SUIT WESTSIDE CBM SEEP CAPTURE AND USE PROJECT MONITORING REPORT #4

Document Prepared By Karen Spray, Southern Ute Indian Tribe Department of Energy

Project Title	Southern Ute Indian Tribe Westside CBM Seep Capture & Use Project
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PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

The Westside Interceptor well project consists of three activities: (1) interception and removal of fugitive coalbed methane, (2) piping raw gas to a compression station and gas processing plant which uses an amine gas scrubber process to produce pipeline quality natural gas (3) compression and injection of the purified gas into a natural gas transmission pipeline.

The project is currently active. Initial construction of vent wells began in 1998. Several wells and pipelines were added between 1998 and 2014. The original pipeline infrastructure used to gather the gas was constructed in the summer/fall of 2008. Commercial operations began on 01-January-2009 and the project has been operating continuously since then.

During the period described in this monitoring report (01-January-2014 through 31-December-2014), the project reduced GHG emissions by 56,363 tCO_2 equivalent.

1.2 Sectoral Scope and Project Type

The SUIT project falls into Sectoral Scope Numbers 1 and 10 as defined by the United Nations Framework Convention on Climate Change (UNFCCC) and the Verified Carbon Standard (VCS).

The project is a grouped project including three instances. The first instance is referred to as Phase I, the second instance as Phase II-a and the third instance as Phase II-b for a total of 29 wells. The third instance, consisting of two new wells, was implemented during the 2014 monitoring period bringing the total well count to 29 from 27 during 2013. Both new wells are located within the project GPS boundary.

1.3 Project Proponent

Organization name	Southern Ute Indian Tribe – Growth Fund – Department of Energy
Contact person	Karen Spray
Title	E&P Manager
Address	14933 Highway 172 PO Box 1500 Ignacio, CO 81137
Telephone	970-563-5556
Email	kspray@sudoe.us

1.4 Other Entities Involved in the Project

Organization name	Red Cedar Gathering
Role in the project	Red Cedar is responsible for gas cleanup, processing, and marketing including monitoring key project parameters and calibration of equipment.
Contact person	Davis Dunagan
Title	Pipeline Systems Manager
Address	125 Mercado Street Durango, CO 81301
Telephone	970-764-6900
Email	ddunagan@redcedargathering.com

Organization name	Red Willow Production Company
Role in the project	Red Willow is responsible for operations and maintenance
Contact person	Mike Yocum
Title	Operations Foreman
Address	14933 Hwy 172 Ignacio, CO 81137
Telephone	970-563-5000
Email	myocum@rwpc.us

Organization name	WSP Environment & Energy
Role in the project	WSP E&E is responsible for providing consulting services to the Southern Ute Growth Fund regarding the carbon credit aspect of the project.
Contact person	Mike Huisenga
Title	Senior Engineer
Address	507 Canyon Blvd, Ste 203 Boulder, CO 80302
Telephone	720-974-0250 x 301
Email	Mike.Huisenga@WSPGroup.com

1.5 Project Start Date

The project began operations on 01-January-2009.

1.6 Project Crediting Period

The project crediting period began on 01-January-2009 and will end 31-December-2018 for a total of 10 years.

1.7 Project Location

The methane capture project is located in La Plata County, Colorado, United States. The project site, including Phase I and Phase II, is situated approximately 25 miles west of Ignacio, Colorado where the tribe's headquarters is located. The gas compression station, processing plant, central delivery point (CDP), and pipeline injection point are also located at this site but approximately 1.5 miles south. The zip code for this location is 81326. The project is located in the WECC Rockies eGRID sub-region. The boundaries of the project include the 29 wells used to intercept and collect methane. The project GPS boundaries are shown in Table 2 and are mapped in Appendix A. Gas compression, upgrading equipment, the CDP site, and the pipeline injection point shared by other CBM operations are not included in this boundary.

Figure 1: Map of Colorado showing location of La Plata County

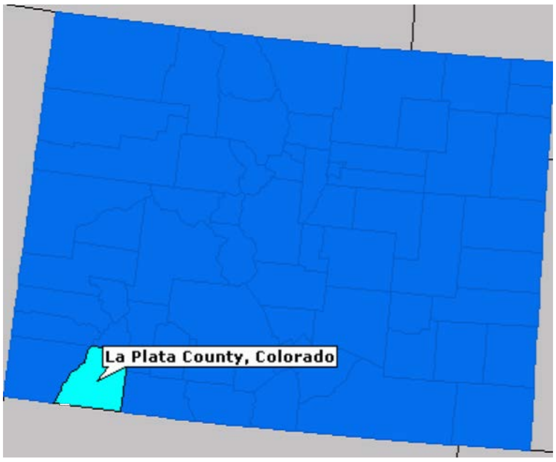


Figure 2: Map of La Plata County, CO, showing project location starred

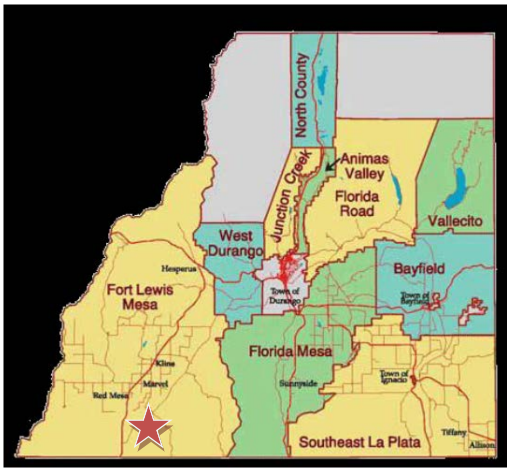


Table 2: Project GPS Boundaries including Phase I, Phase II wells and new instance

Boundary	Latitude (degrees)	Longitude (degrees)
Northwest	37.109103	-108.076449
Northeast	37.109815	-108.048896
Southeast	37.001630	-108.086512
Southwest	37.001681	-108.115573

1.8 Title and Reference of Methodology

The project participants use the approved VCS baseline and monitoring methodology VM0014 "Interception and destruction of fugitive methane from Coal Bed Methane (CMB) seeps", Version 1 and the "Combined tool to identify the baseline scenario and demonstration of additionality" V 3.0.

1.9 Other Programs

The project is not associated with any other programs.

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

The project is currently active. Commercial operations began on 01-January-2009 and the project has been operating continuously since then.

2.2 Deviations

2.2.1 Methodology Deviations

The following methodology deviation was approved for the Project during 2014:

- The Project utilizes a regional default value for the CO_2 emission factor for displaced gas grid fuel ($EF_{CO2,i}$) instead of site-specific data for calculating the emission factor for pipeline natural gas replaced by the project (EF_{GAS}).

2.2.2 Project Description Deviations

During this monitoring period several very minor deviations from the project description's monitoring plan occurred. These are described below:

1. Additionality Criteria for New Instances - The delineation of additionality in the Project Description did not provide specific criteria from which to assess new project instances. The project utilized the UNFCCC for CDM "Combined tool to identify the baseline scenario and demonstrate additionality" V. 3 to define additionality, specifically an investment analysis. The baseline analysis outlined an overall IRR threshold benchmark of 17.08% to demonstrate economic viability. In lieu of completing a full investment analysis the following key criteria will be used to demonstrate addtionality.

    a. The baseline investment analysis for economic viability demonstrated that $6.24/MCF natural gas price is the lower threshold. Therefore the addition of any new project instances will need to demonstrate gas prices at or below that threshold on the date of the Tribal Resolution approving project implementation or a new investment analysis provides a different threshold.

b. The project is a first of its kind methane seepage mitigation system. No regulations exist which would require natural gas producers to install a comparable mitigation system nor is there likely to be. Methane seepage mechanisms are complicated with no definitive causes being quantifiable. At the time of new instances of the project, naturally occurring methane seepage mitigation should not be mandated or regulated by any federal, state or local regulatory authority.

2. Gas flow meters are scheduled to be calibrated on a quarterly basis. Records indicate that although the Coyote Gulch Compressor Fuel flow meter (Meter #0269901) was tested on a quarterly basis during 2014, actual calibration of the meter only occurred on two instances. During the other two instances the meter tested within the prescribed range and no calibration was performed.

