ENVIRON

June 7, 2012

FINAL EMISSIONS TECHNICAL MEMORANDUM No. 4b

To: Tom Moore, Western Governors' Association (WGA) (WRAP)

From: Amnon Bar-Ilan and Ralph Morris, ENVIRON International Corporation

Subject: Source of Oil and Gas Emissions for the WestJumpAQMS 2008 Photochemical Modeling

---

INTRODUCTION

ENVIRON International Corporation (ENVIRON), Alpine Geophysics, LLC (Alpine) and the University of North Carolina (UNC) at Chapel Hill Institute for Environment are performing the West-wide Jump Start Air Quality Modeling Study (WestJumpAQMS) managed by the Western Governors' Association (WGA). WestJumpAQMS is setting up the CAMx and CMAQ photochemical grid models for the 2008 calendar year (plus spin up days for the end of December 2007) on a 36 km CONUS, 12 km WESTUS and several 4 km Inter-Mountain West domains. The WestJumpAQMS Team are currently compiling emissions to be used for the 2008 base case modeling, with the 2008 National Emissions Inventory (NEI) being a major data source. Thirteen Technical Memorandums discussing the sources of the 2008 emissions by major source sector are being prepared as part of the WestJumpAQMS:

1. Point Sources including Electrical Generating Units (EGUs) and Non-EGUs;
2. Area plus Non-Road Mobile Sources;
3. On-Road Mobile Sources that will be based on MOVES;
4. Oil and Gas Sources;
5. Fires Emissions including wildfire, prescribed burns and agricultural burning;
6. Fugitive Dust Sources;
7. Off-Shore Shipping Sources;
8. Ammonia Emissions;
9. Biogenic Emissions;
10. Eastern USA Emissions;
11. Mexico/Canada;
12. Sea Salt and Lightening Emissions; and
13. Emissions Modeling Parameters including spatial surrogates, temporal adjustment parameters and chemical (VOC and PM) speciation profiles.

This document forms part of WestJumpAQMS Emissions Technical Memorandum Number 4 series that discusses the methodology and results for the 2008 emissions for the oil and gas

(O&G) exploration and production source sector. Note that downstream oil and gas emissions (e.g., refining) will be addressed under the point and area source categories. The update of the 2008 O&G emissions will be performed under Task 1C of Phase I of the WestJumpAQMS. Details on the entire WestJumpAQMS are provided in the WestJumpAQMS Scope of Work[1] and Modeling Plan[2].

The O&G Emissions Technical Memoranda series are sub-divided into 5 separate documents of which this is the second. The 5 documents are shown below in Table 1. Because of the variation in activities and key data sources among the various states and regions in the WRAP Phase III analysis, it was determined that 5 separate memoranda would be generated to describe the development of the oil and gas projected 2008 emissions. This is discussed in more detail below.

Table 1. WestJumpAQMS O&G emissions technical memoranda.

Technical Memorandum	
4a: 2008 O&G Emissions for Colorado Basins (Denver-Julesburg, Piceance, and North San Juan)	
4b: 2008 O&G Emissions for the South San Juan (NM) and Uinta (UT) Basins	✓
4c: 2008 O&G Emissions for Wyoming Basins (Greater Green River, Powder River and Wind River)	
4d: 2008 O&G Emissions for the Permian Basin (NM and TX)	
4e: 2008 O&G Emissions for Other Areas	

Background

The WestJumpAQMS study will develop oil and gas emissions for 2008 for use in the regional photochemical ozone modeling. The O&G emissions will be developed in stages based on the geographic region and the type of information available to develop the inventories:

1. Projections to 2008 using the WRAP Phase III project inventories for the Rocky Mountain region including the Denver-Julesburg (D-J) Basin (CO), Piceance Basin (CO), Uinta Basin (UT), North San Juan Basin (CO), South San Juan Basin (NM), Wind River Basin (WY), Powder River Basin (WY), Greater Green River Basin (WY), and the Williston Basin (MT and ND, pending);
2. Development of an independent 2008 Permian Basin (NM and TX) O&G emission inventory; and
3. For remaining Basins, use states' 2008 NEI-reported O&G emission inventories.

WRAP Phase III Inventory Projections

The WRAP Phase III 2006 baseline O&G inventories represent the results of a multiyear effort and represent the most comprehensive and complete O&G inventory ever developed for the Rocky Mountain States[3]. Alternatives include the NEI inventory[4] that is incomplete and the WRAP Phase II O&G inventory[5] that is deficient in VOC emissions since it was designed to

[1] http://www.wrapair2.org/pdf/WestJumpAQMS_SoW_July20_2011revision.pdf
[2] http://www.wrapair2.org/pdf/WestJumpAQMS_Modeling_Plan_Sep30_2011v2.pdf
[3] http://www.wrapair2.org/PhaseIII.aspx
[4] http://www.epa.gov/ttnchie1/net/2005inventory.html
[5] http://wrapair.org/forums/ogwg/documents/2007-10_Phase_II_O&G_Final%29Report%28v10-07%20rev.s%29.pdf

support baseline regional haze planning. Thus, the WRAP Phase III O&G inventory represents the best data available for the Rocky Mountain States. These projections use 2008 production statistics as surrogates to scale emissions from the various source categories considered in Phase III. Reductions in the scaled emissions resulting from controls required by on-the-books federal and state regulations are also considered.

The 2008 updated inventories for the Phase III basins will be formatted identically to the baseline 2006 inventories generated for the Phase III study. The 2008 O&G emissions for the Phase III Basins will also be processed into the IDA format used by the SMOKE emissions modeling system. The O&G emissions will include information for both area and point sources. New 2008 spatial surrogate data will also be developed that will be used to spatially allocate the O&G area source emissions to the air quality model grid cells in the SMOKE emissions modeling.

2008 emissions inventory projections for the Phase III basins will be presented in Emissions Technical Memoranda 4a, 4b, and 4c, of which this is the second memorandum (4b). The WRAP Phase III inventory projections are split into separate memos to reflect where similar methodologies were used for groups of basins. The Colorado basins are grouped into a single memo since the methodology for these basins uses a comprehensive permitted sources data set developed by the CDPHE which reflects the low threshold for permitting emission sources (2 tpy of any criteria pollutant) throughout Colorado. In addition, Regulation 7 in Colorado requires regionally-specific analysis of the impacts of the elements of Regulation 7 on specific O&G sources. The Uinta Basin in Utah and South San Juan Basin in New Mexico are grouped because both states have similar emissions permitting thresholds and therefore both of these Phase III inventories were developed primarily using survey data for unpermitted point and area sources. No specific state regulations were identified for O&G sources in Utah and New Mexico that would impact the 2008 projections. The Wyoming Basins, including the Wind River, Powder River and Greater Green River (Southwest Wyoming) Basins, were similarly grouped because the methodology for developing these inventories relied on unique data sets available in Wyoming through the work of the Wyoming DEQ. These include a highly detailed permitted emissions database, a specialized inventory developed for the Jonah-Pinedale Anticline Development (JPAD) area, and engine emissions databases reflecting actual emissions gathered from Wyoming DEQ field offices for various parts of the state. In addition the projections for Wyoming account for a variety of state regulations impacting emissions from specific sources. These variations in the basins led to the grouping of the 2008 WestJump projections into memos 4a, 4b, and 4c in this series.

2008 Emission Inventory for the Permian Basin

O&G emissions for the Permian Basin are available from the NEI, but these data are much lower quality than the WRAP Phase III database. A study prepared by Applied EnviroSolutions, Inc. (AES) on 2007 O&G emissions in the New Mexico portion of the Permian Basin is also available that is of higher quality data. The AES data will be used to develop a comprehensive inventory of the Permian Basin including activities in Texas. The AES study was commissioned for the Bureau of Land Management (BLM) Carlsbad Field Office (CFO), and used a methodology developed by ENVIRON for the Central Regional Air Planning Association (CENRAP)[6]. The

[6] http://www.cenrap.org/html/presentations.php

preparation of the 2008 inventory for the Permian Basin will expand on the AES study, including both additional emissions estimates in the New Mexico portion of the basin and new emissions estimates for the Texas portion of the basin. The steps in developing the Permian Basin inventory will be described in Emissions Technical Memorandum 4d.

Remainder Basins – use States' 2008 NEI-reported O&G Emissions

Oil and gas emissions for states not covered by the WRAP Phase III and Permian Basin updates (i.e., states than New Mexico, Colorado, Utah, Wyoming, North Dakota and Montana and Basins not covered by Phase III in these 6 states) will be based on the 2008 NEI emissions inventory. In developing the 2008 NEI, EPA acquired O&G emissions for basins not covered by Phase III in the Inter-Mountain West from the WRAP Phase II inventory, emissions for Texas and Oklahoma from the two states' air agencies, and used California's submission directly. These represent the best O&G emissions data available for these states. Emissions inventories for the remaining states in the WestJump domain will be presented in Emissions Technical Memoranda 4e.

