American Carbon Registry
at WINROCK INTERNATIONAL

METHODOLOGY FOR THE QUANTIFICATION, MONITORING, REPORTING AND VERIFICATION OF GREENHOUSE GAS EMISSIONS REDUCTIONS AND REMOVALS FROM

CAPTURING AND DESTROYING METHANE FROM U.S. COAL AND TRONA MINES

VERSION 1.0

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ABOUT AMERICAN CARBON REGISTRY® (ACR)

A leading carbon offset program founded in 1996 as the first private voluntary GHG registry in the world, ACR operates in the voluntary and regulated carbon markets. ACR has unparalleled experience in the development of environmentally rigorous, science-based offset methodologies as well as operational experience in the oversight of offset project verification, registration, offset issuance and retirement reporting through its online registry system.

ACRONYMS

For purposes of this methodology, the following acronyms apply:

AAPG	American Association of Petroleum Geologists
acf	Actual cubic feet
acfm	Actual cubic feet per minute
ACR	American Carbon Registry
AMM	Abandoned Mine Methane
ASTM	American Society of Testing and Materials
atm	Atmosphere in reference to a unit of pressure
Btu	British thermal unit
CBM	Coal Bed Methane
CH_4	Methane
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
d	Day
F	Fahrenheit
GHG	Greenhouse gas
GWP	Global Warming Potential
h	Hour
kg	Kilogram
lb	Pound
m	Minute

MG	Mine Gas
MM	Mine Methane
MMBtu	Million British thermal units
MMC	Mine Methane Capture
Mscf	Thousand standard cubic feet
Mscf/d	Thousand standard cubic feet per day
MSHA	Mine Safety and Health Administration
MT	Metric Ton
MWh	Megawatt hour
N_2O	Nitrous Oxide
R	Rankine
scf	Standard cubic foot
scf/d	Standard cubic feet per day
scfm	Standard cubic feet per minute
SMM	Surface Mine Methane
SSR	GHG sources, sinks, and reservoirs
STP	Standard temperature and pressure
QA/QC	Quality Assurance and Quality Control
VA	Ventilation Air
VAM	Ventilation Air Methane

CONTENTS

FIGURES

TABLES

EQUATIONS

1 PURPOSE

The purpose of the methodology is to quantify greenhouse gas emission reductions associated with the capture and destruction of methane that would otherwise be vented into the atmosphere as a result of mining operations at active underground and surface coal and trona mines and abandoned underground coal mines.

2 ELIGIBLE ACTIVITIES – QUANTIFICATION METHODOLOGY

This methodology includes four mine methane capture activities designed to reduce GHG emissions that result from the mining process at active underground mines, active surface mines, and abandoned underground mines. The following types of mine methane capture activities are eligible:

2.1 ACTIVE UNDERGROUND MINE VENTILATION AIR METHANE ACTIVITIES

This methodology applies to MMC projects that install a VAM collection system and qualifying device to destroy the methane in VA otherwise vented into the atmosphere through the return air shaft(s) as a result of underground coal or trona mining operations.

I. Methane sources eligible for VAM activities include:
   A. Ventilation systems; and
   B. Methane drainage systems from which mine gas is extracted and used to supplement VA. Only the mine methane sent with ventilation air to a destruction device is eligible.
II. In order to be considered a qualifying device for the purpose of this methodology, the device must not have been operational at the mine prior to the project start date.
III. At active underground mines, a Project Proponent may operate both VAM and methane drainage activities as a single offset project all sharing the earliest commencement date. Alternatively, the Project Proponent may elect to operate separate offset projects for each activity with unique commencement dates.
IV. If a newly constructed ventilation shaft is connected to an existing or new qualifying destruction device after the project start date, the Project Proponent may either classify it as an offset project expansion or list the addition as a new MMC project.
V. If an existing ventilation shaft that was not connected to a destruction device at time of the project start date is connected to an existing or new qualifying destruction device after the project start date, the Project Proponent may either classify it as an offset project expansion or as a new MMC project.

VI. If a new qualifying destruction device is added to a ventilation shaft currently connected to an existing qualifying destruction device this addition of the new qualifying destruction device is considered an offset project expansion.
VII. Ventilation air methane from any ventilation shaft connected to a pre-project destruction device at any point during the twelve months prior to the project start date is not eligible for crediting.

2.2 ACTIVE UNDERGROUND MINE METHANE DRAINAGE ACTIVITIES

This methodology applies to MMC projects that install equipment to capture and destroy methane extracted through a methane drainage system that would otherwise be vented into the atmosphere as a result of underground coal or trona mining operations.

I. Methane drainage systems must consist of one, or a combination of, the following methane sources that drain methane from the mineral seam, surrounding strata, or underground workings of the mine before, during, and/or after mining:
   A. Pre-mining surface wells; and
   B. In-mine boreholes and post-mining wells.
II. In order to be considered a qualifying device for the purpose of this methodology, a methane destruction device for an active underground mine methane drainage activity must not have been operational at the mine prior to the project start date.
III. At active underground mines, a Project Proponent may operate both VAM and methane drainage activities as a single project all sharing the earliest commencement date. Alternatively, the Project Proponent may elect to operate separate projects for each activity with unique commencement dates.
IV. If a newly drilled well/borehole is connected to an existing or new qualifying destruction device after the project start date, the Project Proponent may either classify it as an offset project expansion or a new MMC project.
V. If an existing well/borehole that was not connected to a destruction device at the project start date is connected to an existing or new qualifying destruction device after the project start date, the Project Proponent may either classify it as an offset project expansion or a new MMC project.
VI. If a new qualifying destruction device is connected to a well/borehole currently connected to an existing qualifying destruction device, this addition of the new qualifying destruction device is considered an offset project expansion.
VII. Mine methane from any well or borehole connected to a pre-project destruction device at any point during the twelve months prior to the project start date is not eligible for crediting.

VIII. To be eligible for crediting under this methodology, MMC projects at active underground mines must not:

A. Account for virgin CBM extracted from coal seams outside the extents of the mine according to the mine plan or from outside the methane source boundaries as described in Section 3.4; or

B. Use CO_2, steam, or any other fluid/gas to enhance mine methane drainage.

2.3 ACTIVE SURFACE MINE METHANE DRAINAGE ACTIVITIES

This methodology applies to MMC projects that install equipment to capture and destroy methane extracted through a methane drainage system that would otherwise be vented into the atmosphere as a result of surface coal or trona mining operations.

I. Methane drainage systems must consist of one, or a combination, of the following methane sources that drain methane from the coal seam or surrounding strata before and/or during mining:

A. Pre-mining surface wells;

B. Existing CBM wells that would otherwise be shut-in and abandoned as a result of encroaching mining;

C. Abandoned wells that are reactivated; and

D. Converted dewatering wells.

II. In order to be considered a qualifying device for the purpose of this methodology, a methane destruction device for an active surface mine methane drainage activity must not have been operational at the mine prior to the project start date.

III. If a newly drilled well/borehole is connected to an existing or new qualifying destruction device after the project start date, the Project Proponent may either classify it as an offset project expansion or a new MMC project.

IV. If an existing well/borehole that was not connected to a destruction device at time of the project start date is connected to an existing or new qualifying destruction device after the project start date, the Project Proponent may either classify it as an offset project expansion or a new MMC project.

V. If a new qualifying destruction device is connected to a well/borehole currently connected to an existing qualifying destruction device, this addition of the new qualifying destruction device is considered an offset project expansion.

VI. SMM from any well or borehole connected to a pre-project destruction device at any point during the twelve months prior to the project start date is not eligible for crediting.

VII. To be eligible for crediting under this methodology, MMC projects at active surface mines must not:
   A. Account for virgin CBM extracted from wells outside the extents of the mine according to the mine plan or from outside the methane source boundaries as described in Section 3.4;
   B. Use CO_2, steam, or any other fluid/gas to enhance mine methane drainage; or
   C. Occur at mines that employ mountaintop removal mining methods.

2.4 ABANDONED UNDERGROUND MINE METHANE RECOVERY ACTIVITIES

This methodology applies to MMC projects that install equipment to capture and destroy methane extracted through a methane drainage system that would otherwise be vented into the atmosphere as a result of previous underground coal mining operations.

I. Methane drainage systems must consist of only one methane source:
   A. In-mine boreholes and post-mining wells drilled into the mine during or after mining operations;
II. In order to be considered a qualifying device for the purpose of this methodology, a methane destruction device for an abandoned underground mine methane recovery activity must not have been operational at the mine prior to the project start date unless the mine was previously engaged in active underground methane drainage activities and the methane destruction device was considered a qualifying destruction device for those activities.
III. Abandoned underground mine methane recovery activities at multiple mines with multiple mine operators may be included in a single project if they meet the following criteria:
   A. A single Project Proponent is identified and emission reductions achieved by the project will be credited to that Project Proponent.
   B. The Project Proponent meets all monitoring and verification requirements in chapters 6, and 7.
   C. Offset project activities at all abandoned mines are in compliance with laws and regulations.
IV. In the event that there are vertically separated mines overlying and underlying other mines, wells completed in one mine can be used to capture methane in overlying or underlying mines provided the wells are within the maximum vertical extent of each mine per Section 3.4(III)(D)(i).

V. If a newly drilled well/borehole is connected to an existing or new qualifying destruction device after the project start date, the Project Proponent may either classify it as an offset project expansion or a new MMC project.

VI. If an existing well/borehole that was not connected to a destruction device at the project start date is connected to an existing or new qualifying destruction device after the project start date, the Project Proponent may either classify it as an offset project expansion or a new MMC project.

VII. If a new qualifying destruction device is connected to a well/borehole currently connected to an existing qualifying destruction device, this addition of the new qualifying destruction device is considered an offset project expansion.

VIII. AMM from any well or borehole connected to a pre-project destruction device at any point during the twelve months prior to the project start date is not eligible for crediting.

IX. To be eligible for crediting under this methodology, MMC projects at abandoned underground mines must not:

   A. Account for virgin CBM from wells outside the extents of the mine according to the final mine map(s) or from outside the methane source boundaries described in Section 3.4;

   B. Use CO_2, steam, or any other fluid/gas to enhance mine methane drainage; or

   C. Voluntarily pump water from the mine for the sole purpose of extracting methane.

3 ELIGIBILITY

MMC offset projects must adhere to the eligibility requirements below as well as general ACR program requirements included in the ACR Standard.

3.1 GENERAL ELIGIBILITY REQUIREMENTS

I. Offset projects that use this methodology must:
   A. Involve the installation and operation of a device, or set of devices, associated with the capture and destruction of mine methane;
   B. Capture mine methane that would otherwise be emitted to the atmosphere; and
   C. Destroy the captured mine methane through an eligible end-use management option per Section 3.4.

II. Project Proponents that use this methodology must:
   A. Monitor SSRs within the offset project boundary as delineated in chapter 4 per the requirements of chapter 6;
   B. Quantify GHG emission reductions per chapter 5;
   C. Prepare and submit a GHG project plan in accordance with ACR Standard requirements; and
   D. Obtain validation and verification services from an ACR-approved validation and verification body.

3.2 LOCATION

I. Only projects located in the United States are eligible under this methodology.

II. Projects must take place at either:
   A. An active underground or surface mine permitted for coal or trona mining by an appropriate state or federal agency and classified by MSHA or other applicable federal or state agency as active, intermittent, non-producing or temporarily idle;
   B. An abandoned underground coal mine classified by MSHA or other applicable federal or state agency as abandoned.

III. Mines located on federal lands are eligible for implementation of MMC projects.

3.3 ADDITIONALITY

Offset projects must meet the additionality requirements included below. Eligible offsets must be generated by projects that yield additional GHG reductions that exceed any GHG reductions otherwise required by law or regulation or any GHG reduction that would otherwise occur in a conservative business-as-usual scenario. These requirements are assessed through the Legal Requirement Test in Section 3.3.1 and the Performance Standard Evaluation in Section 3.3.2.

3.3.1 Legal Requirement Test

I. Emission reductions achieved by an MMC project must exceed those required by any law, regulation, or legally binding mandate.

II. The following legal requirement test applies to all MMC projects:

   A. If no law, regulation, or legally binding mandate requiring the destruction of methane at the mine at which the project is located exists, all emission reductions resulting from the capture and destruction of mine methane are considered to not be legally required, and therefore eligible for crediting under this methodology.

   B. If any law, regulation, or legally binding mandate requiring the destruction of methane at the mine at which the project is located exists, only emission reductions resulting from the capture and destruction of mine methane that are in excess of what is required to comply with those laws, regulations, and/or legally binding mandates are eligible for crediting under this methodology.

3.3.2 Performance Standard Evaluation

I. Emission reductions achieved by an MMC project must exceed those likely to occur in a conservative business-as-usual scenario.

II. The performance standard evaluation is satisfied if the following requirements are met, on the basis of activity type:

   A. Active Underground Mine VAM Activities

      i. Destruction of VAM via any end-use management option automatically satisfies the performance standard evaluation because destruction of VAM is not common practice nor considered business-as-usual, and is therefore eligible for crediting under this methodology.

   B. Active Underground Mine Methane Drainage Activities

      i. Destruction of extracted mine methane via any end-use management option automatically satisfies the performance standard evaluation because it is not common practice nor considered business-as-usual, and is therefore eligible for crediting under this methodology.

C. Active Surface Mine Methane Drainage Activities
  i. Destruction of extracted mine methane via any end-use management option automatically satisfies the performance standard evaluation because it is not common practice nor considered business-as-usual, and is therefore eligible for crediting under this methodology.

D. Abandoned Underground Mine Methane Recovery Activities
  i. Destruction of extracted mine methane via any end-use management option automatically satisfies the performance standard evaluation because it is not common practice nor considered business-as-usual, and is therefore eligible for crediting under this methodology.

3.4 METHANE SOURCE BOUNDARIES

I. The methane destroyed for the purpose of reducing mine methane emissions under this methodology must be methane that would otherwise be emitted into the atmosphere during the normal course of mining activities or as a result of past mining activities.

II. Methane from a mine's ventilation and gas drainage systems must be collected from within the mine extents according to an up-to-date or final mine plan.

III. Additional physical boundaries on the basis of activity type are as follows:

A. Active underground mine ventilation air methane activities may account for:
  i. All destroyed methane contained in VA collected from a mine ventilation system; and
  ii. All destroyed mine methane contained in mine gas extracted from a methane drainage system used to supplement VA.

B. To ensure that virgin coal bed methane is excluded from the destroyed mine methane accounted for in this methodology, physical boundaries must be placed on methane drainage systems. Active underground mine methane drainage activities may account for:
  i. Destroyed mine methane contained in mine gas extracted from strata up to 150 meters above and 50 meters below a mined seam through pre-mining surface wells and in-mine boreholes; and
  ii. All destroyed mine methane contained in mine gas extracted through post-mining wells.

C. Active surface mine methane drainage activities may account for destroyed surface mine methane contained in mine gas extracted from all strata above and up to 50 meters below a mined seam through pre-mining surface wells, existing coal bed methane wells that would otherwise be shut-in and abandoned as a result of encroaching mining, abandoned wells that are reactivated, and converted dewatering wells.

D. Abandoned underground mine methane recovery activities may account for:
   i. Destroyed abandoned mine methane contained in mine gas extracted from strata up to 150 meters above and 50 meters below a mined seam through existing or newly drilled in-mine boreholes or post-mining wells.

3.5 START DATE

I. An offset project must meet the start date requirements set forth in the ACR Standard.
II. For this methodology, the project start date is defined as the date on which the project's mine methane capture and destruction equipment becomes operational following a start-up period.

3.6 PROJECT CREDITING PERIOD

I. The crediting period for this methodology is ten years.
II. The crediting period begins on the project start date[1].

3.7 REGULATORY COMPLIANCE

I. An offset project must meet the regulatory compliance requirements set forth in the ACR Standard.

[1] As an exception, projects located at active underground mines that become abandoned (and therefore will reclassify an existing, operational project as an "abandoned underground mine methane project") shall designate a start date for abandoned underground mine methane project activities no later than 9 months following the date of mine abandonment.

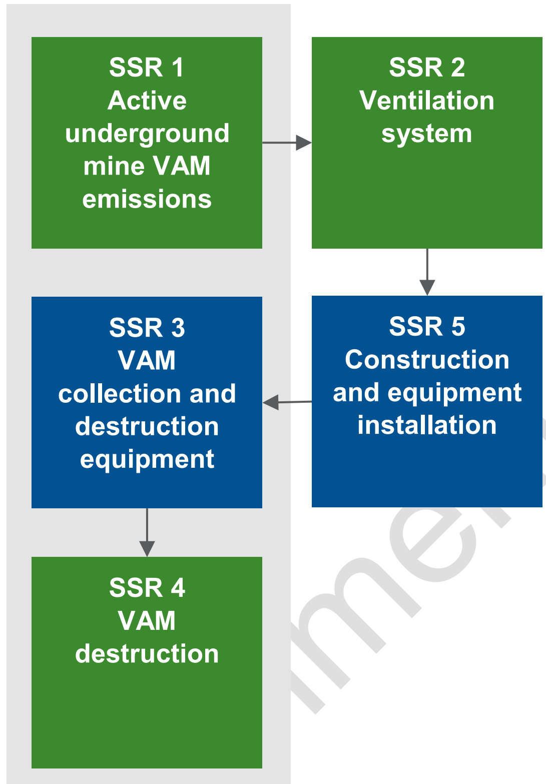
4 OFFSET PROJECT BOUNDARY – QUANTIFICATION METHODOLOGY

The offset project boundary delineates the SSRs that must be included or excluded when quantifying the net change in emissions associated with the installation and operation of a device, or set of devices, associated with the capture and destruction of mine methane. The following offset project boundaries apply to all MMC projects on the basis of activity type:

4.1 ACTIVE UNDERGROUND MINE VAM ACTIVITIES

I. Figure 1 illustrates the offset project boundary for active underground mine VAM activities, indicating which SSRs are included or excluded from the offset project boundary.
   A. All SSRs inside the grey box are included and must be accounted for under this methodology.
   B. SSRs in green boxes are relevant to the baseline and project emissions.
   C. SSRs in blue boxes are relevant only to project emissions.

Figure 1: Offset Project Boundary for Active Underground Mine VAM Activities



II. Table 1 lists the SSRs for active underground mine VAM activities, indicating which gases are included or excluded from the offset project boundary.

Table 1: Greenhouse Gas Sinks, Sources, and Reservoirs for Active Underground Mine VAM Activities

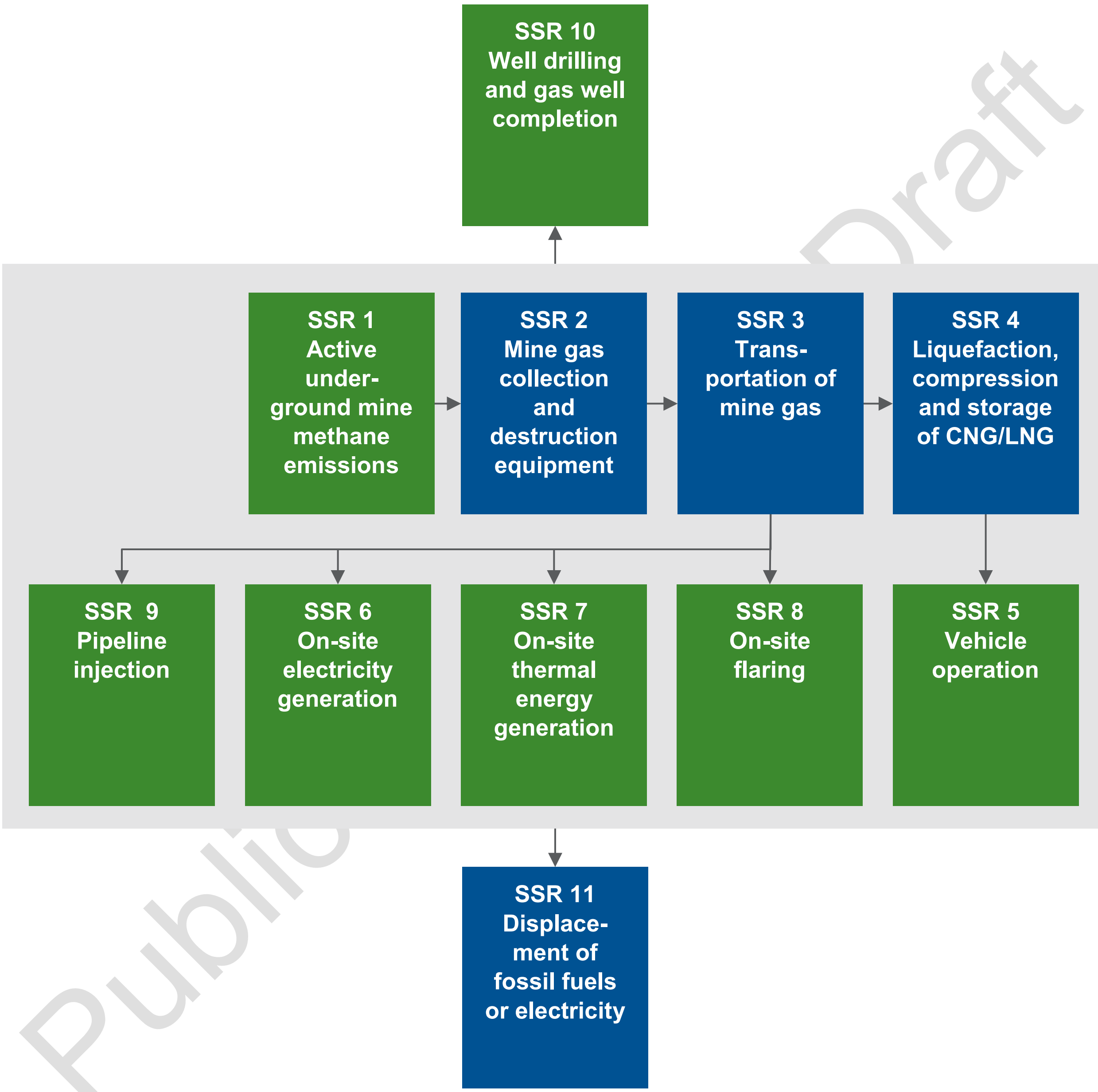
SSR	DESCRIPTION	GHG	BASELINE (B) OR PROJECT (P)	INCLUDED OR EXCLUDED
1 Active underground mine VAM emissions	Emissions from the venting of VAM through mine ventilation system	CH_4	B, P	Included
		CO_2	n/a	Excluded

SSR	DESCRIPTION	GHG	BASELINE (B) OR PROJECT (P)	INCLUDED OR EXCLUDED
2 Ventilation system	Emissions resulting from energy consumed to operate mine ventilation system	CH_4	n/a	Excluded
		N_2O	n/a	Excluded
3 VAM collection and destruction equipment	Emissions resulting from energy consumed to operate additional equipment used to capture or destroy VAM	CO_2	P	Included
		CH_4	n/a	Excluded
		N_2O	n/a	Excluded
4 VAM destruction	Emissions resulting from VAM destruction	CO_2	B, P	Included
		N_2O	n/a	Excluded
	Emissions of uncombusted methane	CH_4	B, P	Included
5 Construction and equipment installation	Emissions from construction and/or installation of new equipment	CO_2	n/a	Excluded
		CH_4	n/a	Excluded
		N_2O	n/a	Excluded
	Fugitive emissions from construction	CH_4	n/a	Excluded

4.2 ACTIVE UNDERGROUND MINE METHANE DRAINAGE ACTIVITIES

I. Figure 2 illustrates the offset project boundary for active underground mine methane drainage activities, indicating which SSRs are included or excluded from the offset project boundary.
   A. All SSRs inside the grey box are included and must be accounted for under this methodology.
   B. SSRs in green boxes are relevant to the baseline and project emissions.
   C. SSRs in blue boxes are relevant only to project emissions.