3. A fuel source was changed for a small heating device that provides freeze protection heating to a small shed housing some of the monitoring equipment. Previously, the operators had been using CBM gas as a fuel source but in November 2013 began using LPG at this location. The heater is only used during the winter months and fuel consumption is minimal and is expected to contribute approximately 1 tCO2e to the project emissions. For completeness, a carbon emission factor (CEF_{LPG}) and a fuel source $CONS_{LPG,PJ}$ have been added to the calculation of emission reductions. The consumption of LPG at this location is recorded annually and included in ER calculations going forward. These two parameters have been added to the parameter tables in this monitoring report. Use of the LPG fired heater will continue to be a part of the project going forward and is considered a part of the current project description.

4. Additional changes to the gas cleanup process were implemented to ensure a higher degree of product quality and consistency in 2013. First, an H_2S scavenger which injects a chemical to eliminate H_2S in the product gas was installed. Next a water injection system is used to increase the gas moisture content and improve the effectiveness of the H_2S scrubber, which is already in place. Both devices have minimal power requirements and are powered by PV panels. These changes have been made to improve the operation of the cleanup process and have no impact of the project's GHG emissions, applicability of choice of methodology, baseline or additionality. Use of the H_2S scavenger and water injection system will continue to be a part of the project going forward and is considered a part of the current project description.

5. Additional calibrations were conducted at the Vent Gas Fuel flow meter (Meter #0400501) and the Vent Gas flow meter (Meter #0410501). These meters are scheduled to be calibrated on a quarterly basis; however, monthly calibrations began in July 2013 as a best management practice and continued through 2014.

6. Red Willow Production Company and Red Cedar Gathering Company were incorrectly identified in the project description. This identification error was inadvertent and these two entities have been properly identified in this monitoring report. However, this discrepancy

represented a deviation from the project description. The proper identification of the entities is now correct and is considered a part of the project description going forward.

Status of Previous Deviations

Project description deviations 3 through 6 were reported during previous monitoring periods and are still relevant during the 2014 annual monitoring period.

2.3 Grouped Project

The project is a grouped project. A new project instance was implemented during the 2014 monitoring period. Two new wells were added to the existing system (VC SU 20-6 and VC SU 30-9) which went online on 13-June-2014. Two new compressors and associated engines were added to the system to assist in gas delivery. All new wells are located within the existing project GPS boundary for the Phase II instance and use the same technologies as specified in the Project Description (re-issued 20-May-2012).

Eligibility criteria

In accordance with the VCS Standard (VCS Version 3) the new wells meet the eligibility criteria for this project as defined in the Project Description.

	Eligibility Criteria	VC SU 20-6	VC SU 30-9
1	Is located within the same geographic region as the initial instance and collects fugitive methane from the same methane gas seep area	√	√
2	The new gas interceptor wells are connected to the gas collection system which has been constructed for the initial instance of the project	√	√
3	The gas collected by the new project instance will utilize all of the same project infrastructure and monitoring systems in place for the initial project instance	√	√
4	The new instance will only be used to produce the same end product as the initial project instance, namely pipeline quality natural gas	√	√

Both VC SU 20-6 and VC SU 30-9 wells are located within the existing Project GPS Boundaries for Phase II gas interception wells as shown in the Facility Diagram. Both new wells collect fugitive methane gas from the same methane gas seep area, are connected to the existing gas collection system and utilize all of the same project infrastructure as the Phase II wells.

Since the new wells are located within the same geographic area as the initial instances, the baseline determination and additionality assessment, as defined in Sections 2.4 and 2.5 of the Project Description and in Section 2.2.2 of this report, includes the new wells. The new wells only act to increase the annual volumes of captured fugitive methane, thus increasing the baseline emissions, project emissions and net emission reductions.

Additionality criteria

Wells VC SU 20-6 and SU 30-9 both meet the additionality criteria defined for this project under Section 2.2.2 of the 2014 Monitoring Report #4.

	Additionality Criteria	VC SU 20-6	VC SU 30-9
1	The baseline investment analysis for economic viability demonstrated that \$6.24/MCF natural gas price is the lower threshold. Therefore the addition of any new project instances will need to demonstrate gas prices at or below that threshold on the date of the Tribal Resolution approving project implementation or a new investment analysis provides a different threshold.	√	√
2	The project is a first of its kind methane seepage mitigation system. No regulations exist which would require natural gas producers to install a comparable mitigation system nor is there likely to be. Methane seepage mechanisms are complicated with no definitive causes being quantifiable. At the time of new instances of the project, naturally occurring methane seepage mitigation should not be mandated or regulated by any federal, state or local regulatory authority.	√	√

The Tribal Resolution approving installation of the two new wells was dated June 24, 2013 and was signed by Mr. Jimmy R. Newton, Jr., Chairman of the Southern Indian Tribal Council. Using weekly data provided by the U.S. Energy Information Administration (EIA), the natural gas price on this date was between \$3.97/MCF (21-June-2013) and \$3.81/MCF (28-June-2013).[1,2] The natural gas price on the date of project approval was below \$6.24/MCF. In addition no regulations requiring mitigation of natural methane seeps currently exist, or existed on June 24, 2013. The new project instance of two wells therefore meets both additionality criteria.

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

Data / Parameter	CEF_{ELEC}
Data unit	kg CO_2 / kWh
Description	Carbon emission factor for electricity from WECC Rockies grid sub-region

[1] http://www.eia.gov/dnav/ng/hist/rngwhhdW.htm

[2] Natural gas prices are reported on the EIA website as \$/mmBtu . To convert multiply \$/mmBtu x 1.025 = \$/MCF (http://www.eia.gov/tools/faqs/faq.cfm?id=45&t=8).

Source of data	US EPA eGRID 2014 version 1.0 February 2014
Value applied:	0.860
Justification of choice of data or description of measurement methods and procedures applied	The US EPA's eGRID database is the foremost authority on scope 2 greenhouse gas emissions from purchases of grid electricity in the United States. The source is appropriate because it provides an up to date CO2 emission rate per kWh purchased that is specific to the region in which the project is located.
Purpose of the data	Parameter is used in the project emission calculations, for electricity used to capture and treat gas
Comments	Updated periodically

Data / Parameter	CEF_{CH4}
Data unit	tCO_2 / tCH_4
Description	Carbon emission factor for methane combustion
Source of data	VM0014; IPCC 2007
Value applied:	2.75
Justification of choice of data or description of measurement methods and procedures applied	This is a prescribed emission factor
Purpose of the data	Parameter is used in the project emission calculations, for combustion of captured methane
Comments	N/A

Data / Parameter	EF_{gas}
Data unit	kg CO_2 / MMBtu
Description	Carbon emission factor for natural gas combustion replaced by the project activity
Source of data	VM0014; IPCC 2007
Value applied:	53.06
Justification of choice of data or description of measurement methods and procedures applied	This is a default value in the methodology, and is appropriate when the end use and location is unknown because it is representative of the US average gas emission factor
Purpose of the data	Parameter is used in the baseline emissions calculation to determine emissions replaced by the project activity
Comments	Constant for project duration

Data / Parameter	GWP_{CH4}
Data unit	N/A
Description	Global warming potential of methane
Source of data	VM0014; IPCC 2007
Value applied:	21
Justification of choice of data or description of measurement methods and procedures applied	Prescribed value
Purpose of the data	Parameter is used to convert methane emissions to carbon dioxide equivalent for project and baseline emissions calculations
Comments	N/A

Data / Parameter	$CEF_{FossFuel}$
Data unit	kg CO_2 / MMBtu
Description	Carbon emission factor for coalbed methane fuel
Source of data	Ex ante gas composition analysis
Value applied:	58.86
Justification of choice of data or description of measurement methods and procedures applied	This value was proposed in the Project Description. It is appropriate because it is based on gas composition analyses collected during the first year of the project operation.
Purpose of the data	Parameter is used to calculate project emissions from the use of CBM as fuel gas to capture and destroy methane
Comments	Assumed constant for project duration

