



Voluntary Carbon Standard
Project Monitoring Report

Corinth Abandoned Mine Methane Recovery Project

Monitoring Report (January 1, 2010 – April 20, 2011)

June 8, 2011

Developed under VCS Version 2007.1
DTE Methane Resources, LLC

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1 Introduction:

1.1 Objective

The objective of this monitoring report is to document the emission reductions (ERs) generated by the project activity during the January 1, 2010 – April 30, 2011 reporting period from coal mine methane captured via surface wells at the 14 abandoned coal mines included in the Project.

ERs = 174,341 tCO₂e generated between January 1, 2010 – April 30, 2011

134,393 tCO₂e generated between January 1, 2010 – December 31, 2010

39,948 tCO₂e generated between January 1, 2011 – April 30, 2011

1.2 Project Description

DTE Methane Resources (DTEMR) operates the Corinth Abandoned Mine Methane (AMM) Recovery and Use project. The project involves the capture of methane from abandoned coal mines that would otherwise be released to the atmosphere.

The project was validated by First Environment in accordance with VCS Methodology Revision VMR0002 Version 1.0 “Revision to ACM0008 to Include Methane Capture and Destruction from Abandoned Coal Mines.” This monitoring report includes the ERs generated by the project between January 1, 2010 and April 30, 2011.

Table 1 shows the wells at the 14 abandoned coal mines included in the project.

Mine	Producing Wells	Start of Production
Interstate 22	Interstate 22-1	Jun-05
Old Ben Coal (OBC) 8	OBC 8-2	Jun-05
	OBC 8-4	Jun-05
	OBC 8-6	Jun-05
	OBC 8-8	Sep-09
Old Ben Coal (OBC) 14	OBC 14-4	Jun-05
	OBC 14-5	Jun-05
	OBC 14-Vent	Jun-05
Old Ben Coal (OBC) 15	OBC 15-1	Jun-05
	OBC 15-3	Jun-05
Old Ben Coal (OBC) 19	OBC 19-1	Jun-05
Old Ben Coal (OBC) 21	OBC 21-2	Jun-05
	OBC 21-3	Jun-05
	OBC 21-5	Jun-05
	OBC 21-7	Jun-05
Old Ben Coal (OBC) 22	OBC 22-1	Jun-05
	OBC 22-3	Jun-05
	OBC 22-5	Jun-05
Old Ben Coal (OBC) 24	OBC 24-1	Jun-05
	OBC 24-3	Jun-05
	OBC 24-7	Jan-07
Old Ben Coal (OBC) 25	OBC 25-1	Sep-07
Old Ben Coal (OBC) 26	OBC 26-2	Jun-05
	OBC 26-3	Jun-05
	OBC 26-4	Jun-05
	OBC 26-5	Jun-05
	OBC 26-Vent	Jun-05
Old Ben Coal (OBC) 27	OBC 27-1	Sep-07
Orient 1	Orient M1-2	May-06
Blackstar	Blackstar	May-08
Orient 3	Orient M3-2	Jan-09

Table 1. Abandoned coal mines and wells included in the Monitoring Period

1.3 Verification Standard

VCS Version 2007.1

1.4 Project Proponent

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1.5 Project Location

The project location is in Jefferson, Franklin and Williamson counties in southern Illinois (**Figure 1**).