Figure 2: Offset Project Boundary for Active Underground Mine Methane Drainage Activities



II. Table 2 lists the identified SSRs for active underground mine methane drainage activities, indicating which gases are included or excluded from the offset project boundary.

Table 2: Identified Greenhouse Gas Sinks, Sources, and Reservoirs for Active Underground Mine Methane Drainage Activities

SSR	DESCRIPTION	GHG	BASELINE (B) OR PROJECT (P)	INCLUDED OR EXCLUDED
1 Active underground mine VAM emissions	Emissions from the venting of mine methane extracted through methane drainage system	CH_4	B, P	Included
2 Mine gas collection and destruction equipment	Emissions resulting from energy consumed to operate additional equipment used to capture, treat, or destroy drained mine gas	CO_2	P	Included
		CH_4	n/a	Excluded
		N_2O	n/a	Excluded
	Fugitive emissions from operation of additional equipment used to capture, treat, or destroy drained mine gas	CH_4	n/a	Excluded
3 Transportation of mine gas	Emissions resulting from additional energy consumed to transport mine gas to treatment or destruction equipment	CO_2	P	Included
		CH_4	n/a	Excluded
		N_2O	n/a	Excluded
	Fugitive emissions from the on-site transportation of mine gas	CH_4	n/a	Excluded
4 Liquefaction, compression and storage of CNG/LNG	Emissions resulting from energy consumed to operate additional equipment used to liquefy, compress,	CO_2	P	Included
		CH_4	n/a	Excluded
		N_2O	n/a	Excluded

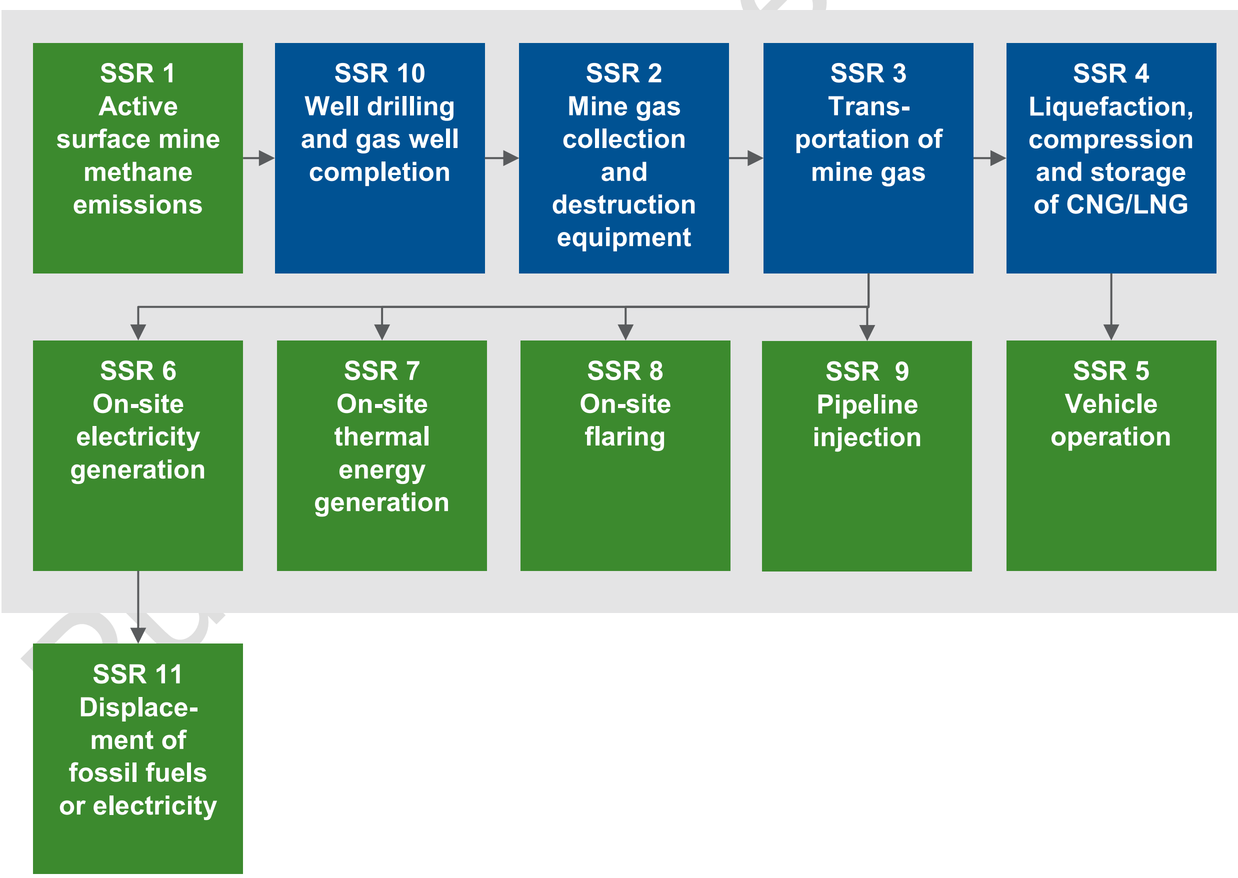
SSR	DESCRIPTION	GHG	BASELINE (B) OR PROJECT (P)	INCLUDED OR EXCLUDED
	or store methane for vehicle use.			
	Fugitive emissions from operation of additional equipment used to liquefy, compress, or store methane for vehicle use	CH_4	n/a	Excluded
5 Vehicle operation	Emissions resulting from methane combustion during vehicle operation	CO_2	B, P	Included
		N_2O	n/a	Excluded
	Emissions resulting from incomplete methane combustion during vehicle operation	CH_4	B, P	Included
6 On-site electricity generation	Emissions resulting from methane combustion during on-site electricity generation	CO_2	B, P	Included
		N_2O	n/a	Excluded
	Emissions resulting from incomplete methane combustion during on-site electricity generation	CH_4	B, P	Included
7 On-site thermal energy generation	Emissions resulting from methane combustion during on-site thermal energy generation	CO_2	B, P	Included
		N_2O	n/a	Excluded
	Emissions resulting from incomplete methane combustion during on-site thermal energy generation	CH_4	B, P	Included
8 On-site flaring		CO_2	B, P	Included

SSR	DESCRIPTION	GHG	BASELINE (B) OR PROJECT (P)	INCLUDED OR EXCLUDED
	Emissions resulting from methane combustion during on-site flaring	N_2O	n/a	Excluded
	Emissions resulting from incomplete methane combustion during flaring	CH_4	B, P	Included
9 Pipeline injection	Emissions resulting from methane combustion resulting from pipeline injection	CO_2	B, P	Included
		N_2O	B, P	Excluded
	Emissions resulting from the incomplete methane combustion resulting from pipeline injection	CH_4	B, P	Included
10 Well drilling and gas well completion	Emissions from well drilling and gas well completion	CO_2	n/a	Excluded
		CH_4	n/a	Excluded
		N_2O	n/a	Excluded
	Fugitive emissions from well drilling and gas well completion	CH_4	n/a	Excluded
11 Displacement of fossil fuels or electricity	Emission reductions resulting from the displacement of fossil fuels or electricity	CO_2	n/a	Excluded
		CH_4	n/a	Excluded
		N_2O	n/a	Excluded

4.3 ACTIVE SURFACE MINE METHANE DRAINAGE ACTIVITIES

I. Figure 3 illustrates the offset project boundary for active surface mine methane drainage activities, indicating which SSRs are included or excluded from the offset project boundary.
   A. All SSRs inside the grey box are included and must be accounted for under this methodology.
   B. SSRs in green boxes are relevant to the baseline and project emissions.
   C. SSRs in blue boxes are relevant only to project emissions.

Figure 3: Offset Project Boundary for Active Surface Mine Methane Drainage Activities



II. Table 3 lists the SSRs for active surface mine methane drainage activities, indicating which gases are included or excluded from the offset project boundary.

Table 3: Greenhouse Gas Sinks, Sources, and Reservoirs for Active Surface Mine Methane Drainage Activities

SSR	DESCRIPTION	GHG	BASELINE (B) OR PROJECT (P)	INCLUDED OR EXCLUDED
1 Active surface mine methane emissions	Emissions from the venting of mine methane during the mining process	CH_4	B, P	Included
2 Mine gas collection and destruction equipment	Emissions resulting from energy consumed to operate additional equipment used to capture, treat, or destroy drained mine gas	CO_2	P	Included
		CH_4	n/a	Excluded
		N_2O	n/a	Excluded
	Fugitive emissions from operation of additional equipment used to capture, treat, or destroy drained mine gas	CH_4	n/a	Excluded
3 Transportation of mine gas	Emissions resulting from additional energy consumed to transport mine gas to treatment or destruction equipment	CO_2	P	Included
		CH_4	n/a	Excluded
		N_2O	n/a	Excluded
	Fugitive emissions from the on-site transportation of mine gas	CH_4	n/a	Excluded
4 Liquefaction, compression and storage of CNG/LNG	Emissions resulting from energy consumed to operate additional equipment used to liquefy, compress,	CO_2	P	Included
		CH_4	n/a	Excluded
		N_2O	n/a	Excluded

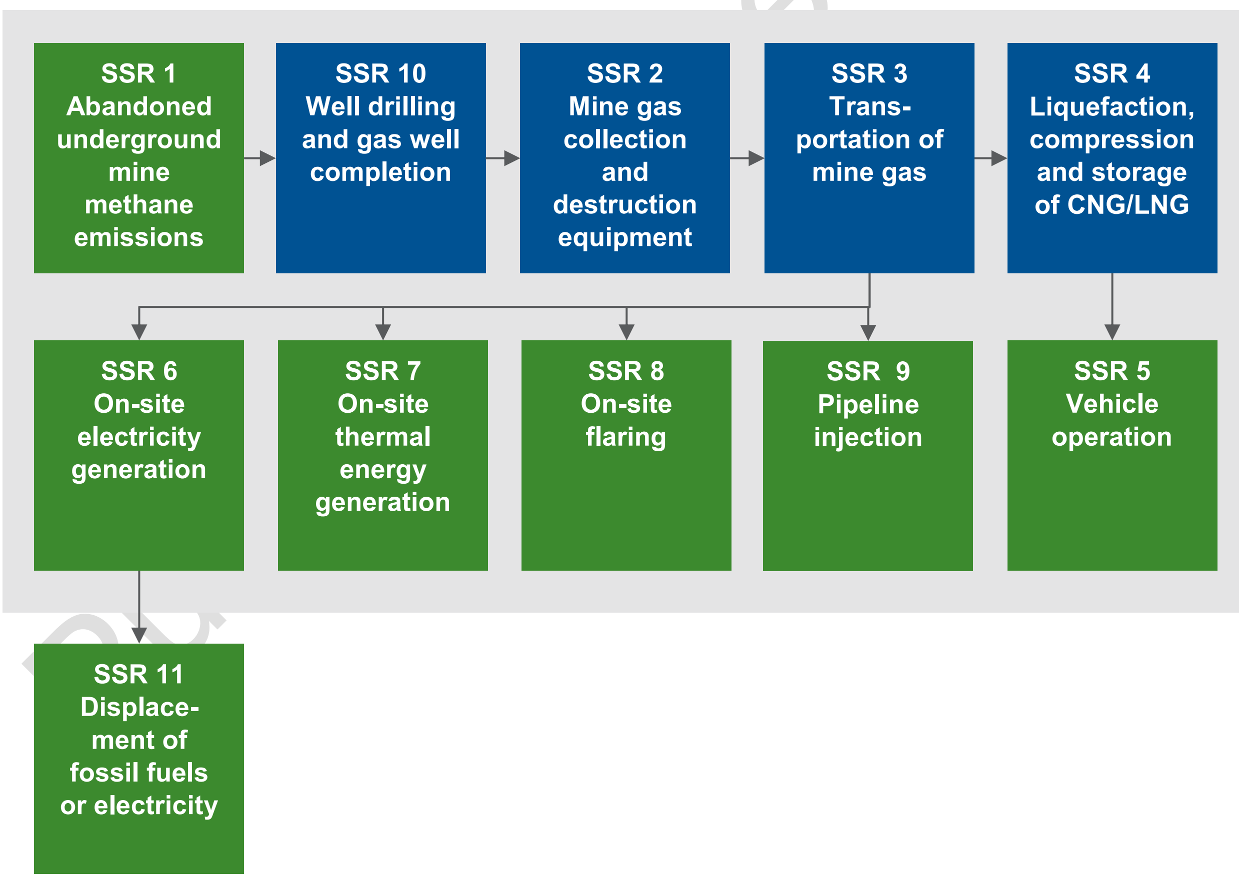
SSR	DESCRIPTION	GHG	BASELINE (B) OR PROJECT (P)	INCLUDED OR EXCLUDED
	or store methane for vehicle use.			
	Fugitive emissions from operation of additional equipment used to liquefy, compress, or store methane for vehicle use	CH_4	n/a	Excluded
5 Vehicle operation	Emissions resulting from methane combustion during vehicle operation	CO_2	B, P	Included
		N_2O	n/a	Excluded
	Emissions resulting from incomplete methane combustion during vehicle operation	CH_4	B, P	Included
6 On-site electricity generation	Emissions resulting from methane combustion during on-site electricity generation	CO_2	B, P	Included
		N_2O	n/a	Excluded
	Emissions resulting from incomplete methane combustion during on-site electricity generation	CH_4	B, P	Included
7 On-site thermal energy generation	Emissions resulting from methane combustion during on-site thermal energy generation	CO_2	B, P	Included
		N_2O	n/a	Excluded
	Emissions resulting from incomplete methane combustion during on-site thermal energy generation	CH_4	B, P	Included
8 On-site flaring		CO_2	B, P	Included

SSR	DESCRIPTION	GHG	BASELINE (B) OR PROJECT (P)	INCLUDED OR EXCLUDED
	Emissions resulting from methane combustion during on-site flaring	N_2O	n/a	Excluded
	Emissions resulting from incomplete methane combustion during flaring	CH_4	B, P	Included
9 Pipeline injection	Emissions resulting from methane combustion resulting from pipeline injection	CO_2	B, P	Included
		N_2O	n/a	Excluded
	Emissions resulting from the incomplete methane combustion resulting from pipeline injection	CH_4	B, P	Included
10 Well drilling and gas well completion	Emissions from additional well drilling and well gas completion	CO_2	P	Included
		CH_4	n/a	Excluded
		N_2O	n/a	Excluded
	Fugitive emissions from additional well drilling and gas well completion	CH_4	n/a	Excluded
11 Displacement of fossil fuels or electricity	Emission reductions resulting from the displacement of fossil fuels or electricity	CO_2	n/a	Excluded
		CH_4	n/a	Excluded
		N_2O	n/a	Excluded

4.4 ABANDONED UNDERGROUND MINE METHANE RECOVERY ACTIVITIES

I. Figure 4 illustrates the offset project boundary for abandoned underground mine methane recovery activities, indicating which SSRs are included or excluded from the offset project boundary.
   A. All SSRs inside the grey box are included and must be accounted for under this methodology.
   B. SSRs in green boxes are relevant to the baseline and project emissions.
   C. SSRs in blue boxes are relevant only to project emissions.

Figure 4: Offset Project Boundary for Abandoned Underground Mine Methane Recovery Activities



II. Table 4 lists the SSRs for abandoned underground mine methane recovery activities, indicating which gases are included or excluded from the offset project boundary.

Table 4: Greenhouse Gas Sinks, Sources, and Reservoirs for Abandoned Underground Mine Methane Recovery Activities

SSR	DESCRIPTION	GHG	BASELINE (B) OR PROJECT (P)	INCLUDED OR EXCLUDED
1 Abandoned underground mine methane emissions	Emissions of mine methane liberated after the conclusion of mining operations	CH_4	B, P	Included
2 Mine gas collection and destruction equipment	Emissions resulting from energy consumed to operate additional equipment used to capture, treat, or destroy drained mine gas	CO_2	P	Included
		CH_4	n/a	Excluded
		N_2O	n/a	Excluded
	Fugitive emissions from operation of additional equipment used to capture, treat, or destroy drained mine gas	CH_4	n/a	Excluded
3 Transportation of mine gas	Emissions resulting from additional energy consumed to transport mine gas to treatment or destruction equipment	CO_2	P	Included
		CH_4	n/a	Excluded
		N_2O	n/a	Excluded
	Fugitive emissions from the on-site transportation of mine gas	CH_4	n/a	Excluded
		CO_2	P	Included

SSR	DESCRIPTION	GHG	BASELINE (B) OR PROJECT (P)	INCLUDED OR EXCLUDED
4 Liquefaction, compression and storage of CNG/LNG	Emissions resulting from energy consumed to operate equipment used to liquefy, compress, or store methane for vehicle use.	CH_4	n/a	Excluded
		N_2O	n/a	Excluded
	Fugitive emissions from operation of equipment used to liquefy, compress, or store methane for vehicle use	CH_4	n/a	Excluded
5 Vehicle operation	Emissions resulting from methane combustion during vehicle operation	CO_2	B, P	Included
		N_2O	n/a	Excluded
	Emissions resulting from incomplete methane combustion during vehicle operation	CH_4	B, P	Included
6 On-site electricity generation	Emissions resulting from methane combustion during on-site electricity generation	CO_2	B, P	Included
		N_2O	n/a	Excluded
	Emissions resulting from incomplete methane combustion during on-site electricity generation	CH_4	B, P	Included
7 On-site thermal energy generation	Emissions resulting from methane combustion during on-site thermal energy generation	CO_2	B, P	Included
		N_2O	n/a	Excluded

SSR	DESCRIPTION	GHG	BASELINE (B) OR PROJECT (P)	INCLUDED OR EXCLUDED
	Emissions resulting from incomplete methane combustion during on-site electricity generation	CH_4	B, P	Included
8 On-site flaring	Emissions resulting from methane combustion during on-site flaring	CO_2	B, P	Included
		N_2O	n/a	Excluded
	Emissions resulting from incomplete methane combustion during flaring	CH_4	B, P	Included
9 Pipeline injection	Emissions resulting from methane combustion resulting from pipeline injection	CO_2	B, P	Included
		N_2O	n/a	Excluded
	Emissions resulting from the incomplete methane combustion resulting from pipeline injection	CH_4	B, P	Included
10 Well drilling and gas well completion	Emissions from additional well drilling and well gas completion	CO_2	B, P	Included
		CH_4	n/a	Excluded
		N_2O	n/a	Excluded
	Fugitive emissions from additional well drilling and gas well completion	CH_4	n/a	Excluded
11 Displacement of fossil fuels or electricity	Emission reductions resulting from the displacement of fossil fuels or electricity	CO_2	n/a	Excluded
		CH_4	n/a	Excluded
		N_2O	n/a	Excluded

5 QUANTIFYING GHG EMISSION REDUCTIONS – QUANTIFICATION METHODOLOGY

I. GHG emission reductions from an MMC project are quantified by comparing actual project emissions to project baseline emissions at the mine.

II. Project Proponents must use the activity type-specific calculation methods provided in this methodology to determine baseline and project GHG emissions.

III. GHG emission reductions must be quantified over a consecutive twelve-month period. The length of time over which GHG emission reductions are quantified is called the "reporting period."

IV. Measurements used to quantify GHG emission reductions must be quantified using flow rates and methane densities adjusted to standard conditions of 60°F and 14.7 pounds per square inch (1 atm).

V. Depending on the methane analyzer technology used, methane concentration readings may or may not need to be adjusted for temperature and pressure. If readings require adjustment, then such adjustments must be performed.

VI. Global warming potential values must be determined in accordance with the requirements set forth in the ACR Standard.

5.1 ACTIVE UNDERGROUND MINE VENTILATION AIR METHANE ACTIVITIES

I. GHG emission reductions for a reporting period (ER) must be quantified by subtracting the project emissions for that reporting period (PE) from the baseline emissions for that reporting period (BE) using Equation 1.

Equation 1: GHG Emission Reductions

$$\mathbf{ER = BE - PE}$$

WHERE

ER	Emission reductions achieved by the project during the reporting period (MT CO_2e)
BE	Baseline emissions during the reporting period (MT CO_2e)
PE	Project emissions during the reporting period (MT CO_2e)

5.1.1 Quantifying Baseline Emissions

I. For active underground mine ventilation air methane projects, baseline emissions equal the baseline emissions from release of methane into the atmosphere during the reporting period.

Equation 2: Baseline Emissions

$$\mathbf{BE = BE_{MR}}$$

WHERE

BE	Baseline emissions during the reporting period (MT CO_2e)
BE_{MR}	Baseline emissions from release of methane into the atmosphere during the reporting period (MT CO_2e)

II. Baseline emissions from the release of methane (BE_{MR}) must be quantified using Equation 3.

III. BE_{MR} must account for the total amount of methane actually destroyed by all qualifying devices during the reporting period.

IV. VAM project activities may supplement VA with mine gas (MG) extracted from a methane drainage system to either increase or help balance the methane concentration of VA flowing into the destruction device. If MG is used to supplement VA, the MG destroyed by the project during the reporting period must be accounted for using Equation 3, either as

$MG_{SUPP,i}$ if VA flow and MG flow are monitored separately, or through $VA_{P,i}$ if only the resulting enriched flow is monitored.

V. Methane that is still vented in the project scenario is not accounted for in the project emissions or baseline emissions since it is vented in both scenarios.

