Methane Mitigation System
Quarterly Operations and Monitoring (O&M) Summary

DWR WATER WELL
PERMIT # 268360

13606 WCR 2 ½
Brighton, Colorado
NWSE S32 T1N R66W

COGCC Remediation # 15469

Prepared by:

TASMAN

6855 WEST 119TH AVENUE
BROOMFIELD, COLORADO 80020

February 8, 2022

Table of Contents

1.0 Introduction

Tasman Geosciences, Inc. (Tasman) has prepared this quarterly operations and monitoring (O&M) summary on behalf of PDC Energy, Inc. (PDC) and Great Western Operating Company, LLC (collectively referred to as the Operators) for the methane mitigation system (System) installed at the (Property) associated with the Colorado Division of Water Resources (DWR) Well Permit Number 268360 (Well). The System was designed to mitigate methane concentrations in the Well water.

2.0 Location and Background

The Property is located at 13606 West County Road (WCR) 2 ½ in Brighton, Colorado, within the NWSE Quarter of Section 32, Township 1 North, Range 66 West. The Property coordinates are approximately 40.007457 degrees north latitude and -104.798748 degrees west longitude.

The Well is permitted for domestic use and is completed within the Laramie Fox Hills aquifer. The Well is constructed with a screened interval between 810 and 1,075 feet below ground surface (bgs), with a static water level of 463 feet bgs, according to DWR records. Water from the Well is pumped and conveyed into the basement of the residence, where it either enters the residential supply stream or is conveyed to exterior irrigation spigots.

As a part of an area water well study requested by the Colorado Oil and Gas Conservation Commission (COGCC), PDC retained Olsson Associates (Olsson) on May 8, 2020, to collect a preliminary baseline water sample from the Well in accordance with the COGCC Baseline Water Quality Sampling Program, Rule 318A. Laboratory results indicated that the sample exhibited a methane concentration of 11.6 milligrams per liter (mg/L) [Table 1]. Notification was provided to the COGCC, as the concentration exceeded the maximum reporting threshold of 10 mg/L. Subsequent isotopic and gas compositional analysis indicated that the methane exhibited properties of both thermogenic and biogenic origin.

On June 26, 2020, PDC retained Tasman to collect a supplemental baseline water sample from the Well. Laboratory and isotopic analyses confirmed an elevated methane concentration of 17.4 mg/L, with properties of thermogenic and biogenic origin.

As a result of the elevated methane concentration and properties of thermogenic origin, the Operators obtained consent from the landowners to install the System.

3.0 System Design

The System was designed to mitigate methane concentrations detected in the Well using a two-phased approach. The following sections summarize the design and installation for each component of the System. A System process and instrumentation diagram (P&ID) is provided as Figure 1. A photographic overview of the System is provided as Attachment B.

3.1 Well Ventilation

The ventilation portion of the System is designed to allow for passive ventilation of methane from the Well casing. A schedule-80 polyvinyl chloride (PVC) pipe stack is constructed directly over the Well, and is sealed with an aluminum screened vent cap (Figure 1).

The Well ventilation stack was installed on August 6, 2020. Following installation, approximately ½-gallon of Clorox® bleach was poured into the Well as a precautionary measure to ensure that no foreign elements were introduced during construction.

3.2 Water Treatment System

The water treatment portion of the System is designed to remove methane dissolved in the Well water using a combination of aeration technology and carbon filtration (Figure 1). All System equipment is housed within the basement of the residence. The water is conveyed from the Well through the existing residential pressure tank and filter into the System for treatment.

Once water enters the System, it is conveyed via 1-inch schedule-40 PVC piping through a screen filter and into an aeration tank equipped with enclosed misters. The process water is sprayed, or atomized, within the tank, thereby volatilizing the dissolved methane. Methane vapors are then transferred from the tank via a small blower through a 3-inch PVC vent stack for discharge outside of the residence. The top of the vent stack is installed on the exterior of the residence, above and away from any windows. Vapor collection and conveyance operate as a closed system to prevent methane accumulation within the basement.

Once treated, process water collects at the bottom of the aeration tank. When the water level in the tank falls below the low liquid level switch (LSL), the switch is engaged thereby opening the solenoid valve and initiating Well pump operation. When the water level in the tank reaches the maximum fill level, the high liquid level switch (LSH) is engaged and the solenoid valve closes.

As water is consumed within the residence, process water is transferred from the aeration tank using an enclosed submersible pump into a small pressure tank. Prior to entering the residential supply stream, process water is conveyed through a granular activated carbon (GAC) filter as a polishing measure.

The water treatment equipment was installed at the Property between August 24 and August 28, 2020. The System became operational on August 28, 2020.

4.0 System Sampling Program

The System sampling program is used to monitor operational efficacy and confirm methane concentrations are reduced below the target level of 10 mg/L. Following the initial system start-up sampling procedures, the sampling program will be conducted on a quarterly schedule and sampled within the third month of every quarter. The following sections provide an overview to the sampling program, as well as data for the reporting period.

4.1 Overview

Water samples are collected from the influent and effluent process streams of the System (Figure 1). The effluent sample port (EFF) is located downstream of the aeration tank and GAC filter. The influent sample port (INF) is located upstream of the aeration tank and downstream of existing residential pressure tank.

Effluent water samples are collected following one minute of purging at a rate of 250 to 500 milliliters (mL) per minute (min). Influent water samples are collected following parameter stabilization while purging at a rate of 250 to 500 mL/min, to ensure that samples are representative of formation conditions.

Samples are collected in laboratory-provided unpreserved glass 40-mL vials and designated using the following sample identification nomenclature:

Prefix [INF or EFF] – mmddyy – time [24-hour]

Sample vials are subsequently placed in an ice-filled cooler to maintain a temperature of approximately 4 degrees Celsius during transportation to the laboratory. Samples are submitted to Summit Scientific Laboratory (Summit) under standard chain-of-custody procedures for analysis of dissolved gases (methane, ethane, propane) by Environmental Protection Agency (EPA) Method RSK-175. Additionally, one sample is collected from the system influent in a laboratory-provided 750-mL IsoFlask™ and submitted to Dolan Integration Group (DIG) for isotopic and gas compositional analysis, per COGCC directive.

4.2 Quarterly Reporting Data

Quarterly sampling was conducted in the third month of the quarter on December 21, 2021. Analytical results indicated that post-treatment methane concentrations were reduced below the target level of 10 mg/L. Isotopic analyses completed by DIG confirmed that the elevated methane concentrations were thermogenic and biogenic in origin. Analytical results are summarized in Table 1 and the combined laboratory report is provided as Attachment A.

5.0 Upcoming Site Activities

System maintenance activities will be conducted concurrent with System sampling events on a quarterly schedule. Maintenance will include inspection, cleaning, and replacement of the System components, as needed.

First quarter 2022 System sampling and maintenance will be conducted in March 2022.

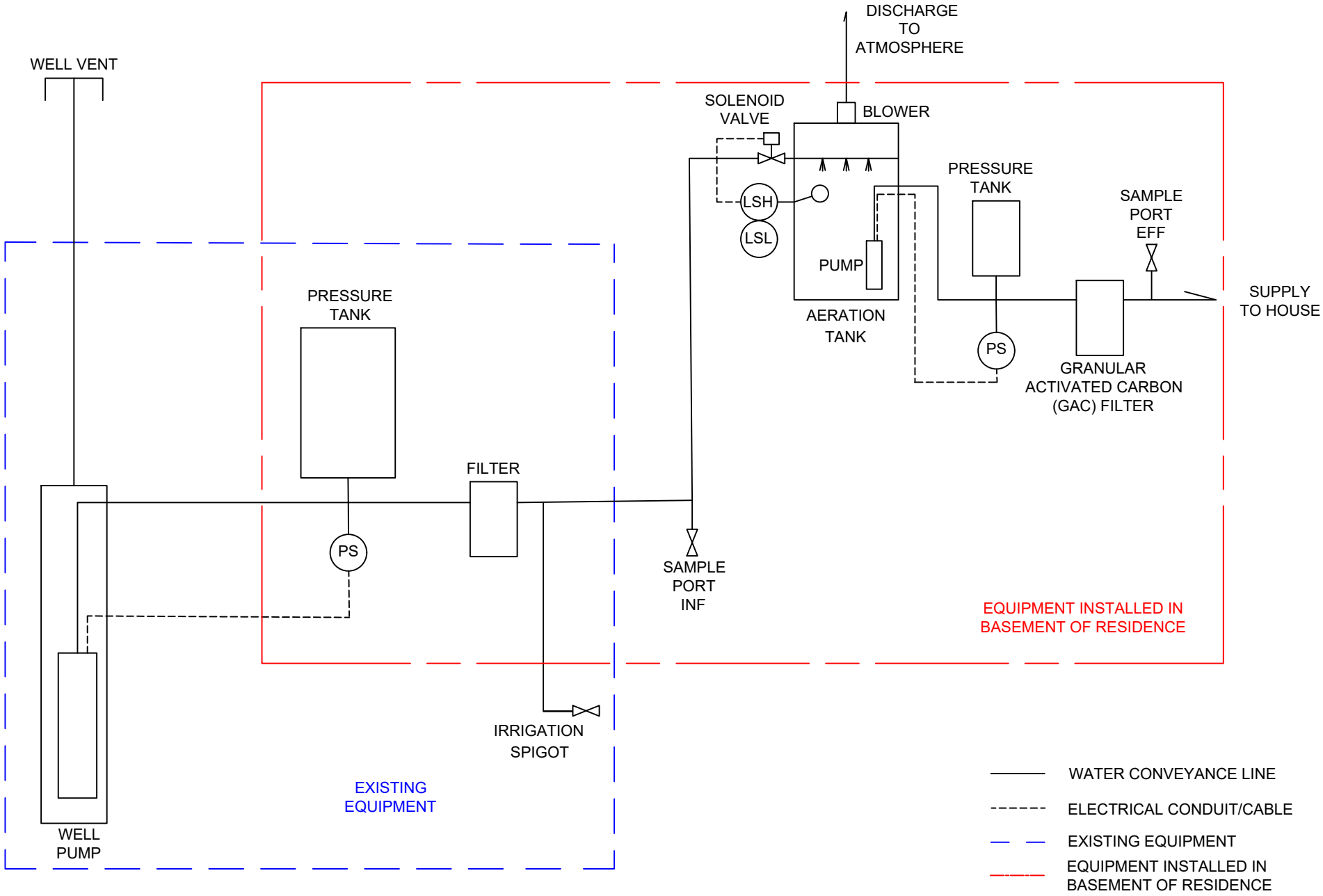
TABLE

TABLE 1
DWR WATER WELL PERMIT # 268360
SYSTEM PROCESS WATER ANALYTICAL RESULTS SUMMARY TABLE

Sample ID	Date Sampled	Methane (mg/L)	Ethane (mg/L)	Propane (mg/L)
Target Level (mg/L)		**10**	**-**	**-**
EFF-083120-1010	8/31/2020	4.1	2.2	1.2
EFF-090820-0926	9/8/2020	2.9	2.0	1.2
EFF-091420-900	9/14/2020	3.4	1.9	1.2
EFF-092120-0915	9/21/2020	4.0	1.7	0.99
EFF-120420-1031	12/4/2020	3.0	1.8	1.6
EFF-030921-1034	3/9/2021	3.5	2.0	1.3
EFF-061521-1045	6/15/2021	3.2	1.7	1.2
EFF-091421-1045	9/14/2021	1.1	<0.010	<0.010
EFF-122121-1040	12/21/2021	3.3	1.8	1.1
INF-082620-1139	8/26/2020	18	12	3.1
INF-083120-1107	8/31/2020	12	5.1	2.7
INF-090820-1019	9/8/2020	12	5.0	2.8
INF-091420-937	9/14/2020	12	5.2	2.9
INF-092120-1010	9/21/2020	12	5.2	4.1
INF-120420-1118	12/4/2020	11	5.4	4.4
INF-030921-1103	3/9/2021	11	4.3	2.3
INF-061521-1127	6/15/2021	9.7	3.2	2.0
INF-091421-1134	9/14/2021	12	5.6	2.9
INF-122121-1107	12/21/2021	14	7.1	3.5

Notes:
mg/L= Milligrams per liter

FIGURE



No.	Date	Revisions	By	Ckd

Project Manager's name: CHRISTINE HAMLIN
Professional Engineer's No.
State | Date Signed | Project Mgr.: CH
Designed by: DAG | Drawn by: DAG | Checked by: CH

TASMAN

Methane Mitigation System
Process and Instrumentation Diagram

DWR Permit Number 268360

TASMAN GEOSCIENCES PROJECT

Date
AUGUST 31, 2020

TASMAN GEOSCIENCES
BROOMFIELD CO 80020
TELEPHONE NO 303-487-1228

ATTACHMENT A

Summit Scientific

4653 Table Mountain Drive, Golden, Colorado 80403

303.277.9310

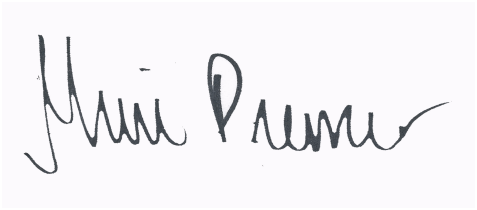
January 11, 2022

Karen Olson
PDC Energy
1775 Sherman St. STE. 3000
Denver, CO 80203

RE: DWR Permit #268360
Work Order #2112382

Enclosed are the results of analyses for samples received by Summit Scientific on 12/21/21 14:25. If you have any questions concerning this report, please feel free to contact me.

Sincerely,



Muri Premer For Paul Shrewsbury
President

S2

PDC Energy 1775 Sherman St. STE. 3000 Denver CO, 80203	Project: DWR Permit #268360 Project Number: AFE # EX-000335 Project Manager: Karen Olson	**Reported:** 01/11/22 12:26

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
EFF-122121-1040	2112382-01	Water	12/21/21 10:40	12/21/21 14:25
INF-122121-1107	2112382-02	Water	12/21/21 11:07	12/21/21 14:25

Summit Scientific

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Summit Scientific 2112382

S_2

4653 Table Mountain Drive ♦ Golden, Colorado 80403
303-277-9310

Client:	PDC Energy / Tasman	Project Manager:	Karen Olson
Address:	6855 W. 119th Ave.	E-Mail:	Karen.Olson@pdce.com; chamlin@tasman-geo.com
City/State/Zip:	Broomfield / CO / 80020		
Phone:	303-487-1228	Project Name:	DWR Permit # 268360
Sampler Name:	Brock Nelson	Project Number:	AFE # EX-000335

					Preservative				Matrix				Analysis Requested								Special Instructions
ID	Sample Description	Date Sampled	Time Sampled	# of containers	HCl	HNO3	None	Other ___	Water	Soil	Air-Canister #	Other ___	RSK-175 (Dissolved Gases)		D-6 Composition Analysis						
1	EFF-122121-1040	12/21/21	1040	3			X		X				X								4 containers for INF-122121-1107 1G ISOFLASK S/N FOCH6
2	INF-122121-1107	12/21/21	1607	3			X		X				X								
3	INF-122121-1107	12/21/21	1107	1			X		X						X						
4																					
5																					
6																					
7																					
8																					
9																					
10																					

Relinquished by:	Date/Time: 12/21/21 1425	Received by: Tasman Lock Box	Date/Time: 12/21/21 1425
Relinquished by:	Date/Time:	Received by:	Date/Time: 122121 1425
Relinquished by:	Date/Time:	Received by:	Date/Time:

Turn Around Time (Check)

Same Day ___ 72 hours ___
24 hours X Standard ___
48 hours ___

Sample Integrity:

Temperature Upon Receipt: 4.1
Samples Intact: (Yes) No

Notes:

Please provide data in PDF and COGCC EDD formats.

COGCC Facility No.: 766146

S2

Sample Receipt Checklist

S2 Work Order# 2112382

Client: Roc Energy/Tasman Client Project ID: DWR Permit # 2683C0

Shipped Via: H.D./P.U./FedEx/UPS/USPS/Other_____ Airbill #: _____

Matrix (check all that apply): ☐ Air ☐ Soil/Solid ☑ Water ☐ Other:_____ (Describe)

Temp (°C)	4.1

Thermometer ID: G86A9201901378

	Yes	No	N/A	Comments (if any)
If samples require cooling, was the temperature at 4°C +/- 2°C (1)? NOTE: If samples are delivered the same day of sampling, this requirement is met if there is evidence that cooling has begun.	–			on ICE
Were all samples received intact (1)?	–			
Was adequate sample volume provided (1)?	–			
If custody seals are present, are they intact (1)?	–			
Are samples with holding times due within 48 hours sample due within 48 hours present?	–			24 hrs
Is a chain-of-custody (COC) form present and filled out completely (1)?	–			
Does the COC agree with the number and type of sample bottles received (1)?	–			
Do the sample IDs on the bottle labels match the COC (1)?	–			
Is the COC properly relinquished by the client w/ date and time recorded (1)?	–			
For volatiles in water – is there headspace present? **If yes, contact client and note in narrative.**		–		
Are samples preserved that require preservation **(excluding cooling)** (1)? Note the type of preservative in the Comments column – HCl, H2SO4, NaOH, HNO3, etc.			–	
If samples are acid preserved for metals, is the pH ≤ 2(1)? Record the pH in Comments.			–	
If dissolved metals are requested, were samples field filtered?			–	
Additional Comments (if any):				

(1) If NO, then contact the client before proceeding with analysis and note in case narrative.

Custodian Printed Name or Initials

12.21.21
Date/Time

S2

PDC Energy 1775 Sherman St. STE. 3000 Denver CO, 80203	Project: DWR Permit #268360 Project Number: AFE # EX-000335 Project Manager: Karen Olson	**Reported:** 01/11/22 12:26

EFF-122121-1040

2112382-01 (Water)

Summit Scientific

Dissolved Gases by RSK-175

Date Sampled: **12/21/21 10:40**

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Methane	**3.3**	1.0	mg/L	100	BEL0492	12/22/21	12/23/21	RSK-175 mod	
Ethane	**1.8**	1.0	"	"	"	"	"	"	
Propane	**1.1**	1.0	"	"	"	"	"	"	

Date Sampled: **12/21/21 10:40**

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Surrogate: Ethene		*108 %*	*70-130*		"	"	"	"	

Summit Scientific

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

S2

PDC Energy 1775 Sherman St. STE. 3000 Denver CO, 80203	Project: DWR Permit #268360 Project Number: AFE # EX-000335 Project Manager: Karen Olson	**Reported:** 01/11/22 12:26

INF-122121-1107

2112382-02 (Water)

Summit Scientific

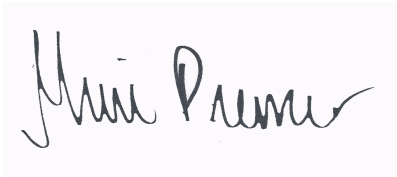
Dissolved Gases by RSK-175

Date Sampled: **12/21/21 11:07**

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Methane	**14**	1.0	mg/L	100	BEL0492	12/22/21	12/23/21	RSK-175 mod	
Ethane	**7.1**	1.0	"	"	"	"	"	"	
Propane	**3.5**	1.0	"	"	"	"	"	"	

Date Sampled: **12/21/21 11:07**

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Surrogate: Ethene		*110 %*	*70-130*		"	"	"	"	



S2

PDC Energy	Project: DWR Permit #268360	
1775 Sherman St. STE. 3000	Project Number: AFE # EX-000335	**Reported:**
Denver CO, 80203	Project Manager: Karen Olson	01/11/22 12:26

Dissolved Gases by RSK-175 - Quality Control

Summit Scientific

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch BEL0492 - GC										
Blank (BEL0492-BLK1)				Prepared: 12/22/21 Analyzed: 12/23/21						
Methane	ND	0.010	mg/L							
Ethane	ND	0.010	"							
Propane	ND	0.010	"							
Surrogate: Ethene	*0.0464*		*"*	*0.0364*		*127*	*70-130*			
LCS (BEL0492-BS1)				Prepared: 12/22/21 Analyzed: 12/23/21						
Methane	0.030	0.010	mg/L	0.0428		71.3	70-130			
Ethane	0.084	0.010	"	0.0798		105	70-130			
Propane	0.12	0.010	"	0.139		87.5	70-130			
Surrogate: Ethene	*0.0839*		*"*	*0.0728*		*115*	*70-130*			
Duplicate (BEL0492-DUP1)	**Source: 2112382-01**			Prepared: 12/22/21 Analyzed: 12/23/21						
Methane	3.3	1.0	mg/L		3.3			0.306	30	
Ethane	1.8	1.0	"		1.8			0.00	30	
Propane	1.1	1.0	"		1.1			1.87	30	
Surrogate: Ethene	*0.0402*		*"*	*0.0364*		*110*	*70-130*			
Matrix Spike (BEL0492-MS1)	**Source: 2112382-01**			Prepared: 12/22/21 Analyzed: 12/23/21						
Methane	5.4	1.0	mg/L	0.0428	3.3	NR	70-130			QM-05
Ethane	2.0	0.10	"	0.0798	1.8	299	70-130			QM-05
Propane	1.2	0.10	"	0.139	1.1	135	70-130			QM-05
Surrogate: Ethene	*0.0750*		*"*	*0.0728*		*103*	*70-130*			

Chain of Custody Form

Job 21126921 DIG-027019

dig Geochemistry for Energy
Dolan Integration Group

main 303.531.2030 • info@digforenergy.com • digforenergy.com
Office and Lab 11025 Dover St • Ste 800 • Westminster, CO 80021

Send Data to:	Send Invoice to (if different):	Additional Information:
Name: Muri Premer / Paul Shrewsbury	Name: Ben Shrewsbury	AFE #:
Company: Summit Scientific	Company: Summit Scientific	Project: 2112382
Address: 4653 Table Mountain Drive	Address: 4653 Table Mountain Drive	PO #:
City, State: Golden, CO 80403	City, State: Golden, CO 80403	Location:
Phone: 303-277-9310	Phone: 303-277-9310	Sampled By:
Email: mpremer@s2scientific.com / pshrewsbury@s2scientific.com	Email: bshrewsbury@s2scientific.com	API #:

Turnaround Time**: ○ Standard (≤ 10 Business days) ○ Rush (≤ 5 Business days) ● Expedited Rush (≤ 3 Business days)

Container Number	Sample Identification	Date Sampled	Time	Sample Type*	Gas Composition	d13C of Methane (C1)	d13C of Ethane (C2)	d13C of Propane+ (C3+)	d13C of Carbon Dioxide (CO2)	dD of Methane (C1)	Whole Oil Gas Chromatography	d18O and dD Isotopes of Water	RSK 175 Dissolved Gas Quantification
	INF-122121-1107	12/21/21	11:07	Other	●	●				●			
				Other									
				Other									
				Other									
				Other									
				Other									
				Other									
				Other									
				Other									
				Other									

Chain of Custody Record

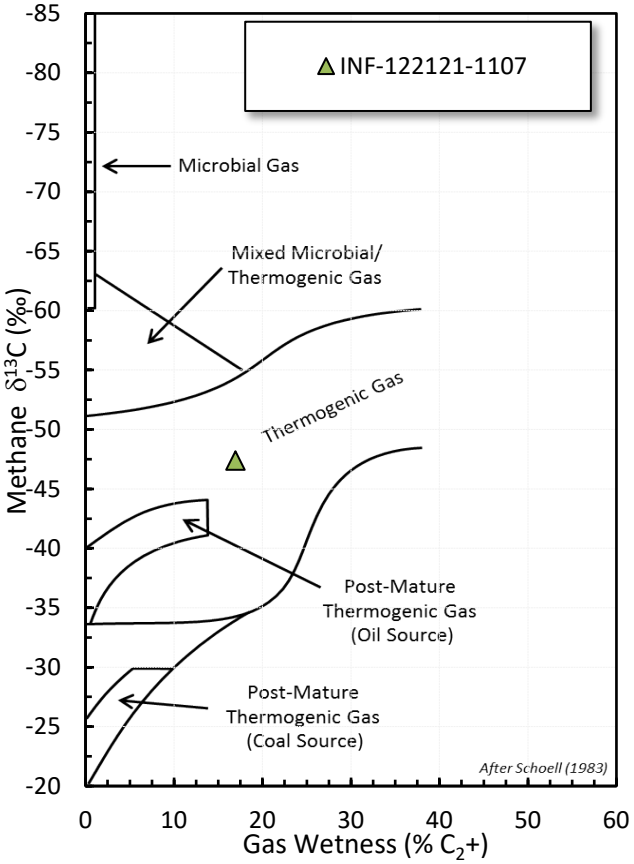
Comments:

Relinquished by Signature	Company	Date	Time	Received by Signature	Company	Date	Time
[signature]	Summit Scientific	12/22/21	11:20	[signature]	DIG	12/22/21	11:22

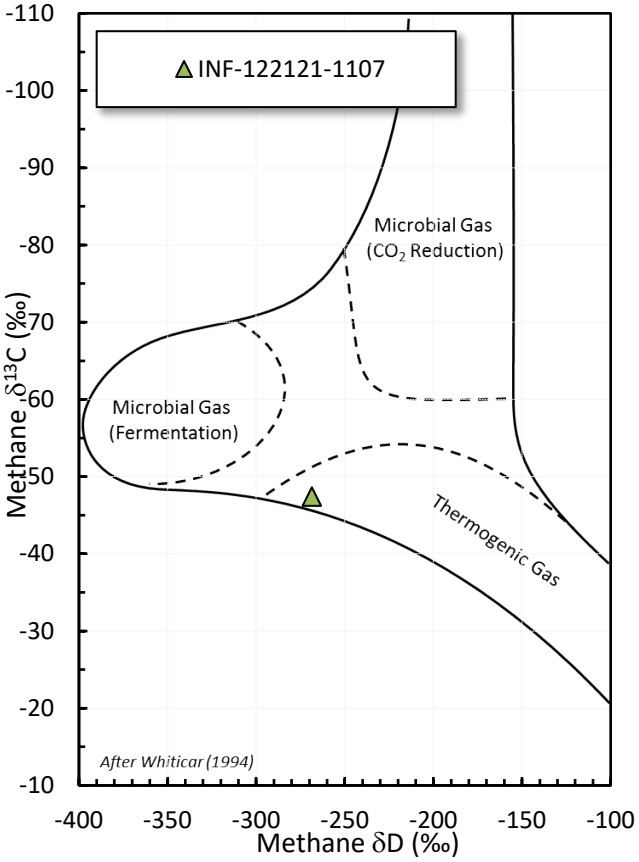
*Gas composition vs RSK-175 - Gas composition is a basic analysis of the concentration (ppm) of gases within the headspace of the sample (headspace is created at the lab). RSK-175 is a specific analysis technique combined with calculations to give the total dissolved gas of each species in the water sample (mg/L). Why one or the other? Gas composition gives us a quick, general look at relative concentrations and ratios (e.g., gas wetness). RSK-175 gives us an exact total of gas present in the sample (headspace and dissolved in the water). Questions? Give us a call at 303-531-2030.
** Rush and Expedited Rush turnaround time analysis will incur additional costs at 2x and 3x the standard turnaround time pricing.

Stable Isotope Interpretive Plots

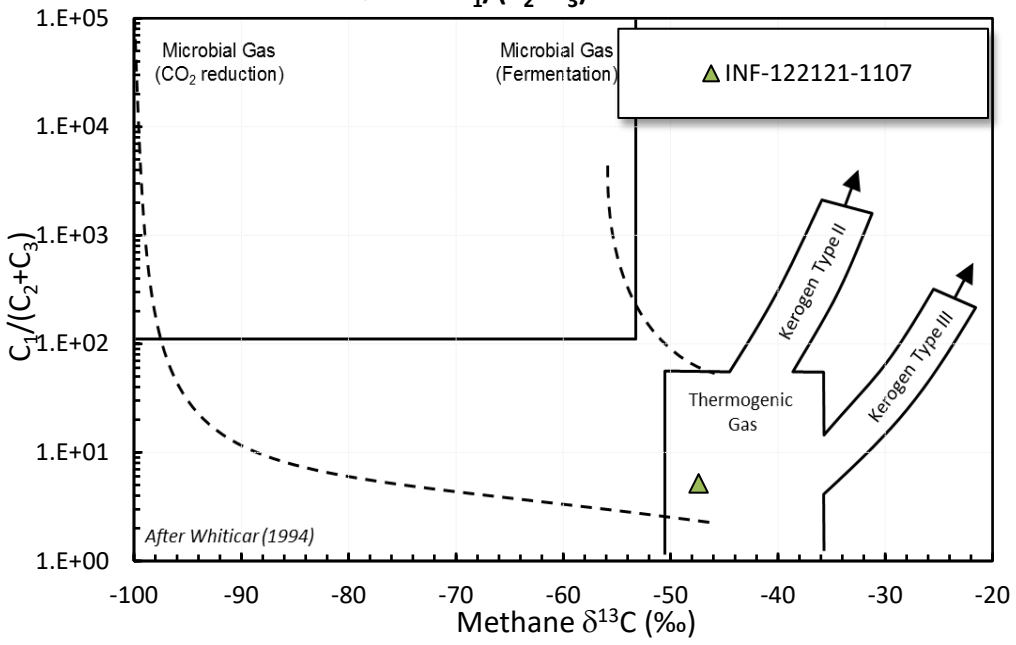
Methane vs Gas Wetness Genetic



Methane $\delta^{13}C$ vs δD Genetic Classification Plot



Methane $\delta^{13}C$ vs $C_1/(C_2+C_3)$ Genetic Classification Plot



Analytical Report

Job #:	21126921
Lab #:	DIG-027019
Client:	Summit Scientific
Sample Name:	INF-122121-1107
Date Sampled:	12/21/21
Time Sampled:	11:07
Sample Description:	Isoflask
Sampling Notes:	
Date Received:	12/22/21
Date Analyzed:	Gas Composition: 12/22/21 δ13C: 12/27/21 δD: 12/22/21
Date Reported:	12/29/21
Comments:	

Measured Values:	Measured ppm	Analyte mol %[a]	HC mol %	$\delta^{13}C$ ‰ VPDB	δD ‰ VSMOW	Comments
Nitrogen (N_2)	45783	4.81	-	-	-	
Oxygen + Argon (O_2+Ar)	5473	0.57	-	-	-	
Carbon Dioxide (CO_2)	966	0.10	-	-	-	
Helium (He)[b]	na	na	-	-	-	Helium added to create headspace.
Hydrogen (H_2)	na	na	-	-	-	
Methane (CH_4)	747779	78.50	83.06	-47.4	-269	
Ethane (C_2H_6)	107625	11.30	11.95	-	-	
Ethene (C_2H_4)	nd	nd	nd	-	-	
Propane (C_3H_8)	36711	3.85	4.08	-	-	
iso-Butane (C_4H_{10})	2530	0.27	0.28	-	-	
n-Butane (C_4H_{10})	4801	0.50	0.53	-	-	
iso-Pentane (C_5H_{12})	476	0.05	0.05	-	-	
n-Pentane (C_5H_{12})	349	0.04	0.04	-	-	
Hexanes + (C_6H_{14})	69	0.01	0.01	-	-	

Calculated Values:	
Total HCs (ppm)	900339
Gas Wetness (mol % C_2+/C_1+)	16.94
C_1/(C_2+C_3) (mol/mol)	5

[a] Analyte concentrations normalized to 100% (Mol. % is approximately equal to Vol. %)

[b] Addition of helium negates the ability to detect native helium and may negate the ability to detect hydrogen.

HC= Hydrocarbons

nd = not detected

na = not analyzed

Stable isotope results based on multi-point laboratory calibration

Error $\delta^{13}C$ < 0.5 ‰

Error δD < 5.0 ‰

Dolan Integration Group
Geochemistry for Energy
11025 Dover Street Unit 800
Westminster, CO 80021
p: 303.531.2030

Hydrocarbon Gas Composition and Stable Isotopes
Data and Interpretation

Job #:	**21126921**
Lab #:	**DIG-027019**
Client:	**Summit Scientific**
Sample Name(s):	**INF-122121-1107**

PDC Energy 1775 Sherman St. STE. 3000 Denver CO, 80203	Project: DWR Permit #268360 Project Number: AFE # EX-000335 Project Manager: Karen Olson	**Reported:** 01/11/22 12:26

Notes and Definitions

QM-05	The spike recovery was outside acceptance limits for the MS and/or MSD due to matrix interference. The associated LCS and/or LCSD were within acceptance limits, therefore the data are considered valid.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

ATTACHMENT B

DWR WATER WELL PERMIT # 268360
Methane Mitigation System
Photographic Overview

TASMAN

Well Ventilation

Water Treatment System