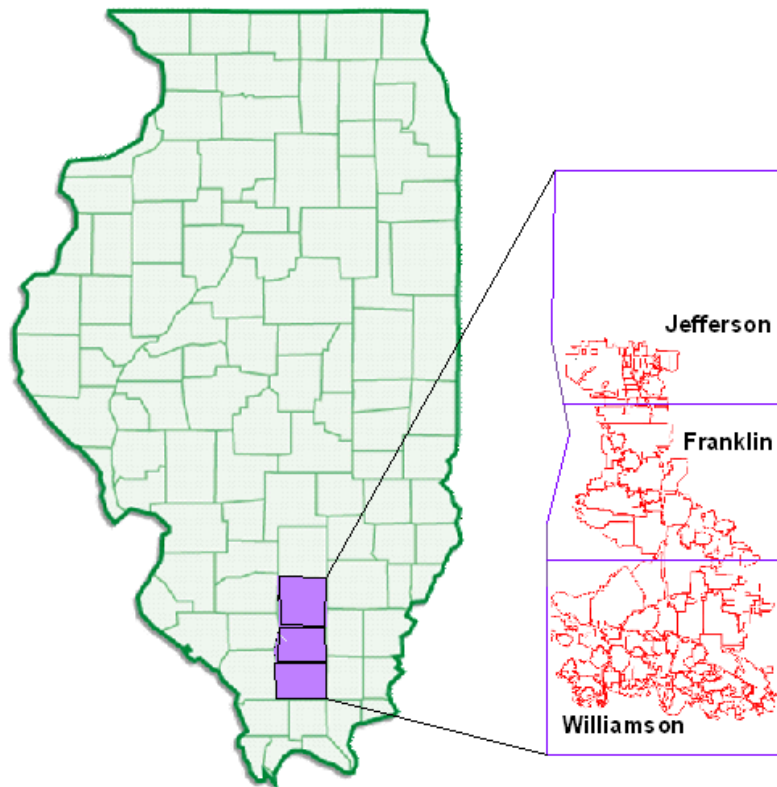


Figure 1. Location map of Corinth AMM Recovery and Use Project

2 Project Monitoring:

The purpose of monitoring is to measure the amount of methane captured by the project activity

The monitored parameters are described in the monitoring section—section 3—of the Project Description. There have been no changes to that monitoring plan for this monitoring period.

2.1 Monitored Parameters

Data collected by DTEMR staff in order to monitor emissions are shown in Table 2.

Parameter	Unit	Recording frequency
AMM_{COMP} Methane sent to compressors	tCH ₄	continuously
AMM_{NRU} Methane sent to nitrogen rejection unit	tCH ₄	continuously
AMM_{GAS} Methane sent to pipeline	tCH ₄	continuously
AMM_{BOILER} Methane sent to boiler	tCH ₄	continuously
PC_{CH4} Concentration (in mass) of methane in extracted gas, measured on wet basis	%	monthly (average from continuous gas sampler)
PC_{CH4} Concentration (in mass) of methane in extracted gas, measured on wet basis	%	monthly (average from continuous gas sampler)
PC_{NMHC} NMHC concentration (in mass) in extracted abandoned coal mine gas	%	annually
CONS_{ELEC,PJ} Additional electricity consumption for capture and use or destruction of methane	MWh	monthly
CONS_{gasoline} Amount of gasoline used in vehicles	U.S. gal	monthly

Table 2. Project monitored parameters

2.2 Parameters Not Monitored

Table 3 shows the fixed values used in calculation of emission reductions.

Parameter	Value	Source
GWP_{CH4} Global warming potential for methane	21	Established by Kyoto Protocol
CEF_{CH4} CO ₂ emissions factor for combusted methane	2.75	ACM0008, v.6, p. 10
CEF_{NMHC} Carbon emission factor for combusted non methane hydrocarbon.	TBD	Samples to be measured are collected by a composite gas sampler located at inlet of plant.
CEF_{ELEC} CO ₂ emission factor of Illinois power grid	0.8070769	Calculated as per eGRID2010 Version 1.0 based on 2007 emission rates
Eff_i Efficiency of methane destruction/leakage in gas pipelines	Eff _{GAS} = 98.5% Eff _{COMP} = 99.5% Eff _{NRU} = 98.1% EFF _{BOILER} = 99.5%	ACM0008, v.6, p. 11-12
Unit conversion: gal gasoline to GJ	0.131078 GJ/gal gasoline	Based on U.S. Consumption 2009: 124, 238 BTU/U.S. gal (DOE EIA) and energy conversion factor: 1KJ=0.947817
CEF_{gasoline} CO ₂ emission factor per unit of energy of the gasoline	0.0693	2006 IPCC Guidelines for National Greenhouse Gas Inventories
t time elapsed from date of mine closure to midpoint of current crediting year y (in years), expressed as a decimal and not rounded to an integer		date of mine closure and midpoint of current crediting year.

Table 3. Fixed data variables

2.3 Equations Used for Calculation of Emission Reductions

Project emissions:

$$PE_y = PE_{ME} + PE_{MD} + PE_{UM}$$

where:

PE _y	=	Project emissions in year y (tCO ₂ e)
PE _{ME}	=	Project emissions from energy use to capture and process methane tCO ₂ e)
PE _{MD}	=	Project emissions from methane destroyed (tCO ₂ e)
PE _{UM}	=	Project emissions from un-combusted methane (tCO ₂ e)

Combustion emissions from additional energy required for CMM capture and use:

$$PE_{ME} = CONS_{ELEC,PJ} \times CEF_{ELEC} + (CONS_{gasoline} \times CEF_{gasoline})$$

where:

- $CONS_{ELEC,PJ}$ = Additional electricity consumption for capture and use or destruction of methane (MWh)
 CEF_{ELEC} = Carbon emissions factor of electricity used by coal mine (tCO₂/MWh)
 $CONS_{gasoline}$ = Additional gasoline consumption for capture and use or destruction of methane