Equation 3: Baseline Emissions from Release of Methane

$$BE_{MR} = \sum_{i}[(VA_{P_i} \times C_{CH4}) + MG_{SUPP_i} \times C_{CH4_{MG}}] \times 0.0423 \times 0.000454 \times GWP_{CH4}$$

WHERE

BE_{MR}	Baseline emissions from release of methane into the atmosphere during the reporting period (MT CO_2e)
i	Use of methane (oxidation or alternative end-use) by all qualifying destruction devices
VA_{P_i}	Volume of ventilation air sent to qualifying devices for destruction through use i during the reporting period (scf)
C_{CH4}	Weighted average of measured methane concentration of captured ventilation air sent to qualifying destruction devices during the reporting period (scf CH_4/scf)
MG_{SUPP_i}	Volume of mine gas that would have been extracted from a methane drainage system and sent with ventilation air to qualifying devices for destruction during the reporting period (scf)
$C_{CH4_{MG}}$	Weighted average of measured methane concentration of captured mine gas that would have been sent with ventilation air to devices for destruction during the reporting period (scf CH_4/scf)
0.0423	Standard density of methane (lb CH_4/scf CH_4)
0.000454	MT CH_4/lb CH_4
GWP_{CH4}	Global warming potential of methane (MT CO_2e/MT CH_4)

WITH

$$C_{CH4} = \frac{\sum_t \left(VA_{flow_t} \times C_{CH4_t}\right)}{\sum_t VA_{flow_t}}$$

WHERE

C_{CH4_t}	Hourly average methane concentration of ventilation air sent to a destruction device (scf CH_4/scf)
VA_{FLOW_t}	Hourly average flow rate of ventilation air sent to a destruction device (scfm)

AND

$$C_{CH4_{MG}} = \frac{\sum_t \left(DV_{MG_t} \times C_{CH4_{MG_t}}\right)}{\sum_t DV_{MG_t}}$$

WHERE

$C_{CH4_{MG_t}}$	Daily average methane concentration of mine gas sent with ventilation air to destruction device (scf CH_4/scf)
DV_{MG_t}	Daily volume of mine gas sent with ventilation air to destruction device (scf)

Methane concentrations and flow rates must be recorded every fifteen minutes with averages calculated at least hourly. If the Project Proponent monitors and records data at a higher frequency, this data may be used within appropriate variables of the above equations to reflect the higher frequency of data collection.

If a mass flow meter is used to monitor gas flow instead of a volumetric flow meter, the volume and density terms must be replaced by the monitored mass value and the methane concentration must be in mass percent.

5.1.2 Quantifying Project Emissions

I. Project emissions must be quantified during the entire reporting period.
II. Project emissions for a reporting period (PE) must be quantified by summing the emissions for all SSRs identified as included in the project in Table 1 and using Equation 4.
III. VAM that is still vented in the project scenario is not accounted for in the project emissions or baseline emissions since it is vented in both scenarios.

Equation 4: Project Emissions

$$\mathbf{PE = PE_{EC} + PE_{MD} + PE_{UM}}$$

WHERE

$\mathbf{PE}$	Project emissions during the reporting period (MT CO_2e)
$\mathbf{PE_{EC}}$	Project emissions from energy consumed to capture and destroy methane during the reporting period (MT CO_2e)
$\mathbf{PE_{MD}}$	Project emissions from destruction of methane during the reporting period (MT CO_2e)
$\mathbf{PE_{UM}}$	Project emissions from uncombusted methane during the reporting period (MT CO_2e)

IV. If the project uses fossil fuel or grid electricity to power additional equipment required for project activities (e.g., capturing and destroying ventilation air, transporting ventilation air, etc.), the resulting CO_2 emissions from the energy consumed to capture and destroy methane (PE_{EC}) must be quantified using Equation 5.

Equation 5: Project Emissions from Energy Consumed to Capture and Destroy Methane

$$\mathbf{PE_{EC} = (CONS_{ELEC} \times CEF_{ELEC}) + \frac{(CONS_{HEAT} \times CEF_{HEAT} + CONS_{FF} \times CEF_{FF})}{1,000}}$$

WHERE

$\mathbf{PE_{EC}}$	Project emissions from energy consumed to capture and destroy methane during the reporting period (MT CO_2e)
$\mathbf{CONS_{ELEC}}$	Additional electricity consumption for the capture and destruction of methane during the reporting period (MWh)
$\mathbf{CEF_{ELEC}}$	CO_2 emission factor of electricity used from Appendix A (MT CO_2e/MWh)
$\mathbf{CONS_{HEAT}}$	Additional heat consumption for the capture and destruction of methane during the reporting period (volume)

CEF_{HEAT}	CO_2 emission factor of heat used from Equation 44 (kg CO_2/volume)
$CONS_{FF}$	Additional fossil fuel consumption for the capture and destruction of methane during the reporting period (volume)
CEF_{FF}	CO_2 emission factor of fossil fuel used from Appendix A (kg CO_2/volume)
$\frac{1}{1,000}$	Conversion of kg to metric tons

V. Project emissions from the destruction of methane (PE_{MD}) must be quantified using Equation 6.

Equation 6: Project Emissions from Destruction of Methane

$$PE_{MD} = \sum_{i} MD_{P_i} \times CEF_{CH4}$$

WHERE

PE_{MD}	Project emissions from destruction of methane during the reporting period (MT CO_2e)
i	Use of methane (oxidation or alternative end-use) by all qualifying destruction devices
MD_{P_i}	Methane destroyed through use i by qualifying devices during the reporting period (MT CH_4)
CEF_{CH4}	CO_2 emission factor for combusted methane (2.744 MT CO_2e/MT CH_4)

VI. The amount of methane destroyed ($MD_{P,i}$) must be quantified using Equation 7.

VII. If MG is used to supplement VA, the MG destroyed by the project during the reporting period must be accounted for using Equation 7 either as $MG_{SUPP,i}$, if VA flow and MG flow are monitored separately, or through $VA_{P,i}$ if only the resulting enriched flow is monitored.

VIII. If cooling air was added to the destruction device after the point of metering for VA, this must be accounted for with term $CA_{flow,i,y}$ in Equations 7 and 8. If no cooling air is added, then $CA_{flow,i,y} = 0$.

IX. If the flow rate of cooling air was metered, then the average metered data flow rate must be used. If the flow rate was not metered, the maximum capacity of the cooling air intake system must be used for the flow rate.

Equation 7: Methane Destroyed

$$\mathbf{MD_{P_i} = (MM_{P_i} - PE_{NO_i})}$$

WHERE

$\mathbf{MD_{P_i}}$	Methane destroyed through use $\mathbf{i}$ by qualifying devices during the reporting period; calculated separately for each destruction device (MT CH_4)
$\mathbf{i}$	Use of methane (oxidation or alternative end-use) by all qualifying destruction devices
$\mathbf{MM_{P_i}}$	Measured methane sent to qualifying devices for destruction through use i during the reporting period (MT CH_4)
$\mathbf{PE_{NO_i}}$	Project emissions of non-oxidized methane emitted as a result of incomplete oxidation of the ventilation air stream during the reporting period (MT CH_4)

WITH

$$\mathbf{MM_{P_i} = (VA_{P_i} \times C_{CH4} + MG_{SUPP_i} \times C_{CH4_{MG}}) \times 0.0423 \times 0.000454}$$

WHERE

$\mathbf{VA_{P_i}}$	Volume of ventilation air sent to qualifying devices for destruction through use $\mathbf{i}$ during the reporting period (scf)
$\mathbf{C_{CH4}}$	Weighted average of measured methane concentration of captured ventilation air sent to qualifying destruction devices during the reporting period; (scf CH_4/scf)
$\mathbf{MG_{SUPP_i}}$	Volume of mine gas extracted from a methane drainage system and sent with ventilation air to qualifying devices for destruction during the reporting period (scf)

$C_{CH4_{MG}}$	Weighted average of measured methane concentration of captured mine gas sent with ventilation air to qualifying destruction devices during the reporting period (scf CH_4/scf)
0.0423	Standard density of methane (lb CH_4/scf CH_4)
0.000454	MT CH_4/lb CH_4

WITH

$$C_{CH4} = \frac{\sum_t \left(VA_{flow_t} \times C_{CH4_t}\right)}{\sum_t VA_{flow_t}}$$

WHERE

C_{CH4_t}	Hourly average methane concentration of ventilation air sent to a destruction device (scf CH_4/scf)
VA_{flow_t}	Hourly average flow rate of ventilation air sent to a destruction device (scfm)

AND

$$C_{CH4_{MG}} = \frac{\sum_t \left(DV_{MG_t} \times C_{CH4_{MG_t}}\right)}{\sum_t DV_{MG_t}}$$

WHERE

$C_{CH4_{MG_t}}$	Daily average methane concentration of mine gas sent with ventilation air to destruction device (scf CH_4/scf)
DV_{MG_t}	Daily volume of mine gas sent with ventilation air to destruction device (scf)

AND

$$PE_{NO_i} = \sum_{y} \left(VA_{flow_{iy}} \times 60 + CA_{flow_{iy}} \times 60 \right) \times C_{CH4_{exhaust_i}} \times 0.0423 \times 0.000454$$

WHERE

y	Hours during which destruction device was operational during reporting period (h)
$VA_{flow_{iy}}$	Hourly average flow rate of ventilation air sent to a device for destruction through use i during the reporting period (scfm)
$CA_{flow_{iy}}$	Hourly average flow rate of cooling air sent to a destruction device after the metering point of the ventilation air stream during period y (scfm)
60	Number of minutes in an hour
$C_{CH4_{exhaust_i}}$	Weighted average of measured methane concentration of exhaust gas emitted from the destruction device during the reporting period (scf CH_4/scf)

WITH

$$C_{CH4_{exhaust_i}} = \frac{\sum_y \left[\left(VA_{flow_{iy}} \times 60 + CA_{flow_{iy}} \times 60 \right) \times C_{CH4_{exhaust_y}} \right]}{\sum_y \left(VA_{flow_{iy}} \times 60 + CA_{flow_{iy}} \times 60 \right)}$$

WHERE

$C_{CH4_{exhaust_y}}$	Hourly average methane concentration of exhaust gas (scf CH_4/scf)

Methane concentrations and flow rates must be recorded every fifteen minutes with averages calculated at least hourly. If the Project Proponent monitors and records data at a higher frequency, this data may be used within appropriate variables of the above equations to reflect the higher frequency of data collection.

If a mass flow meter is used to monitor gas flow instead of a volumetric flow meter, the volume and density terms must be replaced by the monitored mass value and the methane concentration must be in mass percent.

X. Project emissions from uncombusted methane (PE_{UM}) must be quantified using Equation 8.

Equation 8: Project Emissions from Uncombusted Methane

$$PE_{UM} = \sum_{i} \left(PE_{NO_i} \times GWP_{CH_4}\right)$$

WHERE

PE_{UM}	Project emissions from uncombusted methane during the reporting period (MT CO_2e)
i	Use of methane (oxidation or alternative end-use) by all qualifying destruction devices
PE_{NO_i}	Project emissions of non-oxidized methane emitted as a result of incomplete oxidation of the ventilation air stream during the reporting period; calculated separately for each destruction device (MT CH_4)
GWP_{CH_4}	Global warming potential of methane (MT CO_2e/MT CH_4)

WITH

$$PE_{NO_i} = \sum_{y} \left(VA_{flow_{iy}} \times 60 + CA_{flow_{iy}} \times 60\right) \times C_{CH4exhaust_i} \times 0.0423 \times 0.000454$$

WHERE

y	Hours during which destruction device was operational during reporting period (h)
$VA_{flow_{iy}}$	Hourly average flow rate of ventilation air sent to a device for destruction through use i during the reporting period (scfm)
$CA_{flow_{iy}}$	Hourly average flow rate of cooling air sent to a destruction device after the metering point of the ventilation air stream during period y (scfm)
60	Number of minutes in an hour

$C_{CH4exhaust_i}$	Weighted average of measured methane concentration of exhaust gas emitted from the destruction device during the reporting period (scf CH_4/scf)
0.0423	Standard density of methane (lb CH_4/scf CH_4)
0.000454	MT CH_4/lb CH_4

WITH

$$C_{CH4exhaust_i} = \frac{\sum_y \left[\left(VA_{flow_{iy}} \times 60 + CA_{flow_{iy}} \times 60\right) \times C_{CH4exhaust_y}\right]}{\sum_y \left(VA_{flow_{iy}} \times 60 + CA_{flow_{iy}} \times 60\right)}$$

WHERE

$C_{CH4exhaust_y}$	Hourly average methane concentration of exhaust gas (scf CH_4/scf)

Methane concentrations and flow rates must be recorded every fifteen minutes with averages calculated at least hourly. If the Project Proponent monitors and records data at a higher frequency, this data may be used within appropriate variables of the above equations to reflect the higher frequency of data collection.

If a mass flow meter is used to monitor gas flow instead of a volumetric flow meter, the volume and density terms must be replaced by the monitored mass value and the methane concentration must be in mass percent.

XI. If gas flow metering equipment provides an actual or non-standardized flow rate instead of a flow rate adjusted to standard conditions, apply Equation 46 in Appendix C to standardize the flow rate of VA entering the destruction device.

5.2 ACTIVE UNDERGROUND MINE METHANE DRAINAGE ACTIVITIES

I. GHG emission reductions for a reporting period (ER) must be quantified by subtracting the project emissions for that reporting period (PE) from the baseline emissions for that reporting period (BE) using Equation 9.

Equation 9: GHG Emission Reductions

$$ER = BE - PE$$

WHERE

ER	Emission reductions achieved by the project during the reporting period (MT CO_2e)
BE	Baseline emissions during the reporting period (MT CO_2e)
PE	Project emissions during the reporting period (MT CO_2e)

5.2.1 Quantifying Baseline Emissions

I. For active underground mine methane drainage projects, baseline emissions equal the baseline emissions from release of methane into the atmosphere during the reporting period.

Equation 10: Baseline Emissions

$$BE = BE_{MR}$$

WHERE

BE	Baseline emissions during the reporting period (MT CO_2e)
BE_{MR}	Baseline emissions from release of methane into the atmosphere during the reporting period (MT CO_2e)

II. Baseline emissions from the release of methane (BE_{MR}) must be quantified using Equation 11.

III. BE_{MR} must account for the total amount of methane actually destroyed by all qualifying devices during the reporting period.

IV. Emissions from the release of methane through a pre-mining surface well is only accounted for in the baseline during the reporting period in which the emissions would have occurred (i.e., when the well is mined through). For the purposes of this methodology, a well at an active underground mine is considered mined through when any of the following occur:

A. The working face intersects the borehole, as long as the endpoint of the borehole is not more than 50 meters below the mined coal seam;
B. The working face passes directly underneath the bottom of the borehole, as long as the endpoint of the borehole is not more than 150 meters above the mined coal seam;
C. The working face passes both underneath (not more than 150 meters below the endpoint of the borehole) and to the side of the borehole if room and pillar mining technique is employed and the endpoint of the borehole lies above a block of coal that will be left unmined as a pillar; or
D. The well produces elevated amounts of atmospheric gases (the percent concentration of nitrogen in MG increases by five compared to baseline levels). A full gas analysis using a gas chromatograph must be completed by an ISO 17025 accredited lab or a lab that has been certified by an accreditation body conformant with ISO 17025 to perform test methods appropriate for atmospheric gas content analysis. To ensure that elevated nitrogen levels are the result of a well being mined through and not the result of a leak in the well, the gas analysis must show that oxygen levels did not increase by the same proportion as the nitrogen levels.

V. If using Section 5.2.1(IV)(A), (B), or (C) to demonstrate that a well is mined through, an up-to-date mine plan must be used to identify which wells were mined through, based on the above criteria, and therefore eligible for baseline quantification in any given reporting period.
VI. If the mine plan calls for mining past rather than through a borehole, MG from that borehole extracted from within the methane source boundaries as described in Section 3.4(III)(B) is eligible for quantification in the baseline when the linear distance between the endpoint of the borehole and the working face that will pass nearest the endpoint of the borehole has reached an absolute minimum.
VII. If an MMC project at an active underground mine consists of both VAM and methane drainage activities, MG extracted from a methane drainage system ($MG_{SUPP,i}$) may be used to supplement VA to either increase or help balance the concentration of methane flowing into the destruction device. If MG is used to supplement VA, the MG destroyed by the project during the reporting period must be accounted for using Equation 11 as $MG_{SUPP,i}$.
VIII. MM that is still vented in the project scenario is not accounted for in the project emissions or baseline emissions, since it is vented in both scenarios.

Equation 11: Baseline Emissions from Release of Methane

$$\mathbf{BE_{MR}} = \sum_{\mathbf{i}} \left[\left(\mathbf{PSW_{P_i}} \times \mathbf{C_{CH4}} \right) + \left(\mathbf{IBPW_{P_i}} \times \mathbf{C_{CH4}} \right) - \mathbf{MG_{SUPP_i}} \times \mathbf{C_{CH4_{MG}}} \right] \times \mathbf{0.0423} \times \mathbf{0.000454} \times \mathbf{GWP_{CH4}}$$

WHERE

BE_{MR}	Baseline emissions from release of methane into the atmosphere during the reporting period (MT CO_2e)
i	Use of methane (flaring, power generation, heat generation, production of transportation fuel, injection into natural gas pipeline, etc.) by all qualifying destruction devices
PSW_{P_i}	Volume of MG from pre-mining surface wells sent to qualifying devices for destruction through use i during the reporting period. For qualifying devices, only the eligible amount per Equation 12 in accordance with Sections 5.2.1(IV), (V), and (VI) must be quantified (scf)
$IBPW_{P_i}$	Volume of MG from in-mine boreholes and post-mining wells sent to qualifying devices for destruction through use i during the reporting period (scf)
C_{CH4}	Weighted average of measured methane concentration of mine gas sent to qualifying destruction devices during the reporting period; calculated separately for each methane source (scf CH_4/scf)
MG_{SUPP_i}	Volume of mine gas extracted from a methane drainage system and sent with ventilation air to qualifying devices for destruction during the reporting period (scf)
$C_{CH4_{MG}}$	Weighted average of measured methane concentration of captured mine gas sent with ventilation air to qualifying destruction devices during the reporting period (scf CH_4/scf)
0.0423	Standard density of methane (lb CH_4/scf CH_4)
0.000454	MT CH_4/lb CH_4
GWP_{CH4}	Global warming potential of methane (MT CO_2e/MT CH_4)

WITH

$$PSW_{P_i} = PSWe_i$$

WHERE

$PSWe_i$	Volume of MG from pre-mining surface wells sent to qualifying devices for destruction through use i that is eligible for quantification in the reporting period; quantified using Equation 17 (scf)

AND

$$C_{CH4} = \frac{\sum_t (DV_t \times C_{CH4_t})}{\sum_t DV_t}$$

WHERE

C_{CH4_t}	Daily average methane concentration of mine gas sent to a destruction device (scf CH_4/scf)
DV_t	Daily volume of mine gas sent to a destruction device (scf)

AND

$$C_{CH4_{MG}} = \frac{\sum_t \left(DV_{MG_t} \times C_{CH4_{MG_t}}\right)}{\sum_t DV_{MG_t}}$$

WHERE

$C_{CH4_{MG_t}}$	Daily average methane concentration of mine gas sent with ventilation air to destruction device (scf CH_4/scf)
DV_{MG_t}	Daily volume of mine gas sent with ventilation air to destruction device (scf)

Methane concentrations and flow rates must be recorded every fifteen minutes with averages calculated at least daily. If the Project Proponent monitors and records data at a higher frequency, this data may be used within appropriate variables of the above equations to reflect the higher frequency of data collection.

If a mass flow meter is used to monitor gas flow instead of a volumetric flow meter, the volume and density terms must be replaced by the monitored mass value and the methane concentration must be in mass percent.

IX. The eligible amount of MG from pre-mining surface wells destroyed by qualifying devices ($PSWe_i$) must be determined by using Equation 12.

Equation 12: Eligible MG from Pre-mining Surface Boreholes

$$PSWe_i = PSWe_{pre_i} + PSWe_{post_i}$$

WHERE

$PSWe_i$	Volume of MG from pre-mining surface wells sent to qualifying devices for destruction through use i that is eligible for quantification in the reporting period for use in Equation 11. (scf)
i	Use of methane (flaring, power generation, heat generation, production of transportation fuel, etc.) by qualifying destruction devices
$PSWe_{pre_i}$	Volume of MG sent to qualifying destruction devices, from the beginning of the crediting period through the end of the reporting period, captured from pre-mining surface wells that were mined through during the reporting period (scf)
$PSWe_{post_i}$	Volume of MG sent to qualifying destruction devices in the reporting period captured from pre-mining surface wells that were mined through during earlier reporting periods (scf)

5.2.2 Quantifying Project Emissions

I. Project emissions must be quantified during the entire reporting period.
II. Project emissions for a reporting period (PE) must be quantified by summing the emissions for all SSRs identified as included in the project in Table 2 and using Equation 13.
III. Mine methane that is still vented in the project scenario is not accounted for in the project emissions or baseline emissions since it is vented in both scenarios.

Equation 13: Project Emissions

$$PE = PE_{EC} + PE_{MD} + PE_{UM}$$

WHERE

PE	Project emissions during the reporting period (MT CO_2e)
PE_{EC}	Project emissions from energy consumed to capture and destroy methane during the reporting period (MT CO_2e)
PE_{MD}	Project emissions from destruction of methane during the reporting period (MT CO_2e)
PE_{UM}	Project emissions from uncombusted methane during the reporting period (MT CO_2e)

IV. If the project uses fossil fuel or grid electricity to power additional equipment required for project activities (e.g., capturing and destroying mine gas, transporting mine gas, etc.), the resulting CO_2 emissions from the energy consumed to capture and destroy methane (PE_{EC}) must be quantified using Equation 5.14.

V. If the total electricity generated by project activities is greater than the additional electricity consumed for the capture and destruction of methane, then $CONS_{ELEC}$ = 0 in Equation 5.14.

Equation 14: Project Emissions from Energy Consumed to Capture and Destroy Methane

$$PE_{EC} = (CONS_{ELEC} \times CEF_{ELEC}) + \frac{(CONS_{HEAT} \times CEF_{HEAT} + CONS_{FF} \times CEF_{FF})}{1,000}$$

WHERE

PE_{EC}	Project emissions from energy consumed to capture and destroy methane during the reporting period (MT CO_2e)
$CONS_{ELEC}$	Additional electricity consumption for the capture and destruction of methane during the reporting period (MWh)
CEF_{ELEC}	CO_2 emission factor of electricity used from Appendix A (MT CO_2e/MWh)
$CONS_{HEAT}$	Additional heat consumption for the capture and destruction of methane during the reporting period (volume)
CEF_{HEAT}	CO_2 emission factor of heat used from Equation 44 (kg CO_2/volume)

$CONS_{FF}$	Additional fossil fuel consumption for the capture and destruction of methane during the reporting period (volume)
CEF_{FF}	CO_2 emission factor of fossil fuel used from Appendix A (kg CO_2/volume)
$\frac{1}{1,000}$	Conversion of kg to metric tons

VI. Project emissions from the destruction of methane (PE_{MD}) must be quantified using Equation 15.

VII. Project emissions for pre-mining surface wells that are mined through during the reporting period must include the CO_2 emissions resulting from the destruction of all MG from the mined-through wells that took place during and prior to the reporting period.