Off-Shore Oil and Gas Production Emissions

Within the WestJump modeling domains there are two main areas of off-shore oil and gas production where emissions are needed: (1) off the coast of California; and (2) within the Gulf of Mexico. Of these two, the Gulf of Mexico has by far much greater emissions. Off-shore oil and gas emissions off the coast of California are relatively close to shore and are included in the California inventories, like in the 2008 NEI. The Bureau of Ocean Energy Management (BOEM; formerly MMS) has released a draft version of 2008 oil and gas emissions in the Gulf Coast region. This inventory is superior and will replace the 2005 MMS inventory currently being used for PGM modeling. This inventory contain 2008 emissions estimate for both platform and non-platform oil and gas production emissions in the Gulf. The SMOKE modeling input files are currently under development, and will be available for use in the WestJump emissions modeling task. Emissions inventories for offshore O&G activities in the WestJump domain will also be presented in Emissions Technical Memoranda 4e.

Canada and Mexico

Canada's O&G emissions will be based on the 2006 emissions inventory developed by Environment Canada (EC) from the 2006 National Emissions Release Inventory (NPRI). The 2006 EC inventory is utilized rather than newer NPRI data (e.g., 2008) because it has been used in SMOKE emissions modeling and has added the numerous cross-reference fields to the emissions needed to support SMOKE emissions modeling. Note that higher quality O&G emissions are available for the Alberta oil sands region from Alberta Environment. However, these data are not publicly available and are far away from the western states in the most northern section of the WestJump 36 km modeling domain. For Mexico, a comprehensive emissions inventory was originally developed for the 1999 year. More recently this inventory has been projected to several future years (2008, 2012 and 2030). The O&G emissions in the 2008 Mexico emissions will be used for this study. Emissions inventories for O&G activities in Canada and Mexico in the WestJump domain will be presented in a technical memorandum for Canada/Mexico (item 11 in the WestJump emission sector list).

METHODOLOGY AND RESULTS FOR UINTA AND SOUTH SAN JUAN BASINS

Below we describe the results of the emissions inventory analysis for the second group of the WRAP Phase III Basins to be projected to 2008. These include the Uinta Basin in Utah, and the South San Juan Basin in New Mexico. These 2008 projected inventories were grouped due to the absence of state-specific regulations that would affect the inventory projections from 2006 to 2008 in both of these states. The general methodology for these two basins is presented first, followed by discussion and results for each basin separately. Where variations in the O&G operations and the type of data used in the projections were observed among these two basins, those variations are discussed for each basin.

In both the Uinta and South San Juan Basins the inventories were developed primarily using bottom-up inventory estimates for "unpermitted" sources. These were obtained in the Phase III project through detailed surveys sent to the oil and gas industry operators in each basin, with a high rate of return. The survey data was supplemented by permit data for very large sources, typically only Title V or Part 71 sources (for tribal land) which cover gas processing plants and compressor stations. Utah and New Mexico do not have a minor source permitting program that would provide data of sufficient quality for use in the Phase III inventories. Therefore permit data was used only for very large sources on state/fee land, or for large sources on tribal land where permit data was obtained from the EPA regional offices.

Methodology

The 2008 projected oil and gas inventories for the Uinta and South San Juan Basins were developed following 3 primary steps:

1. 2008 permitted point source data for large sources obtained from Utah Division of Air Quality (DAQ) and New Mexico Environment Department's Air Quality Bureau permit databases for sources on state/fee land, and from EPA Region 8 or Region 9 office for sources on tribal land;
2. 2008 production statistics data were derived using the IHS Global Insight database and ratios of the 2008 and 2006 production statistics were used to develop scaling factors and these were applied to the 2006 unpermitted area source inventory creating the "uncontrolled" 2008 projections for area sources;
3. Controls originating from state and federal regulations or natural turnover of equipment were modeled and applied to the uncontrolled 2008 area source emissions projections to develop the final 2008 area source emissions projections;
4. The final 2008 area source and point source inventories were combined to create complete O&G inventories for each basin.

These steps are described in more detail below. It should be noted that the exact process of implementing these steps differs for the two basins covered in this memorandum. The overall

methodology for generating these projections closely follows that used in the WRAP Phase III projects for the midterm projections[7,8].

Permitted Point Sources

In the 2006 baseline WRAP Phase III emission inventories for the Uinta Basin in Utah and the South San Juan Basin in New Mexico, data on permitted point sources was obtained directly from each state's air agency. The reporting threshold in Utah is 100 tpy potential-to-emit and in New Mexico is 25 tpy potential-to-emit for any criteria pollutant. New Mexico Air Quality Bureau staff indicated that minor sources are permitted in some cases but that the database of these sources was not recommended for use in the Phase III inventory because of the difficulty in determining the location of the source. Utah Division of Air Quality indicated that no minor source permit database was available for use in the Phase III inventory. Because of these thresholds in both states it was assumed that permit data would only provide emissions for very large sources such as gas processing plants and compressor stations.

Consistent with the WRAP Phase III 2006 emission inventory, the permitted sources databases in New Mexico and Utah were filtered for O&G point sources using a combination of SCCs and SICs. The SCCs and SICs for oil and gas sources are:

- all of the SCCs 202002*, 310*, 404003* (where * indicates all sub-SCCs for the SCC)
- and only those with the following SICs: 13*, 492*, 4612

This filtering of the permitted sources databases primarily captured gas processing plants, large compressor stations whose emissions exceeded permitting thresholds in each state, and additional sources such as tank batteries or lateral compression.

Both the Uinta Basin and South San Juan Basin include large portions of tribal land within the basins. Significant fractions of the basin-wide oil and gas production occur on tribal lands within these basins. In order to capture emissions from large sources located on tribal land, permit data was requested from the EPA Region 8 office and Region 9 office (for some Navajo Nation land). These Part 71 permits primarily included gas processing plants and some compressor stations.

Production Statistics and Scaling Factors for Area Sources

The 2008 production statistics for the Uinta and South San Juan Basins were derived from the IHS database, a commercial database that was used extensively in the WRAP Phase III work. The IHS database obtains well location, activity, status, production, and drilling data from state oil and gas conservation commissions (or their equivalent) in each state in the Intermountain West. The advantage of using the IHS database is that the data in the IHS database is of significantly higher quality than the raw wells and production data from the state agencies. Significant effort is placed on obtaining accurate well locations, gap-filling missing data fields, and updating data as it is reported. For these reasons the Phase III study chose to use the IHS database, and this was extended to the WestJump study.

[7] http://www.wrapair.org/forums/ogwg/documents/2009-03_12_Projection_Emissions_Uinta_Basin_Technical_Memo_03-25.pdf
[8] http://www.wrapair.org/forums/ogwg/documents/SSanJuanBasin/2009-12_12%20Projections_S_SanJuan_Basin_Technical_Memo_12-08R.pdf

Oil and gas related activity data for each basin were obtained from the IHS Enerdeq database queried via online interface. The IHS database uses data from the Utah Division of Oil, Gas and mining (DOGM) and the New Mexico Oil Conservation Division (OCD). Two types of data were queried from the Enerdeq database: production data and well data. Production data includes information relevant to producing wells while well data includes information relevant to drilling activity ("spuds") and completions.

Production data were obtained by county for each basin in the form of PowerTools input files. PowerTools is an IHS application which, given PowerTools inputs queried from an IHS database, analyzes, integrates, and summarizes production data in an ACCESS database. The input files for each basin were loaded into the PowerTools application. From the ACCESS database created by PowerTools for each basin, extractions of the following data relevant to the emissions inventory development were made:

1. 2008 active wells, i.e. wells that reported any oil or gas production in 2008.
2. 2008 oil, gas, and water production by well and by well type.

The production data are available by API number. The API number in the IHS database consists of 14 digits as follows:

- Digits 1 to 2: state identifier
- Digits 3 to 5: county identifier
- Digits 6 to 10: borehole identifier
- Digits 11 to 12: sidetracks
- Digits 13 to 14: event sequence code (recompletions)

Based on the expectation that the first 10 digits, which include geographic and borehole identifiers, would predict unique sets of well head equipment, the unique wells were identified by the first 10 digits of the API number.

Well data were also obtained from the IHS Enerdeq database for all counties in each basin in the form of "297" well data. The "297" well data contain information regarding spuds and completions. The "297"well data were processed with a PERL script to arrive at a database of by-API-number, spud and completion dates with latitude and longitude information. Drilling events in 2008 were identified by indication that the spud occurred within 2008. If the well API number indicated the well was a recompletion, it was not counted as a drilling event, though if the API number indicated the well was a sidetrack, it was counted as a drilling event.

