



dig
Dolan Integration Group

Geochemistry for Energy

11025 Dover Street Unit 800

Westminster, CO 80021

p: 303.531.2030

**Quantitative High Resolution Whole Oil Gas Chromatography
Analytical Results**

Job #: 260215253

Lab #: DIG-042823

Client: Prairie Operating Company, LLC

Project/ Well Name: COT West QA-30-25HN

API: 123-50404

Facility ID:

Sample Types: Bradenhead Oil

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Geochemistry for Energy

1000 University Avenue, Suite 1000
Berkeley, CA 94702-1000
510.841.4000

Sample ID	Sample Name	Sample Type	Sample Location	Sample Date	Sample Status	Sample Notes
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Sample ID

Sample Name

Sample Type

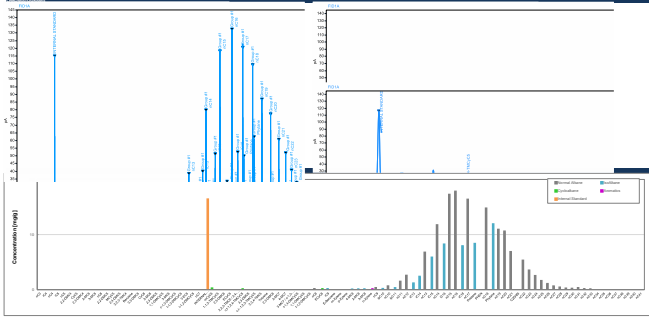
Sample Location

Sample Date

Sample Status

Sample Notes

Year		2010		2011		2012		2013		2014		2015		2016		2017		2018		2019		2020	
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24



m/z	Relative Intensity (%)	Peak Type
41	~10	Methyl Ether
43	100	Methyl Ester
55	~15	Methyl Ether
69	~10	Methyl Ether
83	~10	Methyl Ether
97	~10	Methyl Ether
111	~10	Methyl Ether
125	~10	Methyl Ether
139	~10	Methyl Ether
153	~10	Methyl Ether
167	~10	Methyl Ether
181	~10	Methyl Ether
195	~10	Methyl Ether
209	~10	Methyl Ether
223	~10	Methyl Ether
237	~10	Methyl Ether
251	~10	Methyl Ether
265	~10	Methyl Ether
279	~10	Methyl Ether
293	~10	Methyl Ether
307	~10	Methyl Ether
321	~10	Methyl Ether
335	~10	Methyl Ether
349	~10	Methyl Ether
363	~10	Methyl Ether
377	~10	Methyl Ether
391	~10	Methyl Ether
405	~10	Methyl Ether