Equation 15: Project Emissions from Destruction of Captured Methane

$$PE_{MD} = \sum_{i} MD_{P_i} \times CEF_{CH4}$$

WHERE

PE_{MD}	Project emissions from destruction of methane during the reporting period (MT CO_2e)
i	Use of methane (flaring, power generation, heat generation, production of transportation fuel, injection into natural gas pipeline, etc.) by all qualifying destruction devices
MD_{P_i}	Methane destroyed through use i by qualifying devices during the reporting period (MT CH_4)
CEF_{CH4}	CO_2 emission factor for combusted methane (2.744 MT CO_2e/MT CH_4)

VIII. The amount of methane destroyed (MD_{P_i}) must be quantified using Equation 16.

Equation 16: Methane Destroyed

$$\mathbf{MD_{P_i} = \left(MM_{P_i} \times DE_i\right)}$$

WHERE

MD_{P_i}	Methane destroyed through use i by qualifying devices during the reporting period; calculated separately for each destruction device (MT CH_4)
i	Use of methane (flaring, power generation, heat generation, production of transportation fuel, injection into natural gas pipeline, etc.) by all qualifying destruction devices
MM_{P_i}	Measured methane sent to qualifying devices for destruction through use i during the reporting period (MT CH_4)
DE_i	Efficiency of methane destruction device i, either site-specific or from Appendix B (%)

WITH

$$\mathbf{MM_{P_i} = \left(PSW_{P_{all_i}} \times C_{CH4} + IBPW_{P_i} \times C_{CH4} \times C_{CH4} - MG_{SUPP_i} \times C_{CH4_{MG}}\right) \times 0.0423 \times 0.000454}$$

WHERE

$PSW_{P_{all_i}}$	Volume of MG from pre-mining surface wells sent to qualifying devices for destruction through use i during the reporting period (scf)
$IBPW_{P_i}$	Volume of MG from in-mine boreholes and post-mining wells sent to qualifying devices for destruction through use i during the reporting period (scf)
C_{CH4}	Weighted average of measured methane concentration of mine gas sent to qualifying destruction devices during the reporting period; calculated separately for each methane source (scf CH_4/scf)
MG_{SUPP_i}	Volume of mine gas extracted from a methane drainage system and sent with ventilation air to qualifying devices for destruction during the reporting period (scf)

$C_{CH4_{MG}}$	Weighted average of measured methane concentration of captured mine gas sent with ventilation air to qualifying destruction devices during the reporting period (scf CH_4/scf)
0.0423	Standard density of methane (lb CH_4/scf CH_4)
0.000454	MT CH_4/lb CH_4

AND

$$C_{CH4} = \frac{\sum_t (DV_t \times C_{CH4_t})}{\sum_t DV_{MG_t}}$$

WHERE

C_{CH4_t}	Daily average methane concentration of mine gas sent to a destruction device (scf CH_4/scf)
DV_t	Daily volume of mine gas sent to a destruction device (scf)

AND

$$C_{CH4_{MG}} = \frac{\sum_t \left(DV_{MG_t} \times C_{CH4_{MG_t}}\right)}{\sum_t DV_{MG_t}}$$

WHERE

$C_{CH4_{MG_t}}$	Daily average methane concentration of mine gas sent with ventilation air to destruction device (scf CH_4/scf)
DV_{MG_t}	Daily volume of mine gas sent with ventilation air to destruction device (scf)

Methane concentrations and flow rates must be recorded every fifteen minutes with averages calculated at least daily. If the Project Proponent monitors and records data at a higher frequency, this data may be used within appropriate variables of the above equations to reflect the higher frequency of data collection.

If a mass flow meter is used to monitor gas flow instead of a volumetric flow meter, the volume and density terms must be replaced by the monitored mass value and the methane concentration must be in mass percent.

IX. Project emissions from uncombusted methane (PE_{UM}) must be quantified using Equation 17.
X. Project emissions for pre-mining surface wells that are mined through during the reporting period must include the uncombusted methane portion of MG from the mined-through wells that was emitted during and prior to the reporting period.

Equation 17: Project Emissions from Uncombusted Methane

$$PE_{UM} = \sum_{i} \left[MM_{P_i} \times (1 - DE_i) \right] \times GWP_{CH_4}$$

WHERE

PE_{UM}	Project emissions from uncombusted methane during the reporting period (MT CO_2e)
i	Use of methane (flaring, power generation, heat generation, production of transportation fuel, injection into natural gas pipeline etc.) by all qualifying destruction devices
MM_{P_i}	Measured methane sent to qualifying devices for destruction through use i during the reporting period; calculated separately for each destruction device (MT CH_4)
DE_i	Efficiency of methane destruction device i, either site-specific or from Appendix B (%)
GWP_{CH_4}	Global warming potential of methane (MT CO_2e/MT CH_4)

WITH

$$MM_{P_i} = \left(PSW_{P_{all_i}} \times C_{CH4} + IBPW_{P_i} \times C_{CH4} - MG_{SUPP_i} \times C_{CH4_{MG}} \right) \times 0.0423 \times 0.000454$$

WHERE

$PSW_{P_{all_i}}$	Volume of MG from pre-mining surface wells sent to qualifying devices for destruction through use i during the reporting period (scf)
$IBPW_{P_i}$	Volume of MG from in-mine boreholes and post-mining wells sent to qualifying devices for destruction through use i during the reporting period (scf)
C_{CH4}	Weighted average of measured methane concentration of mine gas sent to qualifying destruction devices during the reporting period; calculated separately for each methane source (scf CH_4/scf)
MG_{SUPP_i}	Volume of mine gas extracted from a methane drainage system and sent with ventilation air to qualifying devices for destruction during the reporting period (scf)
$C_{CH4_{MG}}$	Weighted average of measured methane concentration of captured mine gas sent with ventilation air to qualifying destruction devices during the reporting period (scf CH_4/scf)
0.0423	Standard density of methane (lb CH_4/scf CH_4)
0.000454	MT CH_4/lb CH_4

AND

$$C_{CH4} = \frac{\sum_t (DV_t \times C_{CH4_t})}{\sum_t DV_t}$$

WHERE

C_{CH4_t}	Daily average methane concentration of mine gas sent to a destruction device (scf CH_4/scf)
DV_t	Daily volume of mine gas sent to a destruction device (scf)

AND

$$C_{CH4_{MG}} = \frac{\sum_t \left(DV_{MG_t} \times C_{CH4_{MG_t}}\right)}{\sum_t DV_{MG_t}}$$

WHERE

$C_{CH4_{MG_t}}$	Daily average methane concentration of mine gas sent with ventilation air to destruction device (scf CH_4/scf)
DV_{MG_t}	Daily volume of mine gas sent with ventilation air to destruction device (scf)

Methane concentrations and flow rates must be recorded every fifteen minutes with averages calculated at least daily. If the Project Proponent monitors and records data at a higher frequency, this data may be used within appropriate variables of the above equations to reflect the higher frequency of data collection.

If a mass flow meter is used to monitor gas flow instead of a volumetric flow meter, the volume and density terms must be replaced by the monitored mass value and the methane concentration must be in mass percent.

XI. If gas flow metering equipment provides an actual or non-standardized flow rate or volume instead of a flow rate or volume adjusted to standard conditions, use Equation 47 in Appendix C to standardize the amount of MG sent to each qualifying and non-qualifying device during the reporting period.

5.3 ACTIVE SURFACE MINE METHANE DRAINAGE ACTIVITIES

I. GHG emission reductions for a reporting period (ER) must be quantified by subtracting the project emissions for that reporting period (PE) from the baseline emissions for that reporting period (BE) using Equation 18.

Equation 18: GHG Emission Reductions

$$ER = BE - PE$$

WHERE

ER	Emission reductions achieved by the project during the reporting period (MT CO_2e)
BE	Baseline emissions during the reporting period (MT CO_2e)
PE	Project emissions during the reporting period (MT CO_2e)

5.3.1 Quantifying Baseline Emissions

I. Baseline emissions for a reporting period (BE) must be estimated by summing the baseline emissions for all SSRs identified as included in the baseline in Table 3 and using Equation 19.

II. For active surface mine methane drainage projects, baseline emissions equal the baseline emissions from release of methane into the atmosphere during the reporting period.

Equation 19: Baseline Emissions

$$BE = BE_{MR}$$

WHERE

BE	Baseline emissions during the reporting period (MT CO_2e)
BE_{MR}	Baseline emissions from release of methane into the atmosphere during the reporting period (MT CO_2e)

III. Baseline emissions from the release of methane (BE_{MR}) must be quantified using Equation 20.

IV. BE_{MR} must account for the total amount of methane actually destroyed by all qualifying devices during the reporting period.

V. Emissions from the release of methane are only accounted for in the baseline during the reporting period in which the emissions would have occurred (i.e., when the well is mined through). For the purposes of this methodology, a well at an active surface mine is considered mined through when either of the following occurs:

A. The well is physically bisected by surface mining activities, such as excavation of overburden, drilling and blasting, and removal of the coal; or

B. The well produces elevated amounts of atmospheric gases (the percent concentration of nitrogen in MG increases by five compared to baseline levels). A full gas analysis using a gas chromatograph must be completed by an ISO 17025 accredited lab or a lab that has been certified by an accreditation body conformant with ISO 17025 to perform test methods appropriate for atmospheric gas content analysis. To ensure that elevated nitrogen levels are the result of a well being mined through and not the result of a leak in the well, the gas analysis must show that oxygen levels did not increase by the same proportion as the nitrogen levels.

VI. If using Section 5.3.1(V)(A) to demonstrate that a well is mined through, an up-to-date mine plan must be used to identify which wells were mined through and therefore eligible for baseline quantification in any given reporting period.

VII. SMM that is still vented in the project scenario is not accounted for in the project emissions or baseline emissions, since it is vented in both scenarios.

Equation 20: Baseline Emissions from Release of Methane

$$BE_{MR} = \sum_{i} [(PSW_{P_i} \times C_{CH4}) + (ECW_{P_i} \times C_{CH4}) + (ARW_{P_i} \times C_{CH4}) + (CDW_{P_i} \times C_{CH4})] \times 0.0423 \times 0.000454 \times GWP_{CH4}$$

WHERE

BE_{MR}	Baseline emissions from release of methane into the atmosphere during the reporting period (MT CO_2e)
i	Use of methane (flaring, power generation, heat generation, production of transportation fuel, injection into natural gas pipeline, etc.) by all qualifying destruction devices
PSW_{P_i}	Volume of MG from pre-mining surface wells sent to qualifying devices for destruction through use i during the reporting period. For qualifying devices, only the eligible amount per Equation 21 in accordance with Sections 5.3.1(V) and (VI) must be quantified (scf)
ECW_{P_i}	Volume of MG from existing coal bed methane wells that would otherwise be shut-in and abandoned as a result of encroaching mining sent to qualifying devices for destruction through use i during the reporting period. For qualifying devices, only the eligible amount per Equation 22 in accordance with Sections 5.3.1(V) and (VI) must be quantified (scf)
ARW_{P_i}	Volume of MG from abandoned wells that are reactivated sent to qualifying devices for destruction through use i during the reporting period. For qualifying devices, only the eligible amount per Equation 23 in accordance with Sections 5.3.1(V) and (VI) must be quantified (scf)

CDW_{P_i}	Volume of MG from converted dewatering wells sent to qualifying devices for destruction through use i during the reporting period. For qualifying devices, only the eligible amount per Equation 24 in accordance with Sections 5.3.1(V) and (VI) must be quantified (scf)
C_{CH4}	Weighted average of measured methane concentration of mine gas sent to qualifying destruction devices during the reporting period; calculated separately for each methane source (scf CH_4/scf)
0.0423	Standard density of methane (lb CH_4/scf CH_4)
0.000454	MT CH_4/lb CH_4
GWP_{CH4}	Global warming potential of methane (MT CO_2e/MT CH_4)

WITH

$$PSW_{P_i} = PSWe_i$$

WHERE

$PSWe_i$	Volume of MG from pre-mining surface wells sent to qualifying devices for destruction through use i that is eligible for quantification in the reporting period; quantified using Equation 21 (scf)

AND

$$ECW_{P_i} = ECWe_i$$

WHERE

$ECWe_i$	Volume of MG from existing coal bed methane wells that would otherwise be shut-in and abandoned as a result of encroaching mining sent to qualifying devices for destruction through use i that is eligible for quantification in the reporting period; quantified using Equation 22 (scf)

AND

$$AWR_{P_i} = AWRe_i$$

WHERE

$AWRe_i$	Volume of MG from abandoned wells that are reactivated sent to qualifying devices for destruction through use i that is eligible for quantification in the reporting period; quantified using Equation 23 (scf)

AND

$$CDW_{P_i} = CDWe_i$$

WHERE

$CDWe_i$	Volume of MG from converted dewatering wells sent to qualifying devices for destruction through use i that is eligible for quantification in the reporting period; quantified using Equation 24 (scf)

AND

$$C_{CH4} = \frac{\sum_t (DV_t \times C_{CH4_t})}{\sum_t DV_t}$$

WHERE

C_{CH4_t}	Daily average methane concentration of mine gas sent to a destruction device (scf CH_4/scf)
DV_t	Daily volume of mine gas sent to a destruction device (scf)

Methane concentrations and flow rates must be recorded every fifteen minutes with averages calculated at least daily. If the Project Proponent monitors and records data at a higher frequency, this data may be used within appropriate variables of the above equations to reflect the higher frequency of data collection.

If a mass flow meter is used to monitor gas flow instead of a volumetric flow meter, the volume and density terms must be replaced by the monitored mass value and the methane concentration must be in mass percent.

VIII. The eligible amount of MG destroyed by qualifying devices must be determined by using Equations 21, 22, 23, and 24.

Equation 21: Eligible MG from Pre-mining Surface Wells

$$PSWe_i = PSWe_{pre_i} + PSWe_{post_i}$$

WHERE

$PSWe_i$	Volume of MG from pre-mining surface wells sent to qualifying devices for destruction through use i that is eligible for quantification in the reporting period for use in Equation 20 (scf)
i	Use of methane (flaring, power generation, heat generation, production of transportation fuel, injection into natural gas pipeline, etc.) by qualifying destruction devices
$PSWe_{pre_i}$	Volume of MG sent to qualifying destruction devices, from the beginning of the crediting period through the end of the reporting period, captured from pre-mining surface wells that were mined through during the reporting period (scf)
$PSWe_{post_i}$	Volume of MG sent to qualifying destruction devices in the reporting period captured from pre-mining surface wells that were mined through during earlier reporting periods (scf)

Equation 22: Eligible MG from Existing Coal Bed Methane Wells that Would Otherwise Be Shut-in and Abandoned as a Result of Encroaching Mining

$$ECWe_i = ECWe_{pre_i} + ECWe_{post_i}$$

WHERE

$\mathbf{ECWe_i}$	Volume of MG from existing coal bed methane wells that would otherwise be shut-in and abandoned as a result of encroaching mining sent to qualifying devices for destruction through use $\mathbf{i}$ that is eligible for quantification in the reporting period for use in Equation 20 (scf)
$\mathbf{i}$	Use of methane (flaring, power generation, heat generation, production of transportation fuel, injection into natural gas pipeline, etc.) by qualifying destruction devices
$\mathbf{ECWe_{pre_i}}$	Volume of MG sent to qualifying destruction devices, from the beginning of the crediting period through the end of the reporting period, captured from existing coal bed methane wells that would otherwise be shut-in and abandoned as a result of encroaching mining that were mined through during the reporting period (scf)
$\mathbf{ECWe_{post_i}}$	Volume of MG sent to qualifying destruction devices in the reporting period captured from existing coal bed methane wells that would otherwise be shut-in and abandoned as a result of encroaching mining that were mined through during earlier reporting periods (scf)

Equation 23: Eligible MG from Abandoned Wells that are Reactivated

$$\mathbf{AWRe_i = AWRe_{pre_i} + AWRe_{post_i}}$$

WHERE

$\mathbf{AWRe_i}$	Volume of MG from abandoned wells that are reactivated sent to qualifying devices for destruction through use $\mathbf{i}$ that is eligible for quantification in the reporting period for use in Equation 20 (scf)
$\mathbf{i}$	Use of methane (flaring, power generation, heat generation, production of transportation fuel, injection into natural gas pipeline, etc.) by qualifying destruction devices
$\mathbf{AWRe_{pre_i}}$	Volume of MG sent to qualifying destruction devices, from the beginning of the crediting period through the end of the reporting period, captured from abandoned wells that are reactivated that were mined through during the current reporting period (scf)

$\mathbf{AWRe_{post_i}}$	Volume of MG sent to qualifying destruction devices in the reporting period captured from abandoned wells that are reactivated that were mined through during earlier reporting periods (scf)

Equation 24: Eligible MG from Converted Dewatering Wells that are Reactivated

$$\mathbf{CDWe_i = CDWe_{pre_i} + CDWe_{post_i}}$$

WHERE

$\mathbf{CDWe_i}$	Volume of MG from converted dewatering wells sent to qualifying devices for destruction through use **i** that is eligible for quantification in the reporting period for use in Equation 20 (scf)
i	Use of methane (flaring, power generation, heat generation, production of transportation fuel, injection into natural gas pipeline, etc.) by qualifying destruction devices
$\mathbf{CDWe_{pre_i}}$	Volume of MG sent to qualifying destruction devices, from the beginning of the crediting period through the end of the reporting period, captured from converted dewatering wells that were mined through during the reporting period (scf)
$\mathbf{CDWe_{post_i}}$	Volume of MG sent to qualifying destruction devices in the reporting period captured from converted dewatering wells that were mined through during earlier reporting periods (scf)

5.3.2 Quantifying Project Emissions

I. Project emissions must be quantified during the entire reporting period.
II. Project emissions for a reporting period (PE) must be quantified by summing the emissions for all SSRs identified as included in the project in Table 3 and using Equation 25.
III. SMM that is still vented in the project scenario is not accounted for in the project emissions or baseline emissions, since it is vented in both scenarios.

Equation 25: Project Emissions

$$\mathbf{PE = PE_{EC} + PE_{MD} + PE_{UM}}$$

WHERE

PE	Project emissions during the reporting period (MT CO_2e)
PE_{EC}	Project emissions from energy consumed to capture and destroy methane during the reporting period (MT CO_2e)
PE_{MD}	Project emissions from destruction of methane during the reporting period (MT CO_2e)
PE_{UM}	Project emissions from uncombusted methane during the reporting period (MT CO_2e)

IV. If the project uses fossil fuel or grid electricity to power additional equipment required for project activities (e.g., drilling and completing additional wells or boreholes, capturing and destroying mine gas, transporting mine gas, etc.), the resulting CO_2 emissions from the energy consumed to capture and destroy methane (PE_{EC}) must be quantified using Equation 26.

V. If the total electricity generated by project activities is greater than the additional electricity consumed for the capture and destruction of methane, then $CONS_{ELEC}$ = 0 in Equation 26.

Equation 26: Project Emissions from Energy Consumed to Capture and Destroy Methane

$$PE_{EC} = (CONS_{ELEC} \times CEF_{ELEC}) + \frac{(CONS_{HEAT} \times CEF_{HEAT} + CONS_{FF} \times CEF_{FF})}{1,000}$$

WHERE

PE_{EC}	Project emissions from energy consumed to capture and destroy methane during the reporting period (MT CO_2e)
$CONS_{ELEC}$	Additional electricity consumption for the capture and destruction of methane during the reporting period (MWh)
CEF_{ELEC}	CO_2 emission factor of electricity used from Appendix A (MT CO_2e/MWh)
$CONS_{HEAT}$	Additional heat consumption for the capture and destruction of methane during the reporting period (volume)

CEF_{HEAT}	CO_2 emission factor of heat used from Equation 44 (kg CO_2/volume)
$CONS_{FF}$	Additional fossil fuel consumption for the capture and destruction of methane during the reporting period (volume)
CEF_{FF}	CO_2 emission factor of fossil fuel used from Appendix A (kg CO_2/volume)
$\frac{1}{1,000}$	Conversion of kg to metric tons

VI. Project emissions from the destruction of methane (PE_{MD}) must be quantified using Equation 27.

VII. Project emissions for pre-mining surface wells that are mined through during the reporting period must include the CO_2 emissions resulting from the destruction of all MG from the mined-through wells that took place during and prior to the reporting period.

Equation 27: Project Emissions from Destruction of SMM

$$PE_{MD} = \sum_{i} MD_{P_i} \times CEF_{CH4}$$

WHERE

PE_{MD}	Project emissions from destruction of methane during the reporting period (MT CO_2e)
i	Use of methane (flaring, power generation, heat generation, production of transportation fuel, injection into natural gas pipeline, etc.) by all qualifying destruction devices
MD_{P_i}	Methane destroyed through use i by qualifying devices during the reporting period (MT CH_4)
CEF_{CH4}	CO_2 emission factor for combusted methane (2.744 MT CO_2e/MT CH_4)

VIII. The amount of mine methane destroyed (MD_{Pi}) must be quantified using Equation 28.

Equation 288: Methane Destroyed

$$MD_{P_i} = (MM_{P_i} \times DE_i)$$

WHERE

MD_{P_i}	Methane destroyed through use i by qualifying devices during the reporting period; calculated separately for each destruction device (MT CH_4)
i	Use of methane (flaring, power generation, heat generation, production of transportation fuel, injection into natural gas pipeline, etc.) by all qualifying destruction devices
MM_{P_i}	Measured methane sent to qualifying devices for destruction through use i during the reporting period (MT CH_4)
DE_i	Efficiency of methane destruction device i, either site-specific or from Appendix B (%)

WITH

$$MM_{P_i} = \left(PSW_{P_{all_i}} \times C_{CH4} + ECW_{P_{all_i}} \times C_{CH4} + AWR_{P_{all_i}} \times C_{CH4} + CDW_{P_{all_i}} \times C_{CH4}\right) \times 0.0423 \times 0.000454$$

WHERE

$PSW_{P_{all_i}}$	Volume of MG from pre-mining surface wells sent to qualifying devices for destruction through use i during the reporting period (scf)
$ECW_{P_{all_i}}$	Volume of MG from existing coal bed methane wells that would otherwise be shut-in and abandoned as a result of encroaching mining sent to qualifying devices for destruction through use i during the reporting period (scf)
$AWR_{P_{all_i}}$	Volume of MG from abandoned wells that are reactivated sent to qualifying and devices for destruction through use i during the reporting period (scf)
$CDW_{P_{all_i}}$	Volume of MG from converted dewatering wells sent to qualifying devices for destruction through use i during the reporting period (scf)
C_{CH4}	Weighted average of measured methane concentration of mine gas sent to qualifying destruction devices during the reporting period; calculated separately for each methane source (scf CH_4/scf)

$\mathbf{0.0423}$	Standard density of methane (lb CH_4/scf CH_4)
$\mathbf{0.000454}$	MT CH_4/lb CH_4

WITH

$$C_{CH4} = \frac{\sum_t \left(DV_t \times C_{CH4_t}\right)}{\sum_t DV_t}$$

WHERE

C_{CH4_t}	Daily average methane concentration of mine gas sent to a destruction device (scf CH_4/scf)
DV_t	Daily volume of mine gas sent to a destruction device (scf)

Methane concentrations and flow rates must be recorded every fifteen minutes with averages calculated at least daily. If the Project Proponent monitors and records data at a higher frequency, this data may be used within appropriate variables of the above equations to reflect the higher frequency of data collection.

If a mass flow meter is used to monitor gas flow instead of a volumetric flow meter, the volume and density terms must be replaced by the monitored mass value and the methane concentration must be in mass percent.

IX. Project emissions from uncombusted methane (PE_{UM}) must be quantified using Equation 29.

X. Project emissions for pre-mining surface wells that are mined through during the reporting period must include the uncombusted methane portion of MG from the mined-through wells that was emitted during and prior to the reporting period.

