

## MEMORANDUM

Date: **October 8, 2020**

To: **Tom Moore, WESTAR-WRAP**

From: **John Grant, Rajashi Parikh, Amnon Bar-Ilan**

Subject: **WESTAR-WRAP Region Oil and Gas Emission Inventory Refinement:  
Task 1. Apportion Oil and Gas Emissions by "Federal", "Non-Federal" and  
"Tribal" Mineral Ownership**

### INTRODUCTION

Oil and gas (O&G) emission inventories developed by Ramboll for the WRAP OGWG distinguish emissions by county and Tribal/non-Tribal surface land. Per request of the Bureau of Land Management (BLM), under this task, Ramboll added mineral designation detail (Federal, non-Federal, and Tribal) to county-level emissions in the future year 2028 medium scenario ("Continuation of Historical Trends") emission inventory. Assignment of mineral designation focused on the following states: North Dakota (ND), South Dakota (SD), Montana (MT), Wyoming (WY), Utah (UT), Colorado (CO), and New Mexico (NM). O&G emission inventories for other WRAP states (Idaho (ID), Washington (WA), Oregon (OR), Nevada (NV), Arizona (AZ), and Alaska (AK)) are assigned to the "non-Federal" mineral designation.

### METHODOLOGY

BLM and Ramboll staff collaborated to develop a "Data Request Workbook" to facilitate data exchange for the purpose of defining oil and gas activity by mineral designation. Ramboll populated the "Data Request Workbook" with the following data:

- i. List of counties included in each O&G basin for each WRAP state<sup>1</sup>.
- ii. Summary of the O&G activity which is the basis of the circa-2014 O&G emission inventory for the parameters listed below:
  1. Spuds by well type (oil, gas, coalbed methane)
  2. Active Well Count by well type (oil, gas, coalbed methane)
  3. Oil Production by well type (oil, gas, coalbed methane)
  4. Gas Production by well type (oil, gas, coalbed methane)
- iii. Continuation of historical trends growth factors by basin (i.e., growth factors for each O&G basin by well type for each of the parameters listed above).

BLM modified the "Data Request Workbook" to include O&G activity by mineral designation applicable to future year 2028. The basis of the O&G activity by mineral designation is described in Attachment 1 provided by BLM<sup>2</sup>.

Ramboll added mineral designation detail for each emission source in the future year 2028 medium scenario emission inventory. O&G activity parameter to emissions source category

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<sup>1</sup> Will not include California or Hawaii. The California Air Resources Board estimates California O&G emissions. Hawaii does not have any O&G emission sources.

<sup>2</sup> Email from Bureau of Land Management, Colorado (Forrest Cook). May 27, 2020

cross-references used to assign mineral designation activity fractions to specific emission sources. The O&G activity parameter associated with each emission source category is shown in Table 1. For wellsite sources (typically included in the nonpoint source inventory), mineral designation fractions were applied to emissions at the county-level. Midstream emissions are typically included in the point source emission inventory and are estimated based on agency provided emission data. It was not feasible to determine for each midstream source, the amount of emissions resulting from activity for each mineral designation. For midstream sources, mineral designation emission fractions were estimated based on the fraction of basin-wide O&G activity for each mineral designation. For example, nonpoint drill rig emissions in a given county were disaggregated by mineral designation based on county-level spud fractions; a point source compressor station facility’s emissions were disaggregated by mineral designation based on basin-level gas production fractions.

**Table 1. O&G activity surrogate by O&G source category.**

O&G Activity Surrogate	Emission Source Category
<b>Active Well Count</b>	Refracing
	Water Pump Engines
	Well Venting
	Wellhead Engines (e.g., compressors, artificial lift)
	Workover rigs
	Blowdowns
	Heaters
	Fugitive Leaks
	Pneumatic Devices
	Pneumatic Pumps
	Well Venting
	Recompletions
<b>Gas Production (i.e., total, primary, associated, CBM)</b>	Midstream Sources
	Produced Water Tanks
	Dehydrators
	Casinghead Gas
<b>Liquid Hydrocarbon Production (i.e., oil, condensate)</b>	Oil Tanks
	Condensate Tanks
	Tank Truck/Railcar Loading
<b>Spud Count</b>	Completions
	Drill Rigs
	Hydraulic Fracturing Engines
	Mud Degassing

## RESULTS

O&G emissions by mineral designation for the future year 2028 O&G emission inventory for the WESTAR-WRAP region are presented below as a series of tables and charts. Additional summaries and fully detailed emission inventory data are available in spreadsheets that accompany this report which are posted on the WRAP OGWG website (<https://www.wrapair2.org/OGWG.aspx>).

Future Year 2028 emissions by mineral designation for the WRAP region are summarized in Table 2. Across the WRAP region, 33%-44% of emissions are from non-Federal minerals,

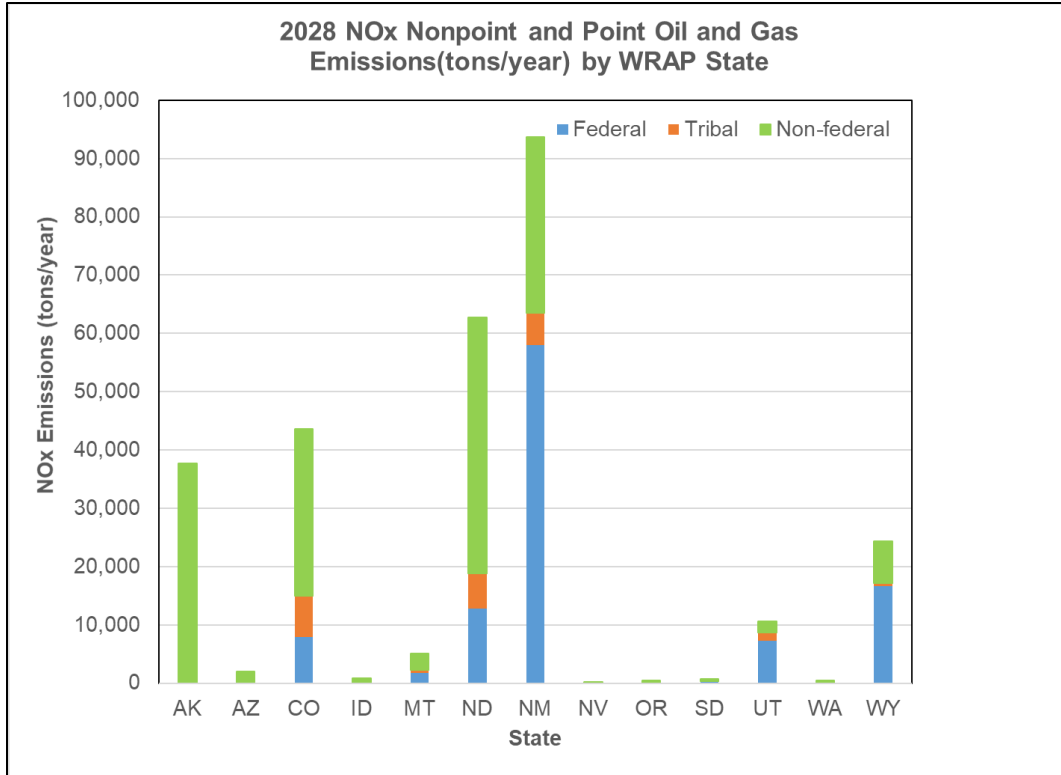
40%-56% of emissions are from non-Federal minerals, and 6%-19% of emissions are from Tribal minerals.

