon dioxide (CO_2) and water (H_2O). That is, the result of the combustion is to destroy the methane while creating carbon dioxide and water vapor. Emission tests to document the percent of the methane destroyed by landfill gas flares combusting landfill gas are rarely performed, although the limited testing show

destruction near 100 percent. EPA typically uses a 98 percent efficiency factor for flares unless evidence for a higher rate is supplied, arguing that "Since flares do not lend themselves to conventional emission testing techniques, only a few attempts have been made to characterize flare emissions. Recent EPA tests using propylene as flare gas indicated that efficiencies of 98 percent can be achieved when burning an off gas with at least 11,200 kJ/m3 (300 Btu/ft3)"[2]

Methane is a far more potent contributor to the greenhouse effect than carbon dioxide – 23 times more potent in accordance with the most recent publication of the United Nations Intergovernmental Panel on Climate Change (IPCC[3]). Thus, the Project provides a substantial net reduction in greenhouse gas emissions through destruction of methane even after accounting for the tons of CO2 released during the combustion process.

Methane that is emitted to the atmosphere uncontrolled despite the Project (that is, methane that is emitted directly from the Landfill without being destroyed in the combustion device) would also be emitted to the atmosphere uncontrolled if there were no project. Such quantities of methane are not considered in the quantification of emission reductions associated with the Project.

In accordance with the above, the reduction of greenhouse gases associated with the Project, in tons of carbon equivalents, is calculated in three steps as follows:

1. Determine the volume of methane in cubic feet destroyed by the flare.
2. Convert the volume of methane in cubic feet to the mass of methane in metric tons.
3. Calculate the global warming potential on a gross basis of the destroyed mass of methane as measured in metric tons of carbon-dioxide-equivalents.

The volume of methane in cubic feet delivered to the flare over a given time interval is determined in accordance with the following formula:

Volume of methane delivered to flare (cubic feet)	=	TRend – TRstart	x	(MCend – MC start)/2

Where:

TRend = Totalizer Reading at the end of the time interval (standard cubic feet)
TRstart = Totalizer Reading at the start of the time interval (standard cubic feet)
MCend = Methane content by volume at the end of the time interval (percent)

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[2] See http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s05.pdf

[3] Houghton, J.T., Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden and D. Xiaosu. Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. United Nations IPCC. Table 3, Global Warming Potential, entry under methane and 100 yrs. See www.grida.no/climate/ipcc_tar/wg1/020.htm#c6 or www.eia.doe.gov/oiaf/1605/gwp.html

MCstart = Methane content by volume at the start of the time interval (percent)

For the quantification of the methane volume destroyed by the Project the calculation above will take place on a weekly basis.

The quantity of methane is converted from volume in cubic feet to mass in metric tons as follows:

Mass of methane destroyed (metric tons)	=	Volume of methane delivered to flare (standard cubic feet)	x	Flare efficienc y fraction of methane oxidized (%)	x	16 pounds per pound-mole (the molar weight of methane)	/	2205 pounds per metric ton	/	385 standard cubic feet per pound-mole (gas constant)

This conversion uses the ideal gas relationship: n = PV/RT where,

n = Mass of methane destroyed in metric tons
P = Pressure in atmospheres (assumed to be 1 atmosphere)
V = Volume of methane destroyed in standard cubic feet
RT = Gas constant at standard conditions (385 standard cubic feet per pound-mole)

The gas constant is converted to metric tons by multiplying the entire formula by the molar weight of methane (16 pounds per pound-mole) and dividing by a conversion factor of 2205 pounds per metric ton.

The default factor utilized for flare efficiency is 98 percent.

The gross global warming potential of the methane is calculated as follows:

Gross global warming potential of methane (metric tons of CO2-equivalents)	=	Mass of methane destroyed (metric tons)	x	21 (market-standard global warming potential potency factor in metric tons of CO2-equivalents per metric ton of methane[4])

[4] The standard global warming potential value (GWP) predominant in the marketplace (21) differs from the value of the IPCC's third assessment report (23). Methane's GWP value has been revised by the IPCC over the years. The predominant GWP value used in the market place is based on IPCC's second assessment report and is consistent with the accounting standard used for the national GHG inventories that fulfill the obligations deriving from the United Nations Framework Convention on Climate Change

4 Monitoring and data collection

Critical for the accuracy and transparency of the calculation is that:

1. Measurements of LFG flows are undertaken with reliable equipment that is regularly calibrated;
2. Sampling of Methane concentration in LFG is undertaken with reliable equipment that is regularly calibrated;
3. Sampling of Methane concentration in LFG takes place with a frequency that is sufficient to calculate average concentration factors that are statistically unbiased (i.e. they reflect the actual methane concentration of the LFG);
4. Measurements of LFG flows are undertaken at least on a monthly basis and are as frequent as necessary to apply statistically valid methane concentration factors (as described above);
5. Measurement and calibration equipment and processes and changes thereof are clearly described as part of the GHG emissions reporting process.

Unless otherwise specified through the GHG emissions reporting process, for the CBE Project in the North County the following system is assumed to be in place.

4.1 Data measurements

Implementation of the calculation methodology described in Section 3 above requires measurement of the following two quantities:

- Volume of landfill gas collected from the Landfill.
- Methane content of the landfill gas

The volumes of landfill gas collected from the Landfill, in standard cubic feet, are measured continuously on a real-time basis with an accumulating volumetric flow meter. The flow meter is located directly upstream of the flare. The specific device used to take readings is one of two Thermo Instruments Model 62-9 flow meters capable of measuring flows from 0 to 2,000 standard cubic feet per minute. One flow meter serves as the primary unit for flow meter measurements, and one flow meter serves as a back-up unit. Each flow meter is equipped with a totalizer that indicates the cumulative standard cubic feet of gas that have passed through that flow meter. Total flow over a given interval of time is determined by subtracting the totalizer reading at the end of the interval from the totalizer reading at the start of the interval. The operator of the Project reads the totalizer on approximately a weekly basis, and records the date and time of each reading. In addition, the data from the primary unit for flow meter measurements is recorded continuously on a circular chart recorder. Each chart has a week of data and is maintained in CBE records.

Figure 3: LFG flow metering: totalizer and circular chart recorder

The methane content of the landfill gas, on a percent volume basis, is measured at sampling ports in the main header pipe near the flow meter with the use of a GEM-500 hand-held meter or equivalent. The methane content is measured at approximately the same time as readings are taken on the flow meter totalizer. The average methane content over the interval is then calculated as the average of the reading taken at the start of the interval and the reading taken at the end of the interval.

The operator typically balances the landfill gas collection wellfield on a weekly basis on the same day that the totalizer reading is taken and the methane content is measured. To account for the impact of balancing the wellfield on the methane content of the landfill gas, the operator typically takes two separate readings of methane content on such days: one before the wellfield is balanced, and one after the wellfield is balanced. The operator also measures and records the carbon dioxide content, oxygen content, and balance gas content at the same time as methane content is being recorded. In addition, in the course of balancing the wellfield, the operator records the methane content, carbon dioxide content, oxygen content, and balance gas content at each individual well or other extraction point in the landfill gas collection system. The results of a recent component analysis of the landfill gas at the landfill flare is provided below:

Component	Units	Value
Methane	Percent by volume	52.8%
Carbon dioxide	Percent by volume	39.9%
Oxygen	Percent by volume	0.4%
Balance gas	Percent by volume	6.9%

Recorded by Sean P. Moran, operator, NCES, May 1, 2009, 10:20 AM
Totalizer reading 620,096,800

Records of all data discussed in this section are recorded in a well monitoring report by the operator, North Country Environmental Services, Inc. (NCES), and provided to CBE. These reports are then entered into a summary spreadsheet that is used for the calculations described previously. All reports and calculations are archived to facilitate verification.

4.2 Instrument calibration

The flow instruments and the GEM-500 handheld meter are calibrated periodically to ensure accurate measurements.

The flow instruments are calibrated at the facility during normal operations at least once during each calendar year and more frequently as necessary. The calibration is performed by measuring the flow at a point in close proximity to the Thermo Instruments Model 62-9 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.

Note that the pitot tube is the standard device used to calibrate all other gas velocity measuring devices. CBE uses a pitot tube Model 160-18,5/16-inch, which is manufactured to AMCA and ASHRAE standards by Dwyer Instruments, Inc.

The pitot tube consists of an impact tube that receives total pressure input from the gas stream. The impact tube is fastened concentrically inside a second tube of slightly larger diameter. The second tube receives static pressure input from radial sensing holes around the tip. The air space between inner and outer tubes permits transfer of pressure from the sensing holes to the static pressure connection at the opposite end of the pitot and then, through connecting tubing, to the low or negative pressure side of a manometer. When the total pressure tube is connected to the high-pressure side of the manometer, velocity pressure is indicated directly. See the figure below. To insure accurate velocity pressure readings, the pitot tube tip is pointed directly into and parallel with a laminar portion of the gas stream.