A summary of the production statistics in 2006 and 2008 for the Uinta and South San Juan Basins in Utah and New Mexico are presented in Table 2. It should be noted that these are overall summary statistics, more detailed breakdown on the type of gas well (CBM vs. conventional) or type of gas and oil production are used in the scaling factors. The detailed oil and gas production statistics are available as part of the summary emissions spreadsheets that accompany each basin inventory.

Table 2. Comparison of 2006 and 2008 O&G production statistics for the Uinta and South San Juan Basins.

	Uinta Basin		South San Juan Basin	
	2006	2008	2006	2008
Gas Production (mcf)	331,844,336	415,443,288	1,020,014,851	951,832,297
Condensate Production (bbl)	1,769,874	3,292,757	1,634,751	1,592,623
Oil Production (bbl)	9,758,247	12,165,460	1,002,060	957,056
Well Count	6,881	8,405	20,649	21,776
Spud Count	1,069	1,149	919	585

Ratios of the production statistics in 2008 to those in 2006 were generated to create activity scaling factors that were applied to all source categories in the 2006 baseline emissions. The mapping of the source category to the production statistic surrogate was described in detail in the WRAP Phase III project.

Scaling factors for the various production statistics in the Uinta and South San Juan Basins are presented below in Tables 3, and 4. As noted above, significant production occurs on Indian Tribal land in both the South San Juan and Uinta Basins. Sources on Indian Tribal land are assumed to be subject to federal regulations but not state regulations, and therefore are projected separately to account for this difference. Tables 3 and 4 show the scaling factors for tribal and nontribal land separately. Although the scaling factors are presented by county, the methodology used was to scale the 2006 baseline Phase III inventories by the basin-wide scaling factors, and then develop county-level emissions by using the 2008 county production, well count and spud count fractions.

Table 3. 2006 to 2008 activity scaling factors for the Uinta Basin in Utah.

County	Conv. Gas Prod	Conv. Gas Well Count	Conv. Oil Well Count	CBM Gas Production	CBM Well Count	Spuds	Gas Well Condensate Production	Oil Well Oil Production	Total Gas Production	Total Well Count	Total Oil Production
Carbon (Nontribal)	2.22	2.14	1.00	0.87	1.03	2.02	1.29	0.97	1.16	1.16	1.29
Duchesne (Nontribal)	1.23	1.44	1.23	0.00	0.00	1.06	1.80	1.59	1.23	1.24	1.60
Emery (Nontribal)	2.61	1.42	0.88	0.93	0.98	1.04	0.00	1.73	1.03	1.05	1.64
Grand (Nontribal)	0.90	0.99	1.20	0.00	0.00	1.07	1.85	1.94	0.90	1.02	1.93
Uintah (Nontribal)[a]	1.26	No activity in 2006	1.17	0.00	0.00	5.50	No activity in 2006	1.38	1.26	1.18	1.39
Total Nontribal	1.68	1.26	1.22	0.89	1.02	1.34	1.72	1.56	1.13	1.15	1.57
Carbon (Tribal)	0.89	1.60	0.00	0.00	0.00	0.00	0.23	0.00	0.86	1.60	0.23
Duchesne (Tribal)	1.14	2.00	1.19	0.00	0.00	0.77	3.65	1.09	1.14	1.20	1.10
Emery (Tribal)[b]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Grand (Tribal)[b]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uintah (Tribal)	1.34	1.30	1.10	0.63	1.00	1.06	1.87	0.98	1.33	1.27	1.30
Total Tribal	1.32	1.30	1.15	0.63	1.00	1.00	1.88	1.04	1.31	1.25	1.21

a – increases in conventional gas production on non-tribal land in Uintah County are from associated gas produced from oil wells

b – there is no activity on tribal land in Emery and Grand Counties in 2006 and 2008

Table 4. 2006 to 2008 activity scaling factors for the South San Juan Basin in New Mexico.

County	Conv. Gas Prod	Conv. Well Count	CBM Gas Production	CBM Well Count	Spuds	Gas Well Condensate Production	Oil Well Oil Production	Total Gas Production	Total Well Count	Total Oil Production
McKinley (Nontribal)	1.08	1.84	1.45	1.50	1.00	0.00	5.80	1.34	1.81	5.80
Rio Arriba (Nontribal)	0.98	1.06	0.94	1.08	0.72	0.97	0.93	0.97	1.06	0.96
Sandoval (Nontribal)	1.04	0.97	22.84	15.00	0.81	8.02	0.88	1.19	1.07	0.97
San Juan (Nontribal)	0.94	1.03	0.89	1.14	0.59	0.97	0.90	0.91	1.06	0.95
McKinley (Tribal)[a]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Rio Arriba (Tribal)	0.94	0.98	0.78	0.90	0.46	0.88	0.77	0.94	0.98	0.81
Sandoval (Tribal)	0.88	0.91	0.00	0.00	0.00	0.81	1.98	0.88	0.91	1.81
San Juan (Tribal)	1.24	1.11	0.88	1.13	1.75	2.06	1.19	1.18	1.11	1.34
Basin-Wide	**0.96**	**1.04**	**0.91**	**1.13**	**0.64**	**0.97**	**0.96**	**0.93**	**1.05**	**0.97**

a – there is no activity on tribal land in McKinley County in 2006 and 2008

Controls Analysis

Following the development of the 2008 production statistics and scaling factors from 2006 to 2008, the scaling factors were applied to the 2006 baseline inventories to generate 2008 "uncontrolled" emission inventories. The uncontrolled inventories were then modified to include any controls on emissions resulting from on-the-books federal or state regulations. Given the short period between 2006 and 2008, natural turnover of equipment (such as for the drilling rig fleet or compressor engine inventory) was not considered. A summary of the controls due to federal/state regulations and their application to the Uinta and South San Juan Basins is shown below in Table 5:

Table 5. Summary of regulatory controls and their implementation for the 2008 projections of the Uinta and South San Juan Basins.

Basin	Source Category	Regulation	Enforcing Agency	Effective Date	Proposed Implementation in the 2008 Emissions Projections
Uinta	Drill Rigs	Nonroad engine Tier standards (1-4)	US EPA	Phase in from 1996 - 2014	None – turnover of drill rig engines is considered too slow to be affected by Tier standards.
Uinta	Workover Rigs	Nonroad engine Tier standards (1-4)	US EPA	Phase in from 1996 - 2014	None – turnover of drill rig engines is considered too slow to be affected by Tier standards.
Uinta	Stationary Engines	New Source Performance Stds. (NSPS)	US EPA	Phase in beginning 2006	Emission factors evaluated for 2006 base year and compared to NSPS requirements – adjustments made for any growth in gas production such that emission factors meet NSPS requirements
South San Juan	Drill Rigs	Nonroad engine Tier standards (1-4)	US EPA	Phase in from 1996 - 2014	None – turnover of drill rig engines is considered too slow to be affected by Tier standards.
South San Juan	Workover Rigs	Nonroad engine Tier standards (1-4)	US EPA	Phase in from 1996 - 2014	None – turnover of drill rig engines is considered too slow to be affected by Tier standards.
South San Juan	Stationary Engines	New Source Performance Stds. (NSPS)	US EPA	Phase in beginning 2006	Emission factors evaluated for 2006 base year and compared to NSPS requirements – adjustments made for any growth in gas production such that emission factors meet NSPS requirements
South San Juan	Stationary Sources	BLM Farmington RMP[a]	US BLM	Phase in beginning 2005	Farmington RMP – all compressor engines in the 15-300 hp range within the Farmington RMP boundaries must meet a 2 g/bhp-hr NOx emission standard

a – both the requirements of the Farmington RMP and NSPS requirements were implemented in the South San Juan Basin depending on the location of the production

As noted in Table 5, natural turnover of equipment in the drilling rig and workover rig fleets was considered too slow to have a measurable impact on emissions from these sources categories in the two-year time frame between 2006 and 2008. Thus no controls assumptions were implemented for these two source categories. With respect to controls requirements on

engines arising from the federal NSPS (or Farmington RMP for the South San Juan Basin), these controls were applied only to the increase in compressor emissions resulting from increases in gas production between 2006 and 2008. Existing engines in 2006 were not assumed to turn over in the two-year period, only increases in gas production were assumed to trigger increases in compression horsepower requirements (i.e. new compressor engines) which would meet the controls requirements. This assumption applied both to the Uinta Basin and to the portion of the South San Juan Basin outside of the boundaries of the Bureau of Land Management's (BLM) Farmington Resource Management Plan (RMP).

Within the area of the Farmington RMP both the NSPS requirements and the compressor NOx emission standards requirements of the Farmington RMP were applied, depending on which was more stringent. These controls were applied only to the grown portion of compressor emissions between 2006 and 2008. The boundaries of the Farmington RMP were provided by the BLM Farmington Field Office and Geographic Information Systems (GIS) analysis was used to determine the fraction of activity represented by the area within the Farmington RMP.

