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ENVIRONMENT
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MEMORANDUM

Date: **July 18, 2019**

To: **Western Regional Air Partnership Oil (WRAP) and Gas Working Group (OGWG)**

From: **John Grant and Amnon Bar-Ilan**

Subject: **Gas Composition Profile Results from the WRAP OGWG Survey**

Gas composition profile data were collected as part of the Western Regional Air Partnership (WRAP) Oil and Gas Working Group (OGWG) baseline emission inventory survey efforts documented in the Baseline Report[1]. Ramboll reviewed, compiled, and analyzed the gas composition data to develop representative gas composition profiles for specific basins, well types, and emission streams.

Over 300 gas composition profiles were submitted by operators and state agencies in response to the WRAP OGWG survey effort. The steps taken to develop representative gas composition profiles are described below.

1. Ramboll reviewed and converted the gas composition profile data into spreadsheet format. Gas composition profiles were provided in many different formats. Each profile was reviewed and transferred into EXCEL spreadsheet format in the most efficient manner feasible. For example, some profiles were provided as spreadsheet model output (e.g., ProMax model output). For these, Ramboll reviewed the model output and copied applicable gas composition data into the master spreadsheet. Some profiles were provided as a laboratory output PDF in picture format; for these Ramboll performed manual spreadsheet data entry of applicable profiles. Some profiles were provided as PDF selectable text format; these were transferred to an EXCEL file via visual basic macro and formatted for inclusion in the master spreadsheet.
2. Ramboll reviewed the profiles to determine whether any profiles needed to be removed from consideration in estimating representative basin-wide average profiles. Samples with species that were identified as outliers were investigated to determine whether they should be removed. Outliers were removed if the sample was not valid. Sample invalidation was primarily due to the wrong sample media (i.e., liquid rather than gas).
3. Ramboll compiled average gas composition profiles weighting by activity surrogate. For produced gas, the activity surrogate is primary gas (for gas wells) and associated gas (for oil wells). For tank flash gas, the activity surrogate is condensate production (for gas wells) and oil production (for oil wells).

[1] Grant et al., 2019. "Circa-2014 Baseline Oil and Gas Emission Inventory for the WESTAR-WRAP Region". Prepared for: Western Regional Air Partnership Oil and Gas Working Group. July 2019.

A vast majority of gas composition profiles were received for Williston Basin oil well produced gas and flash gas. Gas compositions received for basins other than Williston Basin and Central Montana Uplift were not received from sufficient survey respondents to develop a representative gas composition profile. Publishing a single operator's data is not permissible under this effort according to the data confidentiality agreements made with operators for survey data collection.

Table 1 shows the representative gas compositions compiled in this effort. The representative compositions are provided by well type (oil, gas, and coalbed methane), but independent of spud type (horizontal, vertical, and directional) because the emission inventory distinguishes emissions by well type, but not by spud type.

Table 1. Representative Gas Compositions.

Basin (State)	Williston (ND)
Well Type	Oil
Profile Type	Flash Gas
No. Samples	53
Percent of Activity Surrogate	25%
Component	**Mole Percent**
Methane	12.5756
Ethane	29.8529
Propane	31.6877
i-Butane	3.8695
n-Butane	12.1955
i-Pentane	1.9019
n-Pentane	2.6252
Other Hexanes	0.6923
Heptanes	0.5425
Octanes+	0.2394
Benzene	0.0750
Toluene	0.0565
Ethylbenzene	0.0089
Xylenes	0.0230
n-Hexane	0.4438
Carbon Dioxide	0.7021
Nitrogen	2.5082

Basin (State)	Williston (MT)
Well Type	Oil
Profile Type	Flash Gas
No. Samples	126
Percent of Activity Surrogate	43%
Component	**Mole Percent**
Methane	17.0443
Ethane	31.5896
Propane	31.5435
i-Butane	3.0899
n-Butane	9.1097
i-Pentane	1.5012
n-Pentane	2.0560
Hexanes+	0.8520
Benzene	0.0855
Toluene	0.0559
Ethylbenzene	0.0055
Xylenes	0.0171
n-Hexane	0.3960
Carbon Dioxide	1.1450
Nitrogen	1.5087

Basin (State)	Williston (ND)
Well Type	Oil
Profile Type	Produced Gas
No. Samples	87
Percent of Activity Surrogate	60%
Component	**Mole Percent**
Methane	55.2939
Ethane	19.2455
Propane	11.5017
i-Butane	1.4178
n-Butane	4.3794
i-Pentane	0.9310
n-Pentane	1.3628
Other Hexanes	0.3549
Heptanes	0.4707
Octanes+	0.1064
Cyclohexane	0.1653
Cyclopentane	0.1145
Methylcyclohexane	0.0612
2,2,4-Trimethylpentane	0.0081
Benzene	0.0698
Toluene	0.0506
Ethylbenzene	0.0318
Xylenes	0.0678
n-Hexane	0.3705
Carbon Dioxide	0.7534
Nitrogen	3.2294
Hydrogen Sulfide	0.0135

Basin (State)	Williston (MT)
Well Type	Oil
Profile Type	Produced Gas
No. Samples	65
Percent of Activity Surrogate	44%
Component	**Mole Percent**
Methane	56.3874
Ethane	19.0020
Propane	10.8450
i-Butane	1.2089
n-Butane	3.6688
i-Pentane	1.0981
n-Pentane	1.1682
Other Hexanes	0.2770
Heptanes	0.2628
Octanes+	0.1507
Cyclohexane	0.0417
Cyclopentane	0.0188
Methylcyclohexane	0.0268
2,2,4-Trimethylpentane	0.0046
Benzene	0.0672
Toluene	0.0576
Ethylbenzene	0.0425
Xylenes	0.0507
n-Hexane	0.1976
Carbon Dioxide	1.1465
Nitrogen	4.2766
Hydrogen Sulfide	0.0006

Basin (State)	Central Montana Uplift (MT)
Well Type	Gas
Profile Type	Produced Gas
No. Samples	6
Percent of Activity Surrogate	85%
Component	**Mole Percent**
Methane	93.3852
Ethane	1.8075
Propane	0.4100
i-Butane	0.0644
n-Butane	0.0845
i-Pentane	0.0242
n-Pentane	0.0154
Hexanes	0.0245
Oxygen	0.0024
Nitrogen	3.9598
Carbon Dioxide	0.2221