Equation 299: Project Emissions from Uncombusted Methane

$$PE_{UM} = \sum_i \left[MM_{P_i} \times (1 - DE_i)\right] \times GWP_{CH_4}$$

WHERE

PE_{UM}	Project emissions from uncombusted methane during the reporting period (MT CO_2e)

$\mathbf{i}$	Use of methane (flaring, power generation, heat generation, production of transportation fuel, injection into natural gas pipeline, etc.) by all qualifying destruction devices
$\mathbf{MM_{P_i}}$	Measured methane sent to qualifying devices for destruction through use $\mathbf{i}$ during the reporting period; calculated separately for each destruction device (MT CH_4)
$\mathbf{DE_i}$	Efficiency of methane destruction device $\mathbf{i}$, either site-specific or from Appendix B (%)
$\mathbf{GWP_{CH_4}}$	Global warming potential of methane (MT CO_2e/MT CH_4)

WITH

$$\mathbf{MM_{P_i}} = \left(\mathbf{PSW_{P_{all_i}}} \times \mathbf{C_{CH4}} + \mathbf{ECW_{P_{all_i}}} \times \mathbf{C_{CH4}} + \mathbf{AWR_{P_{all_i}}} \times \mathbf{C_{CH4}} + \mathbf{CDW_{P_{all_i}}} \times \mathbf{C_{CH4}}\right) \times \mathbf{0.0423} \times \mathbf{0.000454}$$

WHERE

$\mathbf{PSW_{P_{all_i}}}$	Volume of MG from pre-mining surface wells sent to qualifying devices for destruction through use $\mathbf{i}$ during the reporting period (scf)
$\mathbf{ECW_{P_{all_i}}}$	Volume of MG from existing coal bed methane wells that would otherwise be shut-in and abandoned as a result of encroaching mining sent to qualifying devices for destruction through use $\mathbf{i}$ during the reporting period (scf)
$\mathbf{AWR_{P_{all_i}}}$	Volume of MG from abandoned wells that are reactivated sent to qualifying and devices for destruction through use $\mathbf{i}$ during the reporting period (scf)
$\mathbf{CDW_{P_{all_i}}}$	Volume of MG from converted dewatering wells sent to qualifying devices for destruction through use $\mathbf{i}$ during the reporting period (scf)
$\mathbf{C_{CH4}}$	Weighted average of measured methane concentration of mine gas sent to qualifying destruction devices during the reporting period; calculated separately for each methane source (scf CH_4/scf)
$\mathbf{0.0423}$	Standard density of methane (lb CH_4/scf CH_4)
$\mathbf{0.000454}$	MT CH_4/lb CH_4

WITH

$$C_{CH4} = \frac{\sum_t (DV_t \times C_{CH4_t})}{\sum_t DV_t}$$

WHERE

C_{CH4_t}	Daily average methane concentration of mine gas sent to a destruction device (scf CH_4/scf)
DV_t	Daily volume of mine gas sent to a destruction device (scf)

Methane concentrations and flow rates must be recorded every fifteen minutes with averages calculated at least daily. If the Project Proponent monitors and records data at a higher frequency, this data may be used within appropriate variables of the above equations to reflect the higher frequency of data collection.

If a mass flow meter is used to monitor gas flow instead of a volumetric flow meter, the volume and density terms must be replaced by the monitored mass value and the methane concentration must be in mass percent.

XI. If gas flow metering equipment provides an actual or non-standardized flow rate or volume instead of a flow rate or volume adjusted to standard conditions, use Equation 47 to standardize the amount of MG sent to each qualifying and non-qualifying device during the reporting period.

5.4 ABANDONED UNDERGROUND MINE METHANE RECOVERY ACTIVITIES

I. GHG emission reductions for a reporting period (ER) must be quantified by subtracting the project emissions for that reporting period (PE) from the baseline emissions for that reporting period (BE) using Equation 30.

Equation 30: GHG Emission Reductions

$$ER = BE - PE$$

WHERE

ER	Emission reductions achieved by the project during the reporting period (MT CO_2e)
BE	Baseline emissions during the reporting period (MT CO_2e)
PE	Project emissions during the reporting period (MT CO_2e)

5.4.1 Quantifying Baseline Emissions

I. Baseline emissions for a reporting period (BE) must be estimated by summing the baseline emissions for all SSRs identified as included in the baseline in Table 4 and using Equation 31.

Equation 31: Baseline Emissions

$$BE = BE_{MD} + BE_{MR}$$

WHERE

BE	Baseline emissions during the reporting period (MT CO_2e)
BE_{MD}	Baseline emissions from destruction of methane during the reporting period (MT CO_2e)
BE_{MR}	Baseline emissions from release of methane into the atmosphere during the reporting period (MT CO_2e)

II. Baseline emissions from the destruction of AMM (BE_{MD}) must be quantified using Equation 32.

III. BE_{MD} must include the estimated CO_2 emissions from the destruction of AMM in pre-project devices.

IV. If there is no destruction of methane in the baseline, then BE_{MD} = 0.

Equation 322: Baseline Emissions from Destruction of Methane

$$BE_{MD} = \sum_{i} MD_{B_i} \times CEF_{CH4}$$

WHERE

BE_{MD}	Baseline emissions from destruction of methane during the reporting period (MT CO_2e)
i	Use of methane (flaring, power generation, heat generation, production of transportation fuel, injection into natural gas pipeline, etc.) by pre-project destruction devices
MD_{B_i}	Methane that would have been destroyed through use **i** by non-qualifying devices during the reporting period (MT CH_4)
CEF_{CH4}	CO_2 emission factor for combusted methane (2.744 MT CO_2e/MT CH_4)

V. The amount of methane that would have been destroyed by pre-project devices ($MD_{B,i}$) must be quantified using Equation 33.

VI. MG originates from one source for abandoned underground mine methane recovery activities: in-mine boreholes and post-mining wells drilled into the mine during or after active mining operations.

VII. For the purpose of baseline quantification, only pre-project destruction devices that were operating during the year prior to the project start date should be taken into account.

VIII. The volume or mass of MG that would have been sent to a pre-project device for destruction during the reporting period in the baseline must be determined by calculating and comparing:

   A. The volume or mass of MG sent to pre-project destruction devices during the current reporting period, adjusted for temperature and pressure using Equation 47, if applicable;

   B. The volume or mass of MG sent to pre-project destruction devices during the three-year period prior to the project start date (or during the length of time the devices are operational, if less than three years), adjusted for temperature and pressure using Equation 47, if applicable, and averaged according to the length of the reporting period; and

IX. The largest of the two quantities determined in Sections 5.4.1(VIII)(A)-(B) must be used for volume of MG that would have been sent to a non-qualifying device for destruction through use i during the reporting period in the baseline scenario for $IBPW_{B,i}$ in Equation 33.

X. If using a quantity for $IBPW_{B,i}$, determined by Section 5.4.1(VIII)(A), data for daily volume of mine gas (DV_t) and methane concentration of mine gas ($C_{CH4,t}$) must be monitored for the pre-project destruction devices and used in Equation 33.

XI. If using a quantity for $IBPW_{B,i}$, determined by Section 5.4.1(VIII)(B), historical data for daily volume of mine gas (DV_t), and methane concentration of mine gas ($C_{CH4,t}$) must be used in Equation 33, if available.

XII. Project Proponents may choose to use default methane destruction efficiencies (DE_i) provided in Appendix B or site-specific methane destruction efficiencies. Destruction technologies not listed in Appendix B must use site-specific methane destruction efficiencies. Site-specific methane destruction efficiencies that are demonstrated to the satisfaction of the validation and verification body to be equally or more accurate than the default methane destruction efficiencies may be used.

Equation 333: Methane Destroyed in Baseline

$$MD_{B_i} = (MM_{B_i} \times DE_i)$$

WHERE

MD_{B_i}	Methane that would have been destroyed through use **i** by pre-project devices during the reporting period; calculated separately for each destruction device ($MT\ CH_4$)
i	Use of methane (flaring, power generation, heat generation, production of transportation fuel, injection into natural gas pipeline, etc.) by pre-project destruction devices
MM_{B_i}	Measured methane that would have been sent to pre-project devices for destruction through use **i** during the reporting period ($MT\ CH_4$)
DE_i	Efficiency of methane destruction device **i**, either site-specific or from Appendix B (%)

WITH

$$MM_{B_i} = (IBPW_{B_i} \times C_{CH4}) \times 0.0423 \times 0.000454$$

WHERE

$IBPW_{B_i}$	Volume of MG from in-mine boreholes and post-mining wells that would have been sent to pre-project devices for destruction through use **i** during the reporting period (scf)

C_{CH4}	Weighted average of measured methane concentration of mine gas that would have been sent to pre-project destruction devices during the reporting period (scf CH_4/scf)
0.0423	Standard density of methane (lb CH_4/scf CH_4)
0.000454	MT CH_4/lb CH_4

WITH

$$C_{CH4} = \frac{\sum_t (DV_t \times C_{CH4_t})}{\sum_t DV_t}$$

WHERE

C_{CH4_t}	Daily average methane concentration of mine gas sent to a destruction device (scf CH_4/scf)
DV_t	Daily volume of mine gas sent to a destruction device (scf)

Methane concentrations and flow rates must be recorded every fifteen minutes with averages calculated at least daily. If the Project Proponent monitors and records data at a higher frequency, this data may be used within appropriate variables of the above equations to reflect the higher frequency of data collection.

If a mass flow meter is used to monitor gas flow instead of a volumetric flow meter, the volume and density terms must be replaced by the monitored mass value and the methane concentration must be in mass percent.

XIII. Baseline emissions from the release of methane (BE_{MR}) must be quantified using Equations 34 and 35.

Equation 344: Baseline Emissions from Release of Methane

$$BE_{MR} = \sum_i MM_{P_i} \times GWP_{CH4}$$

WHERE

BE_{MR}	Baseline emissions from destruction of methane during the reporting period (MT CO_2e)
i	Use of methane (flaring, power generation, heat generation, production of transportation fuel, injection into natural gas pipeline, etc.) by pre-project destruction devices
MM_{P_i}	Measured methane sent to qualifying and pre-project devices for destruction through use i during the reporting period (MT CH_4)
GWP_{CH4}	Global warming potential of methane (MT CO_2e/MT CH_4)

Equation 355: Baseline Emissions from Release of Methane

$$MM_{P_i} = \sum_{i} (IBPW_{P_i} \times C_{CH4} - IBPW_{B_i} \times C_{CH4}) \times 0.0423 \times 0.000454$$

WHERE

MM_{P_i}	Measured methane sent to qualifying and pre-project devices for destruction through use i during the reporting period (MT CH_4)
i	Use of methane (flaring, power generation, heat generation, production of transportation fuel, injection into natural gas pipeline, etc.) by all qualifying and pre-project destruction devices
$IBPW_{P_i}$	Volume of MG from in-mine boreholes and post-mining wells sent to qualifying and pre-project devices for destruction through use i during the reporting period (scf)
$IBPW_{B_i}$	Volume of MG from in-mine boreholes and post-mining wells that would have been sent to pre-project devices for destruction through use i during the reporting period (scf)
C_{CH4}	Weighted average of measured methane concentration of mine gas sent to qualifying and pre-project destruction devices during the reporting period (scf CH_4/scf)
0.0423	Standard density of methane (lb CH_4/scf CH_4)

$\mathbf{0.000454}$	MT CH_4/lb CH_4

WITH

$$\mathbf{C_{CH4}} = \frac{\sum_t (\mathbf{DV_t} \times \mathbf{C_{CH4_t}})}{\sum_t \mathbf{DV_t}}$$

WHERE

$\mathbf{C_{CH4_t}}$	Daily average methane concentration of mine gas sent to a destruction device (scf CH_4/scf)
$\mathbf{DV_t}$	Daily volume of mine gas sent to a destruction device (scf)

XIV. Calculations include the application of a hyperbolic emissions rate decline curve. The function is directly related the gassiness of the mine, which is reflective of physical parameters of the coal mine such as the mine size, gas content of the coal, permeability of the coal to the flow of gas.

XV. The decline curve estimates the emission rate of an abandoned mine over time by taking into account the time elapsed since mine closure, the average methane emission rate calculated using available data collected by MSHA or other federal or state agency over the life of the mine. The decline curve for a given mine is initialized at the date of abandonment and calculated for each reporting period through the 10-year crediting period. The baseline emissions represent the baseline emissions for the sum of both pre-project and new qualifying devices. The baseline emissions for each reporting period is calculated using the mid-point date of each reporting period. Because the 10-year baseline remains a fixed value, the total of ten 12-month reporting period emissions are then summed to a determine the total methane baseline emissions (AMM_{DC10}) for the project's 10-year crediting period in Equation 36.

XVI. AMM that is still vented in the project scenario is not accounted for in the project emissions or baseline emissions, since it is vented in both scenarios.

Equation 366: Maximum Methane Emissions Derived from the Hyperbolic Emission Rate Decline Curve over the Crediting Period

$$AMM_{DC10} = \sum_{i}^{10} ER_{AMM} \times (1 + b \times D_i \times t_i)^{\frac{-1}{b}} \times RP_{days_i} \times 42.3 \times 0.000454$$

WHERE

AMM_{DC10}	Maximum emissions of methane during the crediting period (MT CH_4)
ER_{AMM}	Average ventilation air methane emission rate over the life of the mine (Mscf/d)
b	Dimensionless hyperbolic exponent
D_i	Initial decline rate (1/day)
t_i	Time elapsed from the date of mine closure to midpoint of each reporting period i (days)
RP_{days_i}	365 days in each reporting period i
42.3	Standard density of methane (lb CH_4/mcf CH_4)
0.000454	MT CH_4/lb CH_4

XVII. Depending on whether AMM_{DC10} is greater than or less than the total baseline emissions (BE) from the current reporting period and previously verified reporting periods, the project proponent will use Equation either 37 or 38.

XVIII. Cumulative baseline emissions from the project start date cannot exceed AMM_{DC10}. As a result, the eligible amount of AMM released in the baseline scenario for the reporting period must be determined using either Equation 37 and Equation 38 by comparing:

A. The cumulative emissions of methane (AMM_{DC10}) for the crediting period (ten reporting periods) calculated by the decline curve using Equation 36;

i. The total amount of measured methane sent to all qualifying and pre-project devices during the current ($MM_{P,i}$) and previously verified reporting periods ($MM_{P, prev,i}$) calculated using Equation 35; and

ii. The total amount of baseline methane destroyed in pre-project devices during current ($MM_{B,i}$) and previous reporting periods ($MM_{B, prev,i}$) calculated using Equation 33.

iii. Information for $MM_{P, prev,i}$ and $MM_{B, prev,i}$ from previous reporting period(s) does not need to be recalculated; rather, the verified values calculated for the previous reporting period(s) may be applied directly in equations 37 and 38.

Equation 377: Eligible Baseline Emissions from Release of Methane if AMM_{DC10} is Greater or Equal

$$\text{IF } AMM_{DC10} \geq MM_{P_i} + MM_{B_i} + MM_{P_{prev_i}} + MM_{B_{prev_i}} \text{ THEN } BE_{MR} = MM_{P_i} \times \mathbf{GWP_{CH4}}$$

WHERE

BE_{MR}	Baseline emissions from release of methane into the atmosphere during the reporting period (MT CO_2e)
i	Use of methane (flaring, power generation, heat generation, production of transportation fuel, injection into natural gas pipeline, etc.) by all qualifying and pre-project destruction devices for up to 10 reporting periods
AMM_{DC10}	Maximum emissions of methane during the crediting period (MT CH_4)
MM_{P_i}	Measured methane sent to qualifying and pre-project devices for use i during the reporting period (MT CH_4)
$MM_{P_{prev_i}}$	Summation of measured methane sent to qualifying and pre-project devices for destruction through the project's previous reporting period(s) (MT CH_4)
MM_{B_i}	Methane that would have been destroyed through use i by pre-project devices during the reporting period (MT CH_4)
$MM_{B_{prev_i}}$	Summation of measured methane that would have been destroyed through use i by pre-project devices for destruction through the project's previous reporting period(s) (MT CH_4)
GWP_{CH4}	Global warming potential of methane (MT CO_2e/MT CH_4)

Equation 388: Eligible Baseline Emissions from Release of Methane if AMM_{DC10} is Lesser

$$\text{IF } AMM_{DC10} < MM_{P_i} + MM_{B_i} + MM_{P_{prev_i}} + MM_{B_{prev_i}}$$
$$\text{THEN } BE_{MR} = AMM_{DC10} - \left(MM_{P_{prev_i}} + MM_{B_{prev_i}} + MM_{B_i}\right) \times \mathbf{GWP_{CH4}}$$

WHERE

BE_{MR}	Baseline emissions from release of methane into the atmosphere during the reporting period (MT CO_2e)
i	Use of methane (flaring, power generation, heat generation, production of transportation fuel, injection into natural gas pipeline, etc.) by all qualifying and pre-project destruction devices for up to 10 reporting periods
AMM_{DC10}	Maximum emissions of methane during the crediting period (MT CH_4)
MM_{P_i}	Measured methane sent to qualifying and pre-project devices for use i during the reporting period (MT CH_4)
$MM_{P_{prev_i}}$	Summation of measured methane sent to qualifying and pre-project devices for destruction through the project's previous reporting period(s) (MT CH_4)
MM_{B_i}	Methane that would have been destroyed through use i by pre-project devices during the reporting period (MT CH_4)
$MM_{B_{prev_i}}$	Summation of measured methane that would have been destroyed through use i by pre-project devices for destruction through the project's previous reporting period(s) (MT CH_4)
GWP_{CH4}	Global warming potential of methane (MT CO_2e/MT CH_4)

XIX. The decline curve relies upon hyperbolic emission rate decline curve coefficients found in Table 5 below.

Table 5: Default Hyperbolic Decline Curve Coefficients

VARIABLE	VALUE
B	1.886581
D_i (1/day)	0.003519

5.4.2 Quantifying Project Emissions

I. Project emissions must be quantified over the entire reporting period.
II. Project emissions for a reporting period (PE) must be quantified by summing the emissions for all SSRs identified as included in the project in Table 4 and using Equation 39.
III. AMM that is still vented in the project scenario is not accounted for in the project emissions or baseline emissions, since it is vented in both scenarios.

Equation 399: Project Emissions

$$PE = PE_{EC} + PE_{MD} + PE_{UM}$$

WHERE

PE	Project emissions during the reporting period (MT CO_2e)
PE_{EC}	Project emissions from energy consumed to capture and destroy methane during the reporting period (MT CO_2e)
PE_{MD}	Project emissions from destruction of methane during the reporting period (MT CO_2e)
PE_{UM}	Project emissions from uncombusted methane during the reporting period (MT CO_2e)

IV. If the project uses fossil fuel or grid electricity to power additional equipment required for project activities (e.g., drilling and completing additional wells or boreholes, capturing and destroying mine gas, transporting mine gas, etc.), the resulting CO_2 emissions from the energy consumed to capture and destroy methane (PE_{EC}) must be quantified using Equation 40.
V. If the total electricity generated by project activities is greater than the additional electricity consumed for the capture and destruction of methane, then $CONS_{ELEC}$ = 0 in Equation 40.

Equation 400: Project Emissions from Energy Consumed to Capture and Destroy Methane

$$PE_{EC} = (CONS_{ELEC} \times CEF_{ELEC}) + \frac{(CONS_{HEAT} \times CEF_{HEAT} + CONS_{FF} \times CEF_{FF})}{1,000}$$

WHERE

PE_{EC}	Project emissions from energy consumed to capture and destroy methane during the reporting period (MT CO_2e)
$CONS_{ELEC}$	Additional electricity consumption for the capture and destruction of methane during the reporting period (MWh)
CEF_{ELEC}	CO_2 emission factor of electricity used from Appendix A (MT CO_2e/MWh)
$CONS_{HEAT}$	Additional heat consumption for the capture and destruction of methane during the reporting period (volume)
CEF_{HEAT}	CO_2 emission factor of heat used from Equation 43 (kg CO_2/volume)
$CONS_{FF}$	Additional fossil fuel consumption for the capture and destruction of methane during the reporting period (volume)
CEF_{FF}	CO_2 emission factor of fossil fuel used from Appendix A (kg CO_2/volume)
$\frac{1}{1,000}$	Conversion of kg to metric tons

VI. Project emissions from the destruction of methane (PE_{MD}) must be quantified using Equation 41.

Equation 411: Project Emissions from Destruction of Captured Methane

$$PE_{MD} = \sum_{i} MD_{P_i} \times CEF_{CH4}$$

WHERE

PE_{MD}	Project emissions from destruction of methane during the reporting period (MT CO_2e)
i	Use of methane (flaring, power generation, heat generation, production of transportation fuel, injection into natural gas pipeline, etc.) by all qualifying and pre-project destruction devices
MD_{P_i}	Methane destroyed through use i by qualifying and pre-project devices during the reporting period (MT CH_4)

CEF_{CH4}	CO_2 emission factor for combusted methane (2.744 MT CO_2e/MT CH_4)

VII. The amount of methane destroyed ($MD_{P,i}$) must be quantified using Equation 42.

Equation 422: Methane Destroyed

$$MD_{P_i} = (MM_{P_i} - DE_i)$$

WHERE

MD_{P_i}	Methane destroyed through use i by qualifying and pre-project devices during the reporting period; calculated separately for each destruction device (MT CH_4)
i	Use of methane (flaring, power generation, heat generation, production of trans-portation fuel, injection into natural gas pipeline, etc.) by all qualifying and pre-project destruction devices
MM_{P_i}	Measured methane sent to qualifying and pre-project devices for destruction through use i during the reporting period (MT CH_4)
DE_i	Efficiency of methane destruction device i, either site-specific or from Appendix B (%)

WITH

$$MM_{P_i} = (IBPW_{P_i} \times C_{CH4}) \times 0.0423 \times 0.000454$$

WHERE

$IBPW_{P_i}$	Volume of MG from in-mine boreholes and post-mining wells sent to qualifying and pre-project devices for destruction through use i during the reporting period (scf)
C_{CH4}	Weighted average of measured methane concentration of mine gas sent to qualifying and pre-project destruction devices during the reporting period (scf CH_4/scf)

0.0423	Standard density of methane (lb CH_4/scf CH_4)
0.000454	MT CH_4/lb CH_4

WITH

$$C_{CH4} = \frac{\sum_t (DV_t \times C_{CH4_t})}{\sum_t DV_t}$$

WHERE

C_{CH4_t}	Daily average methane concentration of mine gas sent to a destruction device (scf CH_4/scf)
DV_t	Daily volume of mine gas sent to a destruction device (scf)

Methane concentrations and flow rates must be recorded every fifteen minutes with averages calculated at least daily. If the Project Proponent monitors and records data at a higher frequency, this data may be used within appropriate variables of the above equations to reflect the higher frequency of data collection.

If a mass flow meter is used to monitor gas flow instead of a volumetric flow meter, the volume and density terms must be replaced by the monitored mass value and the methane concentration must be in mass percent.

