

June 25, 2018

MEMORANDUM

To: Tom Moore, WESTAR-WRAP
From: John Grant, Rajashi Parikh, and Amnon Bar-Ilan
Subject: Comparison of Oil and Gas Emission Estimates from the Greater San Juan Basin Inventory Project Emission Inventory to the 2014 National Emission Inventory (Version 2)

In this memorandum, we compare Greater San Juan Basin oil and gas (O&G) nonpoint and point source emission estimates from the 2014 National Emission Inventory (version 2; 2014NEIv1¹) with the inventory developed as part of the Greater San Juan and Permian Basin O&G Emissions Inventory Project² (Grant et al., 2017a³; 2014WESTAR-WRAP). The development of 2014NEIv1 and 2014WESTAR-WRAP share many common data sources, but were generated with different tools and compilation methodologies. This analysis describes (1) the magnitude of differences in emissions between the inventories, (2) causes of differences in emissions between the inventories, and (3) areas to focus on for future improvements. The focus of this analysis is upstream O&G well-site emissions and midstream compressor station, gas processing, and tank battery facilities.

POINT SOURCES

Table 1 shows emissions by state and jurisdiction from 2014NEIv1 and 2014WESTAR-WRAP emission inventories. There are substantial differences between 2014NEIv1 and 2014WESTAR-WRAP emissions by jurisdiction. Greater San Juan Basin-wide, emissions from the 2014NEIv1 are 22% lower for NO_x and 48% lower for VOC compared to the 2014WESTAR-WRAP emission inventory.

¹ <https://www.epa.gov/air-emissions-inventories/2014-national-emissions-inventory-nei-data>

² <https://www.wrapair2.org/SanJuanPermian.aspx>

³ Grant et al., 2017a. Final report – San Juan and Permian Basin 2014 Oil and Gas Emission Inventory (Nov. 2017), https://www.wrapair2.org/pdf/2014_SanJuan_Permian_Baseyear_EI_Final_Report_10Nov2017.pdf

Table 1. Point source emissions by state and jurisdiction.

| State | Jurisdiction | Emissions (tpy) | | | | |
|------------------------|--------------|-----------------|---------------|---------------|-----------------|------------------|
| | | NOx | VOC | CO | SO ₂ | PM ₁₀ |
| 2014WESTAR-WRAP | | | | | | |
| Colorado | State | 89 | 26 | 88 | 0 | 2 |
| | Tribal | 3,329 | 1,675 | 2,026 | 52 | 80 |
| New Mexico | State | 10,643 | 6,435 | 8,577 | 232 | 308 |
| | Tribal | 651 | 390 | 264 | 0 | 4 |
| Totals | | 14,712 | 8,525 | 10,955 | 284 | 393 |
| 2014NEIv1 | | | | | | |
| Colorado | State | 1,113 | 91 | 1,369 | 0 | 2 |
| | Tribal | 3,329 | 1,471 | 2,031 | 52 | 80 |
| New Mexico | State | 7,024 | 2,825 | 4,578 | 182 | 223 |
| | Tribal | 9 | 8 | 7 | 0 | 0 |
| Totals | | 11,474 | 4,395 | 7,984 | 234 | 306 |
| Difference | | | | | | |
| Colorado | State | 1,024 | 65 | 1,281 | 0 | 1 |
| | Tribal | 0 | -204 | 5 | 0 | 0 |
| New Mexico | State | -3,619 | -3,610 | -3,999 | -50 | -84 |
| | Tribal | -642 | -382 | -257 | 0 | -4 |
| Totals | | -3,237 | -4,130 | -2,971 | -50 | -87 |

Differences between 2014NEIv1 and 2014WESTAR-WRAP point source emissions are described below.