Data / Parameter	Den_{CH4}
Data unit	Metric tonnes/ mmscf
Description	Density of methane at 14.74 psi and 60 ^oF
Source of data	Ex ante gas composition analysis
Value applied:	19.22
Justification of choice of data or description of measurement methods and procedures applied	This value was determined ex ante in the Project Description and is representative of the actual gas used. It is based on actual gas analyses collected during the first year of project operations.
Purpose of the data	Parameter is used to convert methane flow rates from mmscf as measured to metric tonnes

Comments	N/A

Data / Parameter	CBM $_{CH4}$
Data unit	Metric tonnes / MMBtu
Description	Factor to convert MMBtu of coalbed methane gross calorific value to tonnes of methane, based on average methane content
Source of data	Ex ante gas composition analysis
Value applied:	0.019
Justification of choice of data or description of measurement methods and procedures applied	This value was determined ex ante in the Project Description and is representative of the actual gas used. It is based on actual gas analyses collected during the first year of project operations.
Purpose of the data	Parameter is used to convert MMBtu values from gas sales invoices into tonnes of methane equivalent contained in gas sold, used for both project and baseline emission calculations
Comments	Assumed constant for project duration

Data / Parameter	CEF_{LPG}
Data unit	$kgCO_2$/gallon
Description	Carbon emission factor for LPG used for freeze protection of equipment at the central delivery point.
Source of data	US EPA Climate Leaders Stationary Combustion Guidance, May 2008, Table B-5
Value applied	5.79
Justification of choice of data or description of measurement methods and procedures applied	This value was determined *ex ante* using the EPA Climate Leaders Guidance, a foremost authority for US GHG emission factors and is appropriate because it represents a typical mix of LPG gases.
Purpose of the data	Calculation of project emissions
Comments	N/A

3.2 Data and Parameters Monitored

Data / Parameter	PC,CH4,CDP
Data unit	% wet (v/v)
Description	Concentration of methane in the CBM delivered and sold to Red Cedar at the central delivery point (CDP).
Source of data	Portable gas chromatograph used at sample point

	located at the CDP, near flow meter # 0410501
Description of measurement methods and procedures to be applied	Gas samples are taken at regular intervals using two PGI International gas interceptors (for redundancy). The machine automatically takes a small gas sample approximately each 660 SCF of gas flow and stores the sample in a 300 cc bottle. Each month, a Red Cedar field technician will empty the gas cylinder and run a composite sample through a portable gas chromatograph. Using this approach, the GC analysis is performed once monthly, but is representative of nearly continuous monitoring since the gas cylinder contains 4500 samples spaced at regular intervals. The portable gas chromatograph takes monthly readings and the data is downloaded to a computer in the office after each sample is taken.
Frequency of monitoring/recording	A small 0.5 cubic centimeter sample is extracted from the gas flow and stored in the gas cylinder at a volumetric flow interval of 660 SCF. At an expected flow rate of 550 MCF/day, this would result in a sample frequency of 1 minute and 44 seconds. The pressure inside the cylinder is higher than the line pressure, so the device can store more than 600 x 0.5 cc samples.
Value monitored:	63.12%
Monitoring equipment	A PGI International Gas Sampler with model number PF3MP and serial number 032516. An Agilent Technologies 3000 Micro Gas Chromatograph, various serial numbers.
QA/QC procedures to be applied	Red Cedar field technicians calibrate portable gas chromatographs on a daily basis. Calibration is performed using a standard gas cylinder. GC's are baked-out weekly to remove water build-up and each unit is inspected monthly.
Purpose of the data	Calculation of project emissions
Calculation method	N/A
Comments	N/A

Data / Parameter	$PC_{,NMHC,CDP}$
Data unit	% wet (v/v)
Description	Concentration of non-methane hydrocarbons in the CBM delivered and sold to Red Cedar at the CDP.
Source of data	Portable gas chromatograph used at sample point located at the CDP, near flow meter # 0410501
Description of measurement methods and procedures to be	Gas samples are taken at regular intervals using two PGI International gas interceptors (for redundancy). The

applied	machine automatically takes a small gas sample approximately each 660 SCF of gas flow and stores the sample in a 300 cc bottle. Each month, a Red Cedar field technician will empty the gas cylinder and run a composite sample through a portable gas chromatograph. Using this approach, the GC analysis is performed once monthly, but is representative of nearly continuous monitoring since the gas cylinder contains 4500 samples spaced at regular intervals. The portable gas chromatograph takes monthly readings and the data is downloaded to a computer in the office after each sample is taken.
Frequency of monitoring/recording	A small 0.5 cubic centimeter sample is extracted from the gas flow and stored in the gas cylinder at a volumetric flow interval of 660 SCF. At an expected flow rate of 550 MCF/day, this would result in a sample frequency of 1 minute and 44 seconds. The pressure inside the cylinder is higher than the line pressure, so the device can store more than 600 x 0.5 cc samples.
Value monitored:	Below 1% for 2014.
Monitoring equipment	A PGI International Gas Sampler with model number PF3MP and serial number 032516. An Agilent Technologies 3000 Micro Gas Chromatograph, various serial numbers.
QA/QC procedures to be applied	Red Cedar field technicians calibrate portable gas chromatographs on a daily basis. Calibration is performed using a standard gas cylinder. GC's are baked-out weekly to remove water build-up and each unit is inspected monthly.
Purpose of the data	Calculation of project emissions
Calculation method	N/A
Comments	%NMHCs are neglected unless they cumulatively account for >1% of the raw gas.

Data / Parameter	$CONS_{FossilFuel,PJ}$
Data unit	MMBtu
Description	Million Btus of coal bed methane consumed by gas engine driven compressors located at the vent wellheads and the CDP.
Source of data	Monthly Red Cedar gas sales invoices, wellhead compressor fuel use reported as "Vent Gas Fuel Charge" on invoice.
Description of measurement methods and procedures to be	CBM consumption is metered with a flow meter located near the CDP and maintained by Red Cedar Gathering Company. Monthly totals appear on gas sales invoices.

applied	
Frequency of monitoring/recording	Continuously
Value monitored:	46,015
Monitoring equipment	The gas flow rates are determined using a Daniel orifice type flow meter with a static pressure range of 500 psi and a differential pressure range of 250 psi, a meter tube diameter of 2.067 inches and an orifice diameter of 0.5 inches. A Fisher recorder, with serial number 16984801 is used to meter and record the gas flow rates. The gas flow meter has been assigned the system number 0400501 by Red Cedar.
QA/QC procedures to be applied	Gas flow meters are calibrated four times annually by Red Cedar field technicians and monthly gas composition is determined using portable gas chromatographs which are calibrated daily. All data is stored on-site at Red Cedar offices in Durango, and is remotely backed up.
Purpose of the data	Calculation of project emissions
Calculation method	Gas Btu content determined from volumetric consumption and gas composition using Flow Calc software.
Comments	Measuring equipment inspection and calibration reports have been provided to First Environment for inspections occurring over the monitoring period.

Data / Parameter	$CONS_{LPG,PJ}$
Data unit	Gallons
Description	Gallons of LPG used by freeze protection equipment located at the CDP.
Source of data	Purchase invoices from AmeriGas or other LPG vendors.
Description of measurement methods and procedures to be applied	Parameter relies on the measurement equipment used by vendor.
Frequency of monitoring/recording	Data recording only to occur when fuel deliveries are made
Value monitored:	232.9
Monitoring equipment	N/A, parameter relies on measurement equipment used by the vendor
QA/QC procedures to be applied	N/A, parameter relies on measurement equipment used by the vendor
Purpose of the data	Calculation of project emissions
Calculation method	LPG fuel volumes in gallons multiplied by a carbon emission factor for LPG.
Comments	Fuel deliveries and consumption are minimal and are a

	negligible source of project emissions but are included for completeness.