**Table 2. Summary of WRAP Region Emissions by Mineral Designation.**

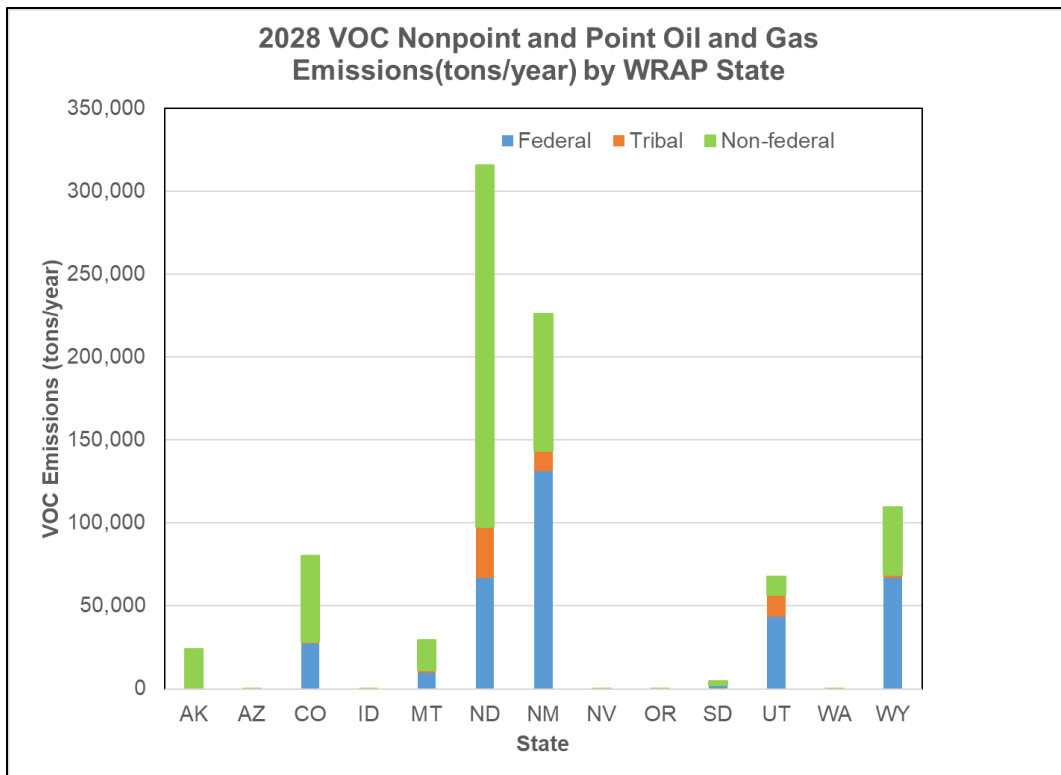
Pollutant	Emissions (tons/year)			
	Federal	Tribal	Non-Federal	Total
NO <sub>x</sub>	104,477	21,079	156,739	282,295
VOC	347,374	59,746	451,108	858,228
CO	131,972	29,762	173,326	335,059
SO <sub>x</sub>	24,322	3,397	33,135	60,854
PM <sub>10</sub>	3,537	518	4,542	8,596
PM <sub>2.5</sub>	3,501	504	4,375	8,380
CO <sub>2</sub>	26,138,930	6,020,946	40,704,693	72,864,569
CH <sub>4</sub>	1,045,123	385,911	945,448	2,376,481
N <sub>2</sub> O	438	247	647	1,332
CO <sub>2</sub> (e)	50,276,864	11,080,422	59,908,854	121,266,141

Figure 1 and Figure 2 show NO<sub>x</sub> and VOC emissions contributions, respectively by state and mineral designation.

A majority of NO<sub>x</sub> and VOC emissions in CO, MT, ND, and SD were from non-federal land: CO (66% NO<sub>x</sub>, 65% VOC), MT (57% NO<sub>x</sub>, 62% VOC), ND (70% NO<sub>x</sub>, 69% VOC) and SD (61% NO<sub>x</sub>, 59% VOC). A majority of NO<sub>x</sub> and VOC emissions in NM, UT and WY, were from Federal minerals: NM (62% NO<sub>x</sub>, 58% VOC), UT (68% NO<sub>x</sub>, 64% VOC) and WY (68% NO<sub>x</sub>, 61% VOC). 100% of NO<sub>x</sub> and VOC emissions were assigned to non-Federal minerals for ID, WA, OR, NV, AZ, and AK.



**Figure 1. 2028 NOx O&G emissions by state and mineral designation (includes nonpoint and point source emissions).**



**Figure 2. 2028 VOC O&G emissions by state and mineral designation (includes nonpoint and point source emissions).**

## **NEXT STEPS**

Upon response to comments and finalization of emission inventory spreadsheet and memorandum deliverables, Ramboll will develop Sparse Matrix Operator Kernel Emissions (SMOKE)-ready emission files for use in air quality modeling.

## ATTACHMENT

### Oil and Gas Mineral Designation Disaggregation Methodology

**Oil and Gas Mineral Designation Disaggregation Methodology  
Provided via Email by BLM (Forrest Cook), May 27, 2020****Overview of oil and gas emissions inventories for modeling prior to BLM add-on**

**task processing:** Ramboll / WRAP developed annual total (no distinction among minerals ownerships) estimates for active wells, spuds and production for year 2014. To develop future year 2028 emissions inventories for modeling, growth factors would be applied to the year 2014 production and count estimates and the projected future (~ 2028) year emissions would be modeled from the year 2014 spatial locations. No distinction made for Federal, Tribal and non-Federal oil and gas, and all oil and gas emissions would be modeled as one group for the future year ~ 2028 modeling.