1. **Colorado, state jurisdiction:** 2014NEIv1 emissions are substantially higher than 2014WESTAR-WRAP emissions because several well-site facility point source emissions from the Colorado Department of Public Health and Environment (CDPHE) are included in NEI2014 that are not included in 2014WESTAR-WRAP. Table 2 shows the top 10 NOx emitting CDPHE point sources in NEI2014; of these sources, only one is included in 2014WESTAR-WRAP. Facilities in 2014NEIv1 which are not in 2014WESTAR-WRAP are all well-site sources. As described below in the nonpoint section, it appears that EPA reconciled nonpoint source and point source well-site emissions by reducing nonpoint emissions in the 2014NEIv1. The inclusion of the CDPHE well-site sources in 2014NEIv1 as point sources and 2014WESTAR-WRAP as nonpoint sources results in a difference in the spatial distribution of emissions, but not in a difference in emissions magnitude.

Table 2. Top 10 facility-level 2014NEIv1 point source NOx emissions.

| 2014NEIv1 Facility Name | 2014NEI v1 NOx Emissions (tpy) | Facility in 2014WESTAR-WRAP? |
|--|--------------------------------|------------------------------|
| BP AMERICA - PINON COMPRESSOR FACILITY | 85.0 | Y |
| XTO ENERGY, INC. - SCHIRARD 3-12U | 57.4 | N |
| XTO ENERGY, INC. - HUBER HECHT 1-4 | 57.2 | N |
| XTO ENERGY, INC. - HUBER CROOK 4-26 | 36.2 | N |
| XTO ENERGY, INC. - HUBER JOHNSON 1-33 | 36.2 | N |
| XTO ENERGY, INC. - 76044-1-06-00 | 35.1 | N |
| BP AMERICA PROD - CUNDIFF GU C1 | 23.2 | N |
| XTO ENERGY, INC. - 04865-L-04-RK | 21.9 | N |
| BP AMERICA PRODUCTION CO. - RICHARDSON | 18.4 | N |
| BP AMERICA - ANNALA ROY GAS UNIT A2 | 14.7 | N |

- Colorado, tribal jurisdiction:** NO_x, CO, SO₂, and PM₁₀ emissions are very similar in 2014NEIv1 and 2014WESTAR-WRAP, differences in emissions between the two inventories are less than 1%. VOC emissions are 12% less in 2014NEIv1 compared to 2014WESTAR-WRAP as a result of higher emissions at a single facility (Ignacio Gas Plant) in 2014WESTAR-WRAP compared to 2014NEIv1.
- New Mexico, state jurisdiction:** 2014NEIv1 NO_x emissions are 34% lower and 2014NEIv1 VOC emissions are 56% lower compared to 2014WESTAR-WRAP. The majority of the difference in emissions between 2014NEIv1 and 2014WESTAR-WRAP results from the inclusion of minor source facilities in 2014WESTAR-WRAP (Table 3 shows 2014WESTAR-WRAP Title V and minor point source emissions provided by the New Mexico Environment Department [NMED]), but not in 2014NEIv1. Additionally, 2014NEIv1 total emissions are lower by 8% for NO_x, 6% for VOC, 10% for CO, 2% for PM₁₀ and 17% for SO₂ compared to 2014WESTAR-WRAP NMED Title V emissions (i.e. excluding 2014WESTAR-WRAP minor sources) as a result of differences in facility-level emissions. Facility-level emission differences may result from facility-level emission reporting refinements as Title V emissions were not provided by NMED to the 2014NEIv1 and 2014WESTAR-WRAP at the same time.

Table 3. New Mexico, state jurisdiction emissions in 2014WESTAR-WRAP.

| Source | 2014WESTAR-WRAP Emissions (tpy) | | | | |
|--------------------|---------------------------------|-------|-------|-----------------|------------------|
| | NOX | VOC | CO | SO ₂ | PM ₁₀ |
| NMED Minor Sources | 2,992 | 3,434 | 3,463 | 45 | 38 |
| NMED Title V | 7,650 | 3,000 | 5,114 | 185 | 269 |

4. **New Mexico, tribal jurisdiction:** Compared to 2014WESTAR-WRAP, 2014NElv1 emissions are very small across all pollutants. 2014WESTAR-WRAP includes several point source facilities on Jicarilla Apache, Ute Mountain, and Laguna Pueblo tribal lands; no facilities from these tribal lands are included in 2014NElv1. Both inventories include a small amount of emissions from three facilities on Navajo Nation tribal land.