VIII. Project emissions from uncombusted methane (PE_{UM}) must be quantified using Equation 43.

Equation 433: Uncombusted Methane Emissions

$$PE_{UM} = \sum_i [MM_{P_i} \times (1 - DE_i)] \times GWP_{CH_4}$$

WHERE

PE_{UM}	Project emissions from uncombusted methane during the reporting period (MT CO_2e)

$\mathbf{i}$	Use of methane (flaring, power generation, heat generation, production of transportation fuel, injection into natural gas pipeline etc.) by all qualifying and pre-project destruction devices
$\mathbf{MM_{P_i}}$	Measured methane sent to qualifying and pre-project devices for destruction through use $\mathbf{i}$ during the reporting period; calculated separately for each destruction device (MT CH_4)
$\mathbf{DE_i}$	Efficiency of methane destruction device $\mathbf{i}$, either site-specific or from Appendix B (%)
$\mathbf{GWP_{CH_4}}$	Global warming potential of methane (MT CO_2e/MT CH_4)

WITH

$$\mathbf{MM_{P_i} = (IBPW_{P_i} \times C_{CH4}) \times 0.0423 \times 0.000454}$$

WHERE

$\mathbf{IBPW_{P_i}}$	Volume of MG from in-mine boreholes and post-mining wells sent to by qualifying and pre-project devices for destruction through use $\mathbf{i}$ during the reporting period (scf)
$\mathbf{C_{CH4}}$	Weighted average of measured methane concentration of mine gas sent to qualifying and pre-project destruction devices during the reporting period (scf CH_4/scf)
$\mathbf{0.0423}$	Standard density of methane (lb CH_4/scf CH_4)
$\mathbf{0.000454}$	MT CH_4/lb CH_4

WITH

$$\mathbf{C_{CH4} = \frac{\sum_t (DV_t \times C_{CH4_t})}{\sum_t DV_t}}$$

WHERE

C_{CH4_t}	Daily average methane concentration of mine gas sent to a destruction device (scf CH_4/scf)
DV_t	Daily volume of mine gas sent to a destruction device (scf)

Methane concentrations and flow rates must be recorded every fifteen minutes with averages calculated at least daily. If the Project Proponent monitors and records data at a higher frequency, this data may be used within appropriate variables of the above equations to reflect the higher frequency of data collection.

If a mass flow meter is used to monitor gas flow instead of a volumetric flow meter, the volume and density terms must be replaced by the monitored mass value and the methane concentration must be in mass percent.

IX. If gas flow metering equipment provides an actual or non-standardized flow rate or volume instead of a flow rate or volume adjusted to standard conditions, use Equation 47 to standardize the amount of MG sent to each qualifying and pre-project device during the reporting period.

6 MONITORING – QUANTIFICATION METHODOLOGY

6.1 GENERAL MONITORING REQUIREMENTS

I. The Project Proponent s responsible for monitoring the performance of the offset project and operating each component of the collection and destruction system(s) in a manner consistent with the manufacturer's specifications.

II. Operational activity of the methane drainage and ventilation systems and the destruction devices must be monitored and documented at least hourly to ensure actual methane destruction. GHG reductions will not be accounted for during periods in which the destruction device is not operational.

   A. For flares, operation is defined as thermocouple readings above 500°F.

   B. For all other destruction devices, the Project Proponent must demonstrate the destruction device was operational. This demonstration is subject to the review and verification of the verification body.

III. If gas flow metering equipment does not internally adjust for temperature and pressure, flow data must be adjusted according to the appropriate quantification methodologies in chapter 5.

IV. If a project uses elevated amounts of atmospheric gases in extracted MG as evidence of a pre-mining well being mined through, nitrogen and oxygen concentrations must be determined for each well at the time of the project start date and when the Project Proponent reports a pre-mining well as eligible. Gas samples must be collected by a third-party technician and amounts of nitrogen and oxygen concentrations determined by a full gas analysis using a chromatograph at an ISO 17025 accredited lab or a lab that has been certified by an accreditation body conformant with ISO 17025 to perform test methods appropriate for atmospheric gas content analysis.

V. Data substitution is allowed for limited circumstances where a project encounters flow rate or methane concentration data gaps. Project Proponents s may apply the data substitution methodology provided in Appendix D. No data substitution is permissible for data gaps resulting from inoperable equipment that monitors the proper functioning of destruction devices and no emission reductions will be credited under such circumstances.

6.2 INSTRUMENT QA/QC

Instruments and equipment used to monitor the destruction of mine methane or the temperature and pressure used to adjust data measurements to STP must be inspected, maintained, checked and calibrated according to the following:

I. All instruments must be:
   A. Inspected and maintained on a quarterly basis, with the activities performed and "as found/as left condition" of the equipment documented;
   B. Checked per manufacturer specifications by a trained professional for calibration accuracy with the percent drift documented, with the check occurring no more than two months before the end date of the reporting period; and
   C. Calibrated by the manufacturer or a certified calibration service per manufacturer's specifications or every 5 years, whichever is more frequent. Instruments are exempted from calibration requirements if the manufacturer's specifications state that no calibration is required.
II. A check must be performed before any corrective action (e.g., instrument calibration or repositioning) is applied.
III. If a portable instrument is used (such as a handheld methane analyzer), the portable instrument must be calibrated according to manufacturer's specifications prior to each use.
IV. For active underground VAM activities, the methane concentration of the reference gas used to check methane analyzers must be below or equal to 2% methane.
V. Flow meter and methane analyzer calibrations must be documented to show that the calibration was carried out to the range of conditions corresponding to the range of conditions as measured at the mine.
VI. If the check on a piece of equipment reveals accuracy beyond a +/- 5% threshold (reading relative to the reference value), corrective action such as calibration by the manufacturer or a certified service provider is required for that piece of equipment.
VII. If a check on a piece of equipment reveals accuracy beyond a +/- 5% threshold, all data from that piece of equipment must be scaled according to the following procedure. These adjustments must be made for the entire period from the last successful check until such time as corrective action is taken and a subsequent check demonstrates the equipment to again be within the +/-5% accuracy threshold.
   A. For each check that indicates the piece of equipment was beyond the +/- 5% accuracy threshold, the project developer shall calculate total emission reductions using:
      i. The monitored values without correction; and
      ii. The monitored values adjusted based on the calibration drift recorded at the time of the check.

B. The lower of the two emission reduction estimates shall be reported as the scaled emission reduction estimate.

6.3 DOCUMENT RETENTION

I. The Project Proponent is required to keep all documentation and information outlined in this methodology. Record retention requirements are set forth in the ACR Standard.

II. Information that must be retained by the Project Proponent must include:

A. All data inputs for the calculation of the project baseline emissions and project emission reductions;

B. Emission reduction calculations;

C. NOVs, and any administrative or legal consent orders related to project activities dating back at least three years prior to the project start date and for each year of project operation;

D. Gas flow meter information (model number, serial number, manufacturer's calibration procedures);

E. Methane analyzer information (model number, serial number, calibration procedures);

F. Cleaning and inspection records for all gas meters;

G. Field check results for all gas meters and methane analyzers;

H. Calibration results for all gas meters and methane analyzers;

I. Corrective measures taken if meter does not meet performance specifications;

J. Gas flow data (for each flow meter);

K. Methane concentration monitoring data;

L. Gas temperature and pressure readings (only if flow meter does not adjust for temperature and pressure automatically);

M. Destruction device information (model numbers, serial numbers, installation date, operation dates);

N. Destruction device monitoring data (for each destruction device);

O. All maintenance records relevant to the methane collection and/or destruction device(s) and monitoring equipment;

P. If using a calibrated portable gas analyzer for CH_4 content measurement the following records must be retained:

i. Date, time, and location of methane measurement;

ii. Methane content of gas (% by volume or mass) for each measurement;

iii. Methane measurement instrument information (model number and serial number);

iv. Date, time, and results of instrument calibration; and

v. Corrective measures taken if instrument does not meet performance specifications.

6.4 ACTIVE UNDERGROUND MINE VENTILATION AIR METHANE ACTIVITIES

I. The flow rate of ventilation air entering the destruction device must be measured continuously, recorded every two minutes, and adjusted for temperature and pressure, if applicable, to calculate average flow per hour.
II. The methane concentration of the ventilation air entering the destruction device and of the exhaust gas leaving the destruction device must be measured continuously and recorded every two minutes to calculate average methane concentrations per hour.
III. If required in order to standardize the flow rate, volume, or mass of ventilation air, the temperature and pressure in the vicinity of the flow meter must be measured continuously and recorded at least every hour to calculate hourly pressure and temperature.
IV. Project Proponents s must monitor the parameters prescribed in Table 6. Data measurements may be recorded in an alternative unit, but must be appropriately converted to specified unit for use in equations provided in chapter 5.

Table 6: Active Underground Mine VAM Activity Monitoring Parameters

EQUATION #	PARAMETER	DESCRIPTION	DATA UNIT	MEASUREMENT FREQUENCY	CALCULATED (C) MEASURED (M) REFERENCE (R) OPERATING RECORDS (O)	COMMENT
37	$C_{CH4,t}$	Hourly average methane concentration of ventilation air sent to a qualifying destruction device	scf CH_4/scf	Continuously	M, C	Readings taken every fifteen minutes to calculate average methane concentration per hour
37	$VA_{flow,t}$	Hourly average flow rate of ventilation air sent to a qualifying	scfm	Continuously	M, C	Readings taken every fifteen minutes to

EQUATION #	PARAMETER	DESCRIPTION	DATA UNIT	MEASUREMENT FREQUENCY	CALCULATED (C) MEASURED (M) REFERENCE (R) OPERATING RECORDS (O)	COMMENT
		destruction device				calculate average flow rate per hour; adjusted to standard conditions, if applicable, using Equation 46
78	y	Hours during which the destruction device was operational during reporting period	h	Continuously	M	
78	$CA_{flow,i,y}$	Hourly average flow rate of cooling air sent to a destruction device after the metering point of the ventilation air stream during period y	scfm	Continuously	M, C	Readings taken every fifteen minutes to calculate flow rate per hour; adjusted to standard conditions, if applicable using Equation 46. If the flow of cooling air is not metered, the maximum capacity of the air intake system must be used for the flow rate

EQUATION #	PARAMETER	DESCRIPTION	DATA UNIT	MEASUREMENT FREQUENCY	CALCULATED (C) MEASURED (M) REFERENCE (R) OPERATING RECORDS (O)	COMMENT
7 8	$C_{CH4, exhaust, y}$	Hourly average methane concentration of exhaust gas	scf CH_4/scf	Continuously	M, C	Readings taken every fifteen minutes to calculate average methane concentration per hour
3 7	$VA_{P,i}$	Volume of ventilation air sent to qualifying devices for destruction through use i during the reporting period	scf	Continuously	M, C	Adjusted to standard conditions, if applicable, using Equation 46
3 7	$MG_{SUPP,i}$	Volume of mine gas extracted from a methane drainage system and sent with ventilation air to qualifying devices for destruction during the reporting period	scf	Every reporting period	M, C	Adjusted to standard conditions, if applicable, using Equation 47
3 7	$C_{CH4,MG,t}$	Daily average methane concentration of mine gas sent with ventilation air to destruction device	scf CH_4/scf	Continuously	M, C	Readings taken every 15 minutes to calculate average methane concentration per day

EQUATION #	PARAMETER	DESCRIPTION	DATA UNIT	MEASUREMENT FREQUENCY	CALCULATED (C) MEASURED (M) REFERENCE (R) OPERATING RECORDS (O)	COMMENT
37	$DV_{MG,t}$	Daily volume of mine gas sent with ventilation air to destruction device	scf	Continuously	M, C	Readings taken every 15 minutes to calculate volume per day; adjusted to standard conditions, if applicable, using Equation 47
5	$CONS_{ELEC}$	Additional electricity consumption for the capture and destruction of methane during the reporting period	MWh	Every reporting period	O	From electricity use records
5	$CONS_{HEAT}$	Additional heat consumption for the capture and destruction of methane during the reporting period	Volume	Every reporting period	O	From heat use records
5	$CONS_{FF}$	Additional fossil fuel consumption for the capture and destruction of methane during the reporting period	Volume	Every reporting period	O	From fuel use records
78	$VA_{flow,i,y}$	Hourly average flow rate of ventilation air sent to a qualifying	scfm	Continuously	M, C	Readings taken every fifteen minutes to calculate flow

EQUATION #	PARAMETER	DESCRIPTION	DATA UNIT	MEASUREMENT FREQUENCY	CALCULATED (C) MEASURED (M) REFERENCE (R) OPERATING RECORDS (O)	COMMENT
		device for destruction through use **i** during the reporting period				rate per hour; adjusted to standard conditions, if applicable using Equation 46
46	$VA_{actual,y}$	Measured average flow rate or total volume of ventilation air sent to a qualifying destruction device during period **y**	acfm or acf	Continuously	M, C	Readings taken every fifteen minutes to calculate average flow rate per hour; adjusted to standard conditions, if applicable, using Equation 46
46	$T_{VAinflow,y}$	Measured absolute temperature of ventilation air sent to a destruction device for the time interval **y**, °R=°F + 459.67	°R	Continuously	M, C	Readings taken at least every hour to calculate temperature for time interval **y**
46	$P_{VAinflow,y}$	Measured absolute pressure of ventilation air sent to a destruction device for the time interval **y**	atm	Continuously	M, C	Readings taken at least every hour to calculate pressure for time interval **y**

6.5 ACTIVE UNDERGROUND MINE METHANE DRAINAGE ACTIVITIES

I. Mine gas from each methane source (i.e., pre-mining surface wells, and in-mine boreholes and post-mining wells) must be monitored separately prior to interconnection with other MG sources. The volumetric or mass gas flow, methane concentration, temperature, and pressure must be monitored and recorded separately for each methane source.

II. The flow rate of MG sent to a destruction device must be measured continuously, recorded every 15 minutes, and adjusted for temperature and pressure, if applicable, to calculate daily volume of MG sent to a destruction device. The flow of mine gas to a destruction device must be monitored separately for each destruction device, unless:

   A. A project consists of destruction devices that are of identical efficiency and verified to be operational throughout the reporting period; then a single flow meter may be used to monitor gas flow to all destruction devices; or

   B. A project consists of destruction devices that are not of identical efficiency, in which case the methane destruction efficiency of the least efficient destruction device must be used as the methane destruction efficiency for all destruction devices monitored by that meter.

III. If a project using a single meter to monitor gas flow to multiple destruction devices has any periods of time when not all destruction devices downstream of a single flow meter are operational, methane destruction from the set of downstream devices during these periods of time will only be eligible provided that the offset verifier can confirm all of the following requirements and conditions are met:

   A. The methane destruction efficiency of the least efficient downstream destruction device in operation must be used as the methane destruction efficiency for all destruction devices downstream of the single meter;

   B. All devices are either equipped with valves on the input gas line that close automatically if the device becomes non-operational (requiring no manual intervention), or designed in such a manner that it is physically impossible for gas to pass through while the device is non-operational; and

   C. For any period of time during which one or more downstream destruction devices are not operational, it must be documented that the remaining operational devices have the capacity to destroy the maximum gas flow recorded during the period.

IV. The methane concentration of the mine gas extracted from each methane source must be measured continuously and recorded every 15 minutes to calculate daily average methane concentration.

V. If required in order to adjust the flow rate, volume, or mass of mine gas, the temperature and pressure of the mine gas from each methane source must be measured continuously and recorded at least every hour to calculate hourly temperature and pressure.

VI. Project Proponents must monitor the parameters prescribed in Table 7. Data measurements may be recorded in an alternative unit, but must be appropriately converted to specified unit for use in equations provided in chapter 5.

Table 7: Active Underground Mine Methane Drainage Activity Monitoring Parameters

EQUATION #	PARAMETER	DESCRIPTION	DATA UNIT	MEASUREMENT FREQUENCY	CALCULATED (C) MEASURED (M) REFERENCE (R) OPERATING RECORDS (O)	COMMENT
16 17	DE_i	Efficiency of methane destruction device i	%	Each reporting period	R or M	Default methane destruction efficiencies provided in Appendix B or site-specific methane destruction efficiencies approved by validation and verification body
11 16 17	$C_{CH4,t}$	Daily average methane concentration of mine gas sent to a qualifying destruction device	scf CH_4/scf	Continuously	M, C	Readings taken every 15 minutes to calculate average methane concentration per day; calculated separately for each methane source
11 16 17	DV_t	Daily volume of mine gas sent to a qualifying destruction device	scf	Continuously	M, C	Readings taken every 15 minutes to calculate volume per day; adjusted to standard conditions, if applicable, using Equation 47

EQUATION #	PARAMETER	DESCRIPTION	DATA UNIT	MEASUREMENT FREQUENCY	CALCULATED (C) MEASURED (M) REFERENCE (R) OPERATING RECORDS (O)	COMMENT
						Calculated separately for each methane source.
11 16 17	$IBPW_{P,i}$	Volume of MG from in-mine boreholes and post-mining wells sent to qualifying devices for destruction through use i during the reporting period	scf	Every reporting period	M, C	Adjusted to standard conditions, if applicable, using Equation 47
11 16 17	$MG_{SUPP,i}$	Volume of mine gas extracted from a methane drainage system and sent with ventilation air to qualifying devices for destruction during the reporting period	scf	Every reporting period	M, C	Adjusted to standard conditions, if applicable, using Equation 47
11 16 17	$C_{CH4,MG,t}$	Daily average methane concentration of mine gas sent with ventilation air to destruction device	scf CH_4/scf	Continuously	M, C	Readings taken every 15 minutes to calculate average methane concentration per day
11 16	$DV_{MG,t}$	Daily volume of mine gas sent with ventilation	scf	Continuously	M, C	Readings taken every 15 minutes to

EQUATION #	PARAMETER	DESCRIPTION	DATA UNIT	MEASUREMENT FREQUENCY	CALCULATED (C) MEASURED (M) REFERENCE (R) OPERATING RECORDS (O)	COMMENT
17		air to destruction device				calculate volume per day; adjusted to standard conditions, if applicable, using Equation 47
12	$PSWe_{pre,i}$	Volume of MG sent to qualifying destruction devices, from the beginning of the crediting period through the end of the reporting period, captured from pre-mining surface wells that were mined through during the reporting period	scf	Every reporting period	M, C	Adjusted to standard conditions, if applicable, using Equation 47
12	$PSWe_{post,i}$	Volume of MG sent to qualifying destruction devices in the reporting period captured from pre-mining surface wells that were mined through during earlier reporting periods	scf	Every reporting period	M, C	Adjusted to standard conditions, if applicable, using Equation 47

EQUATION #	PARAMETER	DESCRIPTION	DATA UNIT	MEASUREMENT FREQUENCY	CALCULATED (C) MEASURED (M) REFERENCE (R) OPERATING RECORDS (O)	COMMENT
14	$CONS_{ELEC}$	Additional electricity consumption for the capture and destruction of methane during the reporting period	MWh	Every reporting period	O	From electricity use records
14	$CONS_{HEAT}$	Additional heat consumption for the capture and destruction of methane during the reporting period	Volume	Every reporting period	O	From heat use records
14	$CONS_{FF}$	Additional fossil fuel consumption for the capture and destruction of methane during the reporting period	Volume	Every reporting period	O	From fuel use records
16 17	$PSW_{P,all,i}$	Volume of MG from pre-mining surface wells sent to qualifying devices for destruction through use i during the reporting period.	scf	Every reporting period	M, C	Adjusted to standard conditions, if applicable, using Equation 47
47	$MG_{actual,y}$	Measured average flow rate or total volume of MG sent to a qualifying destruction device	acfm or acf	Continuously	M	

EQUATION #	PARAMETER	DESCRIPTION	DATA UNIT	MEASUREMENT FREQUENCY	CALCULATED (C) MEASURED (M) REFERENCE (R) OPERATING RECORDS (O)	COMMENT
		during time interval **y**				
47	$T_{MG,y}$	Measured absolute temperature of MG for the time interval y, °R=°F + 459.67	°R	Continuously	M, C	Readings taken at least every hour to calculate temperature for time interval **y**
47	$P_{MG,y}$	Measured absolute pressure of MG for the time interval **y**	atm	Continuously	M, C	Readings taken at least every hour to calculate pressure for time interval **y**

6.6 ACTIVE SURFACE MINE METHANE DRAINAGE ACTIVITIES

I. Mine gas from each methane source (i.e., pre-mining surface wells, , existing CBM wells that would otherwise be shut-in and abandoned as a result of encroaching mining, abandoned wells that reactivated, and converted dewatering wells) must be monitored separately prior to interconnection with other MG sources. The volumetric or mass gas flow, methane concentration, temperature, and pressure must be monitored and recorded separately for each methane source.

II. The flow rate of MG sent to a destruction device must be measured continuously, recorded every 15 minutes, and adjusted for temperature and pressure, if applicable, to calculate daily volume of MG sent to a destruction device. The flow of gas to a destruction device must be monitored separately for each destruction device, unless:

   A. A project consists of destruction devices that are of identical efficiency and verified to be operational throughout the reporting period; then a single flow meter may be used to monitor gas flow to all destruction devices; or

   B. A project consists of destruction devices that are not of identical efficiency, in which case the methane destruction efficiency of the least efficient methane destruction device must be used as the methane destruction efficiency for all destruction devices monitored by that meter.

III. If a project using a single meter to monitor gas flow to multiple destruction devices has any periods of time when not all destruction devices downstream of a single flow meter are operational, methane destruction from the set of downstream devices during these periods of time will only be eligible provided that the offset verifier can confirm all of the following requirements and conditions are met:

   A. The methane destruction efficiency of the least efficient downstream destruction device in operation must be used as the methane destruction efficiency for all destruction devices downstream of the single meter;

   B. All devices are either equipped with valves on the input gas line that close automatically if the device becomes non-operational (requiring no manual intervention), or designed in such a manner that it is physically impossible for gas to pass through while the device is non-operational; and

   C. For any period of time during which one or more downstream destruction devices are not operational, it must be documented that the remaining operational devices have the capacity to destroy the maximum gas flow recorded during the period.

IV. The methane concentration of the SMM extracted from each methane source must be measured continuously and recorded every 15 minutes to calculate daily average methane concentration.

V. If required in order to adjust the flow rate, volume, or mass of mine gas, the temperature and pressure of the SMM must be measured continuously and recorded at least every hour to calculate hourly temperature and pressure.

VI. Project Proponents must monitor the parameters prescribed in Table 8. Data measurements may be recorded in an alternative unit, but must be appropriately converted to specified unit for use in equations provided in chapter 5.