**BLM add-on task goal:** to split the Ramboll provided well and spud counts, and production into mineral ownership (Federal, Tribal and non-Federal) and to do so accounting for recent and projected new oil and gas development while not changing the 2014 total counts and production estimates (sum of Federal, Tribal and non-Federal). This would mean that the application of the pre-determined (developed by Ramboll / WRAP) growth factors to the year 2014 estimates would still achieve the target future counts and rates (i.e. emissions) pre-developed by Ramboll. The accounting of recent (years 2014-2019) and future oil and gas development (years 2020-2028) would affect the distribution among ownership and spatial allocation to be more representative of year 2028.

**Datasets needed and obtained by BLM:**

- \* total (includes Federal, Tribal and non-Federal but not distinguished among these) current well inventory for active wells with spud dates and location information with API numbers. BLM obtained IHS (extracted from IHS early 2020) database download with general information (spud dates, status, coordinates) for all active wells within 7 BLM States.
- \* current Federal and Tribal inventory for wells with spud dates and API numbers. BLM obtained (extracted from AFMSS early 2020) AFMSS database download for all Federal and Tribal wells drilled since year 1901.
- \* inventory of annual gas and liquid production for all current wells. BLM obtained IHS (extracted from IHS early 2020) database download with annual gas and liquid production information for all wells.

**BLM processing methodology:**

- \* used Python to assign Federal, Tribal or non-Federal to all wells in the IHS database; IHS well assigned Federal for a particular API number if that API number is found in AFMSS inventory with Federal label, IHS well assigned Tribal for a particular API number if that API number is found in AFMSS inventory labeled Tribal; all other active wells in the IHS inventory not found in the AFMSS inventory considered non-Federal.
- \* imported all IHS wells into ArcGIS and intersected with WRAP grid, and assigned WRAP grid cell ID, Basin and County to each IHS well.
- # the result is a new created wells dataset that includes mineral ownership (Federal, Tribal and non-Federal), WRAP grid cell ID, Basin, County and spud date for each active well within the BLM 7 States.
- \* using Excel (VBA), for each unique grid cell / County provided by Ramboll, filled in number of active wells (as of early 2020) for Federal, Tribal and non-Federal, and the number of spuds 2014-2019, and added a field for spuds years 2020-2028 assuming development rates seen for previous 6 years (2014-2019) for each Federal, Tribal and non-Federal. This would be the main Worksheet template for the remaining processing.
- \* for the main Worksheet, for each grid cell / County, determined the fraction of the Ramboll provided annual (2014) active and spud counts for Federal, Tribal and non-Federal

so that the sum of these would equal the Ramboll totals while accounting for recent and future spuds, and current active wells (as of early 2020). The fractions of total would account for recent and future projected spuds.

- \* using Excel, for each Basin, from the new created wells dataset, extracted all wells with spud dates 2009 or newer.

- \* used Python with the annual IHS production data for the newer wells (2009 and later) to create annual gas and liquid production list for all wells within a Basin; production list for each well being production for year 1 followed by year 2, and so on; some wells have up to 10 full years of production (spud ~ 2009), and some only have 1 full year of production (spud year 2018).

- \* imported annual production list for each well for each Basin into Excel and created an average first year, second year...10th year production estimate for each Basin based on newer wells (spud 2009 or later) for both gas and liquid production.

- \* normalized the average annual production rates by dividing the Basin annual average for each year (year 1, year 2...) by the year 10 average value meaning that production at year 10 produces "one" unit annually and earlier years for the life of a well (year 9, year 8...) annual production rates are greater than year 10 (year 1 production rate is greatest for a well). Then calculated the average "unit" gas and liquid production value for years 1-9 for each Basin (sum divided by 9).

- \* using Excel, for each grid cell / County in the main Worksheet, determined the fraction of the Ramboll provided annual (2014) production levels for Federal, Tribal and non-Federal accounting for recent and projected new development. The 9-year average production unit rate for gas and liquid was applied to the number of future spuds (years 2020-2028), and the "one" unit annual production rate was applied to all older wells (existing and active early 2020) for Federal, Tribal and non-Federal. The fractions of total production for each grid cell / County would account for recent and future new wells that produce higher quantities of oil and gas on a per-well basis.

- \* using Excel, determined the fraction of County totals for each grid cell for Federal, Tribal and non-Federal for spud and active well counts, and production spatial allocation. The spatial allocation would account for locations of new and future spuds, and the higher quantities of production associated with newer (future spuds ~ 2020 - 2028) wells.