NONPOINT SOURCES

2014NElv1 and 2014WESTAR-WRAP nonpoint source emissions were sourced primarily from Southern Ute Indian Tribe (SUIT) survey-based emission estimates (calculated in CDPHE [2017]⁴) in Colorado. New Mexico nonpoint source O&G emissions in 2014WESTAR-WRAP were based primarily on operator surveys as described in Grant et al. (2017a)³. New Mexico nonpoint source O&G emissions in 2014NElv1 were developed based on the EPA Oil and Gas Tool (version 2.3 for Exploration Activities and version 2.2. for Production Activities). EPA Oil and Gas Tool inputs included input factors compiled from 2014WESTAR-WRAP as described in Grant et al. (2017b)⁵.

Colorado

Table 4 shows differences in 2014NElv1 and 2014WESTAR-WRAP emissions for NOx and VOC. Differences are related primarily to two emission sources, well-site engines and pneumatic pumps.

Nonpoint engine NOx emissions are 1130 tpy less in 2014NElv1 compared to 2014WESTAR-WRAP. As indicated above, point source NOx emissions are 1024 less in the 2014WESTAR-WRAP than in 2014NElv1, mostly offsetting the difference in nonpoint source engine NOx emissions. As described above, the 2014NElv1 includes several well-site facility emissions as point sources provided by CDPHE whereas the 2014WESTAR-WRAP includes all wellsite emissions as nonpoint sources.

Pneumatic pump emissions were not included in CDPHE (2017). Pneumatic pump emissions were included in 2014WESTAR-WRAP based on gas well-site inputs and activity estimates. Pneumatic pump emissions are not included in 2014NElv1, consistent with CDPHE (2017).

Table 4. Colorado Nonpoint NOx and VOC emissions from the Greater San Juan Basin.

| Source | 2014WESTAR-WRAP | | 2014NElv1 | | Difference | |
|------------------|-----------------|-----------|-----------|-----------|------------|-----------|
| | NOx (tpy) | VOC (tpy) | NOx (tpy) | VOC (tpy) | NOx (tpy) | VOC (tpy) |
| All Engine Types | 11,197 | 293 | 10,067 | 276 | -1,130 | -18 |
| Nonpoint Heaters | 635 | 534 | 635 | 534 | 0 | 0 |
| Pneumatic pumps | - | 572 | - | 0 | 0 | -572 |

⁴ Colorado Department of Public Health and Environment, 2017. Personal Communication with CDPHE staff (Dale Wells). April.

⁵ Grant et al., 2017b. EPA O&G Tool 2014 O&G Input Factor Recommendations for the Portions of Greater San Juan and Permian Basins in New Mexico.

https://www.wrapair2.org/pdf/GSJB_Permian_OgToolInputs_12May2017.pdf

| Source | 2014WESTAR-WRAP | | 2014NElv1 | | Difference | |
|-------------------------------|-----------------|--------------|---------------|--------------|---------------|-------------|
| | NOx (tpy) | VOC (tpy) | NOx (tpy) | VOC (tpy) | NOx (tpy) | VOC (tpy) |
| Nonpoint Fugitives | - | 300 | - | 300 | 0 | 0 |
| Pneumatic devices | - | 154 | - | 154 | 0 | 0 |
| Condensate tank | 0 | 142 | - | 142 | 0 | 0 |
| Water Tank Venting | - | 75 | 0 | 75 | 0 | 0 |
| Oil Tank | 0 | 59 | - | 59 | 0 | 0 |
| Dehydrator | - | 27 | - | 27 | 0 | 0 |
| Venting - initial completions | 9 | 14 | 0 | 18 | -9 | 4 |
| Venting – blowdowns | - | 4 | - | 4 | 0 | 0 |
| Oil Well Truck Loading | - | 1 | - | - | 0 | -1 |
| Gas Well Truck Loading | - | 1 | 0 | 0 | 0 | 0 |
| Casinghead Gas Venting | - | 0 | - | - | 0 | 0 |
| Total | 11,842 | 2,176 | 10,702 | 1,588 | -1,139 | -588 |

New Mexico

Greater San Juan Basin nonpoint source O&G NOx emissions in New Mexico are 25% lower in the 2014NElv1 compared to 2014WESTAR-WRAP (see Table 5). NOx emission differences result primarily from (1) higher nonpoint source compressor engines in 2014WESTAR-WRAP due primarily to wellsite compressor engine prevalence in 2014WESTAR-WRAP compared to the EPA O&G Tool and (2) the omission of water pump engines from the EPA O&G Tool.