Definitions & Interpretations

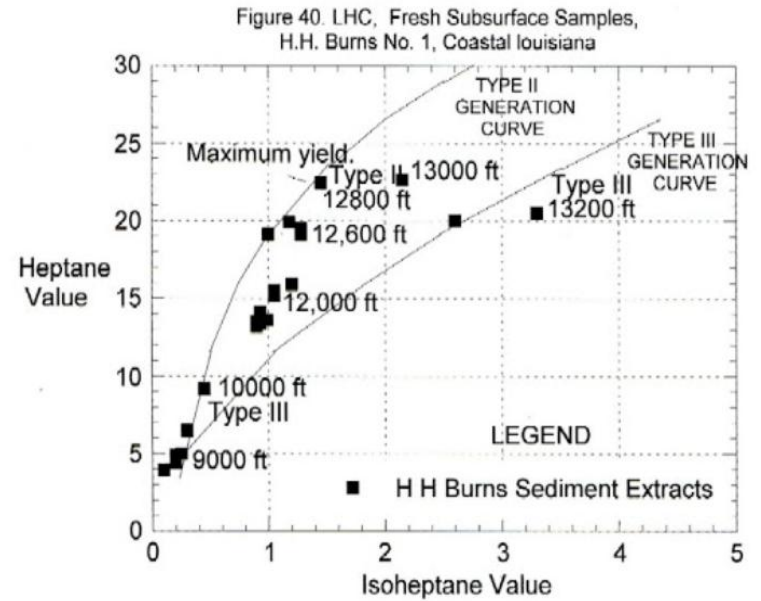
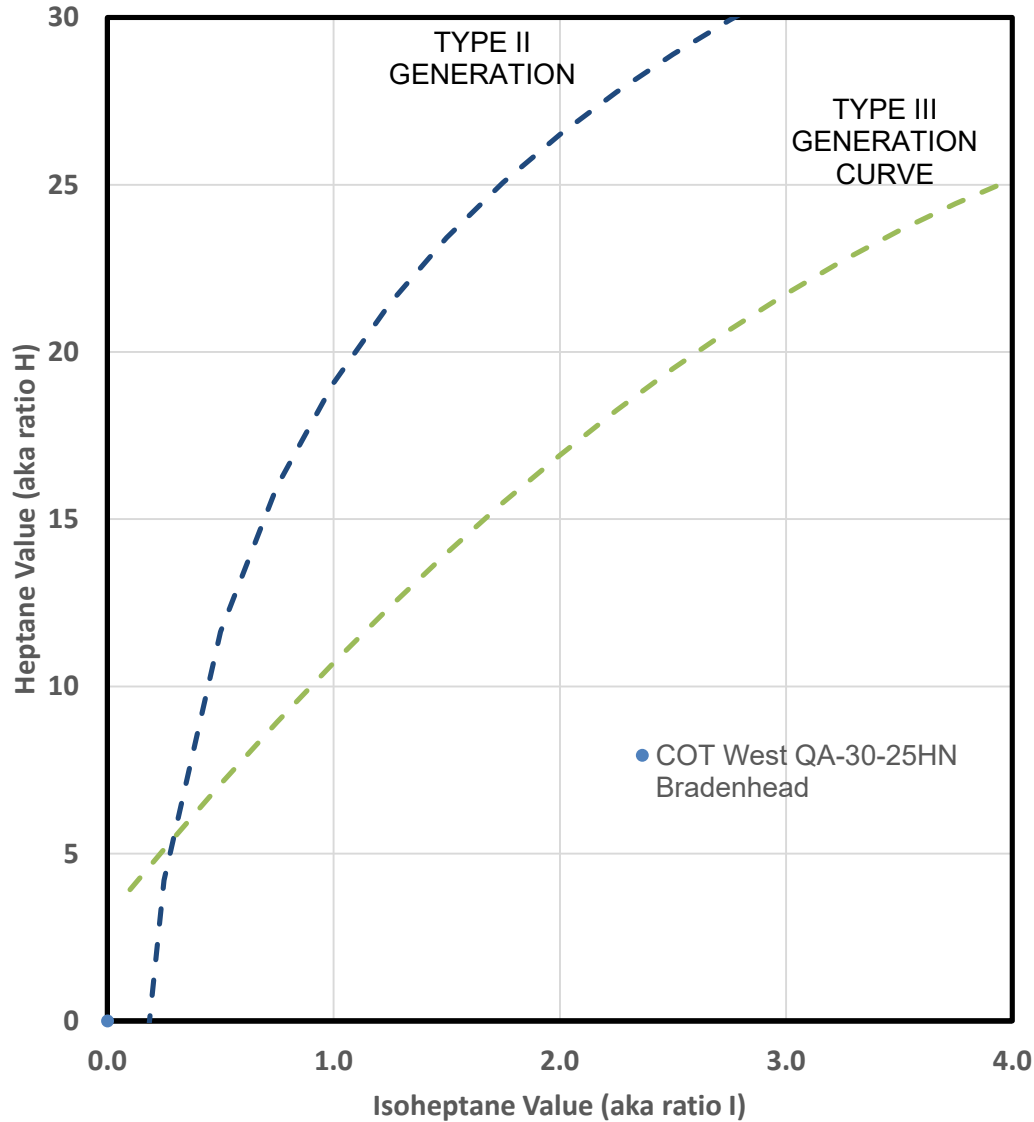
Thompson ratios describe processes affecting light hydrocarbons (C₆-C₇)

Name	Ratio	Property	Process
A	benzene / <i>n</i> -hexane	Aromaticity	Fractionation, water washing, TSR
B	toluene / <i>n</i> -heptane	Aromaticity	Fractionation, water washing, TSR
X	(<i>m</i> -xylene + <i>p</i> -xylene) / <i>n</i> -octane	Aromaticity	Fractionation, water washing, TSR
C	(<i>n</i> -hexane + <i>n</i> -heptane) / (cyclohexane + methylcyclohexane)	Paraffinicy	Maturity, biodegradation
I	(2- + 3-methylhexane) / (1 <i>c</i> 3- + 1 <i>t</i> 3- + 1 <i>t</i> 2-DMCP)	Paraffinicy	Maturity, source, biodegradation
F	<i>n</i> -heptane / methylcyclohexane	Paraffinicy	Maturity, biodegradation
H	(100* <i>n</i> -heptane)/(Σcyclohexane + ΣC ₇ HCs)	Paraffinicy	Maturity, source, biodegradation
S	<i>n</i> -hexane / 2,2-dimethylbutane	Paraffin branching	Maturity, source, biodegradation
R	<i>n</i> -heptane / 2-methylhexane	Paraffin branching	Maturity, source, biodegradation
U	cyclohexane / methylcyclohexane	Naphthene branching	Maturity, source

DMCP, dimethylcyclopentane; H, heptane value; I, isoheptane value; Σcyclohexane, [cyclohexane + 1,1-DMCP + 1*c*3-DMCP + 1*t*3-DMCP + 1*t*2-DMCP + methylcyclohexane]; ΣC₇ HCs, [Σcyclohexane + 2-methylhexane + 3-methylhexane + *n*-heptane + 2,3-dimethylpentane + 3-ethylpentane]; 1*c*3, 1-*cis*-3; 1*t*3, 1-*trans*-3.

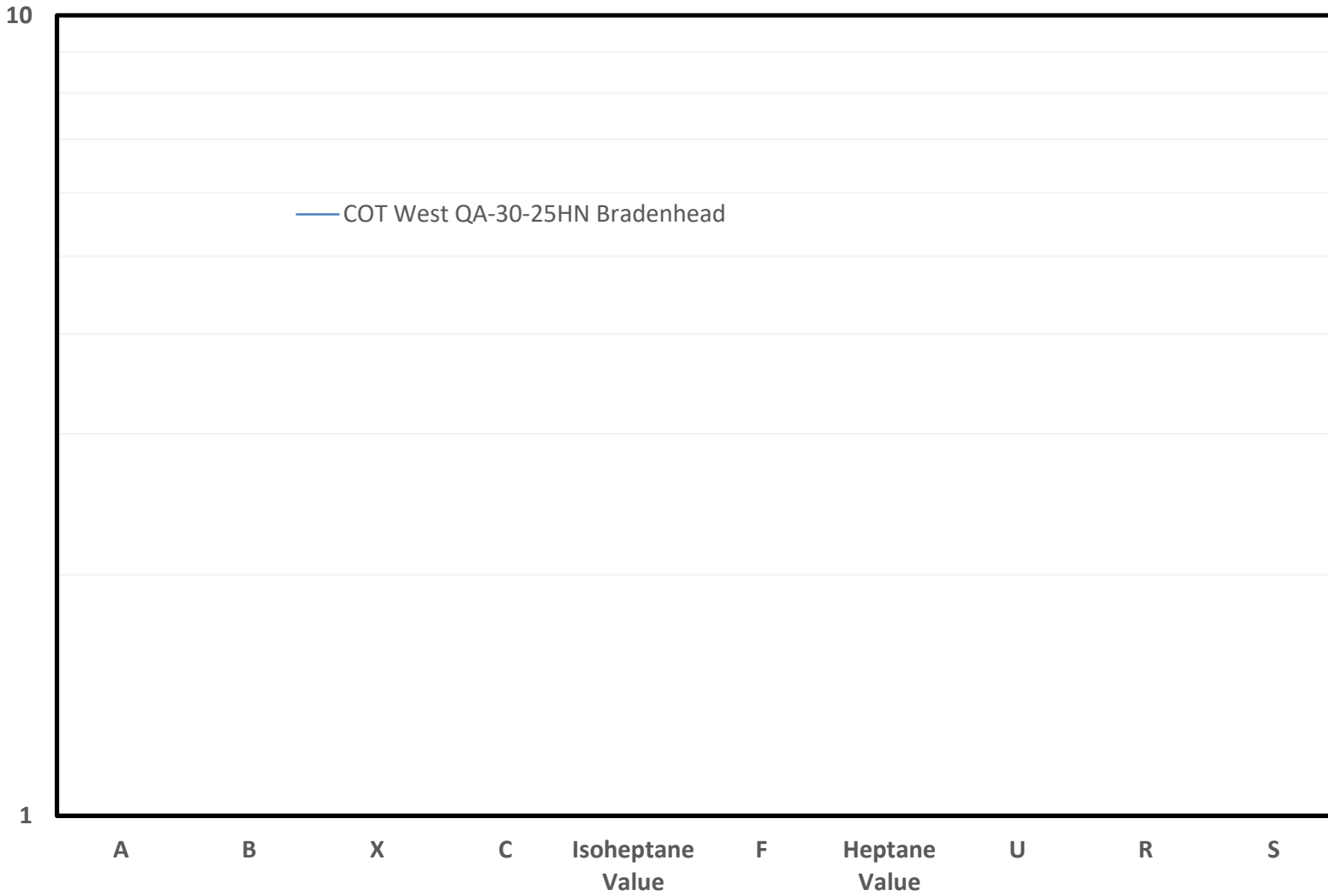
THOMPSON PLOTS

Heptane Plot - Light Hydrocarbon Maturity



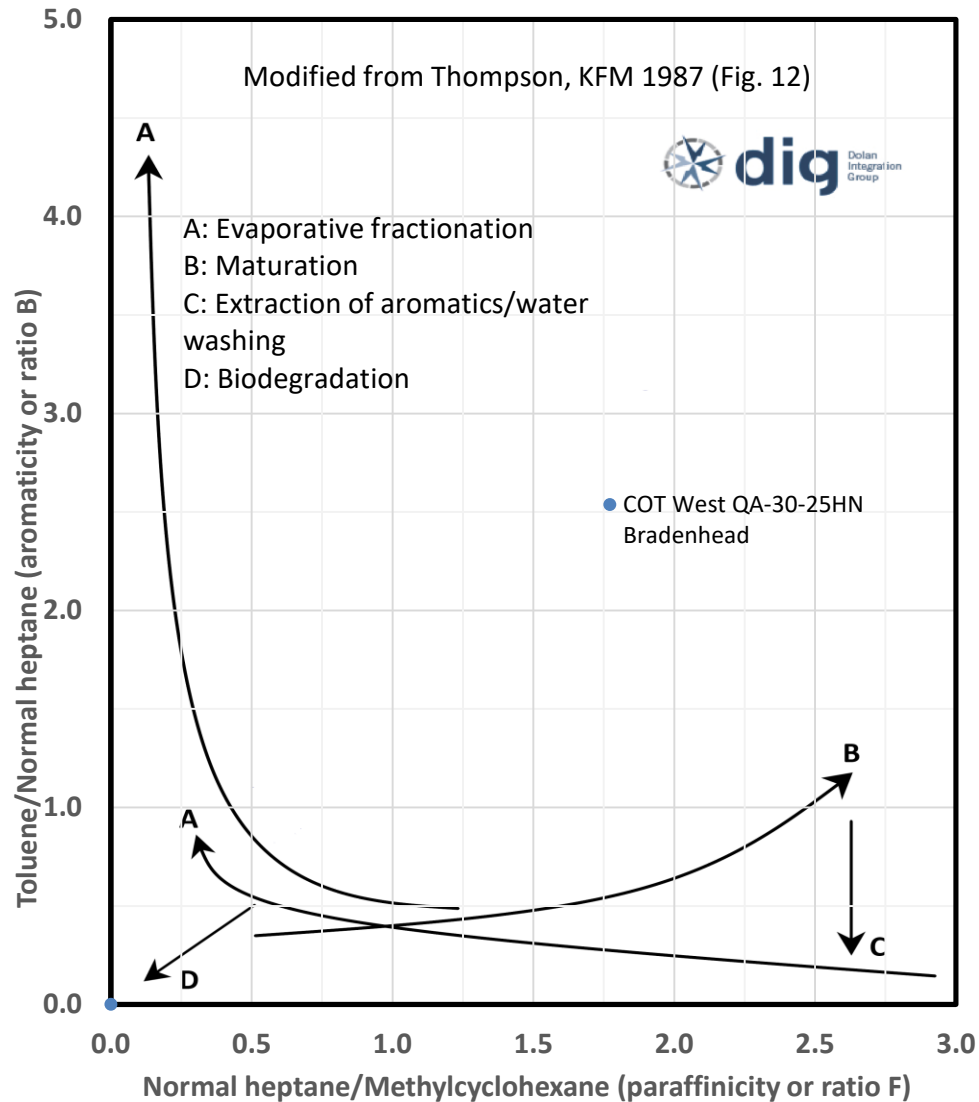
Thompson K F M. Classification and thermal history of petroleum based on light hydrocarbons. *Geochimica et Cosmochimica Acta*, 1983, 47(2): 303-316.

Thompson Ratios



THOMPSON PLOTS

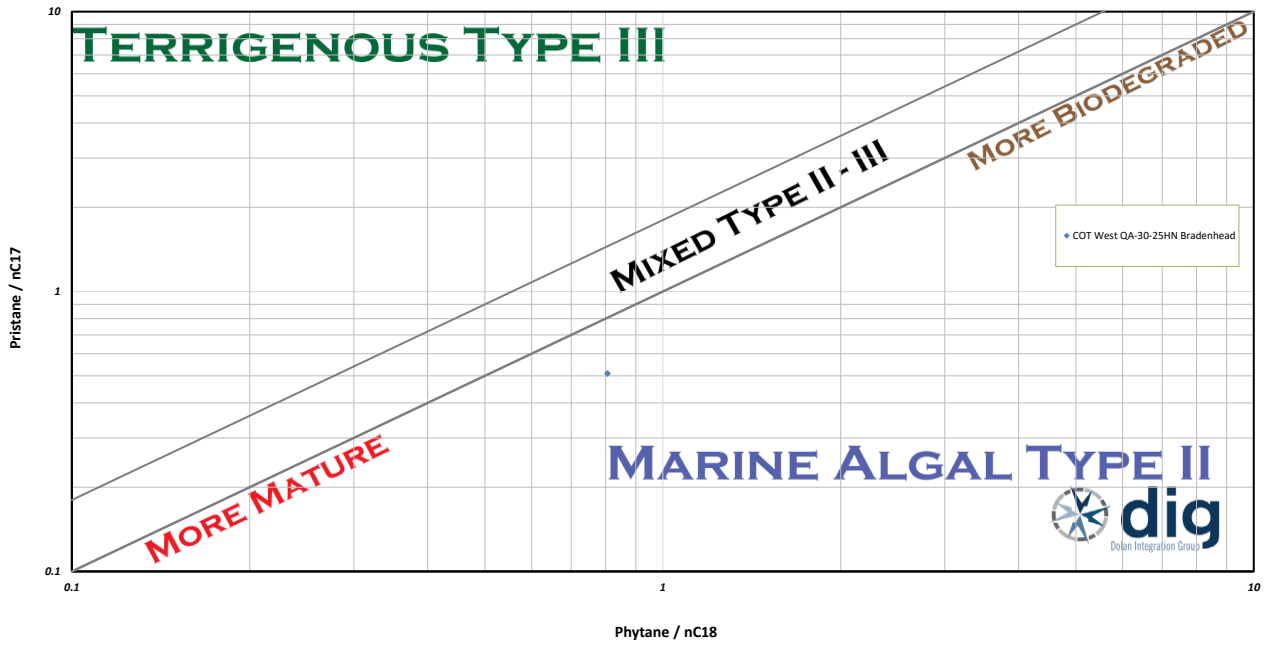
Oil Alteration Vectors

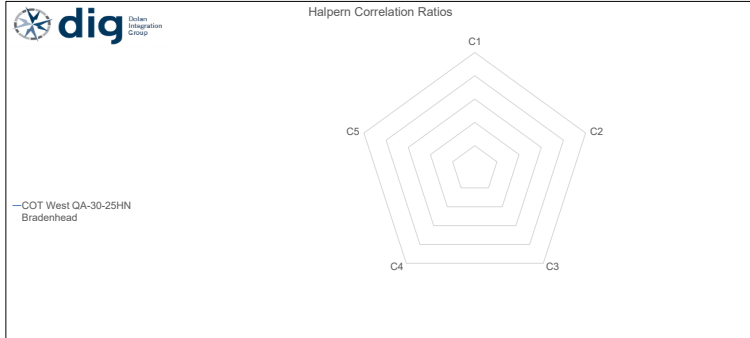
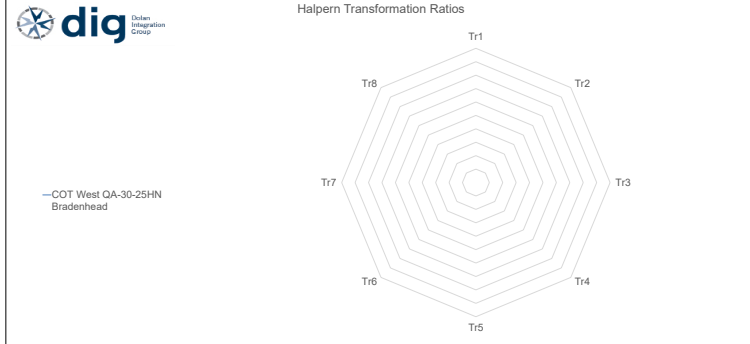