Data / Parameter	$CM_{MECH,CS,PJ}$
Data unit	MMBtu
Description	Million Btu of coal bed methane used by engine driven compressors at the Red Willow Coyote Gulch Compression station.
Source of data	Monthly Red Cedar gas sales invoices, compressor fuel allocation reported as "Coyote Compressor Fuel" on invoice.
Description of measurement methods and procedures to be applied	CBM consumption is metered with a flow meter located at the compressor station and maintained by Red Cedar Gathering Company. Monthly totals appear on gas sales invoices.
Frequency of monitoring/recording	Continuously
Value monitored:	17,505
Monitoring equipment	An orifice type flow meter measures flow rates, with a Fisher FloBoss recorder / monitor with serial number 17957472. Red Cedar assigns the number 0269901 to this station.
QA/QC procedures to be applied	Gas flow meters are calibrated four times annually by Red Cedar field technicians and monthly gas composition is determined using portable gas chromatographs which are calibrated daily. All data is stored on-site at Red Cedar offices in Durango, and is remotely backed up.
Purpose of the data	Calculation of project emissions
Calculation method	Gas Btu content determined from volumetric consumption and gas composition using Flow Calc software.
Comments	Gas consumption apportioned to the fugitive CBM is prorated by Red Cedar.

Data / Parameter	$CM_{MECH,TP,PJ}$
Data unit	MMBtu
Description	Million Btus of coal bed methane used in engine driven compressors, process heating equipment, and reboilers located at the Red Cedar Coyote Gulch Treating Plant.
Source of data	Monthly Red Cedar gas sales invoices, fuel use allocation is 5.5% of CBM delivered to the CDP
Description of measurement methods and procedures to be applied	CBM consumption is metered with a flow meter located at the treating plant and maintained by Red Cedar Gathering Company and prorated to the project on a Btu basis. Monthly totals appear on gas sales invoices.

Frequency of monitoring/recording	Continuously
Value monitored:	8,309
Monitoring equipment	various; maintained by another party
QA/QC procedures to be applied	Gas flow meters are calibrated four times annually by Red Cedar field technicians and monthly gas composition is determined using portable gas chromatographs which are calibrated daily. All data is stored on-site at Red Cedar offices in Durango, and is remotely backed up.
Purpose of the data	Calculation of project emissions
Calculation method	Gas Btu content determined from volumetric consumption and gas composition using Flow Calc software.
Comments	Gas consumption apportioned to the fugitive CBM is prorated by Red Willow.

Data / Parameter	$CM_{GAS,PJ}$
Data unit	MMBtu
Description	Million Btu of gas purchased by Red Cedar at the CDP. This value, less fuel use deductions, is the amount of gas ultimately sold to Kinder Morgan and pipelined.
Source of data	Monthly Red Cedar gas sales invoices, labeled as “Net Receipts” on invoice.
Description of measurement methods and procedures to be applied	Captured aggregated CBM is metered with a flow meter located at the CDP and maintained by Red Cedar Gathering Company.
Frequency of monitoring/recording	Continuously
Value monitored:	125,018
Monitoring equipment	The gas flow rates are determined using a Daniel orifice type flow meter with a static pressure range of 250 psi and a differential pressure range of 250 psi, a tube ID of 3.068 inches and an orifice diameter of 1.750 inches. An Emerson recorder is used to meter and record the gas flow rates. The gas flow meter station has been assigned the system number 0410501 by Red Cedar. Daniel orifice flow meter SN: 08250275 Meter Tube Number: F080118-006 Emerson FloBoss SN: 18329633
QA/QC procedures to be applied	Gas flow meters are calibrated four times annually by Red Cedar field technicians and monthly gas composition is determined using portable gas chromatographs which are calibrated daily. All data is stored on-site at Red Cedar offices in Durango, and is remotely backed up.

Purpose of the data	Calculation of project emissions and baseline emissions
Calculation method	Gas Btu content determined from volumetric consumption and gas composition using Flow Calc software.
Comments	Measuring equipment inspection and calibration reports have been provided for inspections occurring over the monitoring period.

Data / Parameter	$CONS_{ELEC,PJ,Specific}$
Data unit	kWh/MMBtu
Description	Specific consumption of electricity by equipment used to treat CBM to pipeline quality natural gas.
Source of data	Calculated from total gas production and total electricity purchase invoices, over the reporting period
Description of measurement methods and procedures to be applied	Electricity will be metered by the La Plata Electric Association electric meters located on-site and monthly invoices with kWh totals are sent to Red Cedar.
Frequency of monitoring/recording	Consumption is monitored continuously and recorded monthly
Value monitored:	0.33
Monitoring equipment	Electric meters located at the Coyote Gulch treating plant
QA/QC procedures to be applied	Electric invoices are received monthly by Red Cedar and are stored electronically.
Purpose of the data	Calculation of project emissions
Calculation method	Total electricity consumed during each month of the reporting period divided by total energy of gas delivered during each month of the reporting period.
Comments	N/A

Data / Parameter	CEF_{NMHC}
Data unit	$tCO_2/tNMHC$
Description	Carbon emission factor for non-methane hydrocarbons contained in the product gas
Source of data	Computed from annual average gas composition and known gas properties at the start of the project.
Value applied:	2.97
Justification of choice of data or description of measurement methods and procedures applied	This value was determined ex ante using a two year average gas composition analysis and is considered representative for the gas. Since the % NMHC is not expected to exceed 1%, it was decided not to monitor this parameter annually.

Purpose of the data	Calculation of project emissions
Comments	Total % NMHC is less than 1%, so this is not used in ex ante calculations

3.3 Monitoring Plan

Monitoring at SUIT is required to establish the volumes of methane which are injected into the natural gas pipeline. This volume of injected methane defines the gross volume of methane emissions prevented from escaping to the atmosphere. Flow meters and a gas chromatograph take measurements of the total flow of gas being pipeline injected as well as the concentration of methane by volume. The monthly sales volumes in million Btu of gas (MMBtu) are available from gas sales invoices and are used for emission reduction calculations. Electricity and fossil fuel consumption required by the project to compress and treat gas are available from sales invoices and utility invoices. SUGF and its partners Red Willow Gathering Company and Red Cedar Production Company are responsible for all field operations and data collection and management. Table 1 presents the location of unit operations and monitoring equipment used by the project.

Table 1: Collection and Monitoring

Location	Function	Monitoring
Interception Wells & Collection system	There are a total of 29 wellheads associated with the project, each with a gas flow meter. These wells intercept methane from the seam, and the collection system aggregates gas from the various wells. There are also 14 gas engine driven compressors used to inject the intercepted gas into the gathering system pipeline.	Coalbed methane (“Vent Gas Fuel”) is purchased from Red Cedar and delivered to engine driven wellhead compressors. Quantities of CBM gas combusted by the compressors are reported in gas purchasing invoices as “Vent Well Fuel Charge”. Gas composition analysis of CBM fuel gas combusted is provided along with invoices, this is used to calculate $CEF_{FOSSFUEL}$.
Central Delivery Point (CDP)	The CDP meters the total gas flow rate captured by the interceptor well system, and is the point of custody transfer to Red Cedar. A gas interceptor takes gas samples every 30 minutes and stores them in a gas cylinder. A portable gas chromatograph takes monthly gas samples from the cylinder to determine gas composition and Btu value.	Flow meter and GC record data to a plant computer. Gas composition analysis is used to determine NMHC content and BTU value. Flow meter used to establish volumes sold to Red Cedar. A second flow meter located near the CDP is installed on the pipeline which supplies the wellhead compressors (from above) with CBM fuel. The same process is used to establish Btu value.
Red Willow Coyote Gulch Compressor Station	Dehydration and pressurization of gas prior to gas treatment. Here CDP gas from the interceptor project is blended with CBM captured from surrounding operations.	Quantities of captured methane used for mechanical energy generation are reported in gas purchasing invoices as “Coyote Compressor Fuel”.

Red Cedar Coyote Gulch Treating Plant	Gas upgrading for pipeline injection; includes H2S removal, CO_2 removal by amine scrubbers	Quantities of captured methane used for mechanical energy generation are reported at 5.5% of CDP gas in the gas sales invoices. Electricity used to treat gas is reported in LPEA purchase invoices. Net gas delivered to the pipeline is equal to the gross gas sold at CDP less gas used to generate mechanical energy at the compressor station and the treating plant.

