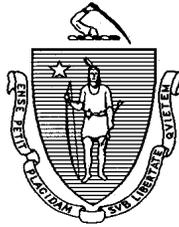


Regional Greenhouse Gas Initiative  
CO<sub>2</sub> Budget Trading Program



**Massachusetts  
Department of Environmental Protection**

**Massachusetts CO<sub>2</sub> Budget Trading Program**

**Offset Project Monitoring and Verification Report  
Instruction Packet**

**Avoided Methane Emissions from Agricultural  
Manure Management**

Version 1.0

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## 1. Overview

To demonstrate the achievement of carbon dioxide (CO<sub>2</sub>)-equivalent (CO<sub>2</sub>e) emissions reductions from an agricultural manure management offset project that has received a consistency determination from the Massachusetts Department of Environmental Protection (MassDEP), a Project Sponsor must submit to MassDEP in accordance with these instructions a fully completed *Massachusetts Offset Project Monitoring and Verification Report – Avoided Methane Emissions from Agricultural Manure Management Version 1.0 (M&V Report)*, consisting of the coversheet and all forms and related attachments. Following these instructions will ensure that the *M&V Report* contains all necessary information and is submitted properly.

The Project Sponsor should review the Massachusetts CO<sub>2</sub> Budget Trading Program regulations, 310 CMR 7.70(10), for information regarding offset projects and the award of CO<sub>2</sub> offset allowances. All Massachusetts offset project submittal materials and documents are available at <http://www.rggi.org/offsets>.

## 2. Submission Instructions

The Project Sponsor should submit the completed *M&V Report*, and all attachments, via the Regional Greenhouse Gas Initiative (RGGI) CO<sub>2</sub> Allowance Tracking System (COATS) at <http://www.rggi-coats.org> under the established general account identified in the Massachusetts *Consistency Application* for the project. For additional information, consult the RGGI COATS User's Guide, available at <http://www.rggi-coats.org>.

The *M&V Report* has three (3) parts, as described below. Each part comprises specified forms and required documentation. The *M&V Report* has been created as a Microsoft Word document with editable fields. Enter information directly in the fields provided or submit information or documentation as an attachment, as instructed. Include headers on all attachments indicating the form to which each is attached, the offset project name, and offset project ID code. If attachments are being submitted as separate electronic documents, please include the form numbers in the file names of the documents.

When submitting documents electronically via RGGI COATS, it is not necessary to submit a scanned or paper hardcopy of the application forms. The Project Sponsor must retain the completed original copy of the *M&V Report* with the original signed documents. MassDEP reserves the right to request the original signed application documents at any time.

A completed hardcopy and/or CD of the *M&V Report* may also be mailed to: Climate Strategies Group, Massachusetts Department of Environmental Protection, Bureau of Waste Prevention, 6<sup>th</sup> Floor, One Winter Street, Boston, MA 02108-4747.

Questions about this form and how to submit it should be directed to [climate.strategies@state.ma.us](mailto:climate.strategies@state.ma.us) or 617-574-6815.

### **3. M&V Report Forms**

The *M&V Report* consists of eight (8) forms divided into three (3) parts, as follows:

#### **Part 1. General Information Forms**

- Form 1.1 – Coversheet
- Form 1.2 – General Information
- Form 1.3 – Attestations
- Form 1.4 – Project Sponsor Statement
- Form 1.5 – Disclosure of Greenhouse Gas Emissions Data Reporting

#### **Part 2. Category-Specific Information and Documentation Forms**

- Form 2.1 – Demonstration of Conformance with M&V Plan
- Form 2.2 – Determination of Emissions Reduction

#### **Part 3. Independent Verification Form**

- Form 3.1 – Independent Verifier Certification Statement and Report

The following instructions address each of the forms in numerical order. Note that the forms themselves include many embedded instructions.