Table 8: Active Surface Mine Methane Drainage Activity Monitoring Parameters

EQUATION #	PARAMETER	DESCRIPTION	DATA UNIT	MEASUREMENT FREQUENCY	CALCULATED (C) MEASURED (M) REFERENCE (R) OPERATING RECORDS (O)	COMMENT
28 29	DE_i	Efficiency of methane destruction device i	%	Each reporting period	R or M	Default methane destruction efficiencies provided in Appendix B or site-specific methane destruction efficiencies approved by the validation and verification body
20 28 29	$C_{CH4,t}$	Daily average methane concentration of mine gas sent to a qualifying destruction device	scf CH_4/scf	Continuously	M, C	Readings taken every 15 minutes to calculate average methane concentration per day; calculated separately for each methane source
20 28 29	DV_t	Daily volume of mine gas sent to a qualifying destruction device	scf	Continuously	M, C	Readings taken every 15 minutes to calculate volume per day; adjusted to standard conditions, if applicable using Equation 47. Calculated

EQUATION #	PARAMETER	DESCRIPTION	DATA UNIT	MEASUREMENT FREQUENCY	CALCULATED (C) MEASURED (M) REFERENCE (R) OPERATING RECORDS (O)	COMMENT
						separately for each methane source.
21	$PSWe_{pre,i}$	Volume of MG sent to qualifying destruction devices, from the beginning of the crediting period through the end of the reporting period, captured from pre-mining surface wells that were mined through during the reporting period	scf	Every reporting period	M, C	Adjusted to standard conditions, if applicable, using Equation 47
21	$PSWe_{post,i}$	Volume of MG sent to qualifying destruction devices in the reporting period captured from pre-mining surface wells that were mined through during earlier reporting periods	scf	Every reporting period	M, C	Adjusted to standard conditions, if applicable, using Equation 47
22	$ECWe_{pre,i}$	Volume of MG sent to qualifying destruction devices, from the beginning of the crediting period through the end of the reporting	scf	Every reporting period	M, C	Adjusted to standard conditions, if applicable, using Equation 47

EQUATION #	PARAMETER	DESCRIPTION	DATA UNIT	MEASUREMENT FREQUENCY	CALCULATED (C) MEASURED (M) REFERENCE (R) OPERATING RECORDS (O)	COMMENT
		period, captured from existing coal bed methane wells that would otherwise be shut-in and abandoned as a result of encroaching mining that were mined through during the reporting period				
22	$ECWe_{post,i}$	Volume of MG sent to qualifying destruction devices in the reporting period captured from existing coal bed methane wells that would otherwise be shut-in and abandoned as a result of encroaching mining that were mined through during earlier reporting periods	scf	Every reporting period	M, C	Adjusted to standard conditions, if applicable, using Equation 47
23	$AWRe_{pre,i}$	Volume of MG sent to qualifying destruction devices, from the beginning of the crediting period through the end of the reporting period, captured	scf	Every reporting period	M, C	Adjusted to standard conditions, if applicable, using Equation 47

EQUATION #	PARAMETER	DESCRIPTION	DATA UNIT	MEASUREMENT FREQUENCY	CALCULATED (C) MEASURED (M) REFERENCE (R) OPERATING RECORDS (O)	COMMENT
		from abandoned wells that are re-activated that were mined through during the reporting period				
23	$AWRe_{post,i}$	Volume of MG sent to qualifying destruction devices in the reporting period captured from abandoned wells that are re-activated that were mined through during earlier reporting periods	scf	Every reporting period	M, C	Adjusted to standard conditions, if applicable, using Equation 47
24	$CDWe_{pre,i}$	Volume of MG sent to qualifying destruction devices, from the beginning of the crediting period through the end of the reporting period, captured from converted dewatering wells that were mined through during the reporting period	scf	Every reporting period	M, C	Adjusted to standard conditions, if applicable, using Equation 47

EQUATION #	PARAMETER	DESCRIPTION	DATA UNIT	MEASUREMENT FREQUENCY	CALCULATED (C) MEASURED (M) REFERENCE (R) OPERATING RECORDS (O)	COMMENT
24	$CDWe_{post,i}$	Volume of MG sent to qualifying destruction devices in the reporting period captured from converted dewatering wells that were mined through during earlier reporting periods	scf	Every reporting period	M, C	Adjusted to standard conditions, if applicable, using Equation 47
26	$CONS_{ELEC}$	Additional electricity consumption for the capture and destruction of methane during the reporting period	MWh	Every reporting period	O	From electricity use records
26	$CONS_{HEAT}$	Additional heat consumption for the capture and destruction of methane during the reporting period	Volume	Every reporting period	O	From heat use records
26	$CONS_{FF}$	Additional fossil fuel consumption for the capture and destruction of methane during the reporting period	Volume	Every reporting period	O	From fuel use records
28 29	$PSW_{P,all,i}$	Volume of MG from pre-mining surface wells	scf	Every reporting period	M, C	Adjusted to standard con-

EQUATION #	PARAMETER	DESCRIPTION	DATA UNIT	MEASUREMENT FREQUENCY	CALCULATED (C) MEASURED (M) REFERENCE (R) OPERATING RECORDS (O)	COMMENT
		sent to qualifying for destruction through use i during the reporting period.				ditions, if applicable, using Equation 47
28 29	$ECW_{P,all,i}$	Volume of MG from existing coal bed methane wells that would otherwise be shut-in and abandoned as a result of encroaching mining sent to qualifying devices for destruction through use i during the reporting period.	scf	Every reporting period	M, C	Adjusted to standard conditions, if applicable, using Equation 47
28 29	$AWR_{P,all,i}$	Volume of MG from abandoned wells that are reactivated sent to qualifying devices for destruction through use i during the reporting period.	scf	Every reporting period	M, C	Adjusted to standard conditions, if applicable, using Equation 47
28 29	$CDW_{P,all,i}$	Volume of MG from converted dewatering wells sent to qualifying devices for destruction through use i during the reporting period.	scf	Every reporting period	M, C	Adjusted to standard conditions, if applicable, using Equation 47

EQUATION #	PARAMETER	DESCRIPTION	DATA UNIT	MEASUREMENT FREQUENCY	CALCULATED (C) MEASURED (M) REFERENCE (R) OPERATING RECORDS (O)	COMMENT
47	$MG_{actual,y}$	Measured average flow rate or total volume of MG sent to a destruction device during time interval **y**	acfm or acf	Continuously	M	
47	$T_{MG,y}$	Measured absolute temperature of MG for the time interval y, °R=°F +459.67	°R	Continuously	M, C	Readings taken at least every hour to calculate temperature for time interval **y**
47	$P_{MG,y}$	Measured absolute pressure of MG for the time interval **y**	atm	Continuously	M, C	Readings taken at least every hour to calculate pressure for time interval **y**

6.7 ABANDONED UNDERGROUND MINE METHANE RECOVERY ACTIVITIES

I. Mine gas from the methane source (i.e., in-mine boreholes and post-mining wells drilled into the mine during or after active mining operations) can be monitored in at a single location, but abandoned mine MG must be monitored separately prior to interconnection with any active mine MG sources. The volumetric or mass gas flow, methane concentration, temperature, and pressure must be monitored and recorded separately for each methane source.

II. The flow rate of MG sent to a destruction device must be measured continuously, recorded every 15 minutes, and adjusted for temperature and pressure, if applicable, to calculate daily volume of MG sent to a destruction device. The flow of gas to a destruction device must be monitored separately for each destruction device, unless:

A. A project consists of destruction devices that are of identical efficiency and verified to be operational throughout the reporting period; then a single flow meter may be used to monitor gas flow to all destruction devices; or
B. A project consists of destruction devices that are not of identical efficiency, in which case the methane destruction efficiency of the least efficient destruction device must be used as the methane destruction efficiency for all destruction devices monitored by that meter.

III. If a project using a single meter to monitor gas flow to multiple destruction devices has any periods of time when not all destruction devices downstream of a single flow meter are operational, methane destruction from the set of downstream devices during these periods of time will only be eligible provided that the offset verifier can confirm all of the following requirements and conditions are met:
A. The methane destruction efficiency of the least efficient downstream destruction device in operation must be used as the methane destruction efficiency for all destruction devices downstream of the single meter;
B. All devices are either equipped with valves on the input gas line that close automatically if the device becomes non-operational (requiring no manual intervention), or designed in such a manner that it is physically impossible for gas to pass through while the device is non-operational; and
C. For any period of time during which one or more downstream destruction devices are not operational, it must be documented that the remaining operational devices have the capacity to destroy the maximum gas flow recorded during the period.

IV. The methane concentration of the MG must be measured continuously and recorded every 15 minutes to calculate daily average methane concentration.

V. If required in order to adjust the flow rate, volume, or mass of AMM, the temperature and pressure of the AMM must be measured continuously and recorded at least every hour to calculate hourly temperature and pressure.

VI. Project Proponents must monitor the parameters prescribed in Table 9. Data measurements may be recorded in an alternative unit, but must be appropriately converted to specified unit for use in equations provided in chapter 5.

Table 9: Abandoned Underground Mine Methane Recovery Activity Monitoring Parameters

EQUATION #	PARAMETER	DESCRIPTION	DATA UNIT	MEASUREMENT FREQUENCY	CALCULATED (C) MEASURED (M) REFERENCE (R) OPERATING RECORDS (O)	COMMENT
33 41 42	DE_i	Efficiency of methane destruction device i	%	Each reporting period	R or M	Default methane destruction efficiencies provided in Appendix B or site-specific methane destruction efficiencies approved by the validation and verification body
33	$IBPW_{B,i}$	Volume of MG from in-mine boreholes and post-mining wells that would have been sent to pre-project devices for destruction through use i during the reporting period	scf	Calculated or reported each reporting period if pre-project device continues to operate after project start	M, C	The largest of the two values calculated per Section 5.4.1 (VIII).
33 42 43	$C_{CH4,t}$	Daily average methane concentration of mine gas sent to a destruction device	scf CH_4/scf	Continuously	M, C	Readings taken every 15 minutes to calculate average methane concentration per day;

EQUATION #	PARAMETER	DESCRIPTION	DATA UNIT	MEASUREMENT FREQUENCY	CALCULATED (C) MEASURED (M) REFERENCE (R) OPERATING RECORDS (O)	COMMENT
33 42 43	DV_t	Daily volume of mine gas sent to a destruction device	scf	Continuously	M, C	Readings taken every 15 minutes to calculate volume per day; adjusted to standard conditions, if applicable, using Equation 47
36	ER_{AMM}	Average ventilation air emission rate over the life of the mine calculated using available data collected by MSHA	Mscf/d	At the project start date	O	Available from MSHA
36	t	Time elapsed from the date of mine closure to midpoint of the reporting period	days	At the project start date	O	Available from public agency (i.e., MSHA, EPA)
36	RP_{days}	Days in reporting period	days	Each reporting period	O	
40	$CONS_{ELEC}$	Additional electricity consumption for the capture and destruction of methane during the reporting period	MWh	Every reporting period	O	From electricity use records

EQUATION #	PARAMETER	DESCRIPTION	DATA UNIT	MEASUREMENT FREQUENCY	CALCULATED (C) MEASURED (M) REFERENCE (R) OPERATING RECORDS (O)	COMMENT
40	$CONS_{HEAT}$	Additional heat consumption for the capture and destruction of methane during the reporting period	Volume	Every reporting period	O	From heat use records
40	$CONS_{FF}$	Additional fossil fuel consumption for the capture and destruction of methane during the reporting period	Volume	Every reporting period	O	From fuel use records
42 43	$IBPW_{P,i}$	Volume of MG from in-mine boreholes and post-mining wells sent to by qualifying devices for destruction through use i during the reporting period	scf	Every reporting period	M, C	Adjusted to standard conditions, if applicable, using Equation 47
47	$MG_{actual,y}$	Measured average flow rate or total volume of MG sent to a destruction device during time interval y	acfm or acf	Continuously	M	
47	$T_{MG,y}$	Measured absolute temperature of MG for the time interval y, °R=°F + 459.67	°R	Continuously	M, C	Readings taken at least every hour to

EQUATION #	PARAMETER	DESCRIPTION	DATA UNIT	MEASUREMENT FREQUENCY	CALCULATED (C) MEASURED (M) REFERENCE (R) OPERATING RECORDS (O)	COMMENT
						calculate temperature for time interval **y**
47	$P_{MG,y}$	Measured absolute pressure of MG for the time interval **y**	atm	Continuously	M, C	Readings taken at least every hour to calculate pressure for time interval **y**

7 VERIFICATION REQUIREMENTS

I. See the ACR Standard for guidance on project validation and verification requirements.

II. Project Proponents are responsible for producing mine and project records requested by the validation and verification body, which could include, but is not limited to, the following:

   A. Mine plans;

   B. Mine ventilation plans;

   C. Mine maps;

   D. Mine operating permits, leases (if applicable), and air, water, and land use permits;

   E. Inspection, cleaning, and calibration records for metering equipment; and

   F. Source testing records for destruction devices that use site-specific methane destruction efficiencies.

DEFINITIONS

For the purposes of this methodology, the following definitions apply:

Abandoned Underground Mine	A mine where all mining activity including mine development and mineral production has ceased, mine personnel are not present in the mine workings, and mine ventilation fans are no longer operative. A mine must provide evidence to demonstrate it to be abandoned by the Mine Safety and Health Administration (MSHA) or other applicable federal or state agencies to be eligible for an abandoned mine methane recovery activity.
Abandoned Mine Methane (AMM)	Methane released from an abandoned mine.
Active Surface Mine	A permitted mine in which the mineral lies near the surface and can be extracted by removing the covering layers of rock and soil. A mine must be classified by the Mine Safety and Health Administration (MSHA) or other applicable federal or state agencies as active, intermittent, non-producing or temporarily idle in order to be eligible for an active surface mine methane drainage activity.
Active Underground Mine	A permitted mine most of which is located below the earth's surface. A mine must be classified by the Mine Safety and Health Administration (MSHA) or other applicable federal or state agencies as active, intermittent, non-producing, or temporarily idle in order to be eligible for an active underground mine methane drainage or ventilation air methane activity.
Borehole	A hole made with a drill, augur, or other tool into a coal seam, mine void, or surrounding strata from which mine gas can be extracted. This includes boreholes designated as methane extraction borehores as well as other utility boreholes from which methane can be extracted.
Coal	Solid fuels classified as anthracite, bituminous, sub-bituminous, or lignite
Coal Bed Methane (CBM or Virgin Coal Bed Methane)	Methane-rich natural gas drained from coal seams and surrounding strata not disturbed by mining. The extraction, capture, and destruction of virgin coal bed methane are unrelated to mining activities and are not eligible under this methodology.

Emission Factor	See ACR Standard for definition
Enclosed Flare	A flare that is situated in an enclosure for the purposes of safety, efficiency and accurate measurement of gas combustion. For purposes of this methodology, an enclosed flare is considered a flare.
End-use Management Option	A method of methane destruction deemed either eligible or ineligible for the purpose crediting under this methodology.
Flare	A combustion device that with a flame used to burn gas when mixed with combustion air; may be classified as "open" or "enclosed.
Flow Meter	Device used to measure the amount of gas flowing through a pipe as measured at a specific point.
Gas Treatment	Applying techniques to extracted mine gas such as dehydration, gas separation, and the removal of non-methane components to prepare the mine gas for an end-use management option, including pipeline injection.
Gob	The part of the mine from which the mineral and artificial supports have been removed and the roof allowed to fall in. Gob is also known as "Goaf." Generally regarded as the area behind the supports of a longwall mining machine.
Start-up period	The period between qualifying destruction device installation and the project start date. After the installation of the qualifying destruction device, the Project Proponent may run, tune, and test the system to ensure its operational quality. A start-up period must not exceed 9 months.
Longwall	A method of underground mining where a mechanical shearer is pulled back and forth across a coal face and loosened coal falls onto a conveyor for removal from the mine.
Methane Drainage System (Drainage System)	A system that drains methane from coal or trona seams and/or surrounding rock strata and transports it to a common collection point. This includes drainage systems within the mine workings or on the surface. Methane drainage systems may comprise multiple methane sources.
Methane Source	A methane source type from the following categories in the aggregate: • Ventilation shafts • Pre-mining surface wells

	- In-mine boreholes and post-mining wells - Existing coal bed methane wells that would otherwise be shut-in and abandoned - Abandoned wells that are reactivated - Converted dewatering wells
Mine Gas (MG)	The untreated gas extracted from within a mine through a methane drainage system that often contains various levels of other components (e.g., nitrogen, oxygen, carbon dioxide, hydrogen sulfide, and nonmethane hyrdocarbons) in addition to methane.
Mine Methane (MM)	Methane contained in mineral deposits and surrounding strata that is released as a result of mining operations; the methane portion of mine gas.
Mine Operator	Any owner, lessee, or other person who operates, controls, or supervises a coal or other mine or any independent contractor performing services or construction at such mine. For purposes of this methodology, the Mine Operator is the operating entity listed on the state or federal mining permit.
Mine Safety and Health Administration (MSHA)	The U.S. federal agency that regulates mine health and safety.
Mining Activities	Activities related to mineral extraction from active surface or underground coal or trona mine.
Mountaintop Removal Mining	A method of surface mining involving the removal of the covering layers of rock and soil at or near the top of a mountain to expose coal seams. Projects which occur at mines that employ mountaintop removal mining are not eligible under this methodology.
Natural Gas Pipeline (Pipeline)	A high-pressure pipeline transporting saleable quality natural gas offsite to gathering or distribution systems, or directly to customers.
Pre-Project Destruction Device (Pre-Project Device)	A destruction device that is operational at the mine prior to the project start date, except as specified in Section 2.4(II). A destruction device that is operational at the mine prior to the project start date is considered a non-qualifying destruction device even if retrofitted thereafter.

Offset Project Expansion	The addition of a new methane source or new destruction device to an existing MMC project. A methane source is deemed new if it is either drilled after the project start date or connected to a destruction device after the project start date. A destruction device is deemed new if it becomes operational after the project start date. Under certain circumstances, described in chapter 2, the addition of new methane sources or new destruction devices may qualify as a new MMC project or an offset project expansion. In those cases, a Project Proponent may choose how to define the addition. Offset project expansion, unlike the establishment of a new MMC project, will not result in a new project start date or crediting period. Offset project expansion, unlike the establishment of a new MMC project, allows the Project Proponent to submit a single monitoring report and undergo a single verification for the reporting period.
Open-pit	A method of surface mining where coal is exposed by removing the overlying rock. This is also known as open-cut or opencast mining.
In-mine Boreholes	A borehole or well drilled into an unmined seam from within the mine to drain methane from the seam ahead of the advancement of mining.
Pre-mining Surface Wells	A well or borehole drilled into an unmined seam from the surface to drain methane from the seam and surrounding strata, often months or years in advance of mining. This is also known as surface pre-mining boreholes, surface-to-seam boreholes, and surface-drilled directional boreholes.
Post-mining Well	A well or borehole used to extract or vent methane from the underground mine workings or gob area. Post-mining wells may be drilled from the surface or within the mine during or after mining activities. This includes gob wells.
Project Activity	A change in mine methane management that leads to a reduction in GHG emissions in comparison to the baseline management and GHG emissions.
Qualifying Destruction Device (Qualifying Device)	A destruction device that was not operational at the mine prior to the project start date, except as specified in Section 2.4(II). Methane destroyed by a qualifying device must be monitored for quantification of both the baseline and project scenarios.
Room and Pillar	A method of underground mining in which approximately half of the coal is left in place as “pillars” to support the roof of the active mining area while "rooms" of coal are extracted. Also known as pillar and stall or board and pillar method.

Shut-in	To close, temporarily, a well capable of production.
Standard Conditions (Standard Temperature and Pressure or STP)	For the purposes of this methodology, 60 degrees Fahrenheit and 14.7 pounds per square inch absolute (1 atm).
Standard Cubic Foot (scf)	For the purposes of this methodology, a measure of quantity of gas, equal to a cubic foot of volume at 60 degrees Fahrenheit and 14.7 pounds per square inch (1 atm) of pressure.
Strata	Plural of stratum, the layers of sedimentary rock surrounding a coal seam.
Surface Mine Methane (SMM)	Methane contained in mineral deposits and surrounding strata that is released as a result of surface mining operations.
Thermal Energy	The thermal output produced by a combustion source used directly as part of a manufacturing process, industrial/commercial process, or heating/cooling application, but not used to produce electricity.
Trona	A water-bearing sodium carbonate compound mineral that is mined and processed into soda ash or bicarbonate of soda.
Ventilation Air (VA)	The gas emitted from the ventilation system of a mine.
Ventilation Air Methane (VAM)	Methane contained in ventilation air.
Ventilation Air Methane Collection System (VAM Collection System)	A system that captures all or a portion of the ventilation air methane from the ventilation system.
Ventilation Shaft	A large diameter borehole used to supply fresh air underground or to remove contaminated air (methane and other gases) from an underground mine.
Ventilation System	A system of fans and barriers that provides a flow of air to underground workings of a mine for the purpose of sufficiently diluting and removing methane and other noxious gases in order to provide a safe working environment.

Well	A well drilled for extraction of natural gas from a coal seam, surrounding strata, or mine.

APPENDIX A: EMISSION FACTORS – QUANTIFICATION METHODOLOGY

Table 10: CO_2 Emission Factors for Fossil Fuel Use

FUEL TYPE	DEFAULT HIGH HEAT VALUE	DEFAULT CO_2 EMISSION FACTOR	DEFAULT CO_2 EMISSION FACTOR
COAL AND COKE	**MMBTU / SHORT TON**	**KG CO_2 / MMBTU**	**KG CO_2 / SHORT TON**
Anthracite	25.09	103.54	2597.819
Bituminous	24.93	93.40	2328.462
Subbituminous	17.25	97.02	1673.595
Lignite	14.21	96.36	1369.276
Coke	24.80	102.04	2530.592
Mixed (Commercial sector)	21.39	95.26	2037.611
Mixed (Industrial coking)	26.28	93.65	2461.122
Mixed (Electric Power sector)	19.73	94.38	1862.117
NATURAL GAS	**MMBTU / SCF**	**KG CO_2 / MMBTU**	**KG CO_2 / SCF**
(Weighted U.S. Average)	1.028×10^{-3}	53.02	0.055

FUEL TYPE	DEFAULT HIGH HEAT VALUE	DEFAULT CO_2 EMISSION FACTOR	DEFAULT CO_2 EMISSION FACTOR
PETROLEUM PRODUCTS	**MMBTU / GALLON**	**KG CO_2 / MMBTU**	**KG CO_2 / GALLON**
Distillate Fuel Oil No. 1	0.139	73.25	10.182
Distillate Fuel Oil No. 2	0.138	73.96	10.206
Distillate Fuel Oil No. 4	0.146	75.04	10.956
Distillate Fuel Oil No. 5	0.140	72.93	10.210
Residual Fuel Oil No. 6	0.150	75.10	11.265
Used Oil	0.135	74.00	9.990
Kerosene	0.135	75.20	10.152
Liquefied petroleum gases (LPG)	0.092	62.98	5.794
Propane	0.091	61.46	5.593
Propylene	0.091	65.95	6.001
Ethane	0.069	62.64	4.322
Ethanol	0.084	68.44	5.749
Ethylene	0.100	67.43	6.743
Isobutane	0.097	64.91	6.296
Isobutylene	0.103	67.74	6.977

FUEL TYPE	DEFAULT HIGH HEAT VALUE	DEFAULT CO_2 EMISSION FACTOR	DEFAULT CO_2 EMISSION FACTOR
PETROLEUM PRODUCTS	**MMBTU / GALLON**	**KG CO_2 / MMBTU**	**KG CO_2 / GALLON**
Butane	0.101	65.15	6.580
Butylene	0.103	67.73	6.976
Naphtha (<401 deg F)	0.125	68.02	8.503
Natural Gasoline	0.110	66.83	7.351
Other Oil (>401 deg F)	0.139	76.22	10.595
Pentanes Plus	0.110	70.02	7.702
Petrochemical Feedstocks	0.129	70.97	9.155
Petroleum Coke	0.143	102.41	14.645
Special Naphtha	0.125	72.34	9.043
Unfinished Oils	0.139	74.49	10.354
Heavy Gas Oils	0.148	74.92	11.088
Lubricants	0.144	74.27	10.695
Motor Gasoline	0.125	70.22	8.778
Aviation Gasoline	0.120	69.25	8.310
Kerosene-Type Jet Fuel	0.135	72.22	9.750
Asphalt and Road Oil	0.158	75.36	11.907
Crude Oil	0.138	74.49	10.280

FUEL TYPE	DEFAULT HIGH HEAT VALUE	DEFAULT CO_2 EMISSION FACTOR	DEFAULT CO_2 EMISSION FACTOR
OTHER FUELS (SOLID)	**MMBTU / SHORT TON**	**KG CO_2 / MMBTU**	**KG CO_2 / SHORT TON**
Municipal Solid Waste	9.95	90.7	902.465
Tires	26.87	85.97	2310.014
Plastics	38.00	75.00	2850.000
Petroleum Coke	30.00	102.41	3072.300
OTHER FUELS (GASEOUS)	**MMBTU / SCF**	**KG CO_2 / MMBTU**	**KG CO_2 / SCF**
Blast Furnace Gas	0.092×10^{-3}	274.32	0.025
Coke Oven Gas	0.599×10^{-3}	46.85	0.028
Propane Gas	2.516×10^{-3}	61.46	0.155
Fuel Gas	1.388×10^{-3}	59.00	0.082
BIOMASS FUELS (SOLID)	**MMBTU / SHORT TON**	**KG CO_2 / MMBTU KG**	**CO_2 / SHORT TON**
Wood and Wood Residuals	15.38	93.80	1442.644
Agricultural Byproducts	8.25	118.17	974.903
Peat	8.00	111.84	894.720
Solid Byproducts	25.83	105.51	2725.323
BIOMASS FUELS (GASEOUS)	**MMBTU / SCF**	**KG CO_2 / MMBTU**	**KG CO_2 / SCF**

FUEL TYPE	DEFAULT HIGH HEAT VALUE	DEFAULT CO_2 EMISSION FACTOR	DEFAULT CO_2 EMISSION FACTOR
Biogas (Captured methane)	0.841 x 10^{-3}	52.07	0.044
BIOMASS FUELS (LIQUID)	**MMBTU / GALLON**	**KG CO_2 / MMBTU**	**KG CO_2 / GALLON**
Ethanol	0.084	68.44	5.749
Biodiesel	0.128	73.84	9.452
Rendered Animal Fat	0.125	71.06	8.883
Vegetable Oil	0.120	81.55	9.786

Source: United States Environmental Protection Agency Mandatory Reporting of Greenhouse Gases (Title 40, Code of Federal Regulations, Part 98, Subpart C, Table C-1) (2013) http://www.arb.ca.gov/cc/reporting/ghg-rep/regulation/subpart_c_rule_part98.pdf.