Table 5. New Mexico nonpoint source NOx emissions from the Greater San Juan Basin.

| Source | NOx Emissions (tpy) | | |
|-----------------------------|---------------------|---------------|---------------------|
| | 2014WESTAR-WRAP | 2014NElv1 | Absolute Difference |
| Nonpoint Compressor Engines | 29,420 | 23,685 | 5,736 |
| Water Pump Engines | 2,299 | - | 2,299 |
| Nonpoint Heaters | 788 | 413 | 375 |
| Artificial Lift | 643 | 569 | 74 |
| Workover rigs | 84 | - | 84 |
| Refracing | 78 | - | 78 |
| Drill rigs | 42 | 103 | -62 |
| Initial completions | 35 | 37 | -2 |
| Oil Tank | 26 | 41 | -14 |
| Fracing | 18 | 7 | 11 |
| Total | 33,436 | 24,854 | 8,581 |

Greater San Juan Basin nonpoint source VOC emissions in New Mexico are 17% lower in the 2014NElv1 compared to 2014WESTAR-WRAP (see Table 5). Compressor engine, pneumatic pump, and tank VOC emissions are substantially higher in 2014WESTAR-WRAP compared to 2014NElv1. Pneumatic devices, nonpoint fugitives, and initial completions emissions are substantially higher in 2014NElv1 compared to 2014WESTAR-WRAP.

Table 6. New Mexico Nonpoint source VOC emissions from the Greater San Juan Basin.

| Source | VOC Emissions (tpy) | | |
|-------------------------------|---------------------|---------------|---------------------|
| | 2014WESTAR-WRAP | 2014NElv1 | Absolute Difference |
| Pneumatic devices | 25,478 | 27,612 | -2,133 |
| Nonpoint Compressor Engines | 14,710 | 485 | 14,225 |
| Nonpoint Fugitives | 11,728 | 15,890 | -4,162 |
| Pneumatic pumps | 10,087 | 4,453 | 5,634 |
| Dehydrator | 7,665 | 7,672 | -7 |
| Condensate tank | 3,331 | 1,980 | 1,350 |
| Oil Tank | 3,085 | 1,104 | 1,981 |
| Venting – blowdowns | 2,151 | 2,175 | -24 |
| Water Pump Engines | 313 | - | 313 |
| Oil Well Truck Loading | 224 | 144 | 79 |
| Venting - initial completions | 212 | 2,956 | -2,744 |
| Water Tank Venting | 148 | 440 | -293 |
| Gas Well Truck Loading | 128 | 26 | 103 |
| Nonpoint Heaters | 43 | 39 | 4 |
| Casinghead Gas Venting | 35 | - | 35 |
| Artificial Lift | 8 | 7 | 1 |
| Workover rigs | 5 | - | 5 |
| Refracing | 5 | - | 5 |
| Drill rigs | 4 | 6 | -2 |
| Fracing | 1 | 0 | 1 |
| Mud Degassing | - | 379 | -379 |
| Others | - | 187 | -187 |
| Total | 79,364 | 65,556 | 13,808 |

In May 2017, Ramboll provided 2014WESTAR-WRAP input factors formatted for use in the EPA Oil and Gas Tools to EPA as documented in Grant et al. (2017b)⁵. The 2014WESTAR-WRAP input factors were incorporated into the EPA Oil and Gas Tools which were used to estimate emissions for the 2014NElv1. Even with input factor updates, key differences between 2014WESTAR-WRAP and 2014NElv1 result in 2014NElv1 emissions that are 26% lower for NOx and 17% lower for VOC. The primary reasons for differences observed for several key source categories are provided below.