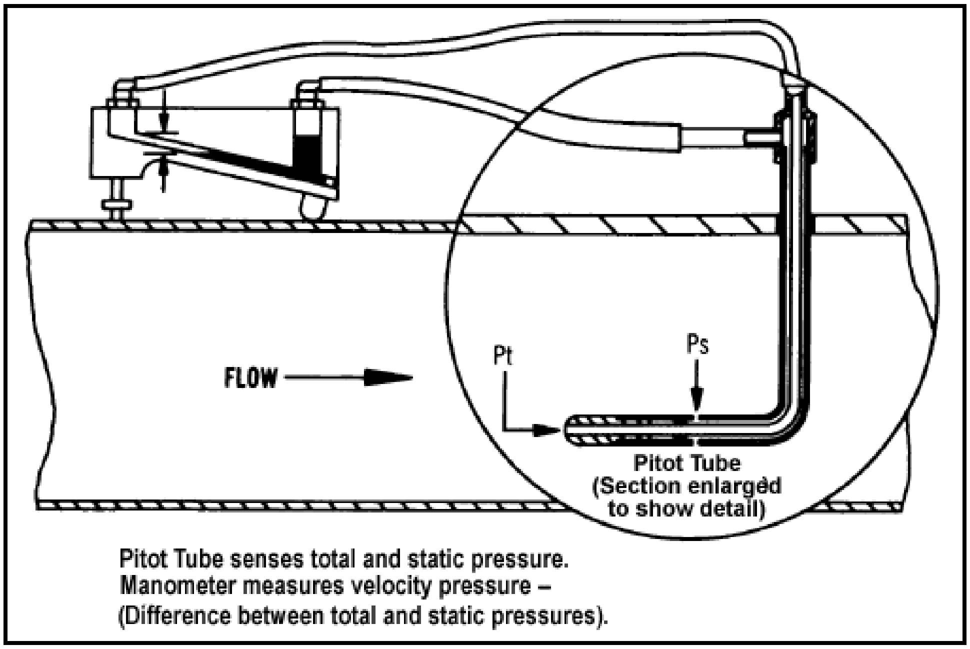


Figure 4: Pitot Tube

The measured data is used to calculate scfm as shown in Appendix VI the flow meter calibration records. The meter is manually adjusted to correspond to the calculated scfm. Typically, the primary meter has been found to be accurate to +/- five percent, and therefore only minor calibrations have been made.

The methane concentration measured by the GEM-500 is calibrated prior to each use. The instrument is calibrated using fifty-percent methane content gas from a standard gas cylinder and zero methane content from ambient air. The GEM-500 is sent to Landtec, the manufacturer of the instrument, twice per year or as necessary to perform routine inspections on the measuring device to ensure that the measurement devices are functioning properly and to perform a factory calibration. See Appendix VI for samples of the calibrations.

4.3 Quality control (QC) at the CBE Project in North Country

The following quality control procedures will be followed:

- The recording and archiving of daily gas flow and methane concentration monitoring records
- The maintenance of a daily log book for flare and treatment plant operating conditions
- The regular calibration of measurement equipment, as specified above and in Appendix I
- The implementation of corrective actions when problems are identified and the reporting of those problems to ERT when they occur
- The establishment of routine reminders for site technicians to perform calibration and other QC procedures

This MRV Guideline will be available for review and comment. The feedback and comments

received will be considered in future revisions.

5 Uncertainties

There are a number of uncertainties related to estimates of methane emission reductions from landfill gas capture projects. Some of these uncertainties are more easily quantified than others. Sources and magnitude of uncertainties (and changes thereof) should be explicitly addressed and discussed as part of the GHG emissions calculation and reporting process.

Unless otherwise specified during the GHG emissions reporting process, the Project uncertainties are as described below.

5.1 Uncertainties for the CBE North Country LFG Utilization Project.

The accuracy and precision of measurement equipment, such as the flow meter and gas analyzer, is easily quantified and considered to be quite low. The extrapolation of gas composition measurements to the total flow of landfill gas can introduce significant errors, depending upon the variability of the methane content of the landfill gas and the frequency of samples taken. The actual methane content of pure landfill gas does not vary significantly each week as shown by the weekly measurements.

The variation in the flare efficiency due to environmental influences or operating practices may also contribute to the overall uncertainty. Operating malfunctions of the flares are recorded, if and when they occur, though, the contribution of this variation to the overall uncertainty is not expected to be large. During normal operations the flares are expected to destroy all or nearly all the methane gas contained within the LFG. During normal operations of the enclosed flare, the combustion temperature and residence time are sufficient to completely destroy all methane gas contained within the LFG (e.g. 99+ percent).

The methodology proposed in this MRV guideline does not address combustion byproducts from wastewater treatment. Small amounts of unburned methane may be included in the hydrocarbon emissions from the wastewater treatment equipment. Unburned methane from the flare is assumed to be approximated by the flare efficiency factor. However, some methane slippage or leakage during collection and flare operations may not be accurately approximated by the flare efficiency.

An additional source of uncertainty relates to the assumed baseline for this landfill gas capture project. In the absence of a landfill gas collection system, a fraction of the methane would have oxidized as it percolated through the Landfill strata, thereby lowering the implicit baseline emissions for the Project and also the estimated emission reductions. The U.N. Framework Convention on Climate Change (UNFCCC) CDM Executive Board requested at its 12th meeting (November 2003) that the UNFCCC Secretariat prepare a technical paper on the impact of oxidation of biogas in the calculation of methane emission reductions for landfill gas projects.

This MRV Guideline may require revision if and when a scientifically valid methodology for correcting baseline emission calculation for landfill gas capture projects is available from the UNFCCC.

6 Reporting and Documentation

All records and logs should be maintained such that they can be audited by an independent third party verifier.

An annual emissions reduction report should be submitted to ERT with data as specified in this MRV guideline.

CBE will utilize an excel worksheet to provide emissions calculation data and results to ERT, utilizing the template worksheet called "CBE calculations <date>.xls", jointly developed by ERT and CBE and based on the methodology described in section 3 above. The figures below are extracts from the template and illustrate the inputs formats and calculation steps performed

Begin period - date	End period - date	Totalizer reading end period	Totalizer reading start period	Methane content end period	Methane content start period	Methane delivered to flare	Methane delivered cumulative
mm/dd/yy	*mm/dd/yy*	*scf*	*scf*	*%*	*%*	*scf*	*scf*
22-Dec-04	3-Jan-05	113,716,100	86,972,050	36.0%	36.0%	9,627,858	9,627,858
3-Jan-05	11-Jan-05	132,897,900	113,716,100	34.2%	34.2%	6,560,176	16,188,034
11-Jan-05	29-Jan-05	171,086,000	132,897,900	38.3%	34.3%	13,862,280	30,050,314
29-Jan-05	3-Feb-05	182,693,650	171,086,000	38.1%	38.7%	4,457,338	34,507,652
3-Feb-05	12-Feb-05	202,853,300	182,693,650	43.2%	38.1%	8,194,898	42,702,549

Figure 5: Emissions calculations worksheet – extract 1 LFG totalizer inputs, methane content inputs and calculations of methane delivered

Flare efficiency	Molar weight methane	Pounds to metric tons conversion	Gas constant	Mass methane destroyed in the period	Mass methane destroyed cumulative	Global warming potential methane	Emission reduction	Emission reduction cumulative
%	*Pounds per mole*	*Pounds per ton*	*scf per pound mole*	*metric tons*	*metric tons*	*tons CO2 equivalent per ton methane*	*CO2 equivalent tons*	*CO2 equivalent tons*
98%	16	2,205	385	178	178	21	3,734	3,734
98%	16	2,205	385	121	299	21	2,545	6,279
98%	16	2,205	385	256	555	21	5,377	11,656
98%	16	2,205	385	82	637	21	1,729	13,385
98%	16	2,205	385	151	789	21	3,179	16,563

Figure 6: Emissions calculations worksheet extract 2 – input parameters for calculation and calculations of methane destroyed and resulting GHG emission reductions

7 Attestation statement

The attestation statement in Appendix II must be signed by management of CBE and submitted annually to ERT, along with the Project report, by March 31 following each year of the Project's lifetime, or upon submittal of periodic emission reduction documentation for verification and

registration.

8 Verification and registration

ERT will conduct a site visit to the Landfill to verify the operating conditions of this Project. The reductions will be verified by ERT and registered in CBE/CRMC's account in ERT's GHG Registry.

ERT will annually verify and apply audit-sampling methods. Once verified following the provision of the annual emissions reduction report and complete supporting documentation, ERT will register emission reductions in the account of CBE/CRMC for the preceding year's vintage of emission reductions. A Project Verification Statement will be produced for each registration of emission reductions cycle.

9 References

Helping Landfill Owners Achieve Effective, Low-Cost Compliance with Federal Landfill Gas Regulations, U.S. Environmental Protection Agency**,** Landfill Methane Outreach Program, Washington, DC, prepared by SCS Engineers under EPA Contract No. 68-W6-0004, <http://www.epa.gov/lmop/pdf/booklet8.pdf>

10 Appendices

Appendix I: Factors, Variables, and QC procedures summary
Appendix II: Existing Conditions Plan of Landfill Site
Appendix III: Attestation statement
Appendix IV: Results from methane component analysis
Appendix V: Copy of flow meter calibration records
Appendix VI: Copy of GEM calibration records
Appendix VII: LFG Extraction Well Design
Appendix VIII: Buildout of Landfill and LFG Management System

Appendix I: Factors, Variables, and QC procedures summary

Factor Used for Converting Methane to Carbon Dioxide Equivalents

Global Warming Potential	Reference
21	See www.grida.no/climate/ipcc_tar/wg1/020.htm#c6 or www.eia.doe.gov/oiaf/1605/gwp.html*Climate Change 1995: The Science of Climate Change*, IPCC (1996)

Conversion Factors

Description	Factor	Units	Description
Methane energy content	50.0 39.6 1012 911	GJ/Mg MJ/m^3 BTU/scf BTU/scf	Net calorific value per unit mass Net calorific value per unit volume (STP) Gross heat content (higher heating value) Net heat content (lower heating value)
Methane density	677	g/m^3 (288°K)	Density should be corrected for local climate and altitude

Data to be collected or used to monitor emissions from the Project activity, and how this data will be archived

Variable	Description	Data unit	Measured, calculated or estimated	Recording Frequency	Proportion of data to be monitored	How are data archived?	Comments
LFG	Amount of landfill gas to flares	$Feet^3$	Measured	Continuous	100%	Electronic	Measured by a flow meter. Data will be aggregated weekly and yearly.
FE	Flare efficiency	%	Estimated		NA		Default factor = 98%, Based on scientific and technical literature.
F_{CH4}	Methane fraction in landfill gas	%	Measured & calculated	Weekly	100%	Electronic	Measured by gas quality analyzer.

Quality control (QC) procedures are needed for the monitoring equipment and the data collected

Data	**Uncertainty (High/Medium/Low)**	**Explanation**
LFG	Low	Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy.
FE	Low	Regular maintenance will ensure optimal operation of flares.
F_{CH4}	Low	The gas analyzer will be subject to a regular maintenance and testing regime to ensure accuracy.

Appendix II: Existing Conditions Plan of Landfill Site
[follows]

NOTES:

1. THE BASE MAP WAS PRODUCED USING AN ELECTRONIC FILE PROVIDED TO SHA NAMED "5431GXL.DWG" CREATED BY EASTERN TOPOGRAPHICS OF WOLFBORO, NEW HAMPSHIRE FOR NORTH COUNTRY ENVIRONMENTAL SERVICES, INC. MAP WAS CREATED FROM AERIAL PHOTOGRAPHY EXPOSED ON NOVEMBER 21, 2006 AND COMPILED ON DECEMBER 8, 2006 USING DIGITAL TERRAIN MODELING METHODS WITH KLT ATLAS SOFTWARE. ORIGINAL SCALE 1" = 40'. HORIZONTAL DATUM IS BASED ON NAD 83 (1996) SPC NH (FEET). VERTICAL DATUM IS BASED ON NAVD 88 (FEET).
2. THE UPDATED FEBRUARY 2007 TOPOGRAPHY SHOWN WITHIN UNCAPPED PORTIONS OF STAGES I, II, III AND IV WAS COMPILED USING THE FOLLOWING:
   A. GROUND SURVEY CONDUCTED ON FEBRUARY 2, 2006 BY ALPINE SURVEYING, INC. OF LITTLETON, NEW HAMPSHIRE.
   B. STAGE IV PHASE I TOP OF PRIMARY SAND GRADES FROM PLANS TITLED "STAGE IV PHASE I RECORD DRAWINGS" PREPARED FOR NCES BY SHA, DATED FEBRUARY 2007.
3. SURVEY CONTROL POINTS WERE PROVIDED BY ALPINE LAND SURVEYING COMPANY OF LITTLETON, NEW HAMPSHIRE. PUBLISHED CONTROL MONUMENT INFORMATION SHOULD BE VERIFIED BY USER PRIOR TO USE. THE CONTROL MONUMENTS CAN POTENTIALLY BE DISTURBED BY NATURAL AND/OR MAN-MADE CAUSES. IT IS THE RESPONSIBILITY OF THE USER TO VERIFY THE POSITION OF ANY CONTROL MONUMENTS UTILIZED.
4. AS-BUILT LOCATIONS OF EXISTING STAGE I LIMIT OF WASTE CONTAINMENT AND CULVERT INVERT ELEVATIONS ALONG THE SOUTHERN PERIMETER OF STAGE I PROVIDED BY CASELLA CONSTRUCTION, INC. EXISTING CULVERT INVERTS ALONG THE EAST PERIMETER OF STAGE III PROVIDED BY PARAGON CONSTRUCTION, INC. OF ORFORD, NEW HAMPSHIRE.
5. AS-BUILT LOCATIONS OF EXISTING STAGE IV PHASE I LIMIT OF WASTE CONTAINMENT AND CULVERT INVERT ELEVATIONS ALONG THE PERIMETER OF STAGE IV PHASE I PROVIDED BY CASELLA CONSTRUCTION, INC.
6. THE PROPERTY LINES SHOWN WERE TAKEN FROM SHEETS 1 THROUGH 3 OF PLANS ENTITLED "BOUNDARY SURVEY PLAN FOR CASELLA WASTE SYSTEMS, INC. ON THE LANDS OF NORTH COUNTRY ENVIRONMENTAL SERVICES" PREPARED BY ALPINE LAND SURVEYING COMPANY (ALPINE) OF LITTLETON, NEW HAMPSHIRE, DATED FEBRUARY OF 2002. PLANS WERE PROVIDED ELECTRONICALLY TO SHA BY ALPINE ON MARCH 1, 2002 IN DRAFT FORMAT AND AT AN ORIGINAL SCALE OF 1" = 100'.

LEGEND:

I.R.F.	IRON ROD FOUND
	PROPERTY LINE
	TREE LINE
B-911	EXISTING MONITORING WELL
B-915	EXPLORATION WITH OBSERVATION WELL
GP-6	EXISTING GAS PROBE
1390	EXISTING 10-FOOT CONTOUR
	EXISTING 2-FOOT CONTOUR
	LIMIT OF WASTE CONTAINMENT/STAGE LIMIT
	PHASE LIMIT LINE
	LIMIT OF CAP
S	EXISTING SECONDARY LEACHATE COLLECTION SYSTEM MANHOLE
P	EXISTING PRIMARY LEACHATE COLLECTION SYSTEM RISER
	EXISTING SECONDARY 10,000-GALLON UST
	EXISTING PRIMARY 15,000-GALLON UST
	EXISTING LOADOUT TANK
	EXISTING 20,000-GALLON UST FOR STAGE II OR 30,000-GALLON UST FOR STAGE III
	EXISTING GABION-LINED SWALE
	EXISTING RIPRAP
	EXISTING BOULDER
	EXISTING FENCE
	EXISTING GUARDRAIL
	EDGE OF WATER
	EDGE OF WETLAND
	EDGE OF ROAD
	EXISTING UTILITY POLE
LDMH-1	LEAK DETECTION MANHOLE
OU	EXISTING OVERHEAD UTILITY LINE
FM	EXISTING FORCE MAIN
	MSE BERM
GW-6	EXISTING GAS WELL
HCT-81	EXISTING GAS WELLHEAD
GV-11	EXISTING GAS VENT
CT-9	EXISTING GAS TRAP
	EXISTING GAS VALVE

SURVEY CONTROL MONUMENTS				
ESTABLISHED BY A.L.S.C. 27 JUNE 2005				
CONTROL POINT	NORTHING	EASTING	ELEV.	DESC.
101	641072.3040	994719.5350	1385.53	ALUM. MON.
102	641095.7335	995184.0514	1395.60	ALUM. MON.
103	641475.5156	995158.0296	1395.82	ALUM. MON.
105	642006.8517	994117.7363	1334.06	ALUM. MON.
106	641848.2678	993619.0518	1332.41	ALUM. MON.
107	641135.3937	993620.1393	1355.07	ALUM. MON.
536	642639.57	995066.64	1349.61	CON. BOUND

NO.	DATE	DESCRIPTION	BY
2	7/18/07	REMOVED CONTROL POINT 104. CORRECTED CONTROL NUMBER.	CJC

GRAPHICAL SCALE 100' 50' 0' 100' 200'

SHA ENGINEERS ■ SCIENTISTS

DRAWN BY: KELM/DJD
DESIGNED BY: KELM
CHECKED BY: JAC
REVIEWED BY: RSS
PROJECT MGR: JAC
PIC: JAC
DATE: APR 07

STATE OF NEW HAMPSHIRE — ERIC SCOTT STEINHAUSER No. 11494 LICENSED PROFESSIONAL

2007 LANDFILL GAS IMPROVEMENTS
NORTH COUNTRY ENVIRONMENTAL SERVICES, INC.
BETHLEHEM, NEW HAMPSHIRE

EXISTING CONDITIONS PLAN

PROJECT NUMBER: 2764.00

SHEET NUMBER: 1 OF 16

FILE: Q:\CONCORD\2764.00\dwg\LFG-Design\2764-00-d01-d02.dwg
LAYOUT: Sheet 1
CTB FILE: SHA STANDARD.CTB
PLOT DATE: 7-20-07

Appendix III: Attestation Statement

As an officer of CommonWealth Bethlehem Energy LLC (CBE) I hereby certify that the emissions reductions reported in connection with methane capture and combustion have been calculated according to the methods and procedures as outlined and described in this MRV Guideline and are a true representation of the emission performance of the Project.

____

Verification Statement Reference Number

____

Name

____

Title

____

Signature Date

Appendix IV: Results from methane component analysis

Site. NCES
Date 3/21/2005 Totalizer 29825655 x 10 scf @ 0850
Temp 25 Deg F
Barometric Pressure 29.95 inHg Weather Sunny, Calm

Flare temp. 1565 deg F Positive pressure. 6 in H2O W/ C.A.B.

Well Number	CH4	CO2	O2	Bal.	Pres	SCFM	Adjusted SCFM	Gas Temp.	Valve position
Flare/ Raw	35.7	29.3	4.3	30.7	-48.0	2000		115	
Flare/ Diluted	Dillution Blower not operating								
GW-1	61.7	38.2	0.0	0.0	-10.9	3	3	66	
GW-2	Not Accessbile								Full Open
GW-3	60.5	39.5	0.0	0.0	-12.1	3	N/C	68	
GW-3A	62.0	38.0	0.0	0.0	-10.6	2	N/C	75	Full Open
GW-4	61.1	38.9	0.0	0.0	-11.0	0	1	58	Full Open
GW-4A	62.0	38.0	0.0	0.0	-11.5	5	N/C	63	Full Open
GW-5	60.5	39.5	0.0	0.0	-11.0	15	18	74	Full Open
GW-6	60.2	39.3	0.0	0.2	-5.7	>>>>	N/C	85	Increased to Full Open
GW-7	57.7	36.7	0.5	5.0	-12.1	26	N/C	70	Full Open
GW-8	60.8	38.8	0.3	0.0	-15.8	16	N/C	79	Full Open
GW-9	61.1	38.9	0.0	0.0	-18.8	1	N/C	57	Full Open
GW-10	58.9	40.7	0.0	0.1	-10.4	60	62	97	Full Open
GW-11	Not Accessbile								Increased to Full Open
GW-12A	47.6	40.2	0.0	12.2	-4.6	77	N/C	85	
GW-13	59.0	41.0	0.0	0.0	-17.4	>>>>	>>>>	85	Full Open
GW-14	50.0	34.7	3.5	12.1	-8.5	20	22	66	Increased to Full Open
GW-15	Not accessbile due to construction								Increased 0.10 Turn to 1.35 Turns Open
GW-16A	Not Accessbile								Full Open
GW-17A	37.6	34.4	0.0	28.1	-4.0	>>>>	>>>>	114	
GW-18	60.4	39.6	0.0	0.0	-19.6	54	N/C	80	Decreased 0.10 Turns
GW-19	47.2	36.9	0.0	15.8	-5.9	45	41	124	Full Open
GW-20	58.5	41.5	0.0	0.0	-16.3	19	N/C	88	Decreased 0.25 Turn
GW-21	37.9	28.4	4.8	28.9	-6.9	25	N/C	93	Full Open
GW-22	32.1	26.7	4.4	36.8	-1.3	24	N/C	109	Increased 0.10 Turn to 1.2 Turns Open
GW-23	48.8	37.0	0.2	13.7	-4.0	30	32	82	Increased 0.25 Turn to 0.75 Turn Open
GW-24	53.7	40.5	0.0	5.5	-1.3	21	21	107	Increased 0.5 Turn to 2.4 Turns Open
GW-25	50.5	39.9	0.0	9.1	-1.0	46	N/C	102	Increased 0.10 Turn to 1.2 Turns Open, N/C in Flow
GW-26	58.8	41.2	0.0	0.0	-2.0	53	49	116	Open 2.75 Turns
GW-27	Not Accessbile								Decreased 0.10 Turns to 2.30 Turns Open
GW-28	34.8	35.4	0.0	29.8	-4.5	>>>>	N/C	78	
GW-29	42.1	34.7	0.0	23.2	-3.5	44	42	118	Open 2.75 Turns
GW-30	52.4	39.6	0.0	7.7	-4.2	81	N/C	103	Decreased 0.10 Turns
GW-31	49.4	38.6	0.0	12.3	-5.6	>>>>	N/C	109	Open 3.25 Turns
HORZ. A	0.0	0.0	20.2	79.8	-19.4	0	N/C	71	Full Open
HORZ. B	60.0	40.0	0.0	0.0	-18.5	1	N/C	68	
HORZ. C	0.2	0.3	19.6	79.9	-18.9	~	~	56	Full Open
S.2 P.2 Ctrap	37.8	30.4	5.4	26.3	-30.1	0	N/C	56	
S.2 S.E.-CO	Not Accessbile								Open 0.25 Turn
S1 SW-C.O.	61.9	38.1	0.0	0.0	4.1	0	0	79	
S.3 SW-Hrz.	Destroyed?								Increased to Full Open
S.3 SO-Hrz.	0.7	12.4	15.9	71.1	-1.5	off	N/C	68	Open 0.6 Turn
S.3 SO.-CO	36.6	27.3	4.6	31.3	-3.0	1	2	60	Off
S.3 S.E.-CO	Destroyed?								Increased 0.10 Turn to 0.20 Turn Open
S.3. C.T. 1	38.9	32.1	2.2	26.6	-1.0	16	N/C	109	Open 0.25 Turn
S.3. C.T. 3	34.7	25.9	6.6	32.8	-11.8	6	N/C	64	Open 1.5 Turns
S.3. C.T.4	5.3	4.8	14.6	75.3	0.0	10	6	60	Open 0.75 Turn
S.3 C.T. 4 Hrz.	10.0	24.7	1.2	64.2	-0.1	10	N/C	70	Decreased 0.10 Turn to 0.25 Turn Open
S.3. C.T.5	12.9	32.7	0.0	54.3	0.0	0	2	63	Open 0.15 Turn
S.3. C.T.6	6.9	18.9	5.3	69.1	0.0	3	N/C	94	Increased 0.10 Turn to 0.85 Turn Open
S.3. C.T.7	17.8	32.3	0.0	49.8	-0.1	11	N/C	55	
S.3. C.T.8	27.9	37.1	0.0	34.8	0.0	6	N/C	73	Open 0.5 Turn
S.3. C.T.9	21.9	31.0	0.0	47.4	-0.1	8	N/C	67	
S.3. C.T. 10	19.7	30.5	0.7	49.2	-0.4	32	31	60	Open 1.0 Turn
S.3 S.R.	0.2	0.3	19.3	80.2	-0.1	~	~	57	Decreased 0.10 Turn to 0.9 Turn Open
MSE-301	46.6	32.9	4.2	15.7	-0.2	1	N/C	66	< 0.10 Turns Open
MSE-302	40.9	29.0	5.7	24.2	-0.3	2	N/C	65	< 0.10 Turns Open
MSE-303	9.3	9.6	13.2	67.9	-0.2	0	2	56	< 0.10 Turns Open
MSE-304	2.9	2.5	16.9	17.7	-0.2	2	N/C	60	Increased 0.10 Turn to 0.20 Turn Open
MSE-305	42.9	30.2	6.7	20.1	-0.2	0	3	54	< 0.10 Turn Open
MSE-306	41.0	29.3	5.9	23.1	-0.4	0	0	54	Increased 0.10 Turn to 0.20 Turn Open
MSE-307	41.2	28.7	5.5	24.1	-0.2	2	4	60	Increased 0.10 Turn to 0.20 Turn Open, N/C in Flow
MSE-308	38.4	26.8	6.4	28.3	-0.2	7	N/C	61	Increased 0.10 Turn to 0.20 Turn Open
MSE-309	Not Accessible								< 0.10 Turns Open
MSE-310	7.8	5.6	16.7	70.1	-0.2	0	N/C	69	
S.3 Hrz. 16A	0.5	0.9	18.9	79.4	-0.2	0	N/C	54	< 0.10 Turns Open
S.3 Hrz. Pmp.	9.6	16.6	6.8	67.0	-0.5	0	2	74	Open 0.1 Turn
P.2/S1 P1 TR	27.8	18.8	10.5	43.8	-11.2	52	47	45	Increased to Full Open
P.3	63.3	36.7	0.0	0.0	-0.2	11	N/C	48	Decreased to 0.25 Turn Open
P.4	13.6	9.9	14.0	62.5	-2.2	0	N/C	61	Open 0.25 Turn
S1 P1 TR	27.4	18.5	10.4	43.2	-1.9	2	N/C	62	Full Open
S2 P1 S.R.	0.3	0.3	19.3	79.9	0.0	2	N/C	56	Full Open
S2 P2 S.R.	2.4	1.8	18.7	77.1	-18.2	0	N/C	62	Open 0.25 Turn
S2 P1 D.L.	0.3	0.3	20.0	79.4	-0.6	4	N/C	64	Open 1.0 Turn
S2 P2 D.L.	5.7	4.0	17.9	72.8	-18.8	0	N/C	66	Open 0.25 Turn
S3 SE Horz	57.3	42.7	0.0	0.0	0.0	5	4	115	Open 0.25 Turn
HCT-82	29.0	25.7	2.8	42.7	0.0	0	4	56	Decreased to 0.10 Turns Open
Flare/ Raw	41.4	32.2	3.2	23.0	-40	1954		108	Open 0.25 Turn
Flare/ Diluted	Dillution Blower not operating								

Comments: New extraction points.

>>>> - Indicates sampling locations where the Landtec GEM-500 gas extraction monitoring device dislplayed the gas flow rate as >>>> The troublshooting guide for the GEM-500 states that this symbol is displayed when there is no valid information to display.

~ - Indicates LandTec Wellhead without flow monitoring ports.

NCES well monitoring reading sheet March 2005

Appendix V: Copy of flow meter calibration records

LFG FLOW CALIBRATION
NCES Landfill, Bethlehem, New Hampshire
Landfill Gas Flow Calculation

											All flow Baker meter
MEASURING INSTRUMENT:		Pitot Tube:	Dwyer 160-18 , 5/16"	Dwyer 160-18 , 5/16"	Dwyer 160-18 , 5/16"	Dwyer 160-18 , 5/16"	Dwyer 160-18 , 5/16"	Dwyer 160-18 , 5/16"	Dwyer 160-18 , 5/16"	Dwyer 160-18 , 5/16"	Dwyer 160-18 , 5/16"
		Manometer:	Dwyer	Dwyer	Dwyer	Dwyer	Dwyer	Dwyer	Dwyer	Dwyer	Dwyer
DATE OF MEASUREMENT:			2-Mar-01	22-May-01	19-Jul-01	2-Aug-01	3-Oct-01	24-Jan-02	23-Apr-03	14-Oct-04	21-Sep-05
TIME OF MEASUREMENT:			10:00 AM	1:00 PM	8:30 AM	8:30 AM	4:00 PM	10:15 AM	10:30 AM	11:20 AM	1:00 PM
PARAMETERS		UNITS									
Pipe dimensions											
	Inside Diameter	inches	**10.000**	**10.000**	**10.000**	**10.000**	**10.000**	**10.000**	**10.000**	**10.000**	**10.000**
	Area of cross section	square feet	0.5454	0.5454	0.5454	0.5454	0.5454	0.5454	0.5454	0.5454	0.5454
Flow Calculation											
Kp	pitot tube constant	ft/sec[(lb/lb-mole)(in. Hg)/(R)(in H20)]^1/2	85.49	85.49	85.49	85.49	85.49	85.49	85.49	85.49	85.49
Cp	Pitot tube coefficient	dimensionless	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
dP	Average velocity pressure of stack gas	in H20	**0.30**	**0.25**	**0.28**	**0.32**	**0.37**	**0.43**	**0.60**	**0.57**	**1.22**
Ts	Stack temperature	Degrees Fahrenheit	**90**	**114**	**110**	**114**	**118**	**106**	**108**	**104**	**140**
		Degrees Rankine	550	574	570	574	578	566	568	564	600
Pg	Stack static pressure	inch H20	**7.0**	**5.2**	**11.0**	**12.0**	**9.0**	**6.0**	**14.2**	**16.0**	**13.5**
		inch Hg	0.51	0.38	0.81	0.88	0.66	0.44	1.04	1.18	0.99
Pbar	Barometric pressure	inch Hg	**29.53**	**30.2**	**30.22**	**30.2**	**30**	**30.19**	**29.74**	**29.73**	**30.01**
Ps	Absolute stack gas pressure	inch Hg	30.04	30.58	31.03	31.08	30.66	30.63	30.78	30.91	31.00
Ms	Molecular weight of stack gas, wet	lb/lb-mole	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	29.30
Vs	Average stack gas velocity	feet per second	37.9	35.0	36.6	39.3	42.7	45.5	53.8	52.1	76.6
Qact	Volumetric Flow	actual cubic feet per minute	1,239	1,145	1,199	1,285	1,396	1,490	1,759	1,705	2,508
Qstd	**Volumetric Flow**	**standard cubic feet per minute ***	**1,194**	**1,077**	**1,152**	**1,228**	**1,307**	**1,423**	**1,683**	**1,649**	**2,287**
Qstd	Volumetric Flow at 50% methane	standard cubic feet per minute **	1,194	1,169	1,184	1,044	1,072	1,156	1,144	1,296	1,464
	Methane Content	%, vol/vol	**50.0%**	**54.3%**	**51.4%**	**42.5%**	**41.0%**	**40.6%**	**34.0%**	**39.3%**	**32.0%**
Meter Reading Pre-calibration		standard cubic feet per minute *	1,250	1,100	1,080	1,220	1,310	1,425	1,700	1,615	1,995
Meter Reading Post-calibration		standard cubic feet per minute *	1,195	1,080	1,150	1,230	1,310	1,425	1,685	1,650	2,287
Difference Post/Pre calibration			95.6%	98.2%	106.5%	100.8%	100.0%	100.0%	99.1%	102.2%	114.6%

* Standard conditions are corrected to 68 degrees F and 29.92 in Hg.
** Standard conditions corrected to 50 % methane content.
Input values are in blue or bold.
Calculated output values are in black or not bold.

Calculation Formulas:
Vs = Kp*Cp*(sqrt dP) * sqrt (Ts/(Ps*Ms))
Qact = Vs * A * 60
Qstd = Qact * Tstd/ Ts * Ps/Pstd

Conversions and constants
13.9 in H2O/in Hg
Tstd = 528 degrees R
Pstd = 29.92 in Hg

NCES Landfill, Bethlehem, NH									
Landfill Gas Flow Measurements									
Field Data									
Measurements by	TY	TY	TY	TY	TY	TY	TY	TY	TY/SM
Date	2-Mar-01	22-May-01	19-Jul-01	2-Aug-01	3-Oct-01	24-Jan-02	23-Apr-03	14-Oct-04	21-Sep-05
Time	10:00 AM	1:00 PM	8:30 AM	8:30 AM	4:00 PM	10:15 AM	10:30 AM	11:20 AM	1:00 PM
Drive # (LFG blower)	2	1	1	1	1	1	1	1	Both
Drive Speed (1 to 10)		9.5	0.8	10	10	0.92	10	10	10 & 10
Drive RPM (VFD readout)									
Pre-Calibration Reading									
Meter Reading (Baker)	1,250	1,100	1,080	1,220	1,310	1,425	1,700	1,615	1995
Post-Calibration Reading									
Meter Reading (Baker)	1,195	1,080	1,150	1,230	1,310	1,425	1,685	1,650	2,287
Ambient Temperature, F	20	70	55	78	56	40	45	51	66
Barometric Pressure, In Hg	29.53	30.2	30.22	30.2	30	30.19	29.74	29.73	30.01
Blower Inlet Temperature, F	60	74	78	78	78	70	85	84	94
Blower Outlet Temperature, F	95	114	110	114	118	106	108	104	140
Blower Inlet Pressure (SP), In H20	-48	-60	-42	-52	-52	-52	-45	-40	-42
Blower Outlet Pressure, In H20	7	5.2	11	12	9	6	14.2	16	13.5
Velocity Pressure (dP)									
Point									1.05
1	0.29	0.23	0.28	0.29	0.38	0.41	0.59	0.58	1.05
2	0.30	0.23	0.28	0.30	0.36	0.41	0.58	0.58	1.1
3	0.30	0.24	0.28	0.31	0.36	0.42	0.58	0.58	1.2
4	0.30	0.25	0.28	0.32	0.35	0.43	0.60	0.58	1.25
5	0.30	0.26	0.29	0.33	0.35	0.43	0.60	0.57	1.3
6	0.31	0.25	0.30	0.33	0.36	0.44	0.62	0.56	1.35
7	0.30	0.25	0.29	0.32	0.38	0.43	0.62	0.55	1.35
8	0.30	0.25		0.32	0.38	0.43			1.3
Average	0.30	0.25	0.28	0.32	0.37	0.43	0.60	0.57	1.22

Appendix VI: GEM calibration records

Site: NCES

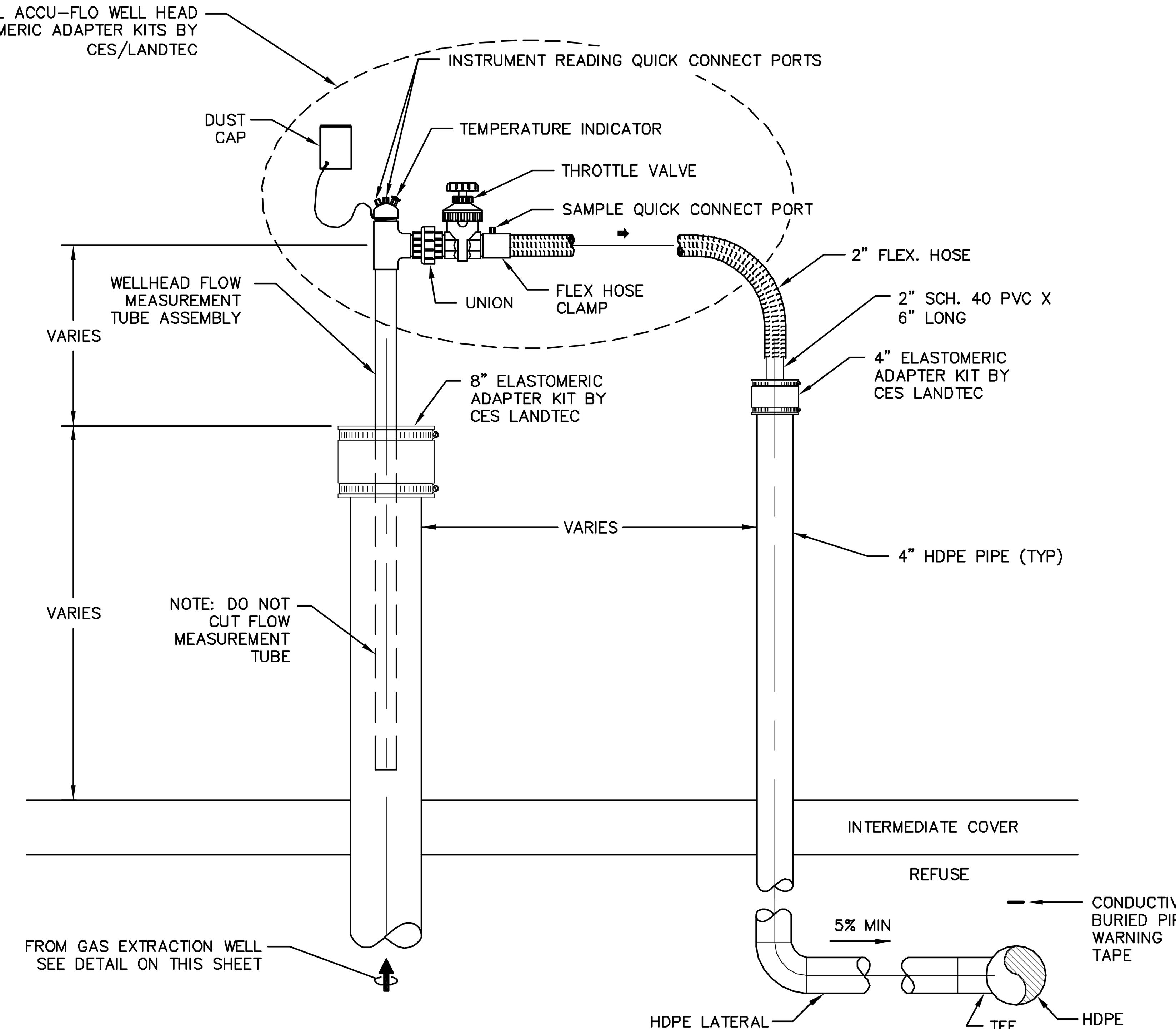
Gem-500 Monthly Calibration Report

Month: February/MARCH/APRIL/05 **Technician** Sean Moran

Date	Notes	Initial			Recalibrated		
		% CH4	% CO2	% O2	% CH4	% CO2	% O2
2/4/05		49.1	34.7	4.3	50.0	34.9	3.9
2/12/05		49.5	34.7	3.9	49.9	35.1	4.0
2/16/05		50.4	35.7	3.8	49.8	34.9	3.9
2/18/05		49.6	36.2	4.1	49.9	34.9	4.1
2/22/05		51.8	34.7	3.8	49.9	35.0	3.9
2/26/05	NEWSVT	49.9	34.9	3.9	50.0	35.0	3.9
3/1/05	"	46.5	34.9	4.1	50.0	35.0	4.0
3/3/05	NCES	48.6	34.8	4.2	50.0	35.0	4.0
3/4/05	NCES	49.8	35.0	4.0	50.0	35.0	4.0
3/8/05	NEWSVT	52.5	34.7	3.9	50.0	34.7	4.0
3/10/05	NCES	47.5	35.0	3.6	49.9	35.0	3.9
3/15/05	NCES	49.5	34.8	4.2	49.9	35.0	3.9
3/16/05	NEWSVT	51.4	34.8	3.9	49.8	34.9	4.0
3/17/05	NCES	49.3	35.4	3.3	50.0	34.8	3.9
3/22/05	NEWSVT	50.9	34.8	5.0	49.9	34.9	4.0
3/29/05	NEWSVT	51.6	35.0	3.8	50.0	35.0	3.9
3/30/05	NCES	47.4	34.8	4.4	49.9	35.0	3.9
4/5/05	NEWSVT	53.2	34.2	3.7	49.9	34.8	3.9
4/6/05	NEWSNY	47.4	34.7	4.4	49.8	35.0	3.9
4/8/05	NCES	51.6	35.0	3.8	49.8	35.0	3.9

Comments:

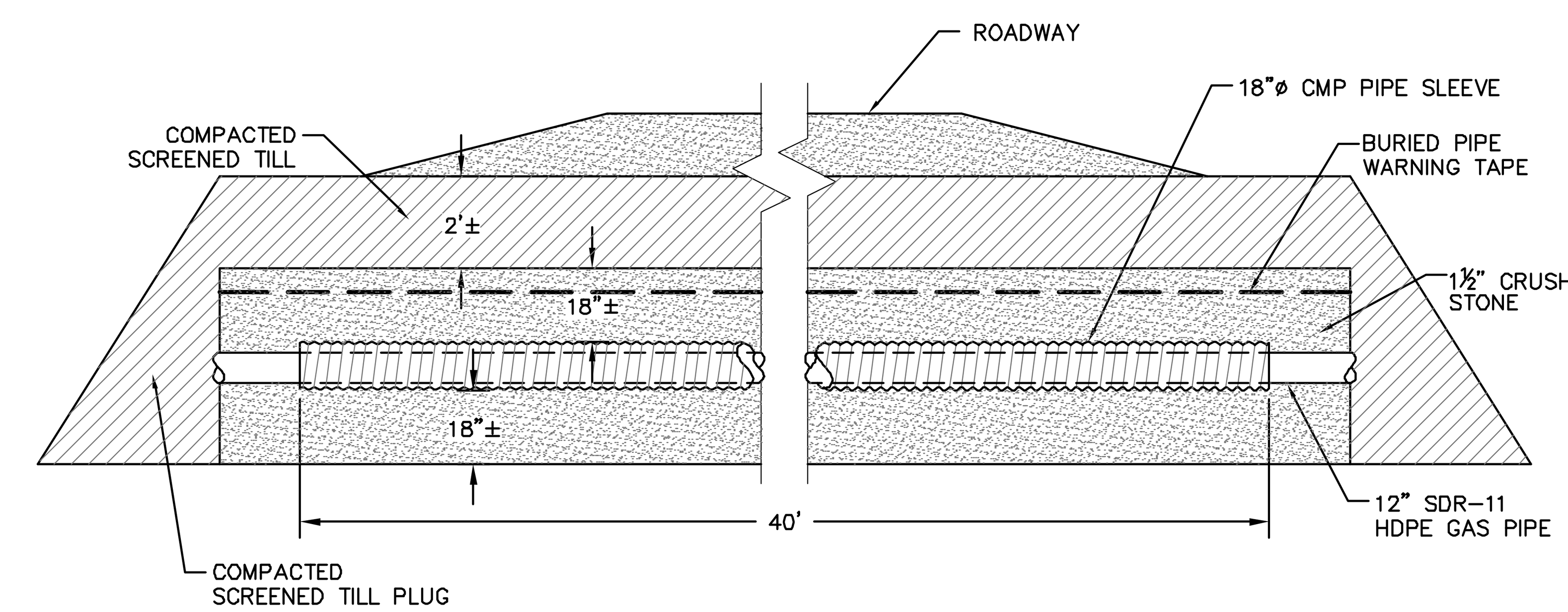
Appendix VII: LFG Extraction Well Design
[follows]



TYPICAL GAS EXTRACTION WELLHEAD DETAIL

11

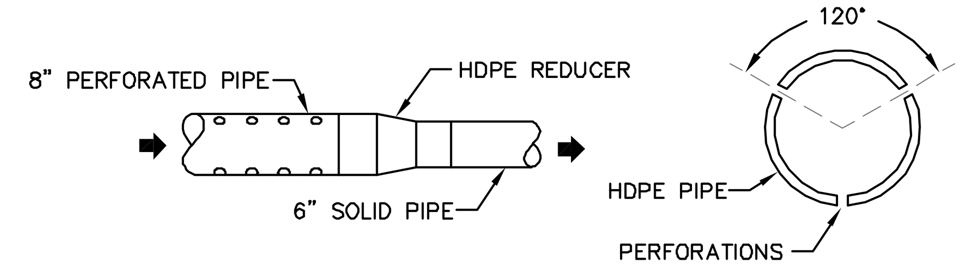
NOT TO SCALE



TYPICAL GAS PIPING ROAD CROSSING SLEEVE DETAIL

12

NOT TO SCALE



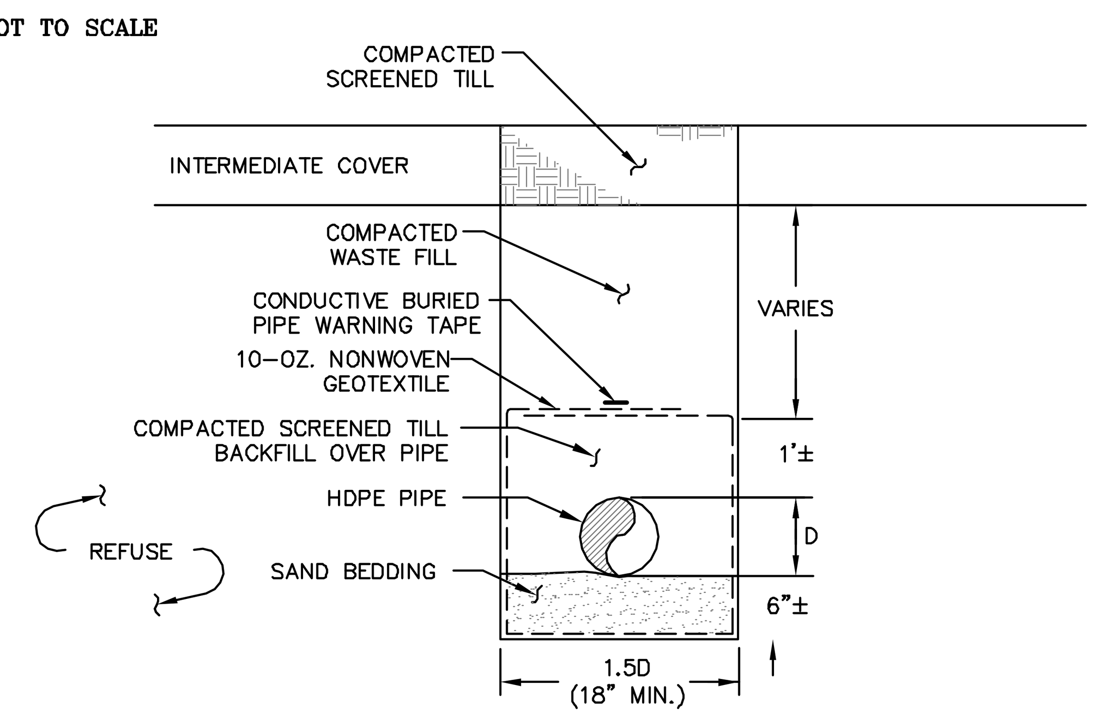
NOTES:

1. HOLES ARE 1/2"ø DRILLED HOLES SPACED 12" APPART ALONG THE LENGTH OF THE PIPE

TYPICAL PERFORATED PIPE DETAIL

13

NOT TO SCALE



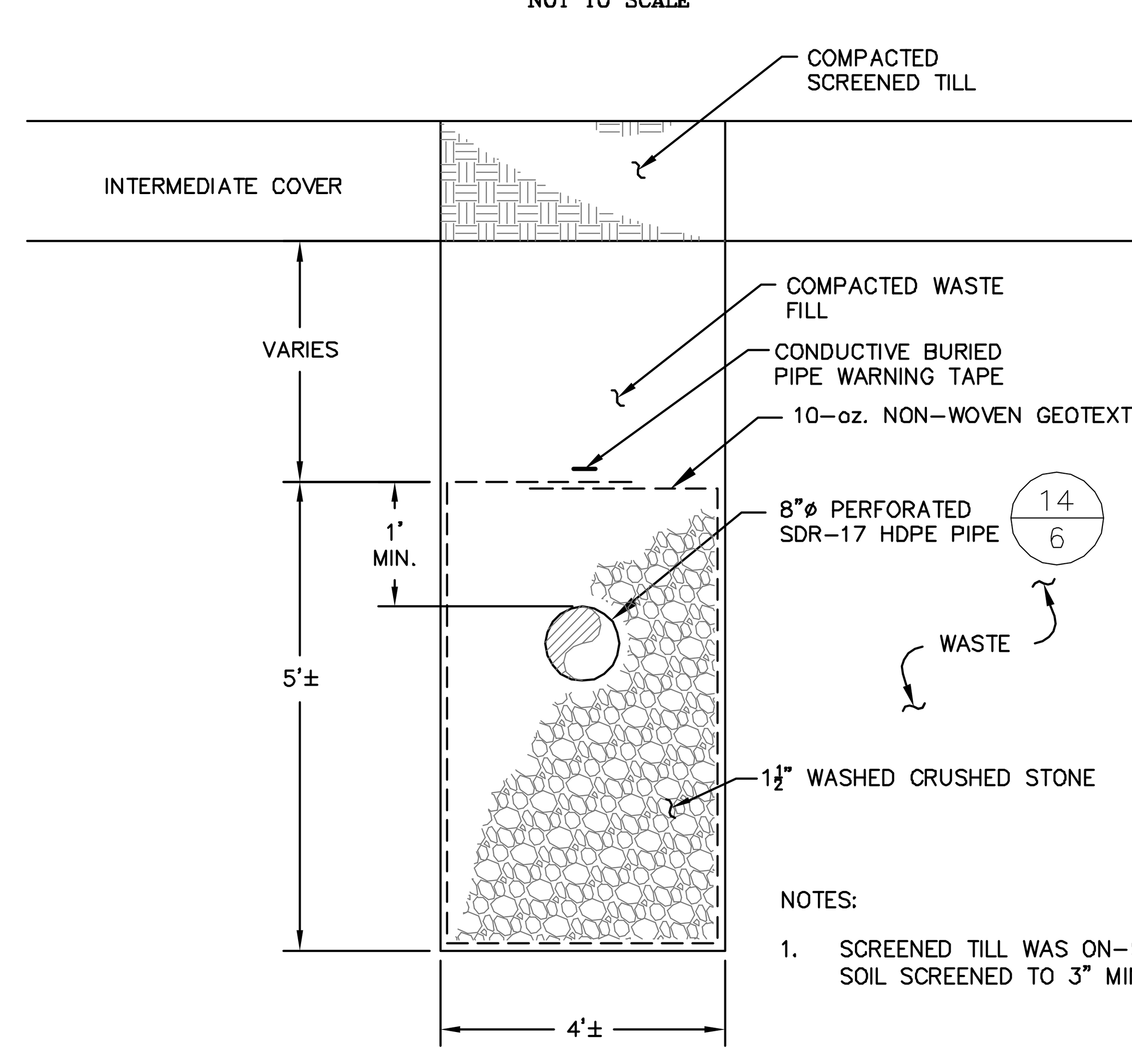
NOTES:

1. SCREENED TILL WAS ON-SITE SOIL SCREENED TO 3" MINUS.
2. HEADER AND LATERAL PIPING WAS INSTALLED WITH A MINIMUM PITCH OF 5 PERCENT.

TYPICAL GAS PIPE TRENCH WITH WASTE BACKFILL

14

NOT TO SCALE



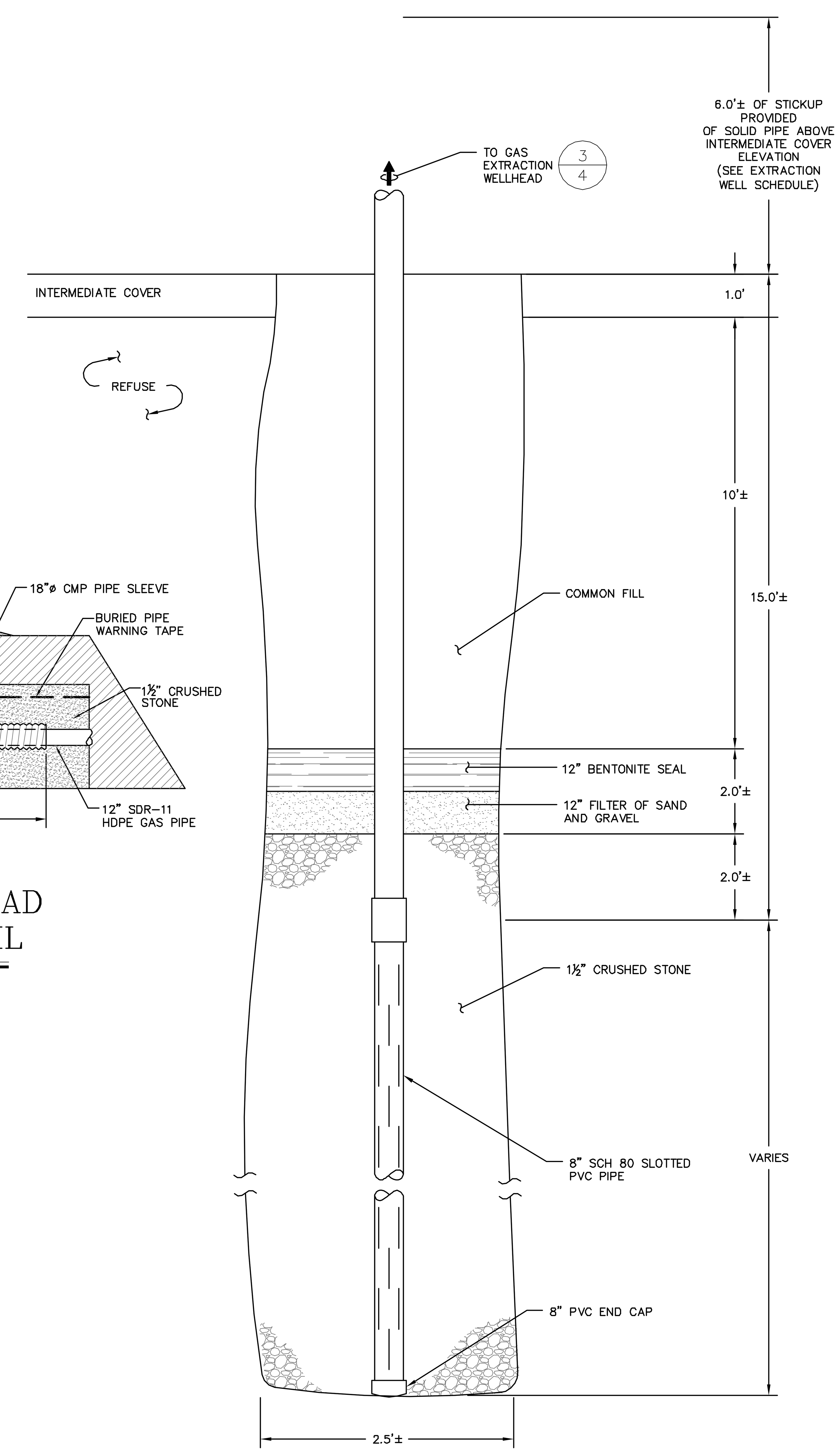
NOTES:

1. SCREENED TILL WAS ON-SITE SOIL SCREENED TO 3" MINUS.

TYPICAL GAS COLLECTION TRENCH SECTION

15

NOT TO SCALE



NOTES:

1. PIPE PERFORATED WITH SLOTS ⅛" TO ¼" WIDE BY 8" LONG. FOUR SLOTS PER ROW SPACED 90° APART, WITH ADJACENT ROWS OFFSET BY 45°.

TYPICAL GAS EXTRACTION WELL DETAIL

16

NOT TO SCALE

PERMIT NO: DES-SW-SP-00-003

NO.	DATE	DESCRIPTION	BY

SCALE: AS NOTED

Sanborn, Head & Associates
Consulting Engineers & Scientists

DRAWN BY: DJD
DESIGNED BY: JAC
CHECKED BY:
REVIEWED BY:
PROJECT MGR: DC
PIC: JAC
DATE: JUL 05

STAGE III GAS SYSTEM MODIFICATIONS
NORTH COUNTRY ENVIRONMENTAL SERVICES, INC.
BETHLEHEM, NEW HAMPSHIRE

RECORD DRAWINGS
TYPICAL GAS SYSTEM DETAILS

PROJECT NUMBER: 2375.01

SHEET NUMBER: 6 OF 13

APPENDIX VIII

BUILD-OUT OF SUBJECT LANDFILL AND RELATED LANDFILL GAS COLLECTION, COMBUSTION AND UTILIZATION SYSTEM

	Units	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Projected 2009
Landfill build-out and operating data:													
Stages of landfill receiving waste during this calendar year:													
Stage 1	N/A	xxxxxxxxxxx											
Stage 2, Phase 1	N/A		xxxxxxxxxxx	xxxxxxxxxxxxx									
Stage 2, Phase 2	N/A			xxxxxxxxxxx	xxxxxxxxxxx	xxxxxx							
Stage 3	N/A					xxxxxxxxxxx	xxxxxxxxxxx	xxxxxxxxxxx	xxxxxxxxxxx	xxxxxxxxxxx	xxxxxxxxxxx	xxxxxxxxxxx	xxxxxxxxxxx
Stage 4, Phase 1	N/A									xxxxxxx	xxxxxxxxxxx	xxxxxxxxxxx	xxxxxxxxxxx
Landfill footprint by end of calendar year	acres	20	20	23	23	29	29	29	31	34	34	34	34
Waste accepted during this calendar year	tons	97,591	157,468	108,938	160,566	130,963	118,612	138,014	144,167	93,446	158,990	100,000	70,000
Total waste in place by end of this calendar year	tons	1,328,381	1,485,849	1,594,787	1,755,353	1,886,316	2,004,928	2,142,942	2,287,109	2,380,555	2,539,545	2,639,545	2,709,545
LFGCCS build out and operating data: [Note 1]													
LFG extraction points in place at start of year [Note 2]	each	-	11	15	33	35	40	51	59	94	108	112	123
LFG extraction points added during this year	each	11	4	20	4	5	11	8	37	14	6	11	9
LFG extraction points removed/abandoned this year	each	-	-	(2)	(2)	-	-	-	(2)	-	(2)	-	-
Net LFG extraction points at end of year	each	11	15	33	35	40	51	59	94	108	112	123	132
Net screened pipe length added during this year	feet	1,521	169	1,177	255	500	1,143	2,179	5,708	2,248	860	1,139	448
Net LFG extraction screened pipe length at the end of year	feet	1,521	1,690	2,866	3,121	3,621	4,765	6,944	12,651	14,900	15,760	16,899	17,347

Notes:

1."LFGCCS" means the landfill gas collection and combustion system

2."Extraction points" means vertical wells, horizontal wells, and points in the leachate collection system from which LFG is actively collected