Gas Composition Analysis

The analysis of vented, fugitive, and tank emissions sources uses gas composition data collected as part of the 2006 survey and data gathering process for the Phase III inventories for the Uinta and South San Juan basins. No updates were made to the speciation profiles assigned to the oil and gas source categories for the 2008 WestJump inventory. These speciation profiles, including standard speciation profiles applied to combustion sources, are summarized in Memo 13 of the WestJump AQMS.

Uinta Basin – Observations and Results

No state-specific regulations were identified in Utah that would impact oil and gas sources. The only controls arising from regulations that impacted the inventory were federal Tier standards and the NSPS requirements. Thus the 2008 VOC emissions projections for the Uinta Basin largely track any increases or decreases in activity.

It is noted that in the Uinta Basin there were counties for which no oil and gas activity in particular surrogates was identified in 2006, but for which new activity in those surrogates was identified in 2008 (for example, new CBM gas production areas in 2008 where no CBM gas production was occurring in 2006). It was therefore not feasible to develop scaling factors by county and by tribal and non-tribal land as this would result in dividing 2008 activity by zero in certain cases. It was therefore necessary to use a different method to forecast 2006 emissions to 2008 for the Uinta Basin.

For each source category, total basin-wide tribal airshed emissions were forecasted to 2008 based on the ratio of 2008 activity within the tribal airshed to 2006 activity within the tribal airshed for the surrogate. The forecasted 2008 tribal airshed total emissions were then disaggregated to each county based on the fraction of tribal airshed activity in each county for the associated surrogate. Non-tribal emissions were forecasted from 2006 to 2008 similarly to tribal emissions.

Results

The 2008 projected O&G emissions for the Uinta Basin are shown below in a series of tables and graphs summarizing the quantitative results by source category, by county and by pollutant. Table 6 below provides an overall summary of the Uinta Basin emissions on a basin-wide level with comparison to the 2006 inventory. Table 6 shows that NOx emissions have increased between 2006 and 2008, which reflects a combination of approximately 30% growth in gas production and well counts and a modest growth of approximately 7% in spud counts, but also increasing control of compressor engines from federal NSPS requirements. VOC emissions increase substantially from 2006 to 2008, largely tracking the growth in both gas production and in oil and condensate production. Condensate production has increased substantially in the period 2006 to 2008 but does not represent the majority of liquid hydrocarbon production in the basin, which is dominated by primary oil production. No state regulatory controls on VOC emission sources were identified.

Table 6. Comparison of overall 2008 WestJump Inventory for the Uinta Basin with 2006 WRAP Phase III Inventory[9].

	NOx [tpy]	VOC [tpy]	CO [tpy]	PM [tpy]	SOx [tpy]
2008 WestJump	15,508	97,302	11,569	716	431
2006 Phase III	13,093	71,546	8,727	623	396
% Change	+18.4%	+36.0%	+32.6%	+14.9%	+8.9%

Tables 7, 8 and 9 below show the 2008 O&G emissions in the Uinta Basin by-county and by-source-category respectively (for NOx and VOC emissions only). Figures 1 and 2 show the breakdown of the 2008 NOx and VOC emissions for the Uinta Basin by source category. Figures 3 and 4 show the breakdown of the 2008 NOx and VOC emissions by tribal and non-tribal emissions.

Emissions from O&G activities in the Uinta Basin are concentrated in Duchesne and Uintah Counties, with additional activity in Carbon, Emery and Grand Counties. Duchesne and Uintah Counties account for approximately 84% of NOx emissions and 74% of VOC emissions. These findings are similar to that of the Phase III 2006 baseline inventory for the Uinta Basin although there has been growth in VOC emissions in Carbon and Grand Counties in the period 2006 to 2008. NOx emissions are made up of a combination of well-head and large permitted compressor engines (37%), drill rigs (33%) and artificial lift engines in oil fields (17%), which combined account for approximately 87% of the total basin-wide NOx emissions in 2008. This is consistent with the findings of the Phase III 2006 baseline inventory for the Uinta Basin, although there have been small increases in the NOx contribution from compressor engines relative to those from drilling. The growth in gas production and number of active gas wells is greater than the growth in spuds between 2006 and 2008. Despite large increases in gas production and gas well count, the requirement of new engines to meet NSPS reduces the impact that this increase has on the NOx emissions from compression.

[9] WRAP Phase III technical memorandum for the 2006 baseline emissions for the Uinta Basin: http://www.wrapair.org/forums/ogwg/documents/2009-03_06_Baseline_Emissions_Uinta_Basin_Technical_Memo_03-25.pdf

VOC emissions are made up of a combination of pneumatic device emissions, condensate and oil tank flashing and venting, dehydrator venting, and pneumatic pump emissions which combined account for approximately 88% of basin-wide VOC emissions in 2008. This is consistent with the findings of the Phase III 2006 baseline inventory, although it is noted that condensate tank flashing has increased in significance as a source category. This is due to the large increase in gas well condensate production between 2006 and 2008 (+86%).

It is also noted that midstream companies, which have not historically participated at a high rate in the Phase III project, did not provide complete data on midstream sources (typically compressor stations) located on tribal land. Since there is no minor source permitting program on tribal land, and these sources were not reported through survey responses by midstream companies, NOx emissions from compressor stations may be underestimated on tribal land.

Table 7. Summary of the projected 2008 O&G Emissions by county in the Uinta Basin.

County	NOx [tons/yr]	VOC [tons/yr]	CO [tons/yr]	SOx [tons/yr]	PM [tons/yr]
Carbon	1,387	6,080	1,049	43	66
Duchesne	4,355	19,195	4,841	92	199
Emery	286	1,101	209	9	14
Grand	761	4,746	415	12	24
Uintah	8,720	66,182	5,055	275	412
Carbon (Tribal)	64	349	53	1	5
Duchesne (Tribal)	2,432	8,485	2,509	46	95
Emery (Tribal)	0	0	0	0	0
Grand (Tribal)	461	274	170	0	6
Uintah (Tribal)	8,444	64,558	4,696	271	398
Carbon (Nontribal)	1,323	5,730	996	42	62
Duchesne (Nontribal)	1,923	10,710	2,332	47	104
Emery (Nontribal)	286	1,101	209	9	14
Grand (Nontribal)	300	4,472	245	11	18
Uintah (Nontribal)	276	1,624	359	4	14
Totals	**15,508**	**97,303**	**11,569**	**431**	**716**

Table 8. NOx emissions by source category for the 2008 projected O&G emission inventory in the Uinta Basin.

County	Compressor Engines	Drill Rigs	Heaters	Workover Rigs	Miscellaneous Engines	Artificial Lift Engines	Glycol Dehydrator	Permitted Sources	Other Categories	Totals
Carbon	621	514	125	28	20	0	42	37	0	**1,387**
Duchesne	175	1,109	265	64	41	1,852	12	838	0	**4,355**
Emery	111	107	43	9	7	1	7	0	0	**286**
Grand	41	130	55	12	9	50	3	461	0	**761**
Uintah	1,773	3,277	752	199	116	802	121	1,679	1	**8,719**
Carbon (Tribal)	23	0	1	0	0	0	2	37	0	**64**
Duchesne (Tribal)	98	541	133	35	21	759	7	838	0	**2,432**
Emery (Tribal)	0	0	0	0	0	0	0	0	0	**0**
Grand (Tribal)	0	0	0	0	0	0	0	461	0	**461**
Uintah (Tribal)	1,767	3,228	739	196	114	600	121	1,679	1	**8,443**
Carbon (Nontribal)	597	514	124	27	19	0	40	0	0	**1,323**
Duchesne (Nontribal)	77	568	132	29	20	1,092	5	0	0	**1,923**
Emery (Nontribal)	111	107	43	9	7	1	7	0	0	**286**
Grand (Nontribal)	41	130	55	12	9	50	3	0	0	**300**
Uintah (Nontribal)	6	49	14	3	2	202	0	0	0	**276**
Totals	**2,720**	**5,136**	**1,241**	**313**	**192**	**2,704**	**185**	**3,015**	**1**	**15,507**

Table 9. VOC emissions by source category for the 2008 projected O&G emission inventory in the Uinta Basin.

