ENVIRON

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FINAL EMISSIONS TECHNICAL MEMORANDUM No. 4a

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

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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 first. 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 first memorandum (4a). 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. The 2008 NEI represents O&G area source emissions reported to the EPA for counties/states that are not part of the Phase III study or the Permian Basin inventory developed as part of the WestJump analysis. 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 COLORADO BASINS

Below we describe the results of the emissions inventory analysis for the first of the WRAP Phase III Basins to be projected to 2008. These include the Denver-Julesburg (D-J) Basin, the Piceance Basin, and the North San Juan Basin, all in Colorado. These 2008 projected inventories were prioritized due to the concurrent need for oil and gas inventories for the Denver area State Implementation Plan (SIP) ozone modeling. The general methodology for all Colorado 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 3 Colorado basins, those variations are discussed for each basin.

In the Colorado basins the inventories were developed using a combination of bottom-up inventory estimates for "unpermitted" sources, and data obtained from detailed Air Permit Emission Notices (APENs) issued by Colorado Department of Public Health and Environment (CDPHE) Air Quality Division. The threshold for issuing an APEN for a stationary source in Colorado is 2 tpy of any criteria pollutant, indicating that many sources are subject to these permit requirements. Because of this low permitting threshold, extensive data on sources are available through the CDPHE's APENs database, and special care was taken to analyze and incorporate this database in the inventory. The CDPHE developed a 2008 APENs database, and this was used directly for this study.

METHODOLOGY

The 2008 projected oil and gas inventories for the Colorado Basins were developed following 3 primary steps:

1. 2008 permitted point source data obtained directly from CDPHE APENs database;
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 each of the Colorado Basins. The overall methodology for generating these projections closely follows that used in the WRAP Phase III projects for the midterm projections[7,8,9].

[7] http://www.wrapair.org/forums/ogwg/documents/2008-04_%2710_Projection_Emissions_DJ_Basin_Technical_Memo%2804-30%29.pdf
[8] http://www.wrapair.org/forums/ogwg/documents/2009-01_12_Projection_Emissions_Piceance_Basin_Technical_Memo_01-21.pdf
[9] http://www.wrapair.org/forums/ogwg/documents/2009-01_12_Projection_Emissions_Piceance_Basin_Technical_Memo_01-21.pdf

Permitted Point Sources

In the 2006 baseline WRAP Phase III emission inventories for Colorado, data on permitted point sources was obtained directly from Air Permit Emission Notices (APENs) collected by the CDPHE. The reporting threshold in Colorado for a point source is 2 tpy of any criteria pollutant, and because of this low permitting threshold the database of emissions for permitted sources in the APENs was considered a highly comprehensive source of data. Unpermitted area sources were then estimated independently in the Phase III study using survey data, and covered only those source categories which were not expected to be part of the APENs database.

Instead of projecting the existing 2006 APENs database of point source emissions for the three Colorado Basins, a new set of actual 2008 APENs emissions data was obtained directly from the CDPHE for use in the WestJump AQMS. The new data set was obtained because rapid development in the Colorado basins suggests that new point sources may be present which would not be captured by projecting from the 2006 APENs database. In addition, CDPHE has been gathering annual data on actual emissions as part of the 2008 APENs data which reflect annual usage, controls or other revisions to the not-to-exceed emission levels. This provides a more accurate emissions inventory for these permitted point sources.

Consistent with the WRAP Phase III 2006 emission inventory, a subset of the complete 2008 APENs database was used representing oil and gas sources. The full 2008 APENs database was 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 APENs database allows for a direct comparison between the 2006 WRAP Phase III point source inventory and the 2008 WestJump inventory for the Colorado Basins.

Production Statistics and Scaling Factors for Area Sources

The 2008 production statistics for the Colorado 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.

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 Colorado Oil and Gas Conservation Commission (COGCC). 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 D-J, Piceance and North San Juan Basins in Colorado 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 Colorado Basins.

	D-J Basin		Piceance Basin		North San Juan Basin	
	2006	2008	2006	2008	2006	2008
Gas Production (mcf)	234,630,779	266,919,382	421,358,666	659,065,078	443,828,500	432,276,612
Condensate Production (bbl)	14,242,088	19,363,429	1,403,229	2,360,392	4,567	7,971
Oil Production (bbl)	NA[a]	NA[a]	5,755,076	5,424,924	27,962	31,491
Well Count	16,774	20,054	6,315	9,300	2,676	2,969
Spud Count	1,500	1,777	1,186	2,121	127	226

a – all liquid hydrocarbon production in the D-J Basin is assumed to be condensate

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 D-J, Piceance and North San Juan Basins in Colorado are presented below in Tables 3, 4 and 5. It should be noted that in the North San Juan Basin, significant production occurs on Indian Tribal land in Archuleta and La Plata Counties. 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. Table 4 shows 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 Denver-Julesburg (D-J) Basin in Colorado.

County	Gas Production	Oil Production	Well Count	Spud Count
Adams	1.078	1.022	1.003	1.857
Arapahoe	0.945	1.024	1.019	0.333
Boulder	1.544	1.774	1.177	2.778
Broomfield	1.281	1.455	1.052	No spuds in 2006
Denver	2.245	1.630	1.265	0.714
Elbert	1.063	0.988	1.117	0.000
Fremont	0.000	0.689	1.162	2.500
Kit Carson	0.481	0.659	0.917	6.500
Larimer	1.697	0.998	1.081	No spuds in 2006
Lincoln	0.813	1.596	1.250	15.000
Logan	1.072	0.956	1.036	0.444
Morgan	0.610	1.082	0.879	1.000
Phillips	3.154	0.000	3.526	6.000
Sedgwick	1.172	0.686	2.333	0.000
Washington	0.652	0.896	0.921	0.435
Weld	1.109	1.408	1.206	1.497
Yuma	1.265	No Oil Production in 2006	1.275	0.605
Basin-wide	**1.138**	**1.360**	**1.196**	**1.185**

Table 4. 2006 to 2008 activity scaling factors for the Piceance Basin in Colorado.

County	Conv. Gas Production	Conv. Gas Well Count	Conv. Oil Well Count	Spuds	Gas Well Condensate Production	Oil Well Oil Production	Total Gas Production	Total Well Count	Total Oil Production
Delta	0.08	0.17	1.00	0.00	0.11	1.00	0.32	0.29	0.11
Garfield	1.61	1.64	1.00	1.89	1.61	1.00	1.61	1.64	1.61
Gunnison	2.38	0.73	1.00	0.14	0.86	1.00	2.45	0.91	0.86
Mesa	2.71	2.11	2.00	1.55	3.46	1.06	2.68	2.05	3.40
Moffat	1.02	1.08	1.04	0.44	1.77	0.88	1.03	1.11	1.11
Rio Blanco	1.08	1.09	1.02	2.11	1.78	0.95	1.08	1.08	0.98
Routt	1.39	1.50	1.00	0.00	0.85	0.68	2.25	1.08	0.69
Pitkin*	1.56	1.52	1.02	1.79	1.68	0.94	1.56	1.47	1.09
Basin-wide	**1.56**	**1.52**	**1.02**	**1.79**	**1.68**	**0.94**	**1.56**	**1.47**	**1.09**

* No O&G production activity occurs in Pitkin County; however storage and production facilities are located in this county and basin-wide scaling factors are used for these sources in Pitkin County.

Table 5. 2006 to 2008 activity scaling factors for the North San Juan Basin in Colorado.

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
Archuleta (Nontribal)	No Conventional Gas Wells in 2006	2.00	0.00	0.00	No Spuds in 2006	1.00	0.62	0.65	1.00	0.62
La Plata (Nontribal)	0.09	0.83	0.90	1.07	7.00	1.00	1.00	0.90	1.06	1.00
Total Nontribal	2.08	1.36	0.89	1.05	9.00	1.00	0.62	0.90	1.06	0.62
Archuleta (Tribal)	No Conventional Gas Wells in 2006	No Conventional Wells in 2006	0.00	0.00	1.42	1.00	1.00	2.00	1.36	1.00
La Plata (Tribal)	0.94	1.04	0.98	1.17	1.63	1.75	1.17	0.98	1.11	1.26
Total Tribal	1.17	1.09	0.97	1.14	1.60	1.75	1.17	0.99	1.12	1.26

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 Colorado basins is shown below in Table 6:

Table 6. Summary of regulatory controls and their implementation for the 2008 projections of Colorado Basins.

Source Category	Regulation	Enforcing Agency	Effective Date	Proposed Implementation in the 2008 Colorado Basin Emissions Projections[a]
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.
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.
All New Nonroad Engines	New Source Performance Stds. (NSPS)	US EPA	Phase in beginning 2006	Permitted Emissions from APENs
Natural Gas Engines	Regulation 7[b]	CDPHE	Phase in from 2007 - 2011	Permitted Emissions from APENs
Glycol Dehydrators	Regulation 7[b]	CDPHE	May 2008	Permitted Emissions from APENs
Condensate Tanks	Regulation 7[b]	CDPHE	May 2008	Permitted Emissions from APENs
Pneumatic Devices	Regulation 7[b]	CDPHE	Feb. 2009	None – effective date of the regulation is after 2008

a – Implementation of the regulatory controls differs in the Indian tribal land portions of the North San Juan Basin as described in further detail below;
b – Information about the State of Colorado's Regulation 7 concerning oil and gas emissions sources can be found at (*http://www.cdphe.state.co.us/ap/oilgas.html*).

As noted in Table 6, 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 and Colorado state Regulation 7, it was assumed that all engines subject to these requirements would be part of the 2008 APENs database on permitted sources and thus not part of the area source inventory. There are smaller engines in the WRAP Phase III inventories under area sources as "miscellaneous engines" but NSPS and Regulation 7 requirements were not assumed to apply to these sources. Miscellaneous engines include portable engines which may not be subject to the NSPS requirements or not operate on natural gas fuel. It should also be noted that – consistent with the WRAP Phase III methodology for midterm projected emissions – if gas production is expected to decline between 2006 and 2008

no NSPS controls are applied to engine emissions since it is assumed that the existing engine infrastructure is sufficient to handle the lower level of gas production.

Regulation 7 requirements for VOC emissions sources including dehydrators and tanks were similarly assumed to be reflected in the 2008 APENs database for these permitted sources. For small condensate tanks which were assumed to be below the reporting threshold in Colorado, Regulation 7 requirements were not applied. The Regulation 7 requirement for installation of low-bleed pneumatic devices was not effective by the end of the 2008 calendar year, and thus not applied to these projections.

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 Colorado 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.

DENVER-JULESBURG (D-J) BASIN – OBSERVATIONS AND RESULTS

For the 2008 WestJump inventory for the D-J Basin, the previous 2006 point source data was wholly replaced with the 2008 APENs data provided directly by CDPHE. The 2008 APENs data has been evaluated and prepared by CDPHE for the concurrent Ozone State Implementation Plan (SIP) analysis for the Denver metropolitan area. Because significant effort has already been taken to prepare a detailed point source inventory for 2008 using the APENs database, ENVIRON used this data in place of projecting the 2006 inventory.

The 2008 APENs data covers all permitted source categories that were previously derived from the APENs database in the Phase III work. The only exception is that for the 2008 WestJump O&G inventory, the 2008 APENs database was used to obtain permitted condensate tank flashing and working and breathing loss emissions. The previous WRAP Phase III 2006 analysis used a combination of APENs data and Regulation 7 reports for those counties within the ozone Early Action Compact (EAC) area (including Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson, Larimer, and Weld Counties). Unpermitted tanks (small condensate tanks) are considered area sources in both Phase III and the WestJump inventories.

Condensate tank emissions in the 2008 APENs database provided by CDPHE have been modified to introduce a “capture efficiency” term. CDPHE has recognized that condensate tanks represent the largest O&G source category in the Denver Metro Area and North Front Range 8-hour Ozone Nonattainment Area. CDPHE has gathered evidence from observations, ambient monitors and inverse photochemical modeling that condensate tanks leak, primarily from "flashing" events, and that flares are used to control the emissions from these leaks. CDPHE has revised the assumption that 100% of flashed gas is captured by the flare, and now assumes that 75% of the flash gases are sent to the flare (possibly less).

Outside of the 9-county ozone nonattainment area the calculation of controlled emissions (those emissions after the control device that go to the environment) are as shown in Equation 1 below:

Equation (1)

$$E_{controlled} = E_{uncontrolled} \times (1 - C \times RE \times RP \times CE)$$

Where:

$E_{controlled}$ are the revised controlled condensate tank flashing emissions [tpy];

$E_{uncontrolled}$ are the uncontrolled condensate tank flashing emissions [tpy];

C is the control efficiency of the control device (typically a flare, C=0.95);

RE is the rule effectiveness (assumed RE=0.83);

RP is the rule penetration (not used, RP=1);

CE is the capture efficiency of the control device (assumed CE=0.75);

Application of Equation 1 results in controlled emissions increasing by a factor of eight. The rule penetration term is not used in this analysis as the emissions from each tank and whether the tank is controlled or uncontrolled can be determined directly from the 2008 APENs data.

Within the 9-county nonattainment area, the modifications to the condensate tank flashing emissions were made using a slightly different methodology than shown above in Equation 1. Condensate tanks that were controlled by more than 90% were identified, and the controlled VOC emissions of those sources were multiplied by a factor of ((1-0.95*0.83*0.75)/0.05).

These changes to the permitted condensate tank emissions have a large effect on the total VOC emissions in the D-J Basin for 2008, as the condensate tanks are the largest VOC source category in the D-J Basin. These results are presented in more detail below.

The 2008 permitted condensate tank APENs data was then used to estimate the throughput of condensate at permitted tanks. This was estimated to be approximately 18,450,000 bbl, indicating that the approximately 911,000 bbl of remaining condensate production in the D-J Basin was handled by unpermitted condensate tanks. The unpermitted tank emissions were estimated by applying the per-unit-throughput tank flashing emission factor developed by the CDPHE for Weld County (13.7 lb-VOC/bbl) to the remaining condensate production in the D-J Basin.

Results

The 2008 projected O&G emissions for the D-J Basin are shown below in a series of tables and graphs summarizing the quantitative results by source category, by county and by pollutant. Table 7 below provides an overall summary of the D-J Basin emissions on a basin-wide level with comparison to the 2006 inventory. Table 7 shows that NOx emissions have been relatively unchanged between 2006 and 2008, which reflects a combination of modest growth in gas production, well counts and spud counts but also increasing control of compressor engines from federal NSPS requirements and Colorado Regulation 7. VOC emissions increase substantially from 2006 to 2008, which reflects a combination of the increase in condensate

production in the D-J Basin (+36%), increased emissions from the capture efficiency analysis conducted by CDPHE, and increasing control of emissions from condensate tanks. Overall this results in a change in VOC emissions which largely tracks the increase in condensate production.

Table 7. Comparison of overall 2008 WestJump Inventory for the D-J Basin with 2006 WRAP Phase III Inventory[10].

	NOx [tpy]	VOC [tpy]	CO [tpy]	PM [tpy]	SOx [tpy]
2008 WestJump	22,165	100,622	14,367	717	115
2006 Phase III	20,783	81,758	12,942	636	226
% Change	+6.6%	+23.1%	+11.0%	+12.8%	-49.0%

Tables 9, 10 and 11 below show the 2008 O&G emissions in the D-J 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 D-J Basin by source category. Figures 3 and 4 show the breakdown of the 2008 NOx and VOC emissions by permitted and unpermitted emission sources.

Emissions from O&G activities in the D-J Basin are still concentrated in Weld and Adams counties in North-Central Colorado, with additional dry gas activity in Yuma County in Eastern Colorado. These 3 counties account for approximately 87% of NOx emissions and 95% of VOC emissions. This finding is similar to that of the Phase III 2006 baseline inventory for the D-J Basin. NOx emissions are dominated by compressor engines, other APEN-exempt engines (small engines or miscellaneous and portable engines), and drilling rigs accounting for approximately 92% of NOx emissions in 2008. Relative to the Phase III 2006 baseline inventory, drilling rigs represent a larger fraction of the total 2008 NOx emissions inventory, which is consistent with the finding that spud counts increased in 2008 relative to 2006. In addition compressor engine NOx, representing the largest NOx category in both 2006 and 2008, has decreased in 2008 in proportion to the total NOx inventory. This reflects the slower growth in gas production between 2006 and 2008, and the effect of NSPS and Regulation 7 controls requirements for compressor engines.

VOC emissions are dominated by large and small condensate tanks accounting for approximately 66% of VOC emissions in 2008, with pneumatic devices representing an additional 14% of the VOC emissions in 2008. The proportional representation of condensate tanks and pneumatic devices to the total VOC inventory in 2008 is similar to 2006. Condensate tanks represent slightly more VOC emissions in 2008 than in 2006, and pneumatic device emissions represent slightly less VOC emissions in 2008 than in 2006. It is observed that condensate tank emissions in 2008 have changed as a result of various factors including: (1) growth in condensate production in Weld County from 2006 to 2008; (2) increasing controls requirements from 2006 to 2008, implemented by operators primarily through flaring; (3) more

[10] WRAP Phase III technical memorandum for the 2006 baseline emissions for the D-J Basin: http://www.wrapair.org/forums/ogwg/documents/2008-04_%2706_Baseline_Emissions_DJ_Basin_Technical_Memo_%2804-30%29.pdf

stringent reporting requirements for permitted tank emissions from 5 tpy to 2 tpy reporting threshold, which increases the fraction of condensate tank emissions reported under APENs rather than estimated as "unpermitted" sources; and (4) the revision to the control factor to account for the flaring capture efficiency as described above. Because of this combination of changes, changes in condensate tank emissions from 2006 to 2008 are shown in more detail in Table 8 below, including the 2006 Phase III condensate tank emissions, the 2008 condensate tank emissions without the capture efficiency revision, and the final 2008 condensate tank emissions with the capture efficiency revision. It is noted that the difference between the 2006 reported APENs data and the 2008 reported APENs data (columns 1 and 2 in Table 8 below) is a combination of growth in condensate production and increasing use of flares as controls on tanks.

Table 8. Comparison of D-J Basin 2006 WRAP Phase III inventory[11], 2008 APENs inventory and 2008 APENs inventory with capture efficiency adjustment for VOC emissions from tanks.

Source Category	D-J Basin Tank Flashing VOC Emissions (tons/year)		
	2006 APENs Data	2008 APENs Data	2008 APENs Data (with Capture Efficiency)
Large Tanks (Permitted)	40,636	21,231	60,609
Small Tanks[a] (Unpermitted)	12,874	6,241	6,241

a – small tank emissions are estimated using condensate throughput estimates based on APENs data; these tanks are not reported under APENs or emissions adjusted for controls or capture efficiency.

[11] WRAP Phase III technical memorandum for the 2006 baseline emissions for the D-J Basin: http://www.wrapair.org/forums/ogwg/documents/2008-04_%2706_Baseline_Emissions_DJ_Basin_Technical_Memo_%2804-30%29.pdf

Table 9. Summary of the projected 2008 O&G emissions by county in the D-J Basin.

County	NOx [tons/yr]	VOC [tons/yr]	CO [tons/yr]	SOx [tons/yr]	PM [tons/yr]
Adams	2,410	2,978	1,001	14	21
Arapahoe	716	373	281	0	3
Boulder	168	1,153	109	1	8
Broomfield	49	149	29	0	3
Crowley	63	1	85	0	1
Denver	40	165	19	0	2
Douglas	0	0	0	0	0
Elbert	44	193	31	0	1
El Paso	0	0	0	0	0
Fremont	27	70	16	0	1
Jefferson	6	2	10	0	0
Kit Carson	47	33	26	1	3
Larimer	67	336	38	0	3
Lincoln	55	87	31	1	4
Logan	515	301	223	3	7
Morgan	711	372	461	0	6
Phillips	118	136	77	1	5
Pueblo	0	0	0	0	0
Sedgwick	2	9	1	0	0
Teller	1	790	1	0	0
Washington	231	88,281	177	1	6
Weld	13,841	5,193	9,864	72	529
Yuma	3,053	0	1,887	21	115
Totals	**22,165**	**100,622**	**14,367**	**115**	**717**

Table 10. NOx emissions by source category for the 2008 projected O&G emission inventory in the D-J Basin.

County	Drill Rigs	Exempt Engines	Heaters	Workover Rigs	Compressor Engines	Glycol Dehydrator	Other Categories	Totals
Adams	45	152	30	29	2,149	0	5	**2,410**
Arapahoe	3	18	4	3	688	0	0	**716**
Boulder	86	46	9	9	16	0	1	**168**
Broomfield	34	10	2	2	0	0	0	**49**
Crowley	0	0	0	0	63	0	0	**63**
Denver	17	7	1	1	12	0	0	**40**
Douglas	0	0	0	0	0	0	0	**0**
Elbert	0	11	2	2	28	0	0	**44**
El Paso	0	0	0	0	0	0	0	**0**
Fremont	17	7	1	1	0	0	0	**27**
Jefferson	0	0	0	0	6	0	0	**6**
Kit Carson	45	2	0	0	0	0	0	**47**
Larimer	27	25	5	5	5	0	0	**67**
Lincoln	52	3	1	0	0	0	0	**55**
Logan	14	20	4	4	474	0	0	**515**
Morgan	3	10	2	2	685	5	3	**711**
Phillips	62	11	2	2	40	0	0	**118**
Pueblo	0	0	0	0	0	0	0	**0**
Sedgwick	0	1	0	0	0	0	0	**2**
Teller	0	0	0	0	1	0	0	**1**
Washington	34	72	14	14	97	0	0	**231**
Weld	4,510	2,434	482	472	5,591	5	347	**13,841**
Yuma	1,154	582	115	113	1,088	1	0	**3,053**
Totals	**6,103**	**3,411**	**675**	**662**	**10,945**	**11**	**357**	**22,165**

Table 11. VOC emissions by source category for the 2008 projected O&G emission inventory in the D-J Basin.

County	Drill Rigs	Unpermitted Fugitives	Permitted Fugitives	Large Condensate Tanks	Pneumatic Devices	Pneumatic Pumps	Small Condensate Tanks	Truck Loading Of Condensate Liquid	Venting – Blowdowns	Venting - Initial Completions	Venting - Recompletions	Compressor Engines	Glycol Dehydrator	Other Categories	Totals
Adams	3	402	64	1,288	614	44	134	23	54	4	6	233	37	70	**2,978**
Arapahoe	0	47	14	144	72	5	19	3	3	0	0	18	28	19	**373**
Boulder	6	123	0	680	188	14	76	13	27	8	11	2	0	5	**1,153**
Broomfield	2	28	0	41	42	3	15	3	6	3	4	0	0	1	**149**
Crowley	0	0	0	0	0	0	0	0	0	0	0	1	0	0	**1**
Denver	1	19	5	89	30	2	8	1	4	2	2	0	0	1	**165**
Douglas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Elbert	0	30	0	95	46	3	12	2	2	0	0	1	0	1	**193**
El Paso	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Fremont	1	19	0	0	30	2	11	2	0	2	2	0	0	1	**70**
Jefferson	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**2**
Kit Carson	3	5	0	0	8	1	5	1	1	4	6	0	0	0	**33**
Larimer	2	66	0	105	100	7	38	7	3	3	4	0	0	3	**336**
Lincoln	4	7	0	6	10	1	40	7	0	5	7	0	0	0	**87**
Logan	1	52	0	0	80	6	64	11	2	1	2	59	9	13	**301**
Morgan	0	26	4	11	40	3	32	6	1	0	0	168	42	38	**372**
Phillips	4	30	0	0	46	3	0	0	13	6	8	12	11	1	**136**
Pueblo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Sedgwick	0	3	0	0	5	0	0	0	0	0	0	0	0	0	**9**
Teller	0	0	0	0	0	0	191	0	0	0	0	0	0	0	**790**
Washington	2	190	0	11	290	21	5,597	33	11	3	4	13	10	11	**88,281**
Weld	312	6,451	394	58,123	9,847	713	0	975	1,508	438	590	1,858	242	1,234	**5,193**
Yuma	80	1,543	0	16	2,355	171	0	0	349	112	151	225	133	59	**0**
Totals	**423**	**9,043**	**481**	**60,609**	**13,802**	**999**	**6,241**	**1,087**	**1,984**	**593**	**798**	**2,592**	**513**	**1,457**	**100,622**

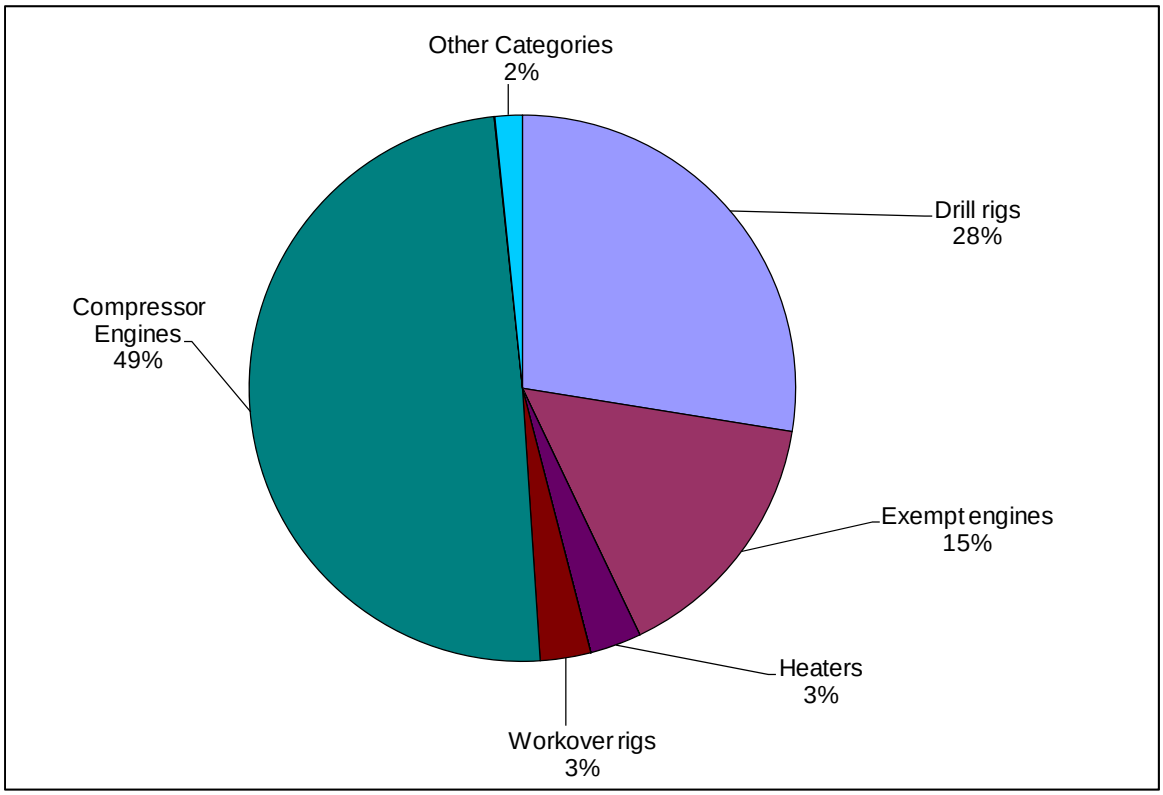

Figure 1. 2008 D-J Basin projected NOx emissions by source category.

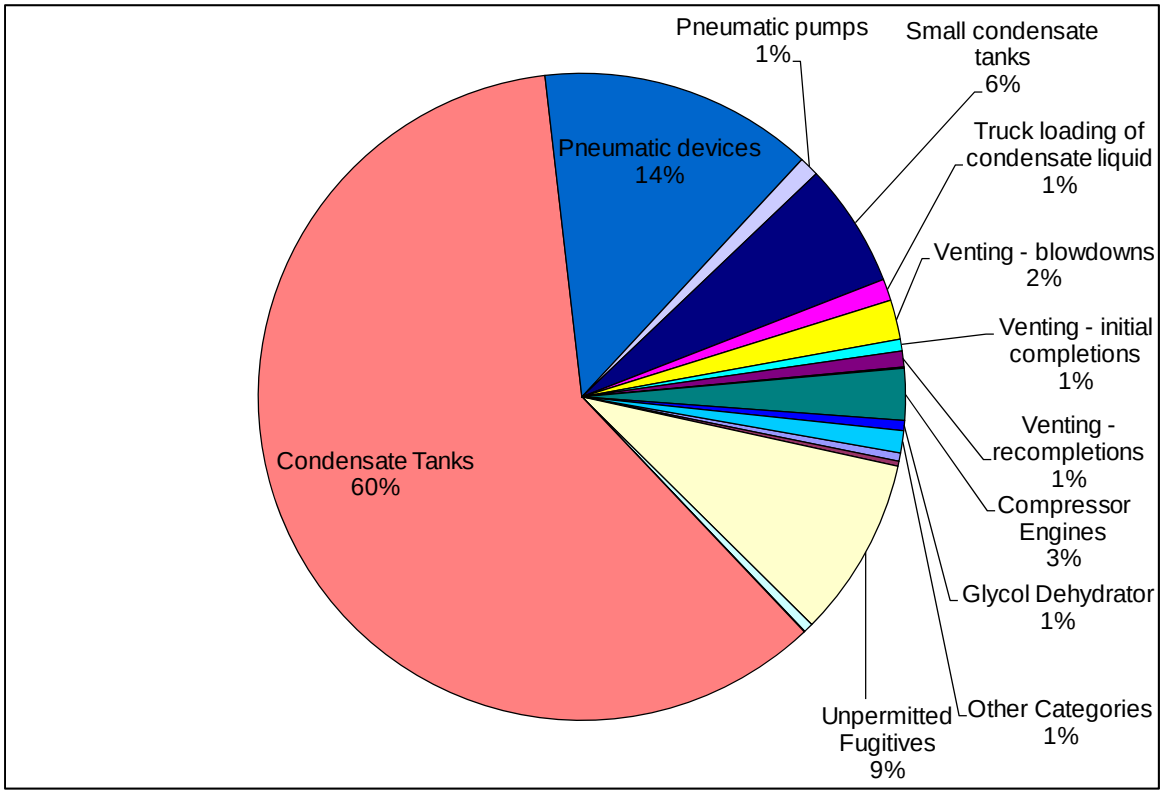

Figure 2. 2008 D-J Basin projected VOC emissions by source category.

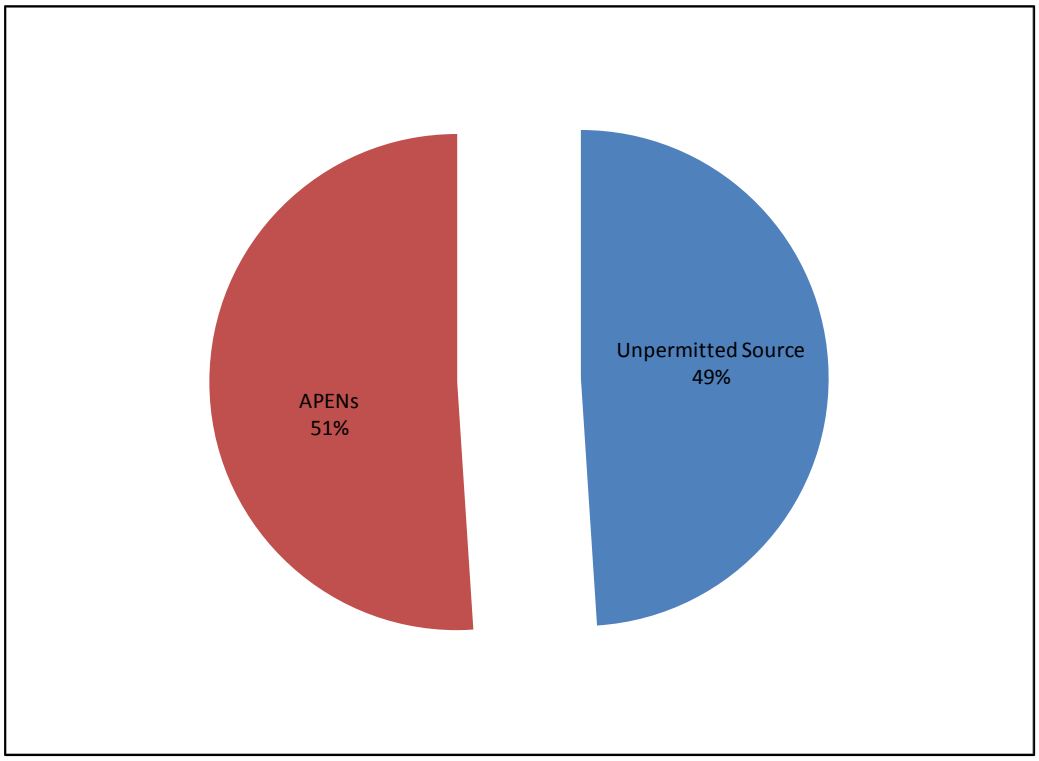

Figure 3. 2008 D-J Basin projected NOx emissions by permitted vs. unpermitted source categories.

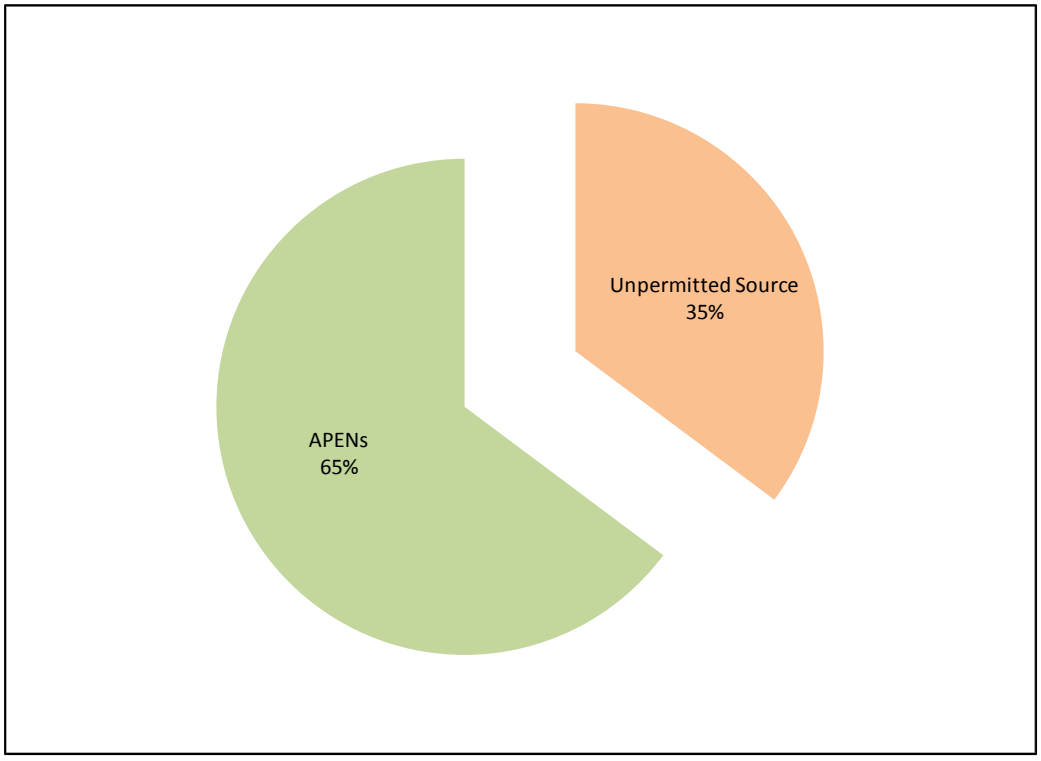

Figure 4. 2008 D-J Basin projected VOC emissions by permitted vs. unpermitted source categories.

PICEANCE BASIN – OBSERVATIONS AND RESULTS

For the 2008 WestJump inventory for the Piceance Basin, the previous 2006 point source data was wholly replaced with the 2008 APENs data provided directly by CDPHE, similar to the procedure described above for the D-J Basin. It should be noted that in the Phase III 2006 baseline inventory for the Piceance Basin, it was not possible to separately determine the emissions from permitted and unpermitted condensate tanks. Instead a "top-down" methodology was developed to estimate all condensate tank flashing emissions. This approach used a basin-wide control factor to estimate the final controlled condensate tank emissions. The WestJump methodology uses the 2008 APENs database to wholly replace all tank emissions. It should be noted that no independent estimate of unpermitted tank emissions is conducted because the APENs database cannot be used to determine the exact condensate throughput to the permitted condensate tanks.

The APENs database indicates that total liquid hydrocarbon throughput for all Piceance Basin tanks is approximately 4.1 million barrels. However the production statistics for the Piceance Basin indicate that only approximately 2.4 million barrels of condensate were produced in 2008. The remainder of the liquid hydrocarbon production in 2008 is primary oil production, of which 95% is owned by Chevron and is indicated as being produced directly to pipeline without use of storage tanks. Therefore the APENs database overestimates the throughput of condensate, and it is likely that this results from reporting of not-to-exceed throughput levels (and hence emissions) in the APENs rather than actual 2008 values. Because of this discrepancy in the APENs tank throughput data, no independent estimate could be used to determine the fraction of liquid hydrocarbon production sent to unpermitted tanks. The total APENs tank emissions were adjusted to reflect the ratio of the actual condensate production to the APENs estimated condensate production, a reduction of approximately 45.3% in the 2008 reported APENs emissions for tanks.

Similar to the D-J Basin, condensate tank emissions in the Piceance Basin were adjusted to reflect the 75% capture efficiency factor described above for condensate tanks where a flaring control system was indicated. In the Phase III 2006 baseline inventory for the Piceance Basin it was assumed that 50% of condensate production was sent to controlled tanks on a basin-wide basis, and the tank flashing VOC emissions were estimated accordingly. For the 2008 WestJump inventory, significant differences in the controls assumptions are observed relative to Phase III as the controls information for each tank is now derived directly from the APENs database and the capture efficiency factor has been introduced.

Results

The 2008 projected O&G emissions for the Piceance Basin are shown below in a series of tables and graphs summarizing the quantitative results by source category, by county and by pollutant. Table 12 below provides an overall summary of the Piceance Basin emissions on a basin-wide level with comparison to the 2006 inventory. Gas production and gas well counts have increased by approximately 50% between 2006 and 2008, and spud counts have increased by approximately 80% in this time period. This drives a significant growth in NOx emissions through a combination of compressor engine emissions and drilling rig emissions. VOC emissions increases are driven by both the increases in gas production (+56%) and the changes to the inventory methodology for condensate tanks as described above. Specifically the

assumption on the fraction of condensate tank that are controlled in the 2006 inventory was replaced by actual 2008 APENs data which suggest a lower fraction of tanks being controlled. The capture efficiency factor also contributes to the increase in the VOC emissions.

Table 12. Comparison of overall 2008 WestJump Inventory for the Piceance Basin with 2006 WRAP Phase III Inventory[12].

	NOx [tpy]	VOC [tpy]	CO [tpy]	PM [tpy]	SOx [tpy]
2008 WestJump	20,113	45,714	11,520	1,812	519
2006 Phase III	12,391	27,464	7,921	992	314
% Change	+62.3%	+66.5%	+45.4%	+82.6%	+65.1%

Tables 14, 15 and 16 below show the 2008 O&G emissions in the Piceance 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 Piceance Basin by source category. Figures 7 and 8 show the breakdown of the 2008 NOx and VOC emissions by permitted and unpermitted emission sources.

Emissions from O&G activities in the Piceance Basin are still concentrated in Garfield County (gas production) and Rio Blanco County (oil production) with some additional activity in Mesa and Moffatt Counties. This finding is similar to the Phase III 2006 baseline inventory for the Piceance Basin. NOx emissions are split between compressor engines and drilling rigs. It is noted that drilling rig emissions are a larger portion of the 2008 NOx emissions than in 2006, and compressor engines are a smaller portion of the 2008 NOx emissions than in 2006. This reflects the large increase in drilling activity in 2008, and the slower growth in gas production between 2006 and 2008. In addition, controls requirements for compressor engines reduce the compressor NOx emissions. These controls (NSPS and Regulation 7) were assumed to apply only to the growth in compressor emissions between 2006 and 2008 – existing compression was assumed to remain in use and not turn over during that period.

VOC emissions are distributed among a number of source categories. The two largest source categories are venting from initial completions (which may include hydraulic fracturing) and flashing emissions from condensate tanks which together account for approximately 58% of the 2008 basin-wide VOC emissions. The remainder of the basin-wide VOC emissions is distributed across a number of venting and fugitive source categories. This differs from the Phase III 2006 baseline findings in that condensate tanks are a significantly larger fraction of the total VOC emissions in 2008 than 2006. It is observed that condensate tank emissions in 2008 have changed as a result of several factors that were described above for the D-J Basin including growth in condensate production, revisions to the controls assumptions from 2006 to 2008, and the revision to the control factor to account for the flaring capture efficiency as described above. Because of this combination of changes, changes in condensate tank emissions from 2006 to 2008 are shown in more detail in Table 13 below, including the 2006 Phase III

[12] WRAP Phase III technical memorandum for the 2006 baseline emissions for the Piceance Basin: http://www.wrapair.org/forums/ogwg/documents/2009-01_06_Baseline_Emissions_Piceance_Basin_Technical_Memo_01-20.pdf

condensate tank emissions, the 2008 condensate tank emissions without the capture efficiency revision or throughput adjustment, and the final 2008 condensate tank emissions with the capture efficiency revision and throughput adjustments.

Table 13. Comparison of Piceance Basin 2006 WRAP Phase III inventory[13], 2008 APENs inventory and 2008 APENs inventory with capture efficiency and throughput adjustments for VOC emissions from tanks.

Source Category	Piceance Basin Tank Flashing VOC Emissions (tons/year)			
	2006 WRAP Phase III	2008 APENs Data	2008 APENs Data (with capture efficiency)	2008 APENs Data (with capture efficiency and throughput adjustment)
Piceance Basin Tanks (All)	3,405	8,487	13,064	7,142

[13] WRAP Phase III technical memorandum for the 2006 baseline emissions for the Piceance Basin: http://www.wrapair.org/forums/ogwg/documents/2009-01_06_Baseline_Emissions_Piceance_Basin_Technical_Memo_01-20.pdf

Table 14. Summary of the projected 2008 O&G emissions by county in the Piceance Basin.

County	NOx [tons/yr]	VOC [tons/yr]	CO [tons/yr]	SOx [tons/yr]	PM [tons/yr]
Chaffee	0	0	0	0	0
Delta	0	1	0	0	0
Eagle	0	0	0	0	0
Garfield	12,949	32,675	7,045	382	1,322
Gunnison	155	107	145	0	2
Lake	0	0	0	0	0
Mesa	2,229	3,905	1,380	53	188
Moffat	1,010	2,564	570	6	24
Pitkin	0	25	0	0	0
Rio Blanco	3,753	6,278	2,363	77	277
Routt	17	160	17	0	0
Totals	**20,113**	**45,714**	**11,520**	**519**	**1,812**

Table 15. NOx emissions by source category for the 2008 projected O&G emission inventory in the Piceance Basin.

County	Compressor Engines	Drill Rigs	Exempt Engines	Heaters	Workover Rigs	Glycol Dehydrator	Flaring	Other Categories	Totals
Chaffee	0	0	0	0	0	0	0	0	**0**
Delta	0	0	0	0	0	0	0	0	**0**
Eagle	0	0	0	0	0	0	0	0	**0**
Garfield	4,267	7,582	141	585	75	20	163	117	**12,949**
Gunnison	144	5	0	1	0	0	2	3	**155**
Lake	0	0	0	0	0	0	0	0	**0**
Mesa	979	1,048	16	67	9	10	45	55	**2,229**
Moffat	841	100	8	41	5	9	6	0	**1,010**
Pitkin	0	0	0	0	0	0	0	0	**0**
Rio Blanco	2,441	889	28	171	22	19	12	169	**3,753**
Routt	13	0	0	3	0	0	1	0	**17**
Totals	**8,686**	**9,624**	**194**	**868**	**111**	**59**	**228**	**344**	**20,113**

Table 16. VOC emissions by source category for the 2008 projected O&G emission inventory in the Piceance Basin.

County	Compressor Engines	Drill Rigs	Unpermitted Fