Uinta Basin

How we understand the O&G sector universe

Local County Officials & Academics Meeting 10/21/15

Any information presented in this PowerPoint is for demonstrative purposes only and represents information gathered from multiple sources, not exclusively from EPA. It is intended to identify information available as of the date presented, is not a final factual determination, and may be subject to change with additional information.

2017-004851-00454

Outline

- Air Quality metrics
- O&G Production data
- Emissions data
- Tribal Minor Source Registration data
- Data gaps

2017-004851-00454

Air Quality

4th Max 8-hour O3, ppb (NAAQS = 75 ppb)

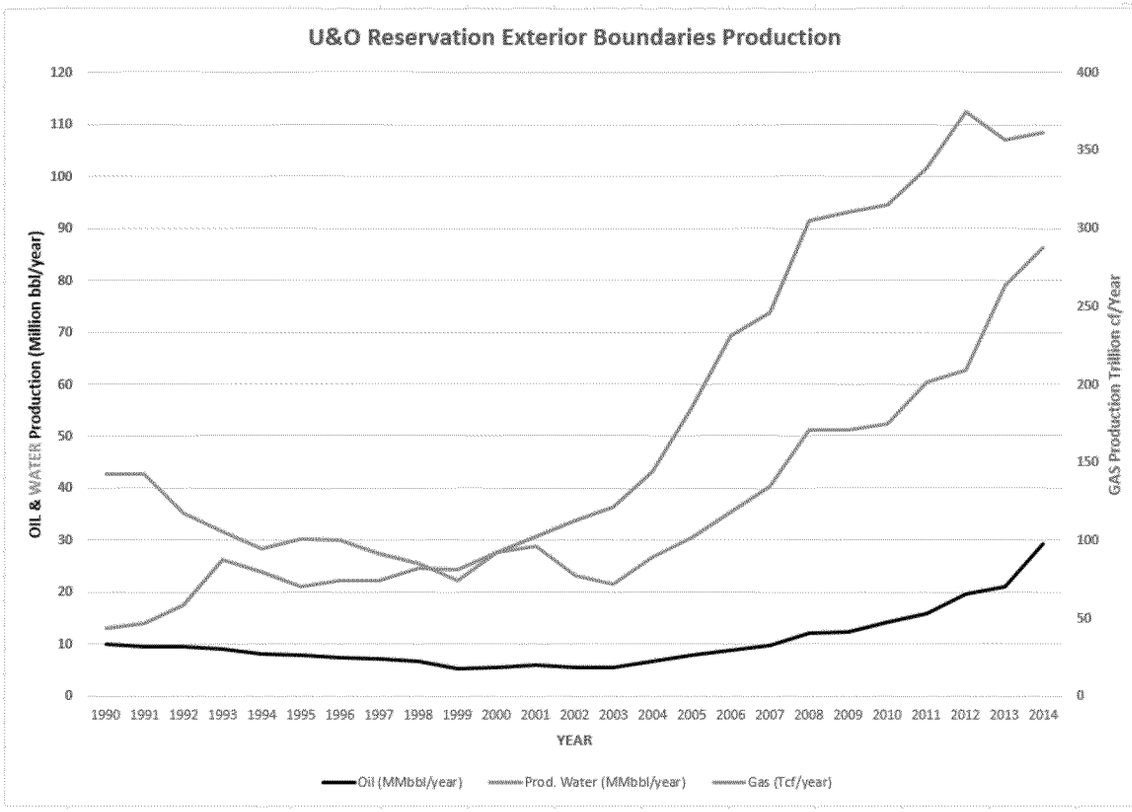
Year	Dinosaur	Vernal	New Vernal	Redwash	Ouray	Roosevelt	Myton	Whiterocks	ENEFIT Dragon Road	Fruitland	Rangely
2007	63										
2008	66										
2009	63			67	67						
2010	68			98	117						58
2011	90			100	116		111	68		65	73
2012	75	64		67	70	67	71	69	72	70	69
2013	113	102		114	132	104	109	95	82	62	91
2014	64	62		63	79	62	67	64		64	62

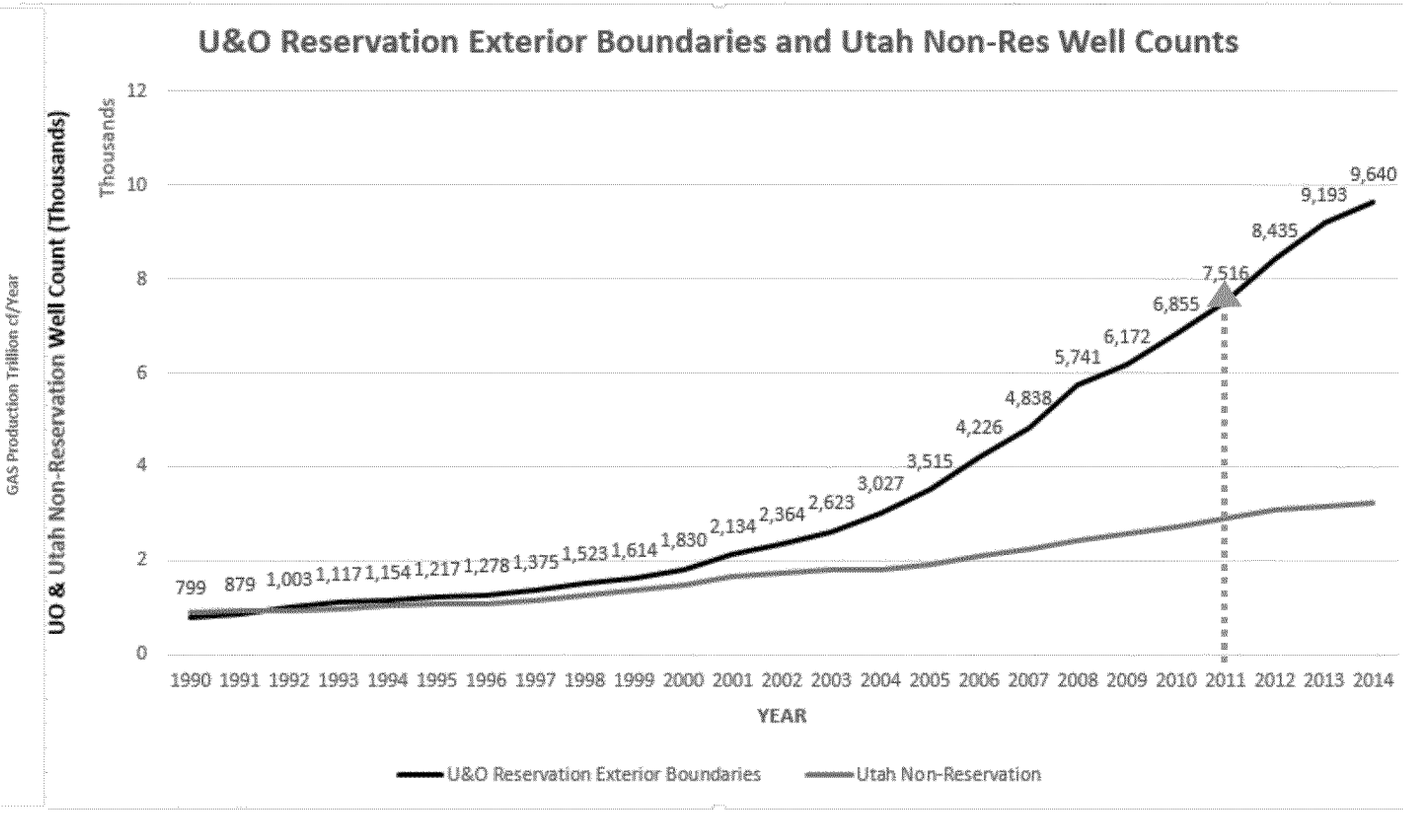
Design Values	Dinosaur	Vernal	New Vernal	Redwash	Ouray	Roosevelt	Myton	Whiterocks	ENEFIT Dragon Road	Fruitland	Rangely
'09-'11	73.7			88.3	100.0						
'10-'12	77.7			88.3	101.0						66.7
'11-'13	92.7			93.7	106.0		97.0	77.3		65.7	77.7
'12-'14	84.0	76.0		81.3	93.7	77.7	82.3	76.0		65.3	74.0

Air Quality Index:	
Green	Good Air Quality
Yellow	Moderate Air Quality
Orange	Unhealthy for Sensitive Groups Air Quality
Red	Unhealthy Air Quality
Purple	Very Unhealthy Air Quality

Nonattainment Designation Classification	Design Value (ppb)		
	Current 75 ppb Ozone NAAQS	70 ppb Ozone NAAQS (Estimated)	65 ppb Ozone NAAQS (Estimated)
Marginal	76 - <86	71 - <80	66 - <75
Moderate	86 - <100	80 - <93	75 - <87
Serious	100 - <113	93 - <105	87 - <98
Severe	113 - <119	105 - <111	98 - <103
Extreme	119 - <175	111 - <163	103 - <152

O&G Production Data





~75% of oil & gas production in Uinta Basin within exterior boundaries of Uintah & Ouray Indian Reservation

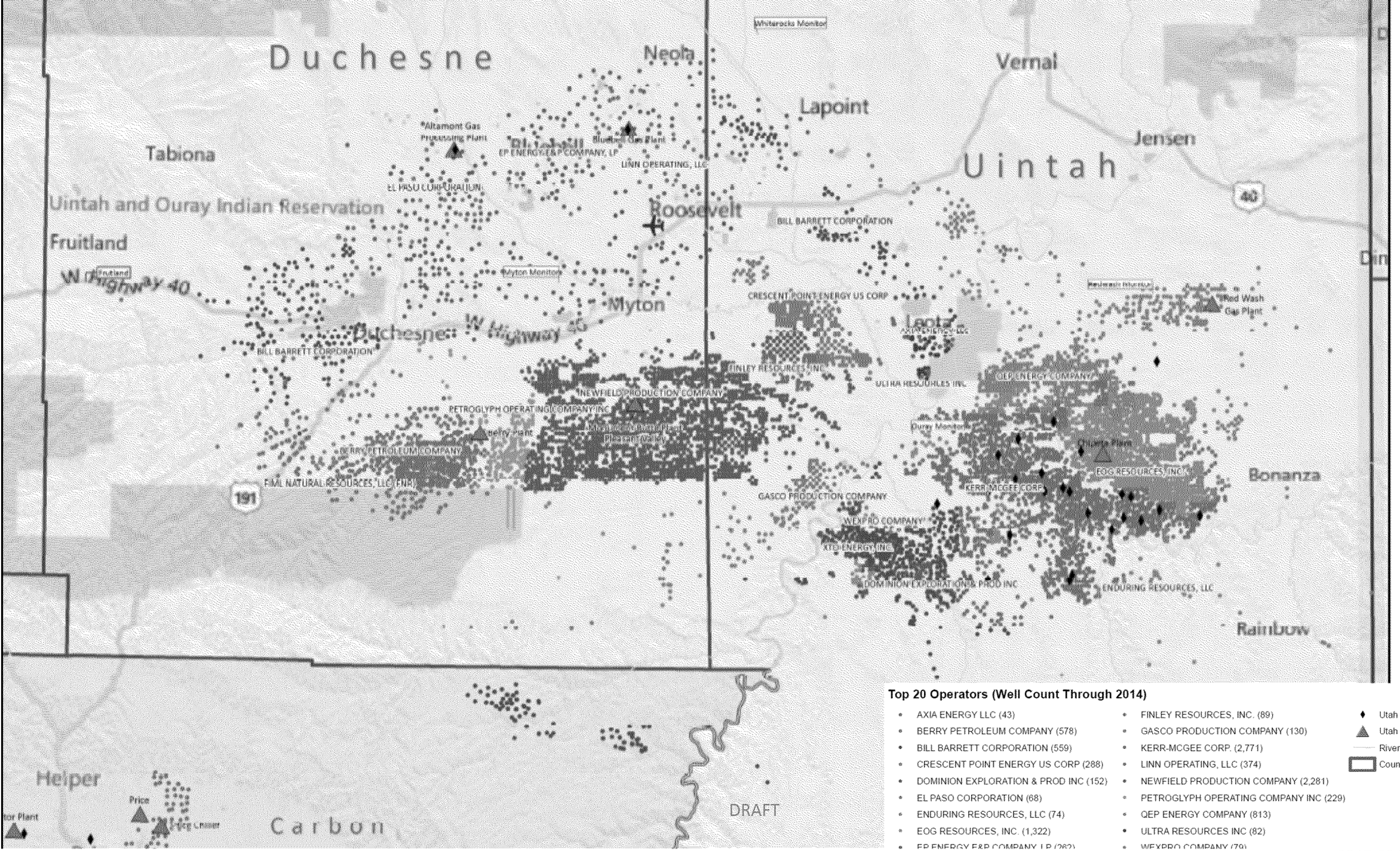
2017-004851-00454

Top 20 O&G Producers

Within the exterior boundaries of U&O		
Within Exterior Boundaries U&O Current Operator	**Number of Wells (2014)**	**OIL Produced Barrels (2014)**
NEWFIELD PRODUCTION COMPANY	1,409	7,043,408
EP ENERGY E&P COMPANY, LP	261	4,571,164
BILL BARRETT CORPORATION	284	3,151,243
CRESCENT POINT ENERGY US CORP	240	2,752,210
BERRY PETROLEUM COMPANY	578	2,171,577
ULTRA RESOURCES INC	82	1,397,871
PETROGLYPH OPERATING COMPANY INC	229	1,193,947
AXIA ENERGY LLC	43	1,106,170
QEP ENERGY COMPANY	793	1,074,473
KERR-MCGEE CORP.	2,706	1,042,197
LINN OPERATING, LLC	374	984,680
EL PASO CORPORATION	68	856,407
EOG RESOURCES, INC.	1,319	655,458
FINLEY RESOURCES, INC.	85	559,420
DEVON ENERGY CORPORATION	9	204,067
QUINEX ENERGY CORP	17	180,084
CITATION OIL AND GAS CORPORATION	43	125,897
XTO ENERGY, INC.	416	97,486
GASCO PRODUCTION COMPANY	123	74,545
HARVEST (US) HOLDINGS, INC	8	50,859
SUM TOP 20	9,087	29,293,163
Compared to TOTAL 2014 U&O:	9,640	29,499,562
Top 20 acount for	**94%**	**99%**
43	Operators account for remainder	

Within exterior boundaries of U&O		
Within Exterior Boundaries U&O Current Operator	**Number of Wells (2014)**	**GAS Produced Mcf (2014)**
KERR-MCGEE CORP.	2,706	203,382,460
EOG RESOURCES, INC.	1,319	35,547,477
QEP ENERGY COMPANY	793	24,401,675
BERRY PETROLEUM COMPANY	578	15,826,652
NEWFIELD PRODUCTION COMPANY	1,409	11,888,643
BILL BARRETT CORPORATION	284	11,389,526
XTO ENERGY, INC.	416	10,740,094
EP ENERGY E&P COMPANY, LP	261	8,395,942
GASCO PRODUCTION COMPANY	123	6,759,713
LINN OPERATING, LLC	374	5,740,810
WHITING OIL AND GAS CORPORATION	22	3,664,200
DOMINION EXPLORATION & PROD INC	152	3,402,929
CRESCENT POINT ENERGY US CORP	240	2,854,439
EL PASO CORPORATION	68	2,486,421
PETROGLYPH OPERATING COMPANY INC	229	2,163,362
ULTRA RESOURCES INC	82	1,450,111
AXIA ENERGY LLC	43	1,406,147
ENDURING RESOURCES, LLC	74	1,213,888
WEXPRO COMPANY	64	1,081,372
MILLER, DYER & CO. LLC	4	879,279
SUM TOP 20	9,241	354,675,140
Compared to TOTAL 2014 U&O:	9,640	361,612,254
Top 20 acount for	**96%**	**98%**
43	Operators account for remainder	

2017-004851-00454



2017-004851-00454

WRAP – Phase III Emission Inventory

UINTA BASIN - WRAP PH.III

Description	2006 Emissions (tons/year)					2012 Emissions (tons/year)				
	NOx	VOC	CO	SOx	PM10	NOx	VOC	CO	SOx	PM10
Dehydrator	148	19,470	124	0	11	225	30,665	189	0	17
Pneumatic devices	0	14,916	0	0	0	0	25,083	0	0	0
Oil Tank	0	14,357	0	0	0	0	20,722	0	0	0
Pneumatic pumps	0	8,386	0	0	0	0	14,322	0	0	0
Condensate tank	0	6,195	0	0	0	0	21,719	0	0	0
Unpermitted Fugitives	0	1,910	0	0	0	0	3,212	0	0	0
Permitted Sources	2,339	1,320	927	5	32	3,184	4,355	2,517	8	48
Truck Loading of Oil	0	964	0	0	0	0	1,391	0	0	0
Venting - Compressor Startup	0	825	0	0	0	0	1,300	0	0	0
Venting - Compressor Shutdown	0	782	0	0	0	0	1,233	0	0	0
Artificial Lift	2,184	674	2,522	1	94	3,053	955	34,750	2	136
Compressor engines	2,207	510	2,318	0	31	3,169	695	4,236	0	46
Drill rigs	4,779	415	1,804	362	354	4,773	362	1,507	3	236
Venting - blowdowns	0	292	0	0	0	0	460	0	0	0
Venting - initial completions	0	241	0	0	0	0	332	0	0	0
Truck Loading of Condensate	0	127	0	0	0	0	445	0	0	0
Heaters	1,016	58	863	7	80	1,671	95	1,420	11	132
Miscellaneous engines	163	39	59	0	1	199	63	201	0	1
Venting - recompletions	0	37	0	0	0	0	51	0	0	0
Workover rigs	255	24	103	21	21	271	22	91	0	15
Gas Plant Truck Loading	0	3	0	0	0	0	12	0	0	0
Condensate tank flaring	1	0	3	0	0	2	0	9	0	0
Dehydrator Flaring	0	0	1	0	0	0	0	1	0	0
Initial completion Flaring	1	0	3	0	0	1	0	4	0	0
Total	**13,093**	**71,546**	**8,727**	**396**	**623**	**16,547**	**127,495**	**44,925**	**24**	**631**

Western Regional Air Partnership (WRAP) defines the Uinta Basin as wholly including the counties of **Carbon, Duchesne, Emery, Grand, Uintah and Wasatch**

GHGRP-W – 2013 Data

Summary data collected by the Greenhouse Gas Reporting Program for 2013
This data was reported to EPA by facilities as of 8/18/2014.
All emissions data is presented in units of metric tons of carbon dioxide equivalent using GWP's from IPCC's AR4 (see FAQs tab)

Facility Id	FRS Id	Facility Name	Basin	Total reported emissions from Onshore Oil & Gas Production	Total Emissions from Onshore Oil & Gas Production by Gas: CO2 emissions (non-biogenic)	Methane (CH4) emissions	Nitrous Oxide (N2O) emissions
1009282	110002994190	575 Uinta Basin QEP Energy Company	575 - Uinta Basin	418,397	29,157	389,205	35
1008167	110055512529	Berry Petroleum Company - Unita Basin 575	575 - Uinta Basin	111,371	15,647	95,699	24
1009357	110028136700	Bill Barrett Corporation - Uinta Basin (575)	575 - Uinta Basin	212,379	66,835	145,436	108
1007481	110015761996	ConocoPhillips' Uinta (575)	575 - Uinta Basin	76,965	536	76,429	
1008086	110002004964	Crescent Point Energy U.S. Corp - Uinta Basin (	575 - Uinta Basin	32,222	6,037	26,170	15
1008354	110034207481	EOG Resources, Inc. 575 Uinta basin	575 - Uinta Basin	562,551	1,513	561,038	1
1009350	110054613539	EP Energy E&P 575 Uinta basin	575 - Uinta Basin	132,740	5,533	127,204	4
1008109	110055512271	Gasco Energy Uintah Basin Operations	575 - Uinta Basin	55,180	611	54,569	1
1008407	110055512388	Newfield.575.Uinta	575 - Uinta Basin	106,375	54,682	51,617	77
1009165	110028136700	Uinta Basin - AAPG Province 575	575 - Uinta Basin	440,990	60,028	380,955	7
1008169	110032607089	Uinta Basin Wexpro Company	575 - Uinta Basin	18,550	11	18,539	
1011221	110014428770	Ultra Resources/Uintah Basin	575 - Uinta Basin	43,960	37,665	6,277	18
1009389	110055516035	XTO Energy Inc 575 Uintah	575 - Uinta Basin	174,221	13,688	160,492	42

EPA's Greenhouse Gas Reporting Program - Subpart W covers the Petroleum and Natural Gas Systems. Defines Uinta Basin as the counties of **Carbon, Daggett, Duchesne, Uintah and Wasatch**.

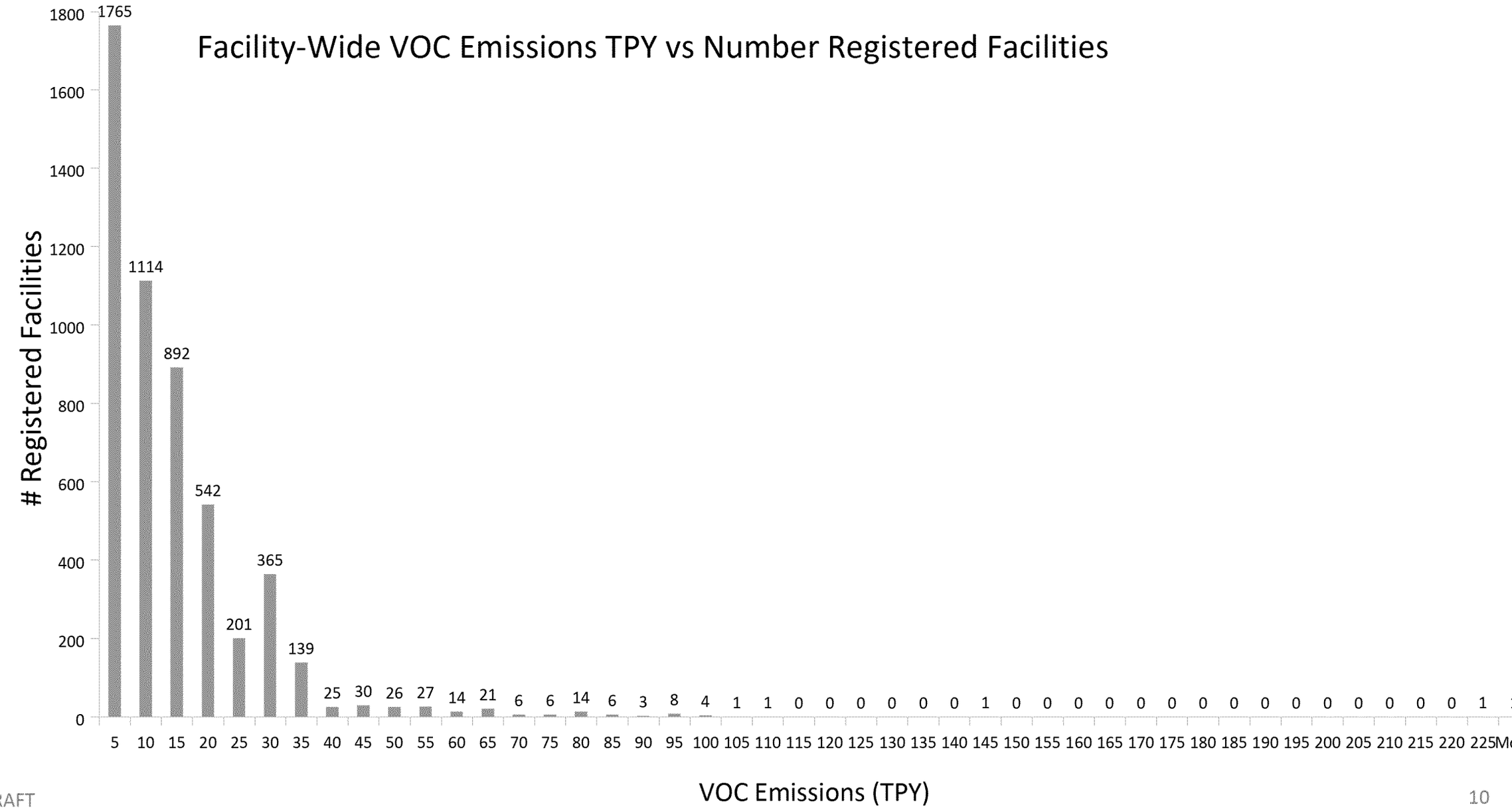
Tribal Minor Source Registrations

Operator	# Registrations	PM10	PM25	SO2	NOx	CO	VOC
American Gilsonite Company							
Anadarko Uintah Midstream, LLC							
Axia Energy, LLC							
Berry Petroleum Company							
Bill Barrett Corporation							
Crescent Point Energy U.S. Corp							
El Paso Midstream Group, Inc							
Enduring Resources, LLC							
EOG Resources, Inc.							
EP Energy E&P Company, L.P.							
Gasco Energy, Inc							
Kerr-McGee Oil and Gas Onshore LP							
Koch Exploration Company							
Mid-America Pipeline Company, LLC							
Monarch Natural Gas, LLC							
Newfield Production Company							
QEP Energy Company							
QEP Field Services Company							
Red Leaf Resources, Inc.							
Red Rock Gathering Company, LLC							
Rhine Construction							
Rosewood Resources, Inc.							
Ultra Resources, Inc.							
US Oil Sands (Utah), Inc.							
Ute Energy, LLC							
Whiting Petroleum Company							
XTO Energy, Inc							
Total registrations as of 8/25/2015	**5,216**	**241**	**223**	**161**	**11,690**	**10,562**	**64,278**

234 facilities have emission controls on tanks

DRAFT

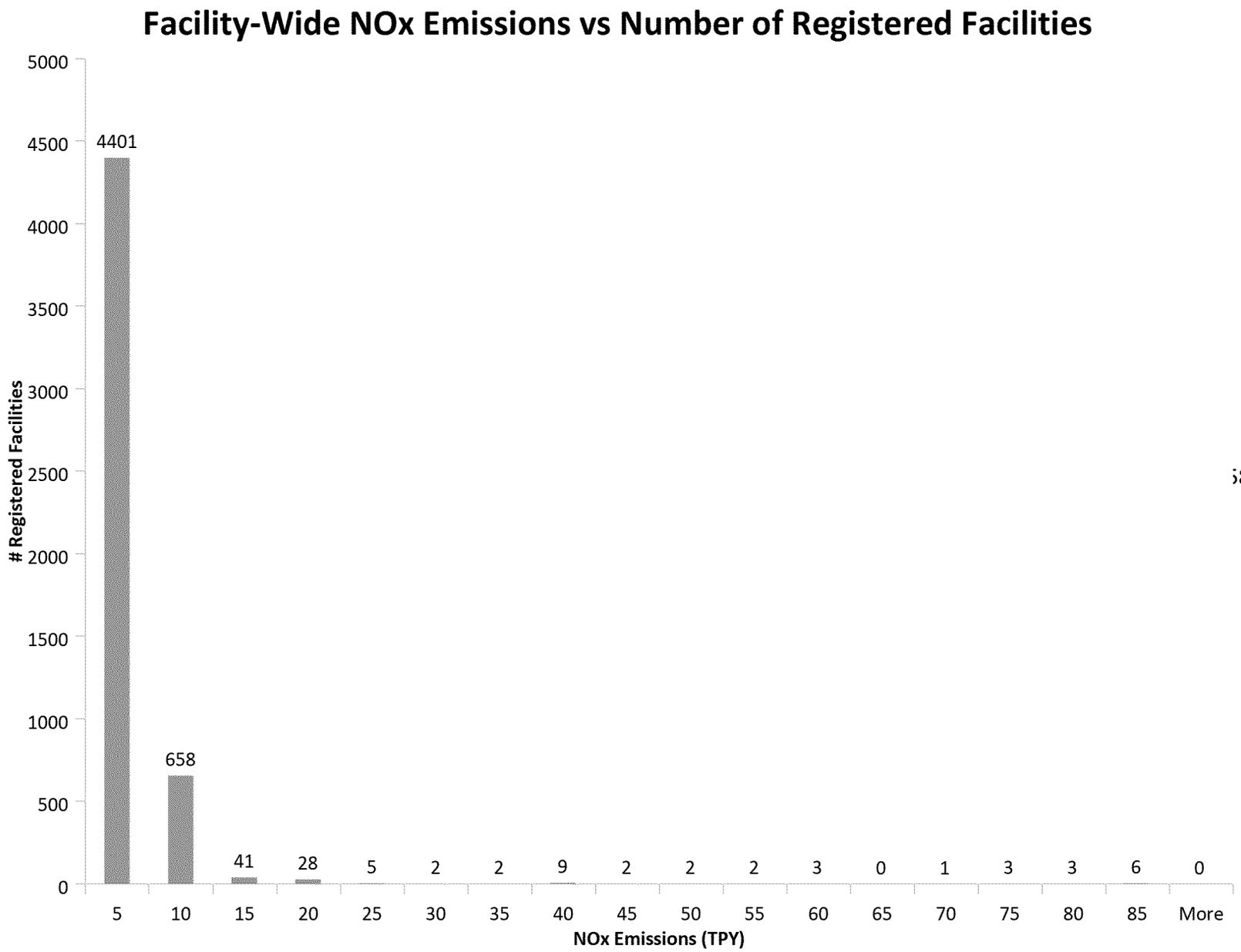
Tribal Minor Source Registrations, cont'd



VOC TPY
:ilities <5
<10, etc.
ar means
lities <25

2017-004851-00454

Tribal Minor Source Registrations, cont'd



Note: X-axis NOx TPY
"5" is 0< facilities <5
"10" <=5 facility <15, etc.
58 on "10" TPY NOx bar means
20<= 658 facilities <25

DRAFT

Tank Data (E&P Tanks & GOR)

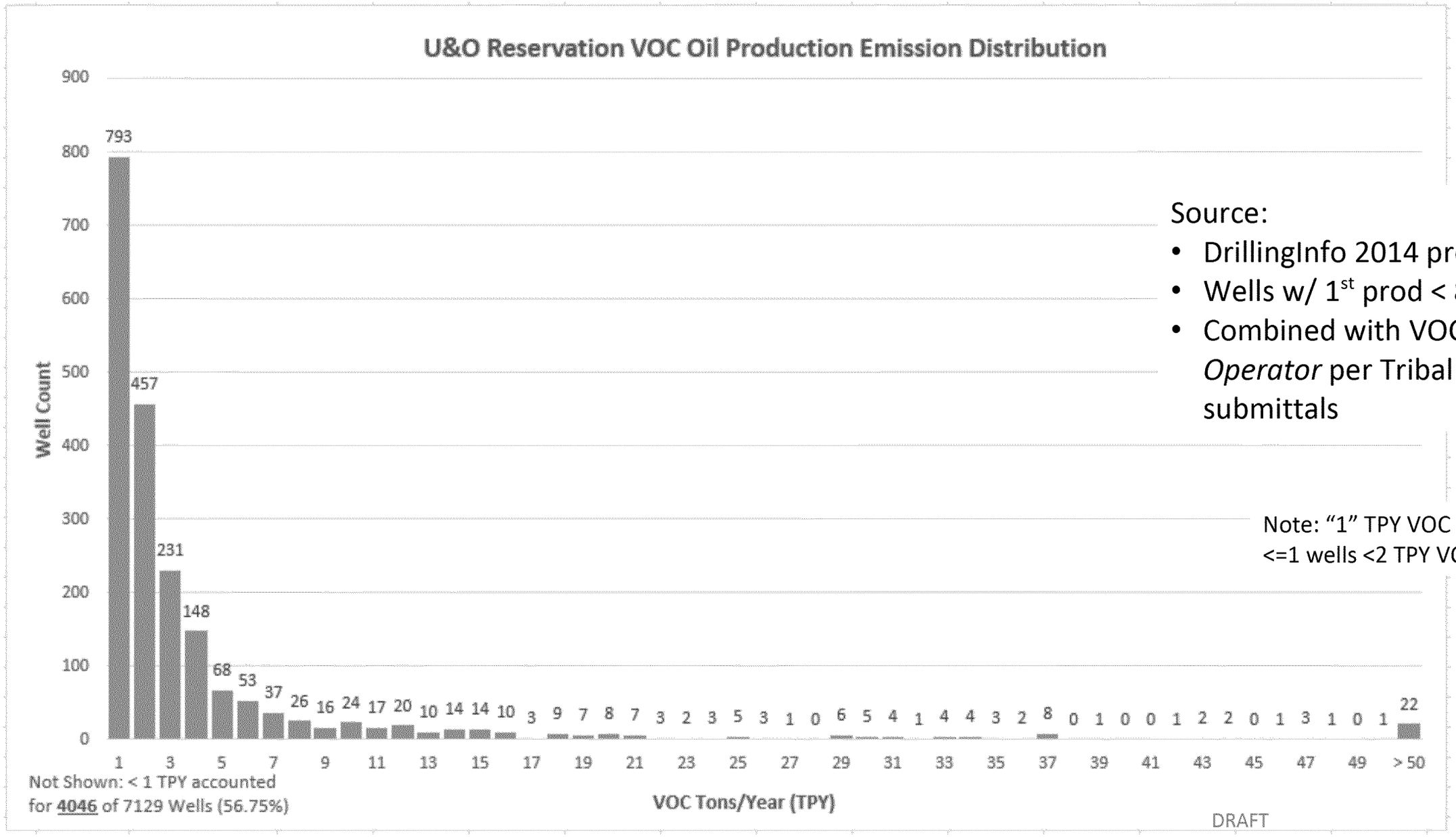
Weighted Average VOC lb/bbl =	10.6

Operator	Separator T (°F)	Separator P (psig)	API Gravity Sales Oil AVG	VOC lb/bbl AVG
A	82	57	62.0	**6.5**
B	160	30-38	40.9	**1.0**
C	74-75	108-138	52.0	**5.9**
D	60-99	200-380	51.4	**1.1**
F	100-168	30-85	39.6	**1.3**
G	70	64	32.0	**0.6**
H	40-157	17-330	50.9	**46**
I	50-157	80-600	50.1	**5.4**
J	100-108	52-700	47.4	**4.2**
K	40-80	25-190	44.1	**0.3**
L	45-90	200-325	63.7	**7.2**
M	158	40	34.4	**1.1**
N	N/A	N/A	N/A	N/A
O	64-163	60-70	30.1	**0.4**
P	80	65	57.0	**4.6**
Q	N/A	N/A	N/A	**1.0**
R	48	90	54.6	**8.2**
S	N/A	N/A	N/A	**2.2**

Operator identifier was randomly assigned (i.e. not alphabetical, not by production, etc.)

Source: Tribal MS Registrations

2017-004851-00454

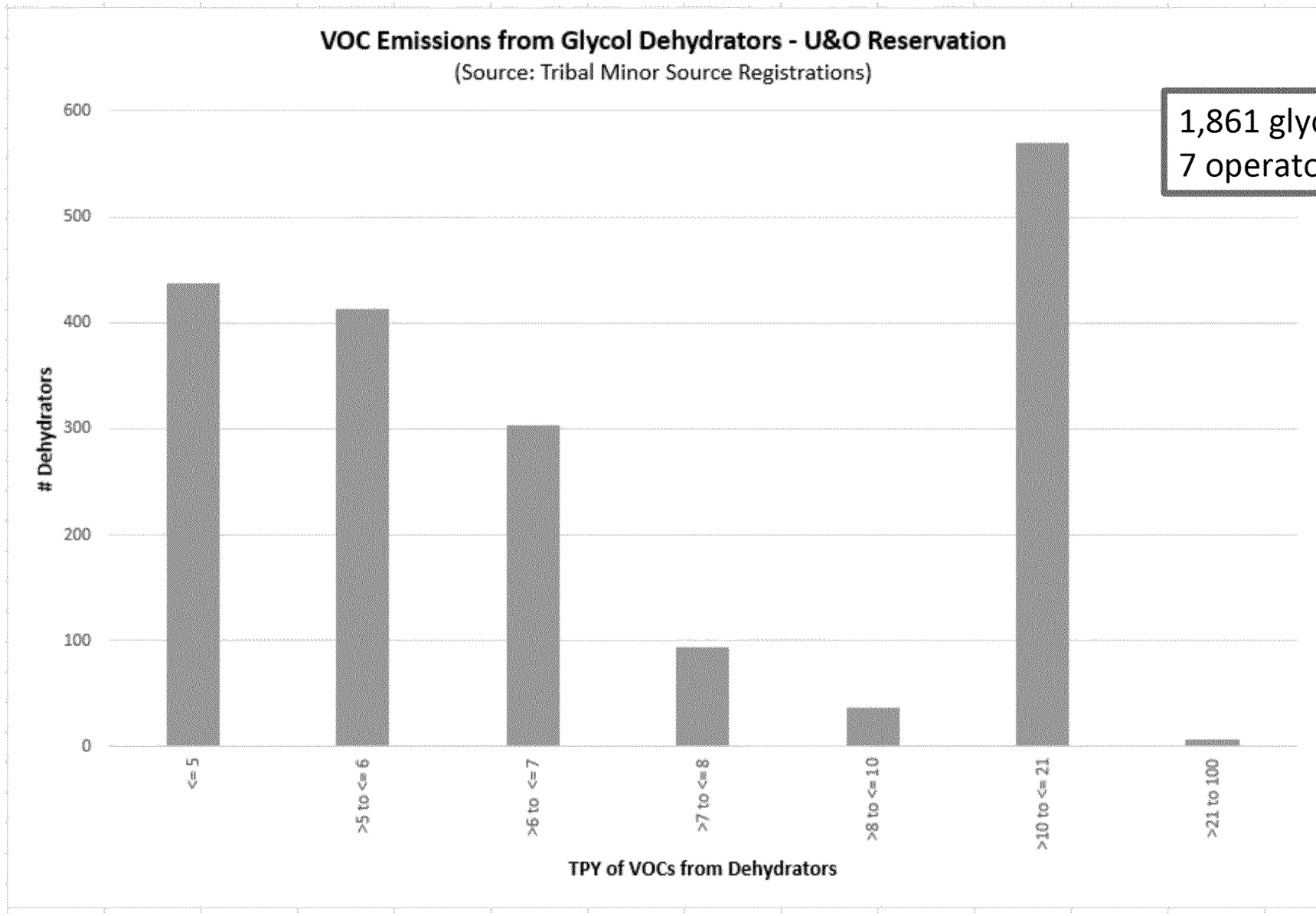


Source:

- DrillingInfo 2014 production
- Wells w/ 1st prod < 8/23/11
- Combined with VOC lb/bbl *by Operator* per Tribal MSR submittals

Note: "1" TPY VOC bar means <=1 wells <2 TPY VOCs

Glycol Dehydrators on U&O Reservation



1,861 glycol dehydrators
7 operators

2017-004851-00454

Normalized Pressurized Liquid Sample Speciation Profile – (mol %)

E&P TANKS

Operator	A	C	D	F	G	H	I	J	K	L	O	P	R
H2S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO2	0.08	0.19	0.03	0.01	0.17	0.24	0.15	0.05	0.02	0.23	0.14	0.01	0.10
N2	0.01	0.00	0.00	0.01	0.02	0.02	0.00	0.01	0.01	0.00	0.02	0.00	0.01
C1	1.40	6.46	2.32	0.38	3.13	7.06	6.38	2.66	1.16	9.74	2.64	0.15	3.70
C2	1.77	2.21	1.09	0.25	0.70	2.56	2.96	1.73	0.71	6.09	0.60	0.57	1.70
C3	4.82	2.83	1.37	0.43	1.07	4.33	2.99	2.75	1.11	9.14	0.95	2.41	4.39
i-C4	2.82	1.35	0.67	0.22	0.88	2.08	1.00	1.64	0.54	3.61	0.77	1.73	2.26
n-C4	5.97	2.73	1.27	0.59	1.11	4.29	2.48	2.38	1.11	6.86	1.05	3.55	5.12
i-C5	4.31	2.46	1.33	0.44	1.05	3.56	1.46	3.23	1.02	4.13	0.97	4.14	4.08
n-C5	4.19	2.57	1.82	0.93	1.00	3.72	2.27	2.82	1.18	4.33	0.94	3.86	4.51
C6	6.51	3.45	16.77	12.29	1.53	4.73	4.43	3.24	0.31	4.11	4.02	6.51	5.41
C7	17.75	19.21	28.81	16.74	4.43	20.09	12.70	9.01	7.80	16.00	5.85	18.71	18.41
C8	18.64	12.48	12.54	12.50	5.89	8.92	7.84	11.44	15.88	6.07	7.26	19.43	16.39
C9	7.44	8.65	6.06	10.48	4.22	5.97	5.10	5.60	8.53	4.08	5.60	6.84	5.90
C10+	11.61	20.24	5.72	28.75	72.44	20.80	38.71	46.28	50.03	14.97	65.47	15.52	16.99
Benzene	0.56	0.88	2.43	1.56	0.31	0.83	1.02	0.36	0.37	0.57	0.39	1.18	1.34
Toluene	3.28	3.92	6.08	2.74	0.38	2.76	3.25	1.96	3.62	2.57	0.66	5.21	2.57
E-Benzene	0.26	0.39	0.30	0.38	0.05	0.34	0.30	0.19	0.43	0.27	0.07	0.46	0.21
Xylenes	3.41	5.43	3.69	2.29	0.50	3.20	3.37	2.45	5.27	3.31	0.63	4.86	1.51
n-C6	5.17	3.24	7.03	7.97	1.12	3.87	2.89	2.19	0.87	3.35	1.89	4.86	5.36
224Trimethylp	0.00	1.30	0.67	1.03	0.00	0.63	0.69	0.00	0.04	0.54	0.10	0.00	0.00
API Sales Oil	62.0	52.0	51.4	39.6	32.0	50.8	50.1	47.4	44.1	63.7	30.1	57.0	54.6

TOG Condensate Tank Emission Profiles: values reported in weight %

Species	A	C	D	H	I	J	K	L	P	R
Methane	6.2997	26.4868	42.5441	13.0250	15.2277	18.8200	41.5324	15.5540	0.7173	12.5141
Ethane	11.2580	18.1956	18.1926	12.6239	24.9393	21.8901	21.2591	17.2700	5.1086	10.7620
Propane	26.8229	19.0308	11.9138	26.0258	31.2682	32.9904	17.4148	34.5372	30.5980	36.3504
Propylene	-	-	-	-	-	-	-	-	-	-
Isobutane (or 2-Methylpr	11.6633	7.7761	3.0643	9.8883	5.0718	7.8964	4.3806	9.8265	18.0008	10.1963
N-butane	18.6914	11.8718	4.0404	13.5358	11.7698	9.1849	6.2354	13.2771	22.4188	14.9828
Isopentane (or 2-Methyll	7.4490	4.7392	1.9953	7.4246	3.1223	3.7800	2.6155	3.6517	7.8238	5.0941
N-pentane	5.4619	3.7033	1.9751	5.5026	3.8963	2.4515	2.1749	2.7245	4.9544	4.0176
N-hexane	2.3255	1.3176	2.3995	4.0770	0.7668	0.4988	0.4274	0.5787	1.4481	1.2907
Isomers of pentane	-	-	-	-	-	-	-	-	-	-
Isomers of hexane	3.6207	1.8203	7.2618	1.2800	1.1982	0.9608	0.1958	0.9225	3.1309	1.6971
Isomers of heptane	3.8975	2.8853	4.5450	4.6626	1.6431	0.8830	1.6757	1.2016	3.4996	2.0047
Isomers of octane	1.5184	1.0730	0.6245	0.5906	0.3199	0.3168	1.1290	0.1425	1.3677	0.5657
Benzene	0.2076	0.2431	0.6298	0.5383	0.2493	0.1042	0.1344	0.0844	0.2276	0.2581
Toluene	0.3921	0.2763	0.5517	0.3972	0.2422	0.1524	0.4307	0.1068	0.3364	0.1565
Ethylbenzene	0.0231	0.0061	0.0040	0.0127	0.0091	-	0.0011	0.0038	0.0161	0.0000
Cumene	-	-	-	-	-	-	-	-	-	-
trimethylbenzene	-	-	-	-	-	-	-	-	-	-
M, O, & p-xylene	0.1384	0.1494	0.0444	0.1057	0.0881	0.0187	0.1602	0.0388	0.1218	0.0549
2,2,4-trimethylpentane	-	0.2	0.0	0.1	0.1	-	0.0	0.0374	0.0	-
C7	-	-	-	-	-	-	-	-	-	-
C8	-	-	-	-	-	-	-	-	-	-
C9	0.2306	0.2473	0.1583	0.1167	0.0661	0.0508	0.2268	0.0327	0.2078	0.0549
C10+	0.0000	0.0264	0.0081	0.0460	0.0071	0.0010	0.0056	0.0098	0.0201	0.0000
C-5 Cycloparaffins	-	-	-	-	-	-	-	-	-	-
C-6 Cycloparaffins	-	-	-	-	-	-	-	-	-	-
C-7 Cycloparaffins	-	-	-	-	-	-	-	-	-	-
C-8 Cycloparaffins	-	-	-	-	-	-	-	-	-	-
Unidentified	-	-	-	-	-	-	-	-	-	-
Total	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000
Total M,E	17.558	44.682	60.737	25.649	40.167	40.710	62.792	32.824	5.826	23.276
API Gravity Sales Oil	62.0	52.0	51.4	50.7	50.1	47.4	44.1	63.7	57.0	54.6

TOG Oil Tank Emission Profiles: values reported in weight %

Species	F	G	O
Methane	6.6536	38.9561	43.0950
Ethane	5.1882	15.3404	13.0040
Propane	6.8041	17.0285	15.1236
Propylene			
Isobutane (or 2-Methylpropane)	2.5083	8.7806	7.6546
N-butane	5.2310	8.2504	7.3244
Isopentane (or 2-Methylbutane)	2.4480	3.9064	3.2775
N-pentane	3.5651	2.8085	2.3326
N-hexane	13.9475	0.8053	1.1838
Isomers of pentane			
Isomers of hexane	22.2600	1.3730	3.3331
Isomers of heptane	16.9461	1.5205	1.9171
Isomers of octane	5.5348	0.7228	0.8322
Benzene	2.5466	0.1951	0.2032
Toluene	1.7094	0.0775	0.2757
Ethylbenzene	0.0899	0.0050	0.0057
Cumene			
trimethylbenzene			
M, O, & p-xylene	0.6178	0.0325	0.0392
2,2,4-trimethylpentane	1.0701	0.0000	0.0449
C7			
C8			
C9	2.2552	0.1976	0.2850
C10+	0.6241	0.0000	0.0684
C-5 Cycloparaffins			
C-6 Cycloparaffins			
C-7 Cycloparaffins			
C-8 Cycloparaffins			
Unidentified			
Total	100.000	100.000	100.000
Total M,E	11.8418	54.2965	56.0990
API Gravity Sales Oil	39.6	32.0	30.1

← Flash + W/S/B from E&P TANKS

Flash from GOR→

DRAFT

TOG Oil Tank Emission Profiles: values reported in mol%

Species	M	B	Q
H2S	0.00	0.00	0.00
N	1.46	0.64	0.57
CO2	0.60	0.12	0.53
C1	30.92	9.45	39.11
C2	18.23	14.34	16.32
C3	23.34	19.62	16.16
i-C4	4.69	5.13	3.57
n-C4	10.70	15.61	8.76
2,2-Dimethylpropane	0.00	0.05	0.03
i-C5	3.41	6.80	3.31
n-C5	4.07	10.72	4.39
2,2-Dimethylbutane	0.00	0.22	0.04
Cyclopentane	0.00	0.32	0.37
2,3-Dimethlybutane	0.00	0.43	0.05
2 Methylpentane	0.00	2.43	1.16
3 Methylpentane	0.00	1.35	0.50
n-Hexane	1.17	5.88	1.75
Methylcyclopentane	0.00	0.74	0.53
Benzene	0.07	0.36	0.13
Cyclohexane	0.00	0.81	0.40
2-Methylhexane	0.00	0.53	0.17
3-Methylhexane	0.00	0.48	0.18
2,2,4-Trimethylpentane	0.00	0.00	0.04
n-Heptane	0.00	1.73	0.53
Methylcyclohexane	0.00	0.67	0.36
Toluene	0.05	0.23	0.10
Other C8's	0.24	0.41	0.31
n-Octane	0.00	0.20	0.07
Ethylbenzene	0.00	0.00	0.00
M&P Xylenes	0.01	0.02	0.03
O-Xylenes	0.00	0.00	0.01
Other C9's	0.05	0.03	0.06
n-Nonane	0.00	0.01	0.01
Other C10's	0.01	0.00	0.02
n-Decane	0.00	0.00	0.01
Undecanes+	0.00	0.00	0.02
API Sales Oil	34.4	40.9	

TOG Glycol Dehydrator Profiles: values reported in weight %							
Species	D	H	J	K	L	O	Q
Methane	35.1081	70.2166	2.3921	5.1952	4.7237	7.0977	32.4064
Ethane	6.0119	4.6730	0.9287	1.0633	2.9450	2.1288	5.1459
Propane	5.5688	2.2560	1.0283	0.9727	3.9224	5.0649	6.0543
iso-butane	1.8251	1.1025	1.0107	0.4236	1.5972	1.6909	1.5343
n-butane	3.1199	1.0694	0.9905	0.6419	2.9889	5.0614	3.4084
iso-pentane	1.5603	0.7675	1.1281	0.4032	1.6175	2.0513	1.3302
n-pentane	1.5158	0.4858	0.6800	0.3854	1.4671	2.8849	1.8152
n-hexane	1.1044	0.3586	0.8094	1.0153	1.3915	2.3667	0.8794
isomers of pentane	-	-	-	-	-	-	-
isomers of hexane	1.2714	0.6131	1.4415	0.8268	1.4196	2.3253	1.4090
isomers of heptane	2.4693	0.8790	2.8676	2.8166	4.3165	5.6727	0.3634
isomers of octane	-	-	-	-	-	-	-
C-5 Compounds	-	-	-	-	-	-	-
C-6 Compounds	-	-	-	-	-	-	-
C-7 Compounds	-	-	-	-	-	-	-
C8+	7.9572	2.3245	10.6949	39.8952	16.8508	2.1291	10.5201
Benzene	4.6812	4.4616	35.7903	9.2118	8.7877	18.8657	7.7701
Isomers of propyl benzene	-	-	-	-	-	-	-
Isomers of butyl benzene	-	-	-	-	-	-	-
Toluene	12.0282	5.7070	29.1334	16.1865	22.1154	21.3574	13.2197
Cumene	-	-	-	-	-	-	-
1,2,4-trimethylbenzene	-	-	-	-	-	-	-
Ethyl-Benzene	0.5441	0.1968	0.7627	0.4152	0.7902	1.7069	2.5963
Xylenes	9.3590	3.1154	6.4650	14.1930	15.2746	6.5196	9.6954
224 Trimethylpentane	0.0928	0.0292	0.0644	0.0839	0.1378	0.2763	0.0230
C-5 cycloparaffins	-	-	-	-	-	-	-
C-6 cycloparaffins	2.0008	0.6167	1.0848	2.1937	3.9102	5.9079	0.9689
C-7 cycloparaffins	3.7817	1.1273	2.7274	4.0767	5.7438	6.8926	0.8601
Total	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000
Total M,E	41.1200	74.8896	3.3209	6.2585	7.6688	9.2265	37.5523

← from GRI GLYCalc

TOG "Raw Gas" Profiles: values reported in weight %

Species	D	E	F	G	H	J	K	L	M	O	P	Q	R
Methyl alcohol	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Methane	74.3315	80.7657	59.0542	67.6564	79.2213	89.6366	79.4964	75.3122	59.7317	47.5473	76.0519	84.5296	68.6577
Ethane	10.1399	7.7534	12.9509	8.9401	7.9579	4.6836	8.6587	9.8878	14.1182	9.5711	8.1062	5.1428	9.3049
Propane	7.0328	4.2630	9.9904	10.9700	5.6784	1.7871	4.2611	5.7556	14.1391	15.0314	6.7065	4.6372	10.0007
Propylene	-	-	-	-	-	-	-	-	-	-	-	-	-
iso-butane	1.7900	1.2675	2.3867	2.0815	1.6057	0.9822	1.1672	1.6511	2.5640	3.6825	1.6946	0.9494	2.5416
n-butane	2.5148	1.5897	5.1265	4.3353	2.1045	0.6426	1.3673	2.1854	4.7111	10.7118	2.4062	1.7660	3.7248
iso-pentane	1.1145	0.8668	2.2238	1.5238	1.0186	0.6507	0.7006	1.1311	1.4868	3.7446	1.1757	0.6880	1.5904
n-pentane	0.8948	0.6268	2.5107	1.4378	0.6622	0.2821	0.5311	0.9105	1.3644	3.8191	0.9009	0.7941	1.3519
n-hexane	0.3784	-	1.1031	-	0.2429	0.1594	0.4837	0.4880	0.4074	0.4903	0.5775	0.2461	0.5828
isomers of pentane	-	-	-	-	-	-	-	-	-	-	-	-	-
isomers of hexane	0.5639	2.8670	1.5314	2.1540	0.4771	0.4071	0.7257	0.7056	0.6105	5.0019	0.7931	0.5317	0.9087
isomers of heptane	0.4139	-	1.2560	0.7824	0.2049	0.2494	0.8110	0.6539	0.3771	0.1274	0.7177	0.0287	0.5148
isomers of octane	-	-	-	-	-	-	-	-	-	-	-	-	-
C8+	0.1881	-	0.9889	-	0.5270	0.1097	1.1819	0.4330	0.2065	0.0720	0.0082	0.3434	0.1907
Benzene	0.0486	-	0.2271	0.0203	0.0324	0.1647	0.0610	0.0728	0.0238	0.0167	0.1569	0.0738	0.0397
Toluene	0.0803	-	0.1264	0.0198	0.0229	0.0960	0.0906	0.0864	0.0263	0.0170	0.0385	0.0833	0.0631
Cumene	-	-	-	-	-	-	-	-	-	-	-	-	-
1,2,4-trimethylbenzene	-	-	-	-	-	-	-	-	-	-	-	-	-
Ethyl-Benzene	0.0023	-	0.0129	0.0005	0.0006	0.0019	0.0058	0.0034	0.0030	0.0004	-	0.0097	0.0022
Xylenes	0.0293	-	0.0555	0.0064	0.0100	0.0128	0.0435	0.0430	0.0131	0.0057	-	0.0322	0.0226
224 Trimethylpentane	0.0322	-	-	0.0097	0.0164	0.0145	0.0250	0.0469	0.0450	0.0094	0.0747	0.0085	0.0389
C-5 cycloparaffins	-	-	-	-	-	-	-	-	-	-	-	-	-
C-6 cycloparaffins	0.1816	-	0.2333	-	0.1065	0.0380	0.1927	0.2318	0.0840	0.1008	0.2854	0.0737	0.1910
C-7 cycloparaffins	0.2631	-	0.2222	0.0622	0.1107	0.0816	0.1964	0.4017	0.0882	0.0507	0.3061	0.0618	0.2737
C-8 cycloparaffins	-	-	-	-	-	-	-	-	-	-	-	-	-
Unidentified	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total M,E	84.5	88.5	72.0	76.6	87.2	94.3	88.2	85.2	73.8	57.1	84.2	89.7	78.0

Data Gaps – Research shows …

- Discrepancy between top-down measurements and bottom-up emission inventories
    - In UB, airborne measurements ~8.9% of gas produced to atmosphere compared to GHGRP-W ~ 1.0%
    - In UB, Ozone modeling shows low negative bias for VOCs and methane by factor of 1.8 and 4.8 respectively

2017-004851-00454

Data Gaps – Research shows …

- Skewed emission distributions, fat tail, "super-emitter" … a small number of sources account for a large % of emissions – **not fixed in time or space**

  - Wellpads – 86 natural gas wellsites … ~5% sites → ~60% of emissions
  - Midstream Compressor Stations - 114 CSs … 30% sites → ~80% of emissions
  - Gas Plants - 16 gas processing plants … 45% sites → ~80% of emissions
  - Transmission Compressor Stations – 45 CSs … 10% sites → ~ 50% of emissions
  - Abandoned Wells – 19 abandoned wells… 3 of the 19 wells had CH4 flow rates three orders of magnitude larger than the median flow rate
  - Well Liquid Unloading – 107 wells with liquid unloadings …
    - w/o plunger lift: 20% wells → 83% of emissions
    - w/ plunger lift and manual: 20% wells → 65% of emissions
    - w/ plunger lift and automatic: 20% wells → 72% of emissions
  - Pneumatic Controllers – 377 controllers … 20% devices → 96% of emissions

2017-004851-00454