County	Pneumatic Devices	Pneumatic Pumps	Venting – Blowdowns	Venting - Initial Completion	Venting - Recompletion	Unpermitted Fugitives	Artificial Lift Engines	Compressor Startup/ Shutdown	Glycol Dehydrator	Condensate Tanks	Oil Tanks	Permitted Sources	Truck Loading	Other Categories	Totals
Carbon	1,352	722	48	8	1	68	0	265	3,231	172	0	4	4	204	**6,080**
Duchesne	249	141	30	42	6	566	574	166	2,001	1,093	12,277	1,035	847	169	**19,195**
Emery	491	264	4	2	0	26	0	20	245	0	10	0	1	40	**1,101**
Grand	2,160	1,222	7	2	0	118	15	38	465	59	333	274	24	27	**4,746**
Uintah	15,004	8,491	308	194	30	1,607	248	1,694	20,469	10,201	5,278	1,299	563	797	**66,182**
Carbon (Tribal)	28	16	4	0	0	3	0	22	263	5	0	4	0	6	**349**
Duchesne (Tribal)	71	40	17	32	5	285	235	93	1,119	124	5,005	1,035	339	86	**8,485**
Emery (Tribal)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Grand (Tribal)	0	0	0	0	0	0	0	0	0	0	0	274	0	0	**274**
Uintah (Tribal)	14,997	8,487	307	193	30	1,578	185	1,689	20,404	10,188	3,939	1,299	473	790	**64,558**
Carbon (Nontribal)	1,323	706	44	8	1	66	0	243	2,968	167	0	0	3	198	**5,730**
Duchesne (Nontribal)	178	101	13	9	1	281	339	73	882	969	7,272	0	508	83	**10,710**
Emery (Nontribal)	491	264	4	2	0	26	0	20	245	0	10	0	1	40	**1,101**
Grand (Nontribal)	2,160	1,222	7	2	0	118	15	38	465	59	333	0	24	27	**4,472**
Uintah (Nontribal)	7	4	1	1	0	29	63	5	65	13	1,340	0	90	7	**1,624**
Totals	**19,255**	**10,841**	**396**	**248**	**38**	**2,386**	**837**	**2,182**	**26,410**	**11,525**	**17,898**	**2,612**	**1,438**	**1,237**	**97,303**

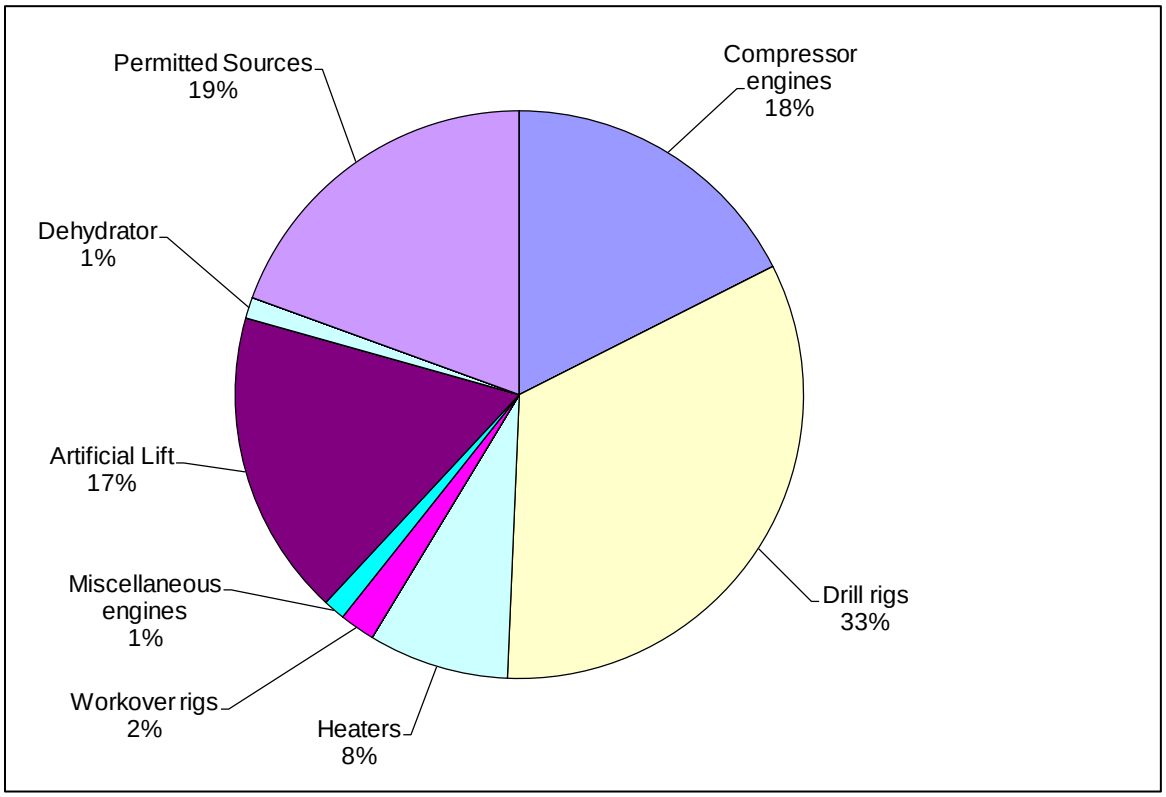

Figure 1. 2008 Uinta Basin projected NOx emissions by source category.

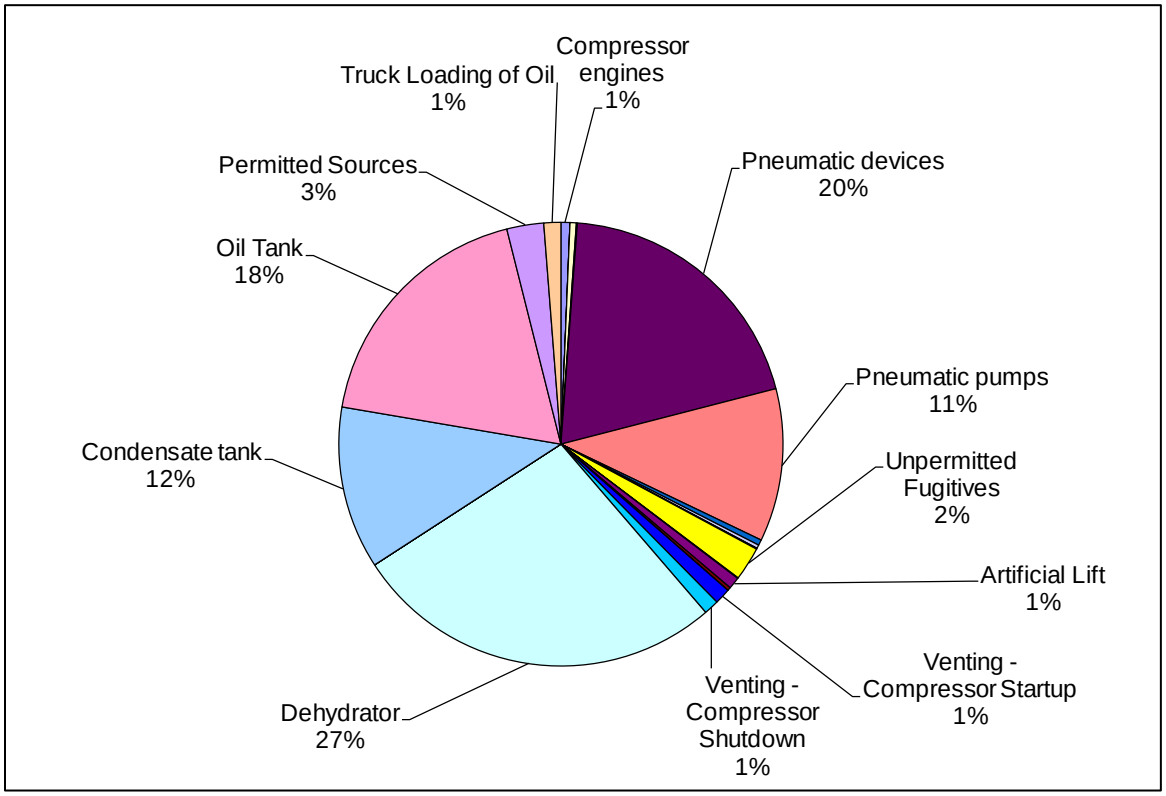

Figure 2. 2008 Uinta Basin projected VOC emissions by source category.