Evaporative Fractionation

- Physical processes can also fractionate petroleum during migration.
- As petroleum migrates upward, temperature and pressure decrease. If the bubble point is reached, a single phase fractionates into liquid and gas phases that can migrate separately.
- Partitioning of petroleum between these phases depends on the vapor equilibrium constants for each component (Thompson, 1987). This can result in reservoirs filled with petroleum from a common source, but with different gross compositions.
- The effects of evaporative or phase fractionation were described based mostly on laboratory experiments (e.g. Thompson, 1987; Larter and Mills, 1991; van Graas et al., 2000).
- The process leads to oils deficient in light ends and enriched in aromatics, as exemplified by many U.S. Gulf Coast oils (Thompson, 1987, 1988).

Peters & Fowler, Organic Geochemistry 33 (2002)
pp 5-36




 Table 7.3. Halpern (1995) C_7 ratios for use in star diagrams to differentiate oils

Name	Ratio	Δ BP ($^{\circ}$ C)	Δ Solubility (ppm)	Process
TR1	Toluene/X	22.8	496	Water washing
TR2	n C ₇ /X	10.6	-21.8	
TR3	3-Methylhexane/X	4.0	-21.4	Evaporation
TR4	2-Methylhexane/X	2.2	-21.5	
TR5	P2/X	(3.2)	(-21.4)	Correlation
TR6	1- <i>trans</i> -2-Dimethylcyclopentane/X	11.7	-11.0	
TR7	1- <i>trans</i> -3-Dimethylcyclopentane/X	3.0	-4.0	Correlation
TR8	P2/P3	(6)	(-2.4)	
C1	2,2-Dimethylpentane/P3	(-5.8)	(-0.6)	Correlation
C2	2,3-Dimethylpentane/P3	(4.8)	(0.3)	
C3	2,4-Dimethylpentane/P3	(-4.5)	(-0.6)	Correlation
C4	3,3-Dimethylpentane/P3	(1.1)	(0.9)	
C5	3-Ethylpentane/P3	(8.5)	(-2.0)	Correlation

X = 1,1-dimethylcyclopentane, boiling point 87.8 $^{\circ}$ C, solubility 24 ppm. P2 = 2-methylhexane + 3-methylhexane, boiling point 91 $^{\circ}$ C, solubility 2.6 ppm. P3 = 2,2-dimethylpentane + 2,3-dimethylpentane + 2,4-dimethylpentane + 3,3-dimethylpentane + 3-ethylpentane, boiling point 85 $^{\circ}$ C, solubility 5 ppm.

Δ BP = boiling point numerator - boiling point denominator ($^{\circ}$ C).

Δ Solubility = solubility of numerator - solubility of denominator (ppm in distilled water).

Parentheses indicate average values for mixtures.