Table 11: Emissions & Generation Resource Integrated Database (eGRID2016)

		ANNUAL OUTPUT EMISSION RATES	
EGRID SUBREGION ACRONYM	**EGRID SUBREGION NAME**	**(LB CO_2/MWH)**	**(METRIC TON CO_2/MWH)***
AKGD	ASCC Alaska Grid	1,072.3	0.486
AKMS	ASCC Miscellaneous	503.1	0.228
AZNM	WECC Southwest	1,043.6	0.473
CAMX	WECC California	527.9	0.239
ERCT	ERCOT All	1,009.2	0.458
FRCC	FRCC All	1,011.7	0.459

		ANNUAL OUTPUT EMISSION RATES	
HIMS	HICC Miscellaneous	1,152.0	0.523
HIOA	HICC Oahu	1,662.9	0.754
MORE	MRO East	1,668.2	0.757
MROW	MRO West	1,238.8	0.562
NEWE	NPCC New England	558.2	0.253
NWPP	WECC Northwest	651.2	0.295
NYCW	NPCC NYC/Westchester	635.8	0.288
NYLI	NPCC Long Island	1,178.3	0.534
NYUP	NPCC Upstate NY	294.7	0.134
RFCE	RFC East	758.2	0.344
RFCM	RFC Michigan	1,272.0	0.577
RFCW	RFC West	1,243.4	0.564
RMPA	WECC Rockies	1,367.8	0.620
SPNO	SPP North	1,412.4	0.641
SPSO	SPP South	1,248.3	0.566
SRMV	SERC Mississippi Valley	838.9	0.381
SRMW	SERC Midwest	1,612.6	0.731
SRSO	SERC South	1,089.4	0.494
SRTV	SERC Tennessee Valley	1,185.4	0.538
SRVC	SERC Virginia/Carolina	805.3	0.365

	ANNUAL OUTPUT EMISSION RATES	
U.S.	998.4	0.453

Source: U.S. EPA eGRID2016, Version 1.0 Year 2016 GHG Annual Output Emission Rates (Created February 2018) https://www.epa.gov/sites/production/files/2018-02/documents/egrid2016_summarytables.pdf.

Equation 444: Calculating Heat Generation Emission Factor

$$CEF_{HEAT} = \frac{CEF_{CO_{2i}}}{Eff_{HEAT}} \times \frac{44}{12}$$

WHERE

CEF_{HEAT}	CO_2 emission factor for heat generation
$CEF_{CO_{2i}}$	CO_2 emission factor of fuel used in heat generation (see Table 10)
Eff_{HEAT}	Boiler efficiency of the heat generation (either measured efficiency, manufacturer nameplate data for efficiency, or 100%)
$\frac{44}{12}$	Carbon to carbon dioxide conversion factor

Equation 455: Converting from lbs CO_2/MWh to metric tons CO_2/MW

$$Metric\ Tons_{CO_2} = \frac{lbs_{CO_2}}{2204.62}$$

APPENDIX B: DEVICE DESTRUCTION EFFICIENCIES – QUANTIFICATION METHODOLOGY

Table 12: Default Methane Destruction Efficiencies by Destruction Device

DESTRUCTION DEVICE	DESTRUCTION EFFICIENCY
Open Flare	0.960
Enclosed Flare	0.995
Lean-burn Internal Combustion Engine	0.936
Rich-burn Internal Combustion Engine	0.995
Boiler	0.980
Microturbine or large gas turbine	0.995
Upgrade and use of gas as CNG/LNG fuel	0.950
Upgrade and injection into natural gas transmission and distribution pipeline	0.981

APPENDIX C: STANDARDIZED FLOW RATE ENTERING DESTRUCTION DEVICES

Equation 466: VA Flow Rate or Volume Adjusted for Temperature and Pressure

$$VA_{adjusted_y} = VA_{actual_y} \times \frac{519.67}{T_{VA_{inflow_y}}} \times \frac{P_{VA_{inflow_y}}}{1}$$

WHERE

$VA_{adjusted_y}$	Average flow rate or total volume of ventilation air sent to a destruction device during time interval y, adjusted to standard conditions (scfm or scf)
VA_{actual_y}	Measured average flow rate or total volume of ventilation air sent to a destruction device during time interval y (acfm or acf)
$T_{VA_{inflow_y}}$	Measured absolute temperature of ventilation air sent to a destruction device for the time interval y, °R = °F + 459.67 (°R)
$P_{VA_{inflow_y}}$	Measured absolute pressure of ventilation air sent to a destruction device for the time interval y (atm)

Equation 477: MG Flow Rate or Volume Adjusted for Temperature and Pressure

$$MG_{adjusted_y} = MG_{actual_y} \times \frac{519.67}{T_{MG_y}} \times \frac{P_{MG_y}}{1}$$

WHERE

$MG_{adjusted_y}$	Average flow rate or total volume of MG sent to a destruction device during time interval y, adjusted to standard conditions (scfm or scf)
MG_{actual_y}	Measured average flow rate or total volume of MG sent to a destruction device during time interval y (acfm or acf)

T_{MG_y}	Measured absolute temperature of MG for the time interval y, °R=°F + 459.67 (°R)
P_{MG_y}	Measured absolute pressure of ventilation air sent to a destruction device for the time interval y (atm)

APPENDIX D: DATA SUBSTITUTION METHODOLOGY – QUANTIFICATION METHODOLOGY

I. ACR expects that MMC projects will have continuous, uninterrupted data for the entire reporting period. However, ACR recognizes that unexpected events or occurrences may result in brief data gaps.
II. This Appendix provides a quantification methodology to be applied to the calculation of GHG emission reductions for MMC projects when data integrity has been compromised due to missing data points.
III. This methodology is only applicable to gas flow metering and methane concentration parameters. Data substitution is not allowed for equipment that monitors the proper functioning of destruction devices such as thermocouples.
IV. This methodology may be used for missing temperature and pressure data used to adjust flow rates to standard conditions.
V. The following data substitution methodology may be used only for flow and methane concentration data gaps that are discrete, limited, non-chronic, and due to unforeseen circumstances.
VI. Data substitution is not allowed for data used to calculate mine specific hyperbolic emission rate decline curve coefficients for an abandoned underground mine methane recovery activity.
VII. Data substitution can only be applied to methane concentration *or* flow readings, but not both simultaneously. If data is missing for both parameters, no reductions can be credited.
VIII. Substitution may only occur when two other monitored parameters corroborate proper functioning of the destruction device and system operation within normal ranges. These two parameters must be demonstrated as follows:
    A. Proper functioning can be evidenced by thermocouple readings for flares or engines, energy output for engines, etc.
    B. For methane concentration substitution, flow rates during the data gap must be consistent with normal operation.
    C. For flow substitution, methane concentration rates during the data gap must be consistent with normal operations.
IX. If corroborating parameters fail to demonstrate any of these requirements, no substitution may be employed. If the requirements above can be met, the following substitution methodology may be applied:

Table 13: Data Substitution Duration and Methodology

DURATION OF MISSING DATA	SUBSTITUTION METHODOLOGY
Less than six hours	Use the average of the four hours of normal operation immediately before and following the outage
Six to 24 hours	Use the 90% lower confidence limit of the 24 hours of normal operation prior to and after the outage
One to seven days	Use the 95% lower confidence limit of the 72 hours of normal operation prior to and after the outage
Greater than one week	No data may be substituted, and no credits may be generated

APPENDIX E: MMC PERFORMANCE STANDARD FOR GAS PIPELINE SALES

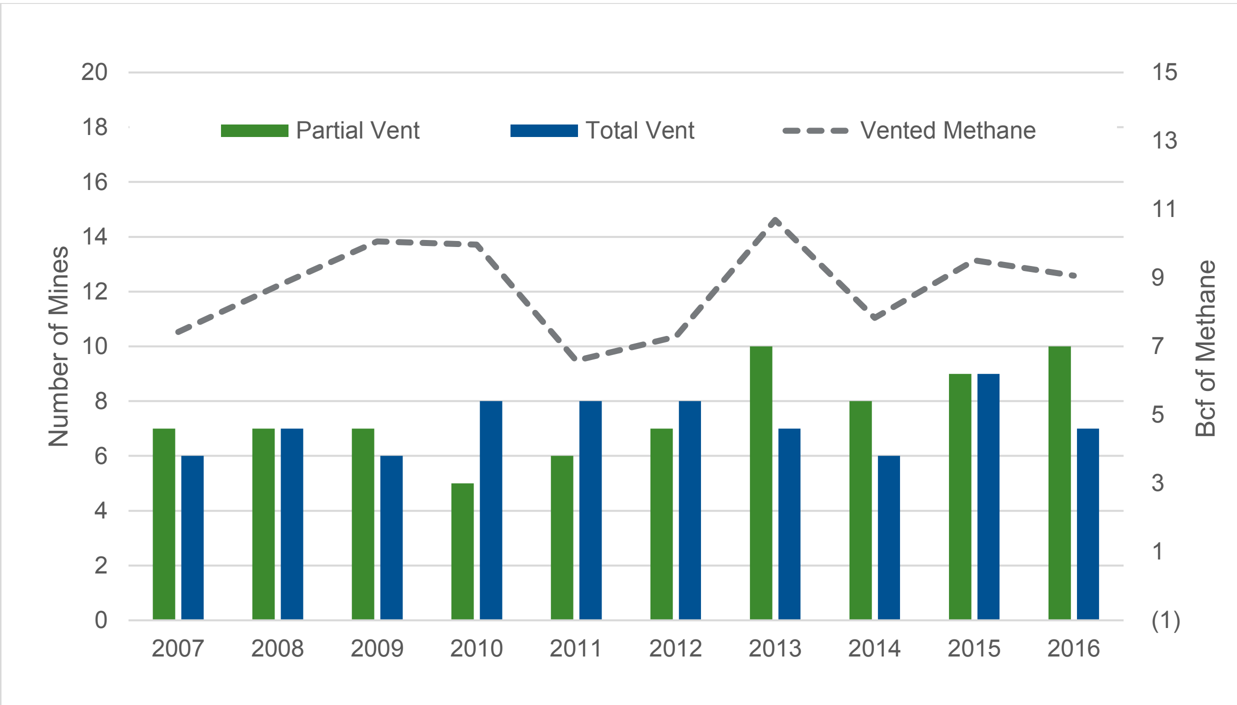
This Appendix presents an updated analysis of mines employing gas drainage systems.

E.1 VENTING METHANE

A review of new coal mine methane projects installed since 2007 show that only four projects were developed over the past ten years, of which two were pipeline sales projects. The four new projects were offset by three projects that shut down (pipeline sales) and one project transitioned to an abandoned mine project. During the same period, methane vented to the atmosphere from coal mine gas drainage systems (located at 13-18 mines depending on the year) increased over 20 percent. Several coal mines with CMM projects recover all methane from drainage systems without venting.

Figure 5 shows the amount of methane vented from gas drainage systems at U.S. coal mines from 2007 – 2016. Also, Figure 5 shows about half of these mines partially vent methane (and recover and use a small portion of the drainage gas), while the other half vent all methane to the atmosphere. In 2016, 17 of the 20 mines with drainage systems vented some methane to the atmosphere.

Figure 5: U.S. Coal Mines Venting Methane Drainage Gas



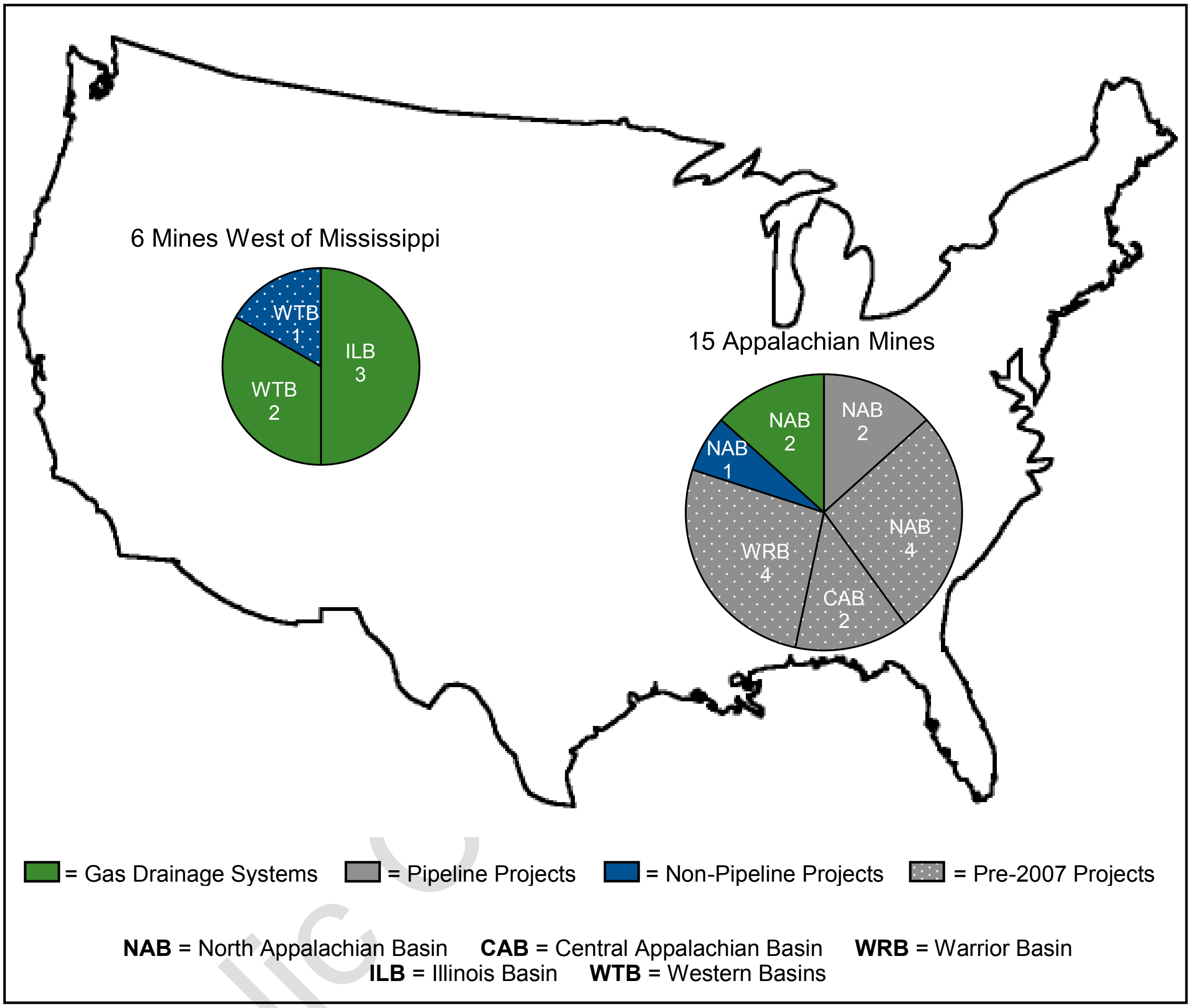
With net zero CMM project gain over the past ten years combined with increased methane venting, the data and analysis demonstrate that common practice at coal mines (venting methane to the atmosphere since 2007) is to continue the practice of venting methane.

E.2 COAL BED METHANE LEGACY PROJECTS

As of 2016, 12 of 14 operating CMM projects in the U.S. were pipeline sales projects. However, 10 of the 12 pipeline sales projects were established prior to 2007, of which 8 were established during the 1990s as part of large-scale coalbed methane (CBM) development in the Appalachian coal basins. The success of Appalachian-based CMM pipeline sales projects was attributed in large part due to the coal mines being co-located with the rapid, large scale CBM infrastructure development (gathering lines, compressor stations, processing facilities, etc.) throughout and surrounding many coal mine lease areas. In 2016, 90 percent of the CMM recovered and used at U.S. coal mines was produced from these 8 older projects co-located with CBM development.

Figure 6 shows a breakdown of 21 coal mines with gas drainage systems in 2016 – indicating whether the mines have a CMM recovery and use project. The graphic divides the coal mines between east and west, and clearly shows all pipeline projects residing in the east.

Figure 6: Current mines with gas drainage systems

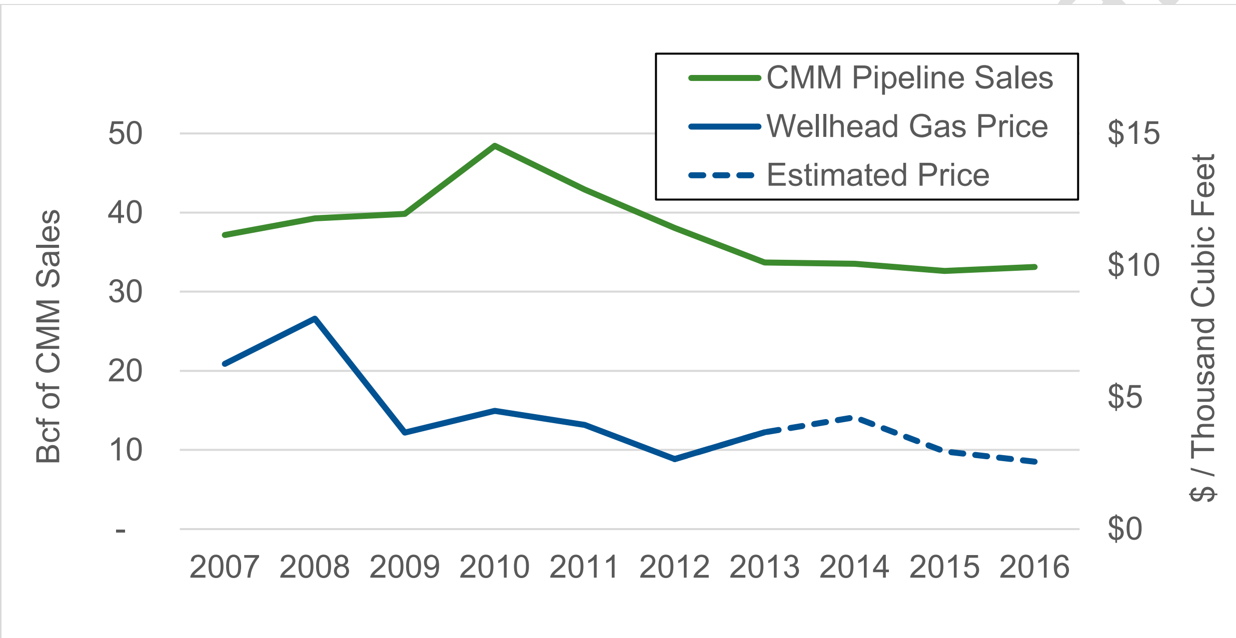


E.3 INCREASED RISK AND UNCERTAINTY

According to U.S. Energy Administration Information (EIA), CBM production in the U.S. peaked in 2008 and declined by 35% by 2015 and is expected to continue to decline. In recent years, unconventional gas development in the U.S. has focused efforts on shale gas development rather than CBM. Accordingly, U.S. CBM reserves analyses project no new discoveries in any active coal mine basins, thus the development of any new CBM fields and associated increases in CMM recovery and use are unlikely. As a result, new CMM projects face similar or greater barriers to development as they did a decade ago.

With the recent restructuring of the U.S. coal mining industry since 2014, project risk has increased significantly. Coal production declines since 2015 have increased the risk of mine shut downs and closures – affecting the long-term CMM project investment risk. The financial barriers associated with CMM gas pipeline sales projects have never been greater. Figure 7 shows CMM gas pipeline sales peaked in 2010 at 48 billion cubic feet (Bcf) and fell to 33 Bcf in 2016. In addition, natural gas prices peaked in 2008, and fell in 2016 to their lowest levels since 1999.

Figure 7: CMM Pipeline Sales and Wellhead Prices (2007 – 2016)



E.4 CONCLUSION

The absence of any meaningful new CMM project development in the U.S. and continued venting of large quantities of methane to the atmosphere by the majority of coal mines over the last decade indicates CMM recovery and use projects are not business as usual or common practice, regardless of the type of end use technology. Past pipeline projects were successful mostly due to the booming CBM development and federal tax credits available in the 1990's. With the declining CBM development combined with low natural gas prices, CMM pipeline projects are facing increased financial barriers today – much more than ten years ago. As a result, any type of CMM recovery and use project should be considered equally eligible for emission reduction credits.

APPENDIX F: REFERENCES

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