Roles and Responsibilities

Monitored data at the project site are analyzed and summarized monthly. Two field operations companies are responsible for data monitoring and quality control and assurance. Red Willow Production Company provides maintenance support and operates the interceptor well system, the CDP and the gas compression facility. Red Cedar Gathering Company operates the treating plant. SUIT receives monthly gas purchase invoices from Red Cedar which summarize gross production and sales, captured CBM gas which is consumed onsite for mechanical energy generation, and CBM fossil fuel purchases. Additionally, Red Cedar is responsible for maintaining and calibrating all data acquisition and storage equipment including gas flow meters and gas chromatographs.

SUIT Growth Fund Department of Energy is responsible for aggregating and managing monitoring data necessary to calculate project emission reductions according to the monitoring plan outlined in the Project Description. SUIT Growth Fund Department of Energy also prepares monitoring reports and assists with project validation and verification.

Data Collection / Monitoring Equipment

A flow meter located at the central delivery point (CDP) meters the volume of captured fugitive CBM which is collected and supplied to Red Cedar for processing and ultimately to Kinder Morgan. A gas interceptor system automatically takes small (0.2 cc) gas samples each 30 minutes and stores these in a 300 cc gas cylinder. A portable gas chromatograph takes monthly readings from this gas cylinder to determine gas composition, which together with continuous volumetric flow rate data, is used to establish the gas Btu content. Monthly totals appear on gas sales invoices.

The CDP represents the transfer of custody from SUIT to Red Cedar but not the point of sale to the final gas buyer. Gas processing downstream of the CDP is tracked and included in the project boundary. The PC hard drives will store data for the entire duration of the crediting period and an additional 2 years thereafter. The PC can be accessed and data can be downloaded remotely by SUIT staff.

The SUIT project also purchases CBM from Red Cedar to operate the wellhead compressors and process equipment at the CDP. This fuel gas is metered at a location near the CDP (meter # 0410501) before the stream is split and sent to both locations. Again, a portable GC samples the stream to determine the gas composition on a regular basis. These data are used to determine the Btus purchased by the project.

Gas flow meters are calibrated four times per year according to the manufacturer's procedure. A copy of a gas flow meter calibration records for the CDP gas sales meter (gas sold by the project) and the vent fuel gas meter (gas consumed by project) is provided along with this report. Gas composition analysis is conducted monthly using portable gas chromatographs at various locations. Portable GCs are calibrated each day prior to use by Red Cedar field technicians according to a company procedure which uses a standard gas cylinder. A copy of the GC Standard Operation Procedure is provided along with this report.

Downstream of the transfer of custody, Red Willow & Red Cedar both use captured coalbed methane pulled directly off of the product stream to operate mechanical energy generation equipment such as engine driven compressors and process heaters. Energy used to operate these equipment are prorated to the quantity of natural gas produced by the interceptor well project and are reported as MMBtu deductions on the sales gas invoices received by SUIT. The difference between gross gas sent to the CDP and these deductions represent the net production quantity being injected into the natural gas pipeline. All gas sales invoices will be kept by SUIT for 2 years following the end of the project crediting period. The same procedure as described above is used here to determine the gas flow rate and composition used to develop Btu energy consumption values.

Fossil Fuel Consumption

Coalbed methane is purchased by the project from Red Cedar and is piped to the interceptor wellhead compressors and used to evacuate fugitive methane from the seam. Red Cedar reports monthly gas purchase quantities on the sales gas invoices that SUIT receives. In addition, Red Cedar provides a gas composition analysis for the CBM fuel gas combusted by the compressors. This is used to determine the MMBtu quantity of fuel gas sold to the project. This is also used by the project to develop a carbon emission factor for the gas which is determined ex ante and used throughout the project crediting period. Red Cedar is responsible for maintaining the accuracy and integrity of gas flow meters and the gas chromatograph which are used. All gas sales invoices will be kept by SUIT for 2 years following the end of the project crediting period. In November of 2013, the project began consuming LPG to fire a freeze protection heater (which previously used CBM gas) at the CDP and these volumes are tracked annually using fuel delivery invoices.

Electricity Consumption

Electric power is supplied to the Red Cedar Coyote Gulch Gas Treating Plant by La Plata Electric Association (LPEA), a Rural Electric Cooperative. Monthly electricity purchase invoices are tracked by Red Cedar and are pro-rated to the quantity of gas produced by the interceptor well project. These data are not reported on gas sales invoices, but are provided separately by Red Cedar staff to the project. LPEA is responsible for maintaining the accuracy of electric meters located on-site. All electricity purchase invoices will be kept by Red Cedar for 2 years following the end of the project crediting period.

Quality Assurance

Volumes of coalbed methane captured and sold by the project, purchased by the project, and used by the project to generate energy used to capture methane are all metered and using differential type gas flow meters. Each flow meter used by the project has an assigned meter number and is inspected and calibrated by Red Cedar field technicians four times annually. Copies of inspection and calibration records have been provided to the project validator.

The composition of coalbed methane captured and sold by the project, purchased by the project, and used by the project to generate energy used to capture methane are all determined using a portable gas chromatograph. GCs are calibrated daily before each use according to a Red Cedar company procedure. A standard gas cylinder is used during the calibration and equipment is regularly inspected to ensure accuracy. A copy of the operations and maintenance procedure produced by Red Cedar technicians has been provided to the project validator.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

Baseline emissions for the project include emissions of natural gas combustion replaced by the project activity as well as baseline methane releases to the atmosphere of fugitive methane avoided by the project. The avoided fugitive methane emission rates in the baseline are equal to methane removal rate by the project.

Monitoring Period	Vintage	BE_{MR} (tCO_2e)	BE_{Use}(tCO_2e)	BE(tCO_2e)
01-January-2014 to 31-December-2014	2014	60,399	6,633	67,032
Sum of Reporting Period		60,399	6,633	67,032

Details on the input parameters and supporting equations can be found in Section 3.0 and Appendix B of this report and Methodology VM0014, v1.0.

4.2 Project Emissions

The emissions generated by the project through the use of electricity and CO2 generated from the combustion of coalbed methane used for energy generation are summarized in the two tables below for these two periods.

Monitoring Period	Vintage	PE_{ME} (tCO_2e)	PE_{MD}(tCO_2e)	PE(tCO_2e)
01-January-2014 to 31-December-2014	2014	2,744	7,925	10,669
Sum of Reporting Period		2,744	7,925	10,669

Details on the input parameters and supporting equations can be found in Section 3.0 and Appendix B of this report and Methodology VM0014, v1.0.

4.3 Leakage

As discussed in the PD, project leakage emissions are considered to be zero.

4.4 Net GHG Emission Reductions and Removals

The emissions reductions achieved by the project are presented table below

Year	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)
Year 2014	67,032	10,669	0	56,363
Total	**67,032**	**10,669**	**0**	**56,363**

This monitoring report is summarized as follows:

Period: 01-January-2014 through 31-December-2014

Project Emissions: 10,669 tCO2 equivalent

Baseline Emissions: 67,032 tCO2 equivalent

Emission Reductions: 56,363 tCO2 equivalent

Emissions reductions are calculated as follows:

$$\mathbf{ER_y = BE_y - PE_y - LE_y}$$

Where:

ER_y = Emission reductions in year *y* (t CO2e/yr)
BE_y = Baseline emissions in year *y* (t CO2e/yr)
PE_y = Project emissions in year *y* (t CO2/yr)
LE_y = Leakage emissions in year *y* (t CO2/yr)

Baseline emissions are calculated as follows:

$$\mathbf{BE_y = BE_{MD,y} + BE_{MR,y} + BE_{USE,y}}$$

Where:

BE_y = Baseline emissions in year *y* (t CO2e/yr)
$BE_{MD,y}$ = Baseline emissions from destruction of methane in the baseline scenario in year *y* (t CO2e/yr)
$BE_{MR,y}$ = Baseline emissions from release of methane into the atmosphere in year *y* that is avoided by the project activity (t CO2e/yr)
$BE_{USE,y}$ = Baseline emissions from the production of power, heat or supply to the gas grid replaced by the project activity in year *y* (t CO2e/yr)

Project emissions are calculated as follows:

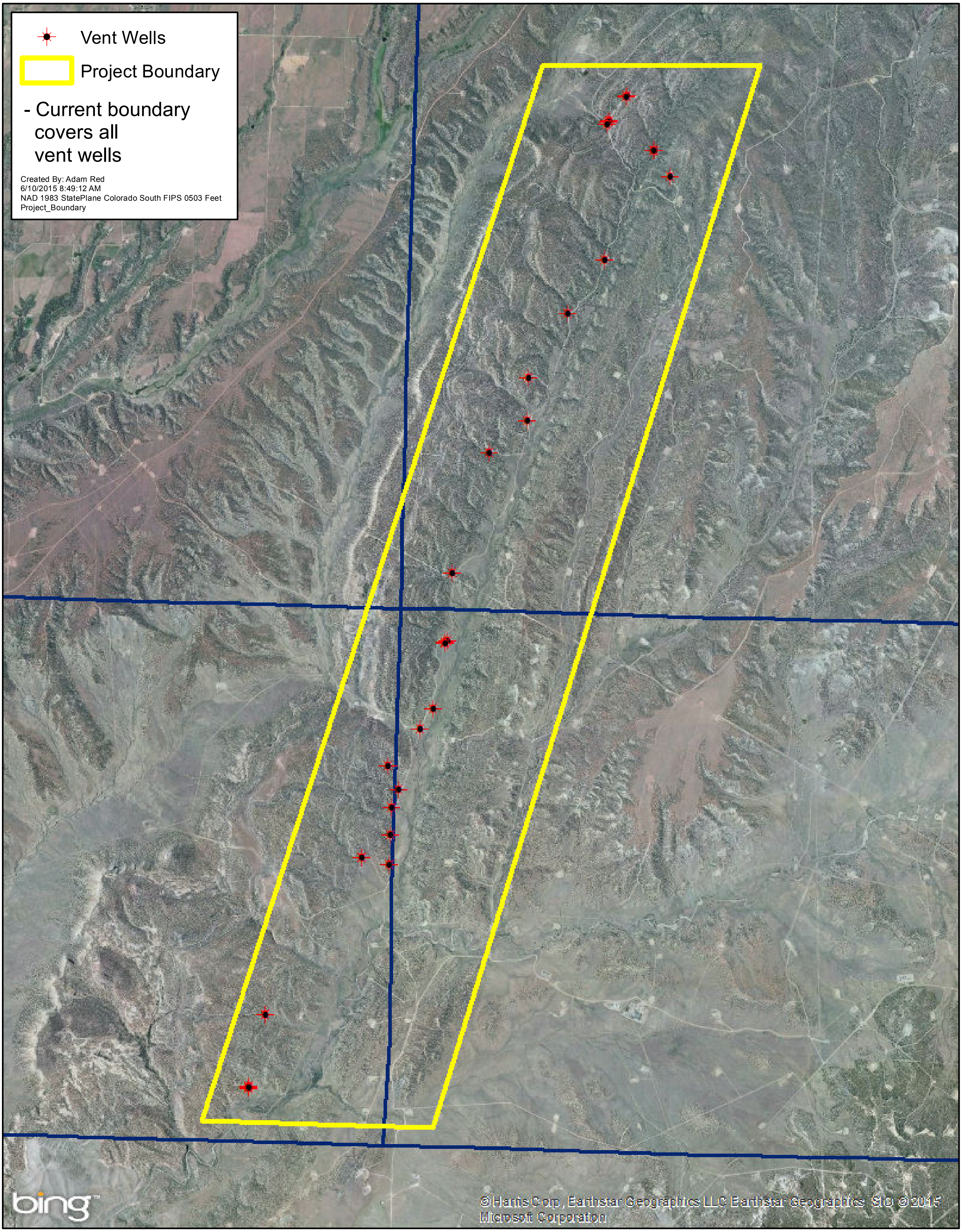
$$PE_y = PE_{ME,y} + PE_{MD,y} + PE_{UM,y}$$

Where:

PE_y	=	Project emissions in year *y* (t CO_2e/yr)
$PE_{ME,y}$	=	Project emissions from energy use to capture and use methane in year *y* (t CO_2e/yr)
$PE_{MD,y}$	=	Project emissions from methane destroyed in year *y* (t CO_2e/yr)
$PE_{UM,y}$	=	Project emissions from un-combusted methane in year *y* (t CO_2e/yr)

Details on the input parameters and supporting equations can be found in Section 3.0 and Appendix B of this report and Methodology VM0014, v1.0.

APPENDIX A: PROJECT GEOGRAPHIC AREA


Vent Wells
Project Boundary
- Current boundary covers all vent wells
Created By: Adam Red
6/10/2015 8:49:12 AM
NAD 1983 StatePlane Colorado South FIPS 0503 Feet
Project_Boundary
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APPENDIX B: SUPPORTING DATA AND EQUATIONS

Ex-post calculation of emission reductions

Average tCO2e/yr	28,052
Sum tCO2e	230,205

		VM00014 Parameter	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14
Monitored Parameters	CBM captured by project and sent to CDP (mmcf)	$CM_{PJ,vol}$	16.95	14.07	18.47	18.56	21.29	16.73	21.50	20.91	20.63	24.72	21.66	20.93
	CBM captured by project and sent to CDP (MMBtu)	$CM_{PJ,energy}$	10,386	8,671	12,164	12,212	14,112	10,593	13,527	13,180	13,196	15,908	13,988	13,122
	Concentration of methane in gas sent to CDP (%, v/v)	$PC_{,CH4,CDP}$	60.64%	61.90%	64.81%	64.21%	66.02%	61.42%	62.50%	62.24%	63.57%	63.91%	64.08%	62.15%
	Concentration of NMHC in gas sent to CDP (%, v/v)	$PC_{,NMHC,CDP}$	0.49%	0.02%	0.61%	0.83%	0.29%	0.70%	0.34%	0.50%	0.33%	0.35%	0.38%	0.41%
	CBM use at Interceptor Well Compressors (MMBtu)	$CONS_{FossilFuel,PJ}$	3,845	2,559	3,547	3,485	3,421	3,448	3,701	4,180	4,105	4,387	4,638	4,699
	CM use at CG Compression Station (MMBtu)	$CM_{MECH,CS,PJ}$	1,265	1,103	1,325	1,338	1,496	1,250	1,570	1,575	1,539	1,820	1,622	1,602
	CM use at CG Treating Plant (MMBtu)	$CM_{MECH,TP,PJ}$	571	477	669	672	776	583	744	725	726	875	769	722
	LPG use at CDP (gallons)	$CONS_{LPG,PJ}$									233			
	Grid Electricity Use at CG Processing Plant (kWh/MMBtu)	$CONS_{ELEC,PJ,Specific}$	0.4	0.4	0.3	0.3	0.3	0.3	0.4	0.3	0.4	0.3	0.3	0.3
	Grid Electricity use at CG Processing Plant (MWh)	$CONS_{ELEC,PJ}$	3.08	2.66	3.03	2.76	3.69	2.84	4.00	3.59	3.83	3.97	3.65	3.54
	Captured Methane sent to pipeline (MMBtu)	$CM_{GAS,PJ}$	8,550	7,091	10,170	10,202	11,640	8,760	11,213	10,880	10,931	13,213	11,570	10,798
	Captured Methane destroyed after being sent to pipeline (tCH4)	$CM_{GAS,PJ}$	163	135	194	195	222	167	214	207	208	252	221	206
	Captured Methane destroyed by mechanical energy generation (tCH4)	$CM_{MECH,PJ}$	35	30	38	38	43	35	44	44	43	51	46	44
	Concentration of methane in gas sent to pipeline (%, v/v)	$PC_{,CH4,GridFuel}$	95.79%	95.77%	95.87%	95.77%	95.69%	95.77%	95.76%	95.66%	95.51%	97.46%	95.57%	95.82%
	Concentration of NMHC in gas sent to pipeline (%, v/v)	$PC_{,NMCH,GridFuel}$	2.33%	2.49%	2.39%	2.34%	2.49%	2.44%	2.42%	2.47%	2.66%	0.69%	2.55%	2.48%
Project emissions	Emissions from energy to capture and destroy (tCO2)	PE_{ME}	229	153	211	208	205	205	221	249	245	262	276	280
	Combustion Emissions from use of captured methane (tCO2e)	PE_{MD}	545	455	638	649	730	562	709	691	692	834	732	688
	Project Emissions (tCO2e)	PE_y	774	608	849	857	934	768	931	940	937	1,096	1,008	968
Baseline Emissions	Baseline emissions of CBM in year y (tCH4)	CM_{BL}	198	165	232	233	265	202	258	251	252	303	266	250
	Baseline CH4 Release (tCO2e)	BE_{MRy}	4,159	3,472	4,871	4,890	5,571	4,242	5,417	5,278	5,284	6,370	5,590	5,255
	Baseline emissions from energy use replaced by project (tCO2)	$BE_{Use,y}$	454	376	540	541	618	465	595	577	580	701	614	573
	Baseline Emissions (tCO2e)	BE_y	4,613	3,848	5,411	5,431	6,188	4,707	6,012	5,855	5,864	7,071	6,204	5,827
VCUs	VCUy (tCO2e/yr)	$ER_{y,Gross\ Project}$	3,839	3,241	4,561	4,575	5,254	3,939	5,081	4,915	4,927	5,975	5,196	4,860
	Σ VCUy (tCO2e)		177,681	180,922	185,483	190,058	195,312	199,251	204,332	209,247	214,174	220,150	225,346	230,205