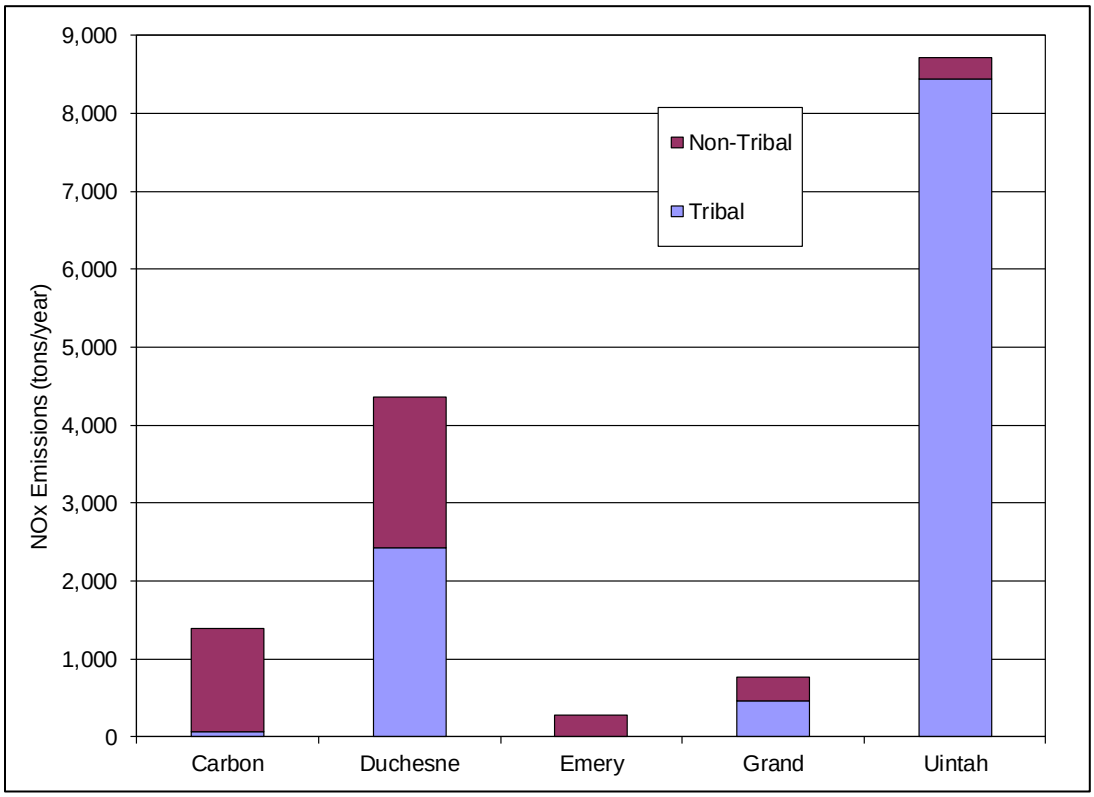

Figure 3. 2008 Uinta Basin projected NOx emissions by tribal vs. non-tribal land for each county.

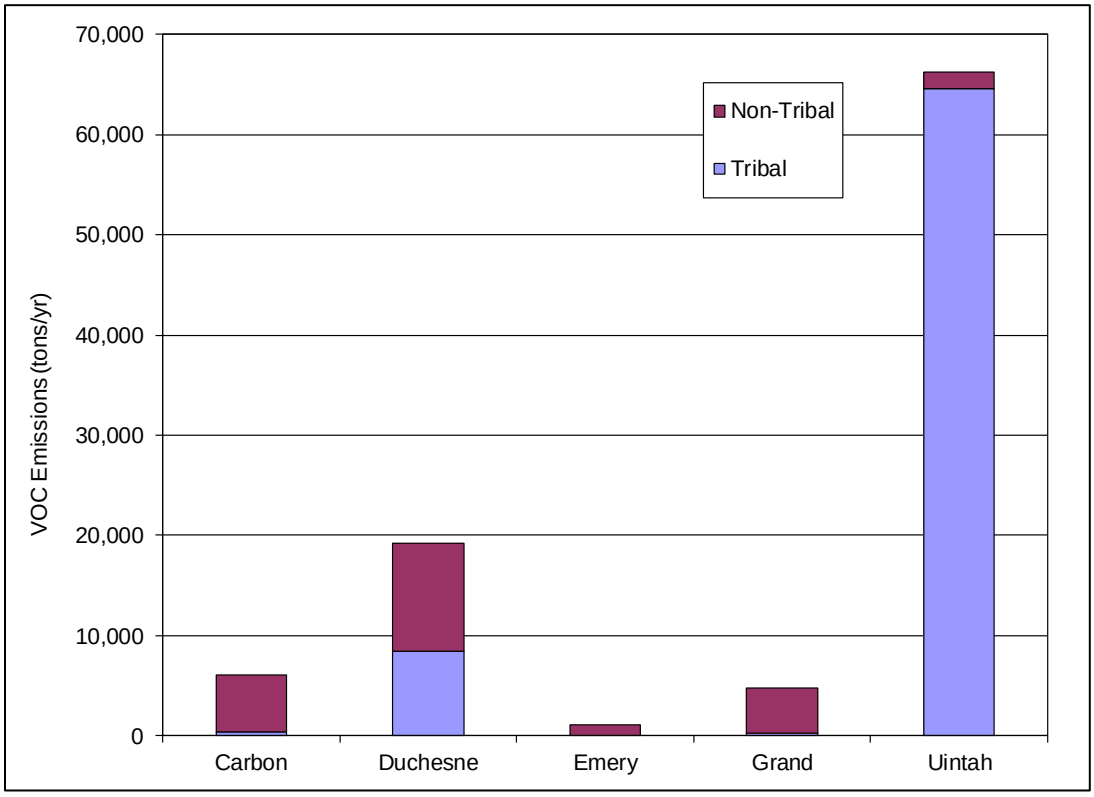

Figure 4. 2008 Uinta Basin projected VOC emissions by tribal vs. non-tribal land for each county.

South San Juan Basin – Observations and Results

No state-specific regulations were identified in New Mexico that would impact oil and gas sources within the time period of this 2008 projection, however there is a requirement developed as part of the BLM's Farmington RMP that compressor engines must meet NOx emission standards in development areas within the boundaries of the Farmington RMP. Thus the controls analysis for regulations impacting the inventory included the federal Tier standards for drilling rigs, the NSPS requirements, and the Farmington RMP requirements. No regulations were identified that would control 2008 VOC emissions projections for the San Juan Basin, and therefore these emissions largely track any increases or decreases in activity similar to the Uinta Basin. For the Farmington RMP, the engine emissions within the boundaries of the RMP were determined using GIS analysis and the projected NOx emissions growth controlled to reflect the engine NOx standard requirements of the Farmington RMP. As with the NSPS regulation analysis in other basins, only the grown portion of NOx emissions were controlled as it was conservatively assumed that no additional turnover in engines would occur in the short period between 2006 and 2008.

Unlike the Uinta Basin, no instances were identified in the South San Juan Basin in which county or tribal activity surrogates had zero values in 2006 and non-zero values in 2008. Therefore a more direct tribal and non-tribal projection method was used for the South San Juan Basin. For a given source category, by county and tribal designation 2006 emissions were forecasted to 2008 based on the ratio of 2008 activity in the given county for each tribal designation to 2006 activity in the given county for each tribal designation for the associated surrogate.

Results

The 2008 projected O&G emissions for the South San Juan Basin are shown below in a series of tables and graphs summarizing the quantitative results by source category, by county and by pollutant. Table 10 below provides an overall summary of the South San Juan Basin emissions on a basin-wide level with comparison to the 2006 inventory. Table 6 shows that NOx emissions have increased only very slightly between 2006 and 2008, which reflects a significant decrease in drilling activity of approximately 36% and a small increase in the total number of active wells of approximately 5%. Although well counts show a small increase during this period (5%), the NSPS and Farmington RMP engine requirements contributed to a small growth in compressor NOx emissions. VOC emissions decreased from 2006 to 2008, largely tracking the decrease in both gas production and in oil and condensate production. There are no regulatory controls identified for VOC sources.

Table 10. Comparison of overall 2008 WestJump Inventory for the South San Juan Basin with 2006 WRAP Phase III Inventory[10].

	NOx [tpy]	VOC [tpy]	CO [tpy]	PM [tpy]	SOx [tpy]
2008 WestJump	42,233	54,469	23,602	557	273
2006 Phase III	42,075	60,698	23,471	574	305
% Change	+0.4%	-10.3%	+0.6%	-2.9%	-10.5%

[10] WRAP Phase III technical memorandum for the 2006 baseline emissions for the South San Juan Basin: http://www.wrapair.org/forums/ogwg/documents/SSanJuanBasin/2009-11y_06_Baseline_S_San_JuanBasin_Technical_Memo_11-25R.pdf

Tables 11, 12 and 13 below show the 2008 O&G emissions in the South San Juan Basin by-county and by-source-category respectively (for NOx and VOC emissions only). Figures 5 and 6 show the breakdown of the 2008 NOx and VOC emissions for the South San Juan Basin by source category. Figures 7 and 8 show the breakdown of the 2008 NOx and VOC emissions by tribal and non-tribal emissions.

Emissions from O&G activities in the South San Juan Basin are still concentrated almost entirely in Rio Arriba and San Juan Counties, similar to the Phase III 2006 baseline inventory for the basin. NOx emissions are dominated by compressor engines, due to the high usage of wellhead compressors in the South San Juan Basin, as noted in the WRAP Phase III inventory[11]. Drilling activity has declined by approximately 36% between 2006 and 2008, and drilling rig emissions are a smaller portion of the total basin-wide NOx in 2008 as compared to 2006. Overall, little change is observed in the NOx emission inventory for the South San Juan Basin between 2006 and 2008, and the distribution of those emissions by source category.

VOC emissions are distributed among a number of source categories. The three largest source categories are venting from initial completions, venting from well blowdowns, and gas dehydration venting which together account for approximately 60% of basin-wide VOC emissions. Relative to the Phase III 2006 baseline inventory, venting from initial completions has decreased in 2008 consistent with the decrease in drilling activity. Additional VOC emissions source categories in 2008 are unpermitted (well site) fugitives and compressor engine combustion VOC emissions which total an additional 16% of basin-wide VOC emissions. Those findings are consistent with the Phase III 2006 baseline inventory. As noted above, no controls requirements were identified for VOC emission sources in the 2008 projection year.

It is also noted that midstream companies, which have not historically participated at a high rate in the Phase III project, did not provide complete data on midstream sources (typically compressor stations) located on tribal land. Since there is no minor source permitting program on tribal land, and these sources were not reported through survey responses by midstream companies, NOx emissions from compressor stations may be underestimated on tribal land.

[11] WRAP Phase III technical memorandum for the 2006 baseline emissions for the South San Juan Basin: http://www.wrapair.org/forums/ogwg/documents/SSanJuanBasin/2009-11y_06_Baseline_S_San_JuanBasin_Technical_Memo_11-25R.pdf

Table 11. Summary of the projected 2008 O&G Emissions by county in the South San Juan Basin.

County	NOx [tons/yr]	VOC [tons/yr]	CO [tons/yr]	SOx [tons/yr]	PM [tons/yr]
McKinley	892	166	207	1	7
Rio Arriba	13,554	24,531	8,492	62	156
Sandoval	27,497	29,134	14,654	207	390
San Juan	290	638	250	3	5
McKinley (Tribal)	834	4	152	1	5
Rio Arriba (Tribal)	1,598	4,418	1,197	13	24
Sandoval (Tribal)	652	1,270	390	5	6
San Juan (Tribal)	130	268	113	1	2
McKinley (Nontribal)	57	163	54	1	1
Rio Arriba (Nontribal)	11,956	20,113	7,295	49	131
Sandoval (Nontribal)	26,845	27,864	14,264	202	383
San Juan (Nontribal)	160	370	136	2	3
Totals	**42,233**	**54,469**	**23,602**	**273**	**557**

Table 12. NOx emissions by source category for the 2008 projected O&G emission inventory in the South San Juan Basin.

County	Compressor Engines	Drill Rigs	Heaters	Workover Rigs	Initial Completion Flaring	CBM Pump Engines	Artificial Lift Engines	Glycol Dehydrator	Other Categories	Totals
McKinley	835	1	4	5	1	2	42	0	2	**892**
Rio Arriba	11,404	199	329	359	55	279	729	5	195	**13,554**
Sandoval	31	12	12	13	1	55	153	0	12	**290**
San Juan	23,557	327	503	548	79	1,262	507	190	525	**27,497**
McKinley (Tribal)	834	0	0	0	0	0	0	0	0	**834**
Rio Arriba (Tribal)	1,124	20	73	80	9	0	262	1	27	**1,598**
Sandoval (Tribal)	18	0	6	7	0	0	97	0	2	**130**
San Juan (Tribal)	413	13	14	15	6	76	101	0	15	**652**
McKinley (Nontribal)	1	1	4	5	1	2	42	0	2	**57**
Rio Arriba (Nontribal)	10,280	179	256	279	46	279	466	4	167	**11,956**
Sandoval (Nontribal)	13	12	6	7	1	55	56	0	9	**160**
San Juan (Nontribal)	23,144	315	489	533	73	1,186	406	190	511	**26,845**
Totals	**35,826**	**540**	**849**	**924**	**136**	**1,598**	**1,431**	**195**	**733**	**42,233**

Table 13. VOC emissions by source category for the 2008 projected O&G emission inventory in the South San Juan Basin.

County	Compressor Engines	Pneumatic Devices	Pneumatic Pumps	Venting – Blowdowns	Venting - Initial Completion	Unpermitted Fugitives	Condensate Tanks	Oil Tanks	CBM Pump Engines	Permitted Tank Losses	Glycol Dehydrator	Other Categories	Totals
McKinley	4	10	1	0	48	25	0	68	3	0	0	6	**166**
Rio Arriba	1,555	705	63	6,047	4,044	1,847	1,822	1,182	373	796	5,254	842	**24,531**
Sandoval	2	29	3	30	106	75	21	249	74	0	25	24	**638**
San Juan	2,627	900	80	6,538	4,990	2,342	2,019	822	1,686	913	5,627	589	**29,134**
McKinley (Tribal)	4	0	0	0	0	0	0	0	0	0	0	0	**4**
Rio Arriba (Tribal)	185	179	16	927	765	469	319	425	0	207	839	86	**4,418**
Sandoval (Tribal)	1	15	1	16	0	39	11	158	0	0	14	14	**268**
San Juan (Tribal)	22	31	3	186	446	81	56	163	102	0	157	24	**1,270**
McKinley (Nontribal)	0	10	1	0	48	25	0	68	3	0	0	6	**163**
Rio Arriba (Nontribal)	1,371	527	47	5,119	3,279	1,377	1,503	756	373	589	4,415	756	**20,113**
Sandoval (Nontribal)	1	14	1	14	106	36	10	91	74	0	12	11	**370**
San Juan (Nontribal)	2,606	869	77	6,352	4,544	2,261	1,962	658	1,585	913	5,470	566	**27,864**
Totals	**4,189**	**1,643**	**147**	**12,615**	**9,189**	**4,289**	**3,862**	**2,321**	**2,136**	**1,709**	**10,907**	**1,462**	**54,469**

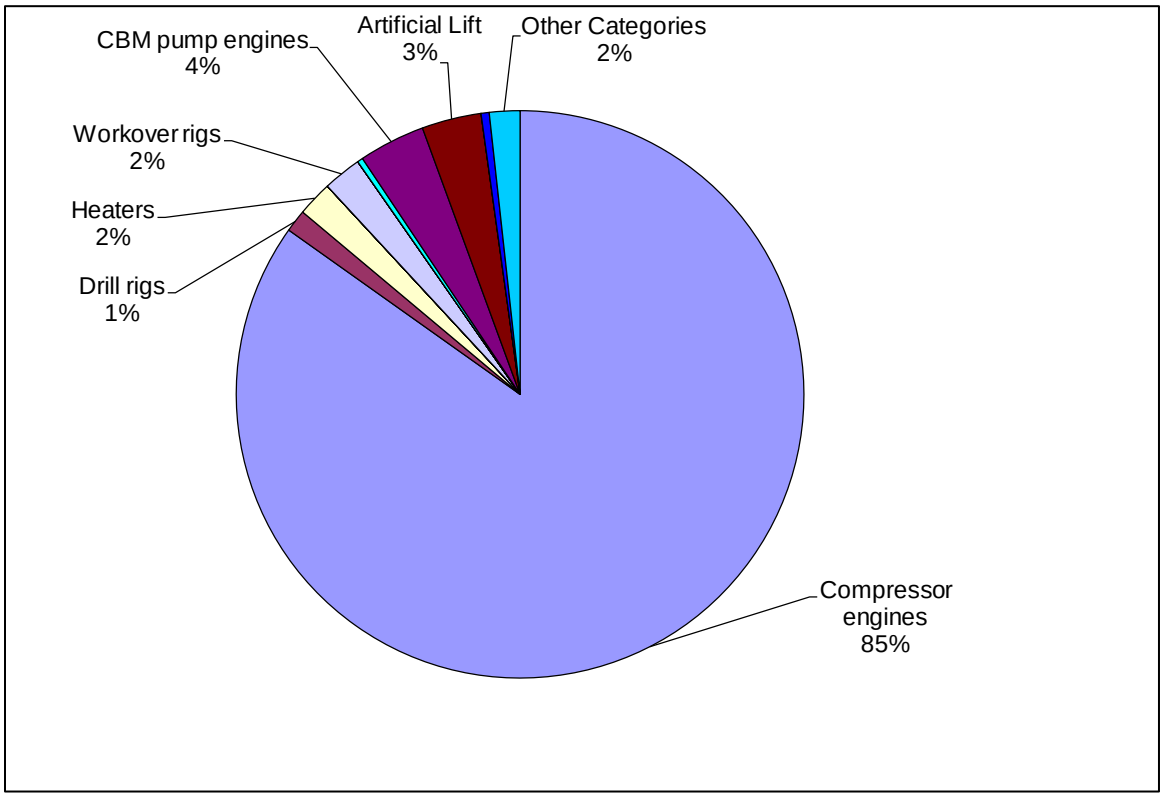

Figure 5. 2008 South San Juan Basin projected NOx emissions by source category.

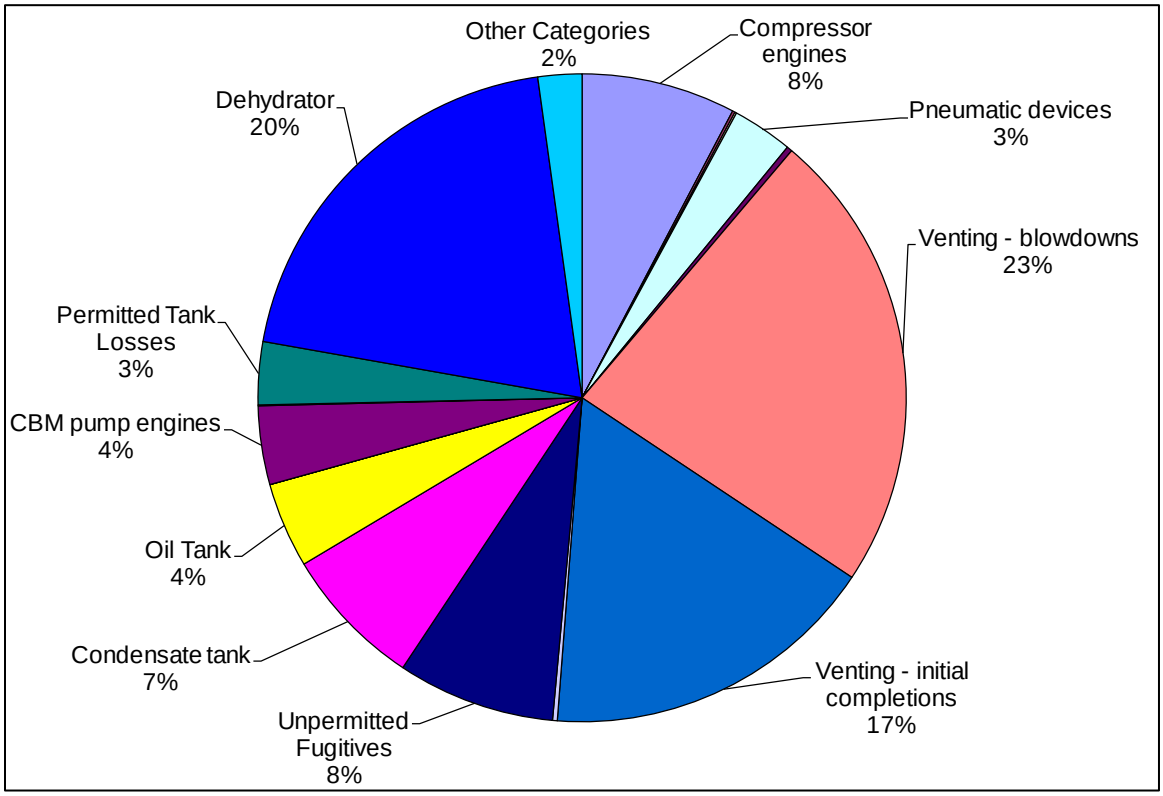

Figure 6. 2008 South San Juan Basin projected VOC emissions by source category.

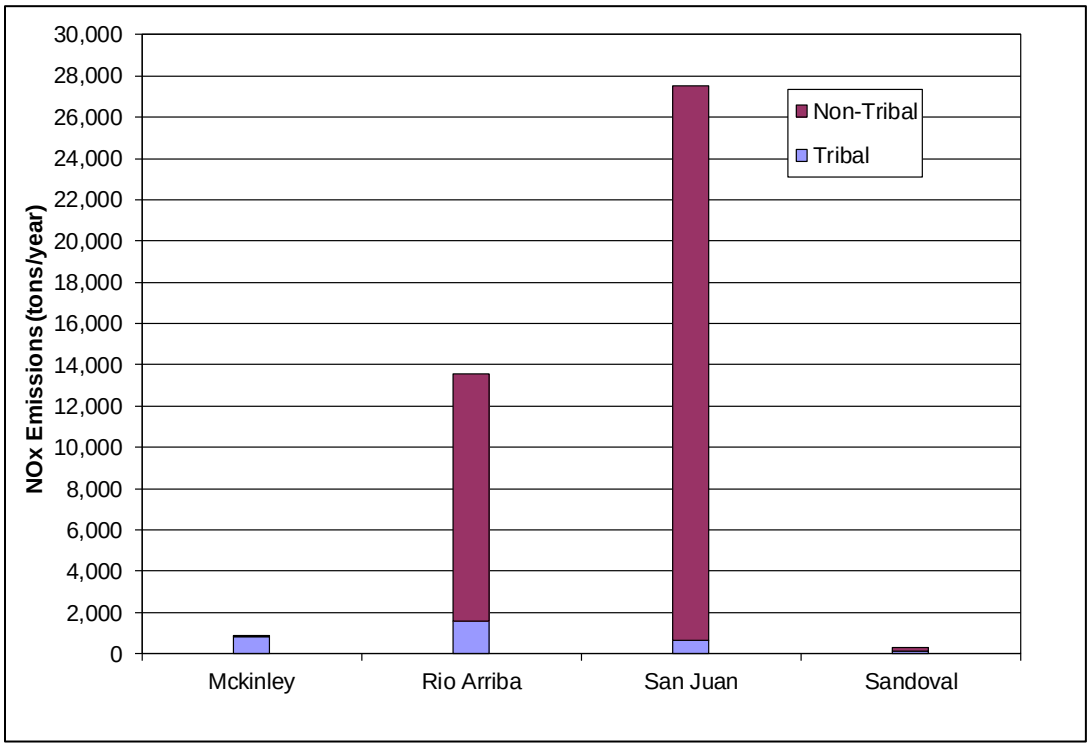

Figure 7. 2008 South San Juan Basin projected NOx emissions by tribal vs. non-tribal land for each county.

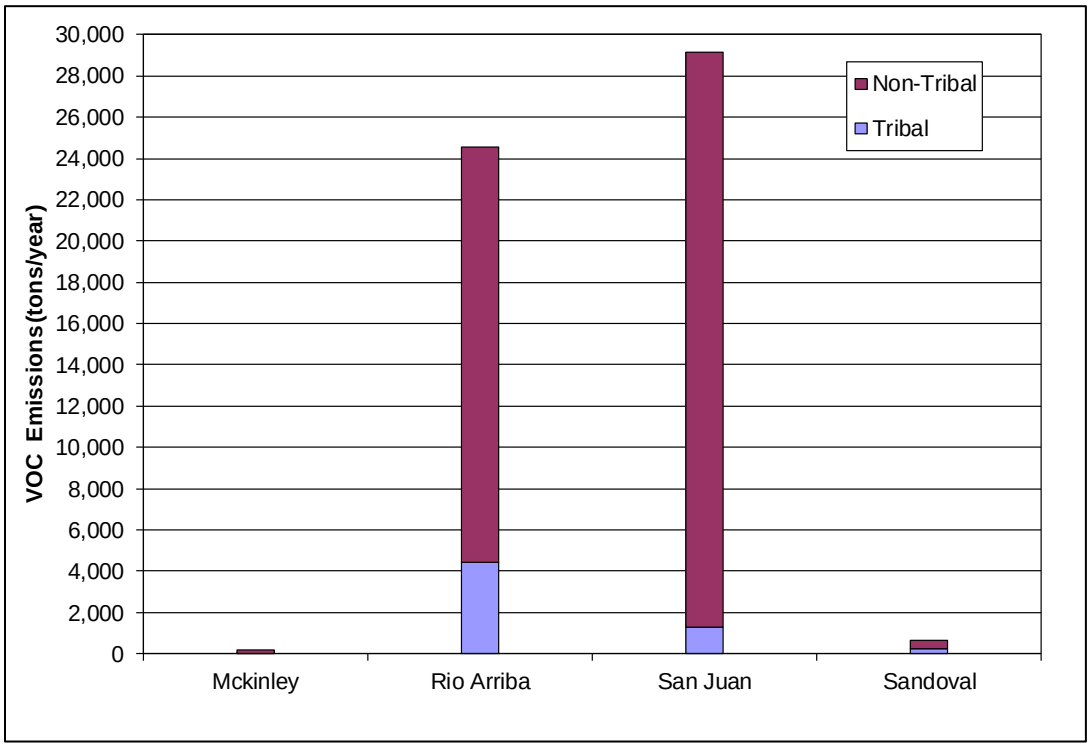

Figure 8. 2008 South San Juan Basin projected VOC emissions by tribal vs. non-tribal land for each county.

.

APPENDIX A

Detailed Emission Inventory Spreadsheets

Detailed Emission Inventory Spreadsheets

Detailed spreadsheets accompany the 2008 WestJump projected emission inventories for each basin. These spreadsheets contain greater detail on the emissions inventory including control factors, and more detailed breakdown of emissions by all source categories within a basin. The reader is referred to these accompanying spreadsheets for more quantitative information on the inventory results.