Combustion emissions from use of captured methane:

$$PE_{MD} = (MD_{GAS} + MD_{COMP} + MD_{BOILER}) \times (CEF_{CH_4} + r \times CEF_{NMHC})$$

with:

$$r = PC_{NMHC} / PC_{CH_4}$$

where:

- MD_{GAS} = Methane destroyed after being supplied to gas grid or for vehicle use (tCH₄)
 MD_{COMP} = Methane destroyed through compressors (tCH₄)
 MD_{BOILER} = Methane destroyed through boiler (tCH₄)
 CEF_{CH_4} = Carbon emission factor for combusted methane (2.75 tCO₂e/tCH₄)
 CEF_{NMHC} = Carbon emission factor for combusted non methane hydrocarbons (tCO₂/tNMHC)
 r = Relative proportion of NMHC compared to methane
 PC_{CH_4} = Concentration (in mass) of methane in extracted gas (%), measured on wet basis
 PC_{NMHC} = NMHC concentration (in mass) in extracted gas (%)

and:

$$\begin{aligned}
 MD_{GAS} &= AMM_{GAS} \times Eff_{GAS} \\
 MD_{COMP} &= AMM_{COMP} \times Eff_{COMP} \\
 MD_{BOILER} &= AMM_{BOILER} \times Eff_{BOILER}
 \end{aligned}$$

where:

- AMM_{GAS} = Methane measured supplied to gas grid for vehicle use or heat/power generation off-site (tCH₄)
 Eff_{GAS} = Overall efficiency of methane destruction/oxidation through gas grid to various combustion end uses, combining fugitive emissions from the gas grid and combustion efficiency at end user (taken as 98.5% from IPCC)
 MD_{COMP} = $AMM_{COMP} \times Eff_{COMP}$
 AMM_{COMP} = Methane measured supplied to the compressors on-site (tCH₄)
 Eff_{COMP} = Overall efficiency of methane destruction/oxidation in compressors

Un-combusted methane from project activity:

$$PE_{UM} = GWP_{CH_4} \times [(AMM_{COMP} \times (1 - Eff_{COMP})) + (AMM_{NRU} \times (1 - Eff_{NRU})) + (AMM_{GAS} \times (1 - Eff_{GAS})) + AMM_{BOILER} \times (1 - Eff_{BOILER})]$$

where:

PE_{UM} =	Project emissions from un-combusted methane (tCO ₂ e)
GWP_{CH_4} =	Global warming potential of methane (21 tCO ₂ e/tCH ₄)
AMM_i =	Methane measured sent to each use i (tCH ₄)
i =	Use of methane in compressors (COMP), nitrogen rejection unit (NRU), pipeline (GAS) and boiler (BOILER)

Baseline emissions:

If the baseline emissions are greater than the methane sent to project activities, than the following equation is used to calculate the baseline emissions:

$$BE_y = BE_{MD,y} + BE_{MR,y} + BE_{Use,y}$$

where:

BE_y =	Baseline emissions in year y (tCO ₂ e)
$BE_{MD,y}$ =	Baseline emissions from the destruction of methane in the baseline scenario in year y (tCO ₂ e)
$BE_{MR,y}$ =	Baseline emissions from release of methane into the atmosphere in year y that is avoided by the project activity (tCO ₂ e)
$BE_{Use,y}$ =	Baseline emissions from the production of power, heat or supply to gas grid replaced by the project activity in year y (tCO ₂ e)

There was no AMM captured, sent to and destroyed by any use in the baseline, therefore:

$$BE_{MD,y} = 0$$

$$BE_{MR,y} = AMM_{PJ}$$

where:

AMM_{PJ} =	$AMM_{COMP} + AMM_{BOILER} + AMM_{GAS}$
AMM_{COMP} =	Volume of gas measured for compressor use X Methane content
AMM_{BOILER} =	Volume of gas measured for boiler use X Methane content
AMM_{GAS} =	Volume of gas sent to pipeline X Methane content

There was no production of heat or power in the baseline calculations as it was not a part of the project, therefore:

$$BE_{Use,y} = 0$$

The *ex ante* projection of emissions of methane from venting and sealed abandoned mines is calculated using the following equation:

$$AMM_{DC,y} = V_{AMM,i} * D_{CH_4,corr} * 365 * S * (1 + b * D_i * t)^{-1/b}$$

where:

- $AMM_{DC,y}$ = Emissions of methane from the decline curve of the abandoned mine in year y measured (expressed in tCH₄)
- $V_{AMM,I}$ = Emissions of methane prior to mine closure at time (t_0) in normal cubic meters per day (m³/d)
- $D_{CH_4,corr}$ = Density of methane at normal conditions of temperature and pressure (0.67 kg CH₄/m³)
- b = The dimensionless hyperbolic exponent
- D_i = The initial decline rate, (1/yr)
- t = The time elapsed from the date of mine closure to midpoint of the current crediting year y in years, expressed as a decimal and not rounded to an integer.
- S = sealed mine fully venting flow ratio ($S < 1$ for sealed mines; $S = 1$ for venting mines)

If the mine is unsealed and fully venting, set S equal to 1, otherwise use the following equation:

$$S = V_{AMM,is} / V_{AMM,I}$$

where:

- S = The ratio of fully venting flow for a sealed mine
- $V_{AMM,is}$ = Initial emissions of methane from abandoned mine at time t_0 (after sealing)
- $V_{AMM,I}$ = Emission rate at abandonment prior to sealing

On an annual basis, the *ex ante* projected mass of methane emissions calculated using the decline curve is compared to the mass of methane captured by the project activity. The lesser of these two annual masses will be used to calculate the baseline emissions of AMM, as shown in the following equation:

$$AMM_y = \min(\sum_i AMM_{PJ,i,y}, AMM_{DC,y})$$

where:

- $AMM_{PJ,i,y}$ = AMM captured by use i of the project activity in year y (tCH₄)
- $AMM_{DC,y}$ = Emissions of methane from the decline curve of the abandoned mine in year y (tCH₄)

Using the minimum of these values is conservative, and ensures that AMM_y never is greater than either the emissions projected using a decline curve or the amount of methane captured by the project activity.

Emission Reductions:

The emission reductions ER_y by the project activity during a given year y is the difference between the baseline emissions BE_y and project emissions PE_y , as follows:

$$ER_y = BE_y - PE_y - LE_y$$

Where:

- ER_y = Emissions reductions of the project activity during the year y (tCO₂e)
- BE_y = Baseline emissions during the year y (tCO₂e)
- PE_y = Project emissions during the year y (tCO₂e)
- LE_y = Leakage emissions in year y (tCO₂e)

3 GHG Emission Reductions:

3.1 Methodology

The project proponents used the approved VCS methodology Revision VMR0002 Version 1.0 “Revision to ACM0008 to Include Methane Capture and Destruction from Abandoned Coal Mines” to calculate emission reductions. These procedures and equations are outlined in the project description document. The calculated baseline and project emissions are shown in Tables 4 and 5 below.

3.2 Baseline Emissions

Table 4 shows a summary of the baseline emissions (BE_y) based on the comparison of the *ex ante* projected mass of the methane emissions calculated using the decline curve to the mass of methane captured by the project activity. Old Ben 15 and Old Ben 27 have been shut in and are not part of the project during this reporting period.

Mine	2010 BE _y (tCO ₂ e)	2011 BE _y (tCO ₂ e)
Old Ben # 8	10,191	3,558
Old Ben # 14	4,717	1,542
Old Ben # 15	-	-
Old Ben # 19	5,176	2,081
Old Ben # 21	11,659	3,762
Old Ben # 22	8,398	2,745
Old Ben # 24	36,247	11,649
Old Ben # 26	42,530	13,668
Interstate # 22	2,684	168
Orient # 1	9,276	3,034
Old Ben # 25	12,100	6,045
Old Ben # 27	-	-
Blackstar	6,953	2,607
Orient # 3	32,398	10,539
Total	182,329	61,398

Table 4. Baseline emissions from project mines

3.3 Project Emissions

Emission source	2010 (tCO ₂ e)	2011 (tCO ₂ e)
Additional gasoline consumption for capture and use or destruction of methane	54.8	20.9
Additional electricity consumption for capture and use or destruction of methane	3,093.5	1,831.5
Subtotal: Combustion emissions from additional energy required for CMM capture and use	3,148	1,852
Methane destroyed after being supplied to gas grid or for vehicle use	27,933.9	12,050.4
Methane destroyed through compressors	6,802.3	3,008.0
Methane destroyed in boiler	2,260.5	1,167.9
Subtotal: Emissions from methane destroyed	36,997	16,226
Methane supplied to compressors on site	261.0	115.4
Methane sent to NRU	4,194.4	1,809.4
Methane sent to pipeline	3,248.4	1,401.3
Methane sent to boiler	86.7	44.8
Subtotal: Emissions from un-combusted methane	7,791	3,371
Total Project Emissions (PEy)	47,936	21,450

Table 5. Summary of Project Emissions (tCO₂e)

3.4 GHG Emission Reductions

ERs = 174,341 tCO₂e generated between January 1, 2010 – April 30, 2011

	2010 (tCO ₂ e)	2011 (tCO ₂ e)
Baseline Emissions (BEy)	182,329	61,398
Project Emissions (PEy)	47,936	21,450
Emission Reductions (ERs)	134,393	39,948

Table 6. Summary of Emission Reductions (tCO₂e)