Baseline emissions

Baseline emissions included in this methodology are:

- CO2 emissions resulting from the destruction of methane by flares and combustion in heat and / or power generation equipment
- CH_4 from free flowing gas seeps at locations where exposed coal outcroppings exist
- CO2 emissions from the generation of heat and / or power replaced by the project activity using recovered methane

Baseline emissions are calculated as follows:

$$\mathbf{BE_y = BE_{MD,y} + BE_{MR,y} + BE_{USE,y}} \qquad \textbf{(1)}$$

Where:

BE_y	=	Baseline emissions in year *y* (t CO_2e/yr)
$BE_{MD,y}$	=	Baseline emissions from destruction of methane in the baseline scenario in year *y* (t CO_2e/yr)
$BE_{MR,y}$	=	Baseline emissions from release of methane into the atmosphere in year *y* that is avoided by the project activity (t CO_2e/yr)
$BE_{USE,y}$	=	Baseline emissions from the production of power, heat or supply to the gas grid replaced by the project activity in year *y* (t CO2e/yr)

Methane destruction in the baseline

Depending on the project type, methane destruction may already be occurring in the baseline in flares, flameless oxidation units or for the production or heat and/or power.

$$BE_{MD} = \left(CEF_{CH4} + r \times CEF_{NMHC}\right) \times \sum_i CM_{BL,i} \qquad \textbf{(2)}$$

With:

$$r = PC_{NMHC} / PC_{CH4} \qquad \textbf{(3)}$$

Where:

$BE_{MD,y}$	=	Baseline emissions from destruction of methane in the baseline scenario in year *y* (t CO_2e/yr)
CEF_{CH4}	=	Carbon emission factor for combusted methane (2.75 t CO_2/ t CH_4)
CEF_{NMHC}	=	Carbon emission factor for combusted non-methane hydrocarbons. This parameter should be obtained through periodical analysis of captured methane (t CO_2/ t NMHC)
$CM_{BL,i}$	=	Captured methane that is destroyed by use *i* in the baseline (t CH_4)
r	=	Relative proportion of NMHC compared to methane

PC_{CH4} = Concentration (in mass) of methane in extracted gas (%), measured on wet basis
PC_{NMHC} = NMHC concentration (in mass) in extracted gas (%) measured on wet basis

$$\boldsymbol{BE_{MR} = GWP_{CH4} * \sum_i \left(CM_{PJ,i,y} - CM_{BL,i,y}\right)} \quad \textbf{(4)}$$

Where:

BE_{MR}	=	Baseline emissions from release of methane into the atmosphere that is avoided by the project activity (t CO_2e)
$CM_{PJ,i,y}$	=	Captured methane that is destroyed by use *i* of the project activity in year *y* (tCH4)
$CM_{BL,i}$	=	Captured methane that would have been destroyed by use *i* in the baseline scenario in year *y* (t CH_4)

Emissions from power/heat generation replaced by project

$$BE_{USE} = GEN \times EF_{ELEC} + HEAT \times EF_{HEAT} + GAS \times EF_{GAS} \quad \textbf{(5)}$$

Where:

BE_{USE}	=	Baseline emissions from the production of power and / or heat or from destruction following injection into gas grids replaced by the project activity (t CO_2e/yr)
GEN	=	Electricity generated by project activity (MWh)
EF_{ELEC}	=	Emission factor of electricity (grid, captive or a combination) replaced by project (t CO_2/MWh)
HEAT	=	Heat generated by project activity (GJ)
EF_{HEAT}	=	Emission factor of heat production replaced by project activity (t CO_2/GJ)
GAS	=	Gas delivered to the gas grid (GJ)
EF_{GAS}	=	Emission factor for gas grid fuel replaced by the project activity (t CO_2/GJ)

Grid power emission factor

If the baseline scenario includes grid power supply that would be replaced by the project activity, the combined margin emission factor for replaced electricity shall be calculated using the "Tool to calculate the emission factor for an electricity system". However, projects based in the United States can choose to use emission factors corresponding to the applicable grid sub-region in the most recent version of the EPA's eGRID database.

Captive power emissions factor

If the baseline scenario includes captive power generation (either existing or new) that would be replaced by the project activity, the Emissions Factor for replaced electricity is calculated as follows:

$$EF_{captive} = \frac{EF_{CO2,i}}{Eff_{captive}} \times \frac{44}{12} \times \frac{3.6TJ}{1000MWh} \quad \textbf{(6)}$$

Where:

$EF_{captive}$	=	Emission factor for captive power generation (t CO_2e/MWh)
$EF_{CO2,i}$	=	CO2 emission factor of fuel used in captive power generation (tC/TJ)
$Eff_{captive}$	=	Efficiency of the captive power generation (%)
44/12	=	Carbon to Carbon Dioxide conversion factor
3.6/1000	=	TJ to MWh conversion factor

Combination of grid power and captive power emissions factor

If the baseline scenario selection determines that both captive and grid power would be used, then the emission factor for the baseline is the weighted average of the emissions factor for grid power and captive power.

$$EF_{ELEC} = s_{grid} \times EF_{grid} + s_{captive} \times EF_{captive} \quad \textbf{(7)}$$

Where:

EF_{ELEC}	=	CO_2 baseline emission factor for the electricity replaced due to the project activity (t CO_2/MWh)
EF_{grid}	=	CO_2 baseline emission factor for the grid electricity replaced due to the project activity (t CO_2/MWh)
$EF_{captive}$	=	CO_2 baseline emission factor for the captive electricity replaced due to the project activity (t CO_2/MWh)
s_{grid}	=	Share of facility electricity demand supplied by grid imports over the last 3 years (%)[1]
$s_{captive}$	=	Share of facility electricity demand supplied by captive power over the last 3 years (%)1

Heat generation emissions factor

If the baseline scenario includes heat generation (either existing or new) that is replaced by the project activity, the Emissions Factor for replaced heat generation is calculated as follows:

$$EF_{HEAT} = \frac{EF_{CO2,i}}{Eff_{heat}} \times \frac{44}{12} \times \frac{1TJ}{1000GJ} \quad \textbf{(8)}$$

Where:

EF_{HEAT}	=	Emission factor for heat generation (t CO_2/GJ)
$EF_{CO2,i}$	=	CO_2 emission factor of fuel used in heat generation (t C/TJ)
Eff_{heat}	=	Boiler efficiency of the heat generation (%)
44/12	=	Carbon to Carbon Dioxide conversion factor
1/1000	=	TJ to GJ conversion factor

To estimate the boiler efficiency, project propoents may choose between the following two options:

Option A:

Use the highest value among the following three values as a conservative approach:

(a) Measured efficiency prior to project implementation

(b) Measured efficiency during monitoring

(c) Manufacturer nameplate data for efficiency of the existing boilers

[1] If the facility is a new facility, then the share of grid versus import power determined to be the most likely baseline scenario should be used.

Option B:

Assume a boiler efficiency of 100% based on the net calorific values as a conservative approach.

Gas grid emission factor

The emission factor occuring in the baseline from the use of gas grid fuel replaced by the project activity is calculated as follows:

$$EF_{GAS} = EF_{CO2,i} \times \frac{1}{Eff_{processing}} \times \frac{44}{12} \times \frac{1TJ}{1000GJ} \quad \textbf{(9)}$$

Where:

EF_{GAS}	=	Emission factor for gas grid fuel replaced by the project activity (t CO_2/GJ)
$EF_{CO2,i}$	=	CO_2 emission factor for displaced gas grid fuel (t C/TJ)
$Eff_{processing}$	=	The efficiency of gas processing facilities used to treat captured methane onsite prior to injection into gas grids (%)[2]
44/12	=	Carbon to Carbon Dioxide conversion factor
1/1000	=	TJ to GJ conversion factor

Project emissions

Project emissions included in this methodology are:

- CO_2 emissions due to consumption of fossil fuels and electricity for the recovery, compression, and transportation of the raw gas stream;
- CO_2 emissions from the destruction of methane and non-methane hydrocarbons by flares, by heat and / or power generation equipment ;
- CH_4 emissions from incomplete combustion of raw gas by flares

Project emissions are calculated as follows:

$$PE_y = PE_{ME,y} + PE_{MD,y} + PE_{UM,y} \quad \textbf{(10)}$$

Where:

PE_y	=	Project emissions in year *y* (t CO_2e/yr)
$PE_{ME,y}$	=	Project emissions from energy use to capture and use methane in year *y* (t CO_2e/yr)
$PE_{MD,y}$	=	Project emissions from methane destroyed in year *y* (t CO_2e/yr)
$PE_{UM,y}$	=	Project emissions from un-combusted methane in year *y* (t CO_2e/yr)

[2] This efficiency refers to the combined efficiency of upgrading and injection into gas grids where resulting losses are fugitive emissions, gas flared and / or used for heat and power onsite. If gas delivered to gas grids is metered after the processing facility, then $Eff_{processing}$ is equal to 1. When gas sales to grid are metered before processing, $Eff_{processing}$ should reflect the fugitive emissions by the processing facility used.

Combustion emissions from additional energy required for methane capture and use

Additional energy may be used for the capture, compression, clean-up, and use or destruction of methane. Emissions from this energy use should be included as project emissions.

$$PE_{ME} = CONS_{ELEC,PJ} \times CEF_{ELEC} + CONS_{HEAT,PJ} \times CEF_{HEAT} + CONS_{FossFuelPJ} \times CEF_{FossFuel} \quad \textbf{(11)}$$

Where:

PE_{ME}	=	Project emissions from energy use to capture and use or destroy methane (t CO_2/yr)
$CONS_{ELEC,PJ}$	=	Additional electricity consumption for capture and use or destruction of methane, if any (MWh)[3]
CEF_{ELEC}	=	Carbon emissions factor of electricity used by the process equipment (t CO_2/MWh)
$CONS_{HEAT,PJ}$	=	Additional heat consumption for capture and use or destruction of methane, if any (GJ)
CEF_{HEAT}	=	Carbon emissions factor of heat used by the process equipment (t CO_2/GJ)
$CONS_{FossFuel,PJ}$	=	Additional fossil fuel consumption for capture and use or destruction of methane, if any (GJ)
$CEF_{FossFuel}$	=	Carbon emissions factor of fossil fuel used by the process equipment (t CO_2/GJ)

For electricity emissions factor, the same formulae are used as in the calculations of baseline emissions. In other words, if the source of power for the process equipment is the grid, then the formulae from "Tool to calculate the emission factor for an electricity system" for calculating the combined margin emissions factor are used. If the source of power for the process equipment is captive power generation, then the emissions factor is calculated based on the emission factor for the fuel used and efficiency of the captive power plant.

For the heat generation emission factor, the same formulae are used as in the calculations of baseline emissions. In other words, the boiler efficiency and the emission factor for the fuel used are the basis of the emissions factor.

Combustion emissions from use of captured methane

When the captured methane is burned in a flare, heat or power plant, mechanical power generation equipment, or oxidized in a flameless oxidation unit, combustion emissions are released. In addition, if NMHC account for more than 1% by volume of the extracted raw gas, combustion emissions from these gases should also be included. Captured methane delivered to heat and / or power generation is equal to the methane destroyed by these end uses since IPCC 2006 assumes complete combustion in these end uses.

$$PE_{MD} = (MD_{FL} + CM_{ELEC} + CM_{MECH} + CM_{HEAT} + CM_{GAS}) \times (CEF_{CH4} + r \times CEF_{NMHC}) \quad \textbf{(12)}$$

With:

$$r = PC_{NMHC}/PC_{CH4} \quad \textbf{(13)}$$

Where:[4]

PE_{MD}	=	Project emissions from destruction of captured methane (t CO_2/yr)
MD_{FL}	=	Methane destroyed through flaring (t CH_4)

[3] For example, electricity may be required to run pumps, motors, compressors, and gas clean-up equipment

[4] Note that throughout this baseline methodology, it is assumed that measured quantities of raw gas are converted to tones of methane using the measured concentration of the extracted raw gas and the density of methane.

CM_{ELEC}	=	Captured methane destroyed through electrical power generation (t CH_4)
CM_{MECH}	=	Captured methane destroyed through mechanical power generation (tCH4)
CM_{HEAT}	=	Captured methane destroyed through heat generation (t CH_4)
CM_{GAS}	=	Captured methane destroyed after being supplied to natural gas grid (t CH_4)
CEF_{CH4}	=	Carbon emissions factor for combusted methane (2.75 t CO_2/ t CH_4)
CEF_{NMHC}	=	Carbon emissions factor for combusted non-methane hydrocarbons (the concentration varies and, therefore, to be obtained through periodical analysis of captured methane) (t CO_2/ t NMHC)
r	=	Relative proportion of NMHC compared to methane
PC_{CH4}	=	Concentration (in mass) of methane in extracted gas (%), measured on wet basis
PC_{NMHC}	=	NMHC concentration (in mass) in extracted gas (%) measured on wet basis

In each end-use, the amount of gas destroyed depends on the efficiency of combustion of each end use.

$$MD_{FL} = CM_{FL} - \left(PE_{flare}/GWP_{CH4}\right) \quad \textbf{(14)}$$

Where:

MD_{FL}	=	Methane destroyed through flaring (t CH_4)
CM_{FL}	=	Captured methane delivered to flare (t CH_4)
PE_{flare}	=	Project emissions of non-combusted CH_4, expressed in terms of CO_2e, from flaring of the raw gas stream (t CO_2e)
GWP_{CH4}	=	Global warming potential of methane (21 t CO_2e/tCH_4)

The project emissions of non-combusted CH_4 expressed in terms of CO_2e from flaring of the raw gas stream (PE_{flare}) shall be calculated following the procedures described in the “Tool to determine project emissions from flaring gases containing methane”. PE_{flare} can be calculated on an annual basis or for the required period of time using this tool.

Un-combusted methane from project activity

Not all of the methane sent to the flare will be combusted, so a small amount will escape to the atmosphere. These emissions are calculated using the following:

$$PE_{UM} = PE_{flare} \quad \textbf{(15)}$$

Where:

PE_{UM}	=	Project emissions from un-combusted methane (t CO_2e)
PE_{flare}	=	Project emissions of non-combusted CH4 expressed in terms of CO2e from flaring of the raw gas stream (t CO_2e)

The project emissions from flaring of the raw gas stream (PE_{flare}) shall be calculated following the procedures described in the “Tool to determine project emissions from flaring gases containing methane”. PE_{flare} can be calculated on an annual basis or for the required period of time using this tool.

Leakage

There are no known sources of emissions leakage caused by the project type.

Emission Reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \quad \textbf{(16)}$$

Where:

ER_y = Emission reductions in year *y* (t CO_2e/yr)
BE_y = Baseline emissions in year *y* (t CO_2e/yr)
PE_y = Project emissions in year *y* (t CO_2/yr)
LE_y = Leakage emissions in year *y* (t CO_2/yr)