Organization	Reporting Organization	Reporting Organization Name	Order Number	Entity Requesting Analysis	Purpose	Project	Sample Date and Time	AP #	LAB Sample ID	Sample Type	Matrix	Comments	Project Number	Chain of Custody #	K Date Received by Lab	Int Vol	Final Vol	Analysis Date and Time	Report Bal	Comments	File Name	Column #
Batch	COGCC Facility No.	10206	2019261920	7830906	Private Operating Company, LLC		20210223		000-04262	LIQUID			20210223									
Sample	Lab Batch Identifier	2019261920	2019261920	7830906	Private Operating Company, LLC		20210223		000-04262	LIQUID			20210223									
Result	CAS Number	Analysis Name	Analysis Method	Analytical Method Modifier	Unit	Result Value	Qualifier	Test Type	Result Text	Date Flag	Dilution	Fraction Type	MDC	Requested MDC	Detection Limit	Instrument Detection Limit	Method Dr	Comments	AnalysisBatchID			
	75-28-5	ISOBUTANE	0020		PPM	10	ND								20210223							
	106-97-8	BUTANE	0020		PPM	10	ND								20210223							
	106-97-8	ISOPENTANE	0020		PPM	10	ND								20210223							
	109-66-0	PENTANE	0020		PPM	10	ND								20210223							
	75-83-2	2,2-DIMETHYLBUTANE	0020		PPM	10	ND								20210223							
	207-28-3	CYCLOPENTANE	0020		PPM	10	ND								20210223							
	75-29-8	2,3-DIMETHYLBUTANE	0020		PPM	10	ND								20210223							
	107-23-5	2-METHYLPENTANE	0020		PPM	10	ND								20210223							
	96-14-0	3-METHYLPENTANE	0020		PPM	10	ND								20210223							
	912-08-1	HEXANES	0020		PPM	10	ND								20210223							
	590-35-2	2,2-DIMETHYLPENTANE	0020		PPM	10	ND								20210223							
	98-37-7	METHYLCYCLOPENTANE	0020		PPM	10	ND								20210223							
	108-08-7	2,4-DIMETHYLPENTANE	0020		PPM	10	ND								20210223							
	484-06-2	2,3-DIMETHYLBUTANE	0020		PPM	10	ND								20210223							
	71-43-2	BENZENE	0020		PPM	10	ND								20210223							
	502-44-2	3,3-DIMETHYLPENTANE	0020		PPM	10	ND								20210223							
	110-80-7	CYCLOHEXANE	0020		PPM	10	ND								20210223							
	991-79-4	2-Methylhexane	0020		PPM	10	ND								20210223							
	505-90-3	2,3-Dimethylpentane	0020		PPM	10	ND								20210223							
	1638-26-2	1,1-dimethylcyclopentane	0020		PPM	10	ND								20210223							
	989-34-4	3-methylhexane	0020		PPM	10	ND								20210223							
	2453-00-1	cis-1,3-dimethylcyclopentane	0020		PPM	10	ND								20210223							
	1759-58-6	trans-1,3-dimethylcyclopentane	0020		PPM	10	ND								20210223							
	617-87-7	3-ethylpentane	0020		PPM	10	ND								20210223							
	20729-52-4	trans-1,2-dimethylcyclopentane	0020		PPM	10	ND								20210223							
	108-87-2	METHYL CYCLOHEXANE	0020		PPM	256									20210223							
	4616-89-2	1,3,3-trimethylcyclopentane	0020		PPM	10	ND								20210223							
	1040-39-7	ethylcyclopentane	0020		PPM	10	ND								20210223							
	4850-28-6	1,2,4-dimethylcyclopentane	0020		PPM	84									20210223							
	2015-37-8	1,2,3-dimethylcyclopentane	0020		PPM	10	ND								20210223							
	108-88-3	TOLUENE	0020		PPM	10	ND								20210223							
	111-65-9	n-octane	0020		PPM	125									20210223							
	1072-45-5	isopropyl C9	0020		PPM	114									20210223							
	104-14-4	ETHYLBENZENE	0020		PPM	10	ND								20210223							
	108-36-3	m-XYLENE	0020		PPM	11	ND								20210223							
	106-42-3	p-XYLENE	0020		PPM	10	ND								20210223							
	95-47-6	o-XYLENE	0020		PPM	90									20210223							
	61193-19-9	Normal Alkane C9	0020		PPM	320									20210223							
	2081-08-1	isopropyl C10	0020		PPM	162									20210223							
	74296-31-4	Propylbenzene	0020		PPM	10	ND								20210223							
	124-18-5	Decane	0020		PPM	631									20210223							
	17002-28-2	isopropyl C11	0020		PPM	311									20210223							
	1120-21-4	n-C11	0020		PPM	1473									20210223							
	112-43-3	n-C12	0020		PPM	2952									20210223							
	17001-23-4	isopropyl C13	0020		PPM	1157									20210223							
	6884-03-6	isopropyl C14	0020		PPM	2371									20210223							
	629-50-5	n-C13	0020		PPM	6743									20210223							
	3891-98-3	isopropyl C15	0020		PPM	5846									20210223							
	629-50-4	n-C14	0020		PPM	11719									20210223							
	3891-98-4	isopropyl C16	0020		PPM	8218									20210223							
	629-50-6	n-C15	0020		PPM	17244									20210223							
	544-76-3	n-C16	0020		PPM	17610									20210223							
	3892-00-0	isopropyl C18	0020		PPM	7913									20210223							
	629-76-7	n-C17	0020		PPM	16351									20210223							
	1921-70-6	pristane	0020		PPM	8335									20210223							
	865018	PHENANTHRENE	0020		PPM	10	ND								20210223							
	593-45-3	n-C18	0020		PPM	14752									20210223							
	638-36-8	phytane	0020		PPM	1893									20210223							
	629-62-5	n-C19	0020		PPM	10001									20210223							
	11295-88	n-C20	0020		PPM	10079									20210223							
	629-64-7	n-C21	0020		PPM	6853									20210223							
	73903-36-3	highly branched C25 isoprenoid	0020		PPM	10	ND								20210223							
	629-97-0	n-C22	0020		PPM	5296									20210223							
	638-67-5	n-C23	0020		PPM	3497									20210223							
	648-31-1	n-C24	0020		PPM	2505									20210223							
	629-98-2	n-C25	0020		PPM	1603									20210223							
	630-01-3	n-C26	0020		PPM	1059									20210223							
	629-40-7	n-C27	0020		PPM	621									20210223							
	630-02-4	n-C28	0020		PPM	408									20210223							
	630-03-5	n-C29	0020		PPM	230									20210223							
	638-68-6	n-C30	0020		PPM	198									20210223							
	638-68-8	n-C31	0020		PPM	317									20210223							
	544-84-4	n-C32	0020		PPM	114									20210223							
	630-05-7	n-C33	0020		PPM	76									20210223							
	14107-59-0	n-C34	0020		PPM	10	ND								20210223							
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	630-06-8	n-C36	0020		PPM	10	ND								20210223							
	7184-44-8	n-C37	0020		PPM	10	ND								20210223							
	7184-45-6	n-C38	0020		PPM	10	ND								20210223							
	7184-46-7	n-C39	0020		PPM	10	ND								20210223							
	4181-95-7	n-C40	0020		PPM	10	ND								20210223							
	75-28-5	ISOBUTANE	0020		AREA COUNT	1	ND								20210223							
	106-97-8	BUTANE	0020		AREA COUNT	1	ND								20210223							
	106-97-8	ISOPENTANE	0020		AREA COUNT	1	ND								20210223							
	109-66-0	PENTANE	0020		AREA COUNT	1	ND								20210223							
	75-83-2	2,2-DIMETHYLBUTANE	0020		AREA COUNT	1	ND								20210223							
	207-28-3	CYCLOPENTANE	0020		AREA COUNT	1	ND								20210223							
	75-29-8	2,3-DIMETHYLBUTANE	0020		AREA COUNT	1	ND								20210223							
	107-23-5	2-METHYLPENTANE	0020		AREA COUNT	1	ND								20210223							
	96-14-0	3-METHYLPENTANE	0020		AREA COUNT	1	ND								20210223							
	912-08-1	HEXANES	0020		AREA COUNT	1	ND								20210223							
	590-35-2	2,2-DIMETHYLPENTANE	0020		AREA COUNT	1	ND															

Send Data to:	Send Invoice to (if different):	Additional Information:
Name: Dana Hanneman	Name:	AFE #:
Company: Prairie Operating Company	Company:	Project: Bradenhead Sampling
Address: 44 Cook Street Suite 1000	Address:	PO #: 09F4045003
City, State: Denver, CO 80206	City, State:	Location: COT 30-J Pad
Phone: 832.744.1484	Phone:	Sampled By: Jeff Braden
Email: dana.hanneman@prairieopco.com	Email:	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)	δD of Methane (C1)	Whole Oil Gas Chromatography	d13O and δD Isotopes of Water	RSK 175 Dissolved Gas Quantification
F02ASK	COT West QA-30-25HN bh	2/11/26	1020	Bradenhead Gas	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
F023HG	COT West QA-30-25HN pr	2/11/26	1030	Production gas	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
F023HH	COT West T-30-25HC bh	2/11/26	1050	Bradenhead gas	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
F027J4	COT West T-30-25HC pr	2/11/26	1100	Production gas	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
				Bradenhead gas	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
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				Bradenhead gas	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
				Production gas	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
				Bradenhead gas	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
				Production gas	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Chain of Custody Record Comments:

Relinquished by Signature	Company	Date	Time	Received by Signature	Company	Date	Time
Jeffrey D Braden <small>Digitally signed by Jeffrey D Braden Date: 2026.02.12 12:32:37 -0700</small>	Ensolum, LLC	2/12/26	1230	Katy Dang <small>Digitally signed by Katy Dang Date: 2026.02.12 14:36:13 -0700</small>	DIG	2/12/26	1430

*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.