1. **Nonpoint compressor engine** emission factors are higher in the EPA Oil and Gas Tool compared to 2014WESTAR-WRAP. Grant et al. (2017b) recommended a higher wellhead compressor engine prevalence than was included in the EPA Oil and Gas Tool activity file.
2. **Water pump engines** are not included in the EPA Oil and Gas Tool. Water pump engines will be added to a future version of the EPA Oil and Gas Tool as they are an important emission source category for coalbed methane wells.
3. **Pneumatic pump** emissions are estimated in the EPA Oil and Gas Tool using a different methodology than was implemented in 2014WESTAR-WRAP. Pneumatic pump inputs to the EPA Oil and Gas Tool were not recommended for update in Grant et al. (2017b)⁵. 2014NEIv1 and 2014WESTAR-WRAP pneumatic pump emissions are not expected to be consistent.
4. **Nonpoint fugitives** input factor for VOC/TOC is higher in the EPA Oil and Gas Tool than in the 2014WESTAR-WRAP emission inventory. Updates to speciation factors were not recommended in Grant et al. (2017b).
5. **Initial completion** venting volume was inadvertently assigned to total volume of gas flared and vented in Grant et al. (2017b) inputs.
6. **Pneumatic devices:** VOC weight fractions in the 2014NEIv1 are slightly lower than VOC weight fractions in 2014WESTAR-WRAP and well counts differ slightly between the two inventories.
7. **Condensate tank** emissions in the EPA Oil and Gas Tool are based on an estimate of condensate production that is 51% less than condensate production estimated in 2014WESTAR-WRAP. Additionally, EPA Oil and Gas Tool assumptions of emission control fraction based on Subpart W data were smaller than control fraction estimates (also based on Subpart W data) in 2014WESTAR-WRAP.
8. **Oil tank** emission control fraction in the EPA Oil and Gas Tool is higher (97%) compared to the 2014WESTAR-WRAP estimate (72%).

SUMMARY OF KEY DIFFERENCES BETWEEN 2014WESTAR-WRAP AND 2014NEIv1

Colorado Point sources:

1. CDPHE point source emissions were much higher in the 2014NEIv1 compared to 2014WESTAR-WRAP. This does not result in a major difference in emissions magnitudes between the 2014NEIv1 and 2014WESTAR-WRAP because these point source emissions were included in the 2014WESTAR-WRAP inventory as nonpoint sources.

New Mexico point sources:

1. NMED minor sources were included in 2014WESTAR-WRAP, but not in 2014NEIv1. NMED submits point source emissions to the EPA for inclusion in national emission inventories. In the past, NMED has not included minor sources in their NEI submissions because in many

instances minor source emissions available to NMED are not year specific. If minor source emissions are not included, the point source emission inventory will be missing emissions from these facilities, however, there is concern about the accuracy associated with minor source emissions that are not year specific.

2. 2014WESTAR-WRAP includes, but the 2014NEIv1 does not include several point source facilities on Jicarilla Apache, Ute Mountain, and Laguna Pueblo tribal lands. We recommend that emissions from O&G point source facilities on Jicarilla Apache, Ute Mountain, and Laguna Pueblo be included in NEI emission inventories.

Colorado nonpoint sources:

1. Pneumatic pump emissions (primarily from gas wells) are included in 2014WESTAR-WRAP, but not in 2014NEIv1. Pneumatic pump emissions may be undercounted in 2014NEIv1.

New Mexico nonpoint sources:

1. Differences in EPA Oil and Gas Tool inputs for several source categories (wellhead compressor engines, condensate tanks, oil tanks, nonpoint fugitives, initial completions, pneumatic devices, and pneumatic pumps) were the primary cause of nonpoint sources emissions that were 10% lower for NOx and 17% lower in 2014NEIv1 compared to 2014WESTAR-WRAP. EPA O&G Tool input factor updates should be considered for the 2016 modeling platform and 2017 NEI.
2. Water pump engines were not included in the version of the EPA Oil and Gas Tool used to generate the 2014NEIv1.