## Part 1. Instructions for General Information Forms

The five (5) forms in Part 1 of the *M&V Report* address general requirements applicable to agricultural manure management offset projects. Instructions for the Part 1 forms are provided below.

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### Form 1.1 Coversheet

Enter the requested information in the editable text fields in the form. Check the boxes to indicate that all forms are being submitted. For information about entering the Project Sponsor, offset project name and offset project ID code, and Regional Greenhouse Gas Initiative (RGGI) CO<sub>2</sub> Allowance Tracking System (COATS) account name and number, see instructions below for Form 1.2, General Information.

Submission of all forms, including the Coversheet, is required. If a form is not submitted, the *M&V Report* will not be considered complete for commencement of review by MassDEP.

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### Form 1.2 General Information

Enter the requested information in the editable text fields in the form. If a text field is not applicable or is unanswerable, enter "NA." Note the following:

Offset Project ID Code: Enter the offset project ID code. The offset project ID code is the alphanumeric code generated when the Project Sponsor creates a record of the offset project in the RGGI CO<sub>2</sub> Allowance Tracking System (RGGI COATS). See the RGGI COATS User's Guide for more information about creating an offset project record in RGGI COATS, available at <http://www.rggi-coats.org>.

Project Information: Enter project information. The name of the offset project should be the same name entered by the Project Sponsor when creating a project record in RGGI COATS. The project location entered should be the primary location of the project if the project consists of actions at multiple locations. The summary narrative of the project should indicate all locations where project actions occur or will occur.

Project Sponsor: Identify the Project Sponsor and provide his or her contact information. The Project Sponsor is the natural person who is the Authorized Account Representative for the RGGI COATS general account identified in the *Consistency Application*.

Project Sponsor Organization: Provide the full legal name of the organization the Project Sponsor represents, including any alternative names under which the organization also may be doing business (e.g., John Doe Enterprises, Inc., d/b/a JDE). If the Project Sponsor is representing himself or herself as an individual, enter "NA".

RGGI COATS General Account Name and Number: Enter the RGGI COATS general account name and number. The RGGI COATS general account identified in the *Consistency Application* is the RGGI COATS account into which any awarded CO<sub>2</sub> offset allowances related to the offset project will be transferred.

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### **Form 1.3      Attestations**

Sign and date the form. Submit the originally signed form via RGGI COATS as directed in the submittal instructions above. Note that the Project Sponsor must retain the completed original copy of the *M&V Report* and attachments with all original signed documents. MassDEP reserves the right to request the original signed application documents at any time.

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### **Form 1.4      Project Sponsor Statement**

Sign and date the form. Submit the originally signed form via RGGI COATS as directed in the submittal instructions above. Note that the Project Sponsor must retain the completed original copy of the *M&V Report* and attachments with all original signed documents. MassDEP reserves the right to request the original signed application documents at any time.

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### **Form 1.5      Disclosure of Greenhouse Gas Emissions Data Reporting**

Check the appropriate box in the form to indicate whether greenhouse gas emissions data related to the offset project have been or will be reported to any voluntary or mandatory programs, other than the Massachusetts CO<sub>2</sub> Budget Trading Program. For each program for which data have been or will be reported, provide the program name, the program type (voluntary or mandatory), program contact information (website or street address), the categories of data reported, the frequency of reporting, when the reporting began or will begin, and reporting status (prior, current, future). The Project Sponsor must disclose future reporting related to current commitments made to voluntary programs as well as future reporting mandated by current statutes, regulations, or judicial or administrative orders.

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## Part 2. Instructions for Category-Specific Information and Documentation Forms

The two (2) forms in Part 2 of the *M&V Report* address documentation of conformance with the Monitoring and Verification Plan (M&V Plan) and determination of CO<sub>2</sub>-equivalent (CO<sub>2</sub>e) emissions reductions during the reporting period. Instructions for the Part 2 forms are provided below.

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### Form 2.1 Demonstration of Conformance with M&V Plan

Provide documentation as an attachment to Form 2.1 that procedures and protocols specified in the M&V Plan were performed and records specified in the M&V Plan were generated and retained. Check the boxes in the tables on Form 2.1 to indicate that the referenced documentation is provided as an attachment to Form 2.1. Each attachment must include a header that identifies it as an attachment to Form 2.1, identifies the appropriate table number and the reference number in the left-hand column of the table, and includes the offset project name and offset project ID code. If attachments are being submitted as separate electronic documents, please include the form numbers in the file names of the documents.

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### Form 2.2 Determination of Emissions Reduction

Provide documentation of CO<sub>2</sub>-equivalent (CO<sub>2</sub>e) emissions reductions achieved during the reporting period. Enter requested information where indicated in Form 2.2 and attach documentation to Form 2.2, as directed below. Each attachment must include a header that indicates it is an attachment to Form 2.2 and identifies the offset project name and offset project ID code. Multiple attachments may be integrated into a single document, as appropriate, as long as each element is clearly identified, as specified below. Each spreadsheet must be provided as a distinct electronic file or files (distinct spreadsheets may be incorporated into a single spreadsheet file, as appropriate, as long as each spreadsheet element is clearly identified, as specified below). Please include the form numbers in the file names on each submitted electronic document. Check the boxes in Form 2.2 to indicate that requested documentation is attached.

1. Baseline Emissions. Enter calculated baseline methane emissions during the reporting period for all facilities supplying manure and/or organic food waste influent to the anaerobic digester, in short tons of CO<sub>2</sub>-equivalent (CO<sub>2</sub>e), where indicated in the form. For each reporting month, enter values for the data parameters identified in the form, as a sum of each parameter (except for the van't Hoff-Arrhenius factor), for all facilities supplying manure and/or organic food waste influent to the anaerobic digester. Enter the calculated methane emissions in short tons of CO<sub>2</sub>-equivalent (CO<sub>2</sub>e) for each reporting month, for all facilities supplying manure and/or organic food waste influent to the anaerobic digester. Attach a spreadsheet that documents the calculation of baseline CO<sub>2</sub>-equivalent (CO<sub>2</sub>e) emissions for *each facility* and the sum of CO<sub>2</sub>-equivalent (CO<sub>2</sub>e) emissions for all facilities. The spreadsheet must also document for each facility the calculation of each monthly data parameter identified in the form and specify the units for all relevant data parameters, as specified below.

For each facility, document calculation of baseline methane emissions for each month of the reporting period in accordance with the procedures at (a). through (g). below. The baseline methane emissions in CO<sub>2</sub>-equivalent (CO<sub>2</sub>e) represent potential emissions due to methane production under site-specific anaerobic storage and weather conditions.

$$\text{Baseline Emissions (short tons CO}_2\text{e)} = [(\text{V}_m \times \text{M})/2000] \times \text{GWP}$$

where:

V<sub>m</sub> = Volume of methane produced (scf) each month from degradation of volatile solids

M = Mass of methane per cubic foot (lbs/scf) (note that 0.04246 lbs/scf is the default value at one (1) atmosphere and 68°F or 20°C)

GWP = 23 (CO<sub>2</sub>e global warming potential of methane)

- a. Volatile Solids Degraded. Document calculation of the estimated amount in kilograms (kg) of volatile solids degraded each month under the uncontrolled anaerobic storage baseline scenario in accordance with the following equation:

$$\text{VS}_{\text{deg}} = \text{VS}_{\text{avail}} \times f$$

where:

VS<sub>deg</sub> = volatile solids degraded each month (kg)

VS<sub>avail</sub> = volatile solids available for degradation in manure or organic food waste storage each month (kg)

f = van't Hoff-Arrhenius factor for the specific month

- b. Application of van't Hoff-Arrhenius Factor. Document calculation of the van't Hoff-Arrhenius factor for each month, which specifies conversion efficiency of volatile solids to methane, in accordance with the following equation:

$$f = \exp\{[E(T_2 - T_1)]/[(GC \times T_1 \times T_2)]\}$$

where:

f = van't Hoff-Arrhenius factor

E = activation energy constant (15,175 cal/mol)

T<sub>2</sub> = average monthly ambient temperature in Kelvin (K) for facility where manure or organic food waste is generated if reported temperature is greater than 5 degrees Celcius (°C)

T<sub>1</sub> = 303.15 K (30 degrees Celcius (°C) converted to Kelvin (K))

GC = ideal gas constant (1.987 calories per Kelvin mole (cal/K mol))

If reported temperature is less than 5 degrees Celcius (°C), as determined from the nearest National Weather Service certified weather station for the facility where manure or organic food waste is managed, then f equals 0.104.

- c. Volatile Solids Available for Degradation. Document calculation of the volatile solids available for degradation in manure or organic food waste storage for each month in accordance with the following equation:

$$VS_{avail} = VS_p + \frac{1}{2} VS_{in} - VS_{out}$$

where:

$VS_{avail}$  = volatile solids available for degradation each month

$VS_p$  = volatile solids present in manure or organic food waste storage at beginning of the month in kilograms (kg)

$VS_{in}$  = volatile solids added to manure or organic food waste storage during the course of the month in kilograms (kg); multiply this number by the factor of  $\frac{1}{2}$  to represent the average mass of volatile solids available for degradation for the entire duration of the month

$VS_{out}$  = volatile solids removed from manure or organic food waste storage for land application or export

- d. Mass of Volatile Solids Available at Start of Month. Document calculation of the volatile solids present in manure or organic food waste storage at the beginning of each month in accordance with the equation below:

$$VS_p = (M_m \times TS\% \times VS\%)_p$$

where:

$VS_p$  = volatile solids present in manure or organic food waste storage at the beginning of each month in kilograms (kg)

$M_m$  = mass in kilograms (kg) of manure or organic food waste present in storage at the beginning of the month

$TS\%$  = concentration (percent) of total solids in manure and organic food waste as determined through U.S. EPA 160.3 testing method (U.S. EPA Method Number 160.3, Methods for the Chemical Analysis of Water and Wastes (MCAWW) (EPA/600/4-79/020))

$VS\%$  = concentration (percent) of volatile solids in total solids as determined through U.S. EPA 160.4 testing method (U.S. EPA Method Number 160.4, Methods for the Chemical Analysis of Water and Wastes (MCAWW) (EPA/600/4-79/020))

- e. Mass of Volatile Solids Added During Month. Document calculation of the volatile solids added to manure or organic food waste storage during the course of each month in accordance with the following equation:

$$VS_{in} = (M_m \times TS\% \times VS\%)_{in}$$

where:

$VS_{in}$  = volatile solids added to manure or organic food waste storage during the course of each month in kilograms (kg)

- $M_m$  = mass in kilograms (kg) of manure or organic food waste added to storage at the beginning of the month
- $TS_{\%}$  = concentration (percent) of total solids in manure and organic food waste as determined through U.S. EPA 160.3 testing method (U.S. EPA Method Number 160.3, Methods for the Chemical Analysis of Water and Wastes (MCAWW) (EPA/600/4-79/020))
- $VS_{\%}$  = concentration (percent) of volatile solids in total solids as determined through U.S. EPA 160.4 testing method (U.S. EPA Method Number 160.4, Methods for the Chemical Analysis of Water and Wastes (MCAWW) (EPA/600/4-79/020))

- f. Mass of Volatile Solids Removed During Month. Document calculation of the volatile solids removed from manure or organic food waste storage for land application or export for each month (document assumed value based on practices the farm employed prior to the commencement of the offset project consistent with standard practice) in accordance with the following equation:

$$VS_{out} = (M_m \times TS_{\%} \times VS_{\%})_{out}$$

where:

$VS_{out}$  = volatile solids removed from manure or organic food waste storage during the course of each month in kilograms (kg)

$M_m$  = mass in kilograms (kg) of manure or organic food waste removed from storage during the month

$TS_{\%}$  = concentration (percent) of total solids in manure or organic food waste as determined through U.S. EPA 160.3 testing method (U.S. EPA Method Number 160.3, Methods for the Chemical Analysis of Water and Wastes (MCAWW) (EPA/600/4-79/020))

$VS_{\%}$  = concentration (percent) of volatile solids in total solids as determined through U.S. EPA 160.4 testing method (U.S. EPA Method Number 160.4, Methods for the Chemical Analysis of Water and Wastes (MCAWW) (EPA/600/4-79/020))

- g. Volume of Methane Produced. Document calculation of the volume of methane produced from degradation of volatile solids each month in accordance with the following equation:

$$V_m = (VS_{deg} \times B_o) \times 35.3147 \text{ cubic feet per cubic meter}$$

where:

$V_m$  = volume of methane produced in standard cubic feet (scf)

$VS_{deg}$  = volatile solids degraded in kilograms (kg)

$B_o$  = manure or organic food waste type-specific maximum methane generation constant ( $m^3$  methane/kg  $VS_{deg}$ ). For dairy cow manure,  $B_o = 0.24 m^3$  methane/kg  $VS_{deg}$ . For other types of manure, use the methane generation

constants cited in U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2004, Annex 3, Table A-162 (U.S. EPA, April 2007)

2. Methane Emissions Captured and Destroyed Using Anaerobic Digester. Attach a spreadsheet documenting the data sources and calculations used to quantify the annual volume of methane emissions in standard cubic feet (scf) of methane and CO<sub>2</sub>-equivalent (CO<sub>2</sub>e) captured and destroyed by the anaerobic digester. Indicate whether methane concentration of digester biogas is continuously monitored.

If a direct continuous monitoring system is measuring methane concentration of recovered digester biogas, the spreadsheet must include the following data and calculations:

- Daily methane recovery in standard cubic feet of methane (scf) from the continuous monitoring system for each day in the reporting period
- Sum of the daily methane recovery in standard cubic feet of methane (scf) on a monthly basis
- Sum of the monthly methane recovery to obtain total annual methane recovery in standard cubic feet of methane per year (scf/yr) and short tons of CO<sub>2</sub>-equivalent per year (CO<sub>2</sub>e/yr) from the digester

If a direct continuous monitoring system is monitoring digester biogas flow only, the spreadsheet must include the following data and calculations:

- Tabulation of daily digester biogas flow in standard cubic feet (scf) from the continuous monitoring system for each day in the reporting period
- Sum of daily digester biogas flow on a weekly basis in standard cubic feet (scf)
- Weekly methane concentration measurements (in percent of sample by volume) using calibrated digester biogas analyzer
- Weekly methane recovery in standard cubic feet of methane (scf), obtained by multiplying the weekly digester biogas flow rate by the respective week's methane concentration measurement (in percent of sample by volume)
- Sum of weekly methane recovery in standard cubic feet of methane (scf) on a monthly basis
- Sum of monthly methane recovery to obtain total annual methane recovery from the digester in standard cubic feet (scf) of methane and short tons of CO<sub>2</sub>-equivalent (CO<sub>2</sub>e)

3. Transport CO<sub>2</sub>-Equivalent Emissions. If the offset project is a regional-type digester, attach a spreadsheet documenting quantification of CO<sub>2</sub> emissions due to transportation of manure and/or organic food waste from the off-site facilities where the manure and/or organic food waste was generated to the anaerobic digester. The spreadsheet must specify data sources and calculations. To determine transport CO<sub>2</sub> emissions, the spreadsheet must document use of one (1) of the following two (2) methods:

a. Method 1: Emission factors for type and quantity of fuel used

Identify data sources and calculations used to determine fuel use for all shipments of manure and organic food waste from off-site facilities to the anaerobic digester during the reporting period. Specify how transport miles and quantity of fuel used for

each shipment were determined and recorded. Specify the emissions factors used, which may include:

- Diesel fuel: 22.912 pounds of CO<sub>2</sub> per gallon (lbs CO<sub>2</sub>/gallon)
- Gasoline: 19.878 pounds of CO<sub>2</sub> per gallon (lbs CO<sub>2</sub>/gallon)
- Other fuel: emission factor approved by MassDEP

b. Method 2: Emission factors for type of fuel used by the ton-mile

Identify data sources and calculations used to determine total tons of manure and organic food waste transported from off-site facilities for input into the anaerobic digester during the reporting period. Specify how transport tons, transport miles, and fuel type used for each shipment were determined and recorded. Specify the emissions factors used, which may include:

- Diesel fuel: 0.131 pounds (lbs) CO<sub>2</sub> per ton-mile
- Gasoline: 0.133 pounds (lbs) CO<sub>2</sub> per ton-mile
- Other fuel: emission factor approved by the [Regulatory Agency]

4. Determination of Emissions Reductions. Enter the emissions reductions achieved by the offset project in short tons of CO<sub>2</sub>-equivalent (CO<sub>2</sub>e) where indicated in Form 2.2. Emissions reductions are equivalent to the annual baseline methane emissions or annual methane captured and destroyed by the anaerobic digester, both in short tons of CO<sub>2</sub>-equivalent (CO<sub>2</sub>e), whichever is less. For regional-type digesters, emissions reductions must be the net emissions reductions achieved after subtraction of any transport-related CO<sub>2</sub> emissions.

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## Part 3. Instructions for Independent Verification Form

The form in Part 3 of the *M&V Report* addresses requirements and documentation related to the independent verifier certification statement and report. Instructions for the form in Part 3 are provided below.

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### Form 3.1 Independent Verifier Certification Statement and Report

An accredited independent verifier must sign and date the form. Attach the accredited independent verifier report. The attached verifier report must include a header that indicates it is an attachment to Form 3.1 and includes the offset project name and offset project ID code. If attachments are being submitted as separate electronic documents, please include the form numbers in the file names of the documents. Note that the Project Sponsor must retain the completed original copy of the *M&V Report* and attachments, including the verifier's original signed documents. MassDEP reserves the right to request the original signed documents at any time. The verifier report must document the following:

1. The verifier has reviewed the entire *M&V Report* and evaluated the contents of the report in relation to the applicable requirements of 310 CMR 7.70(10).
2. The verifier has evaluated the adequacy and validity of information supplied by the Project Sponsor to determine CO<sub>2</sub>-equivalent (CO<sub>2</sub>e) emissions reductions in accordance with 310 CMR 7.70(10)(e)5, and the documentation required in the M&V Report.
3. The verifier has evaluated the adequacy and consistency of methods used by the Project Sponsor to quantify, monitor, and verify CO<sub>2</sub>-equivalent (CO<sub>2</sub>e) emissions reductions in accordance with the applicable requirements of 310 CMR 7.70(10)(e)5 and the Monitoring and Verification Plan submitted as part of the *Consistency Application*.

The verifier report must include the following contents, in the order listed below:

- Cover page with report title and date
- Table of contents
- List of acronyms and abbreviations
- Executive summary
- Description of objective of report
- Identification of the client, including name, address, and other contact information
- Identification of the offset project
- Description of evaluation criteria (applicable regulatory provisions and documentation required in the *M&V Report*)
- Description of the review and evaluation process, including any site visits and interviews
- Identification of individuals performing the verification work, including the verification team leader and key personnel, and contact information for the team leader
- Description of the materials provided to the verifier by the Project Sponsor
- Evaluation conclusions and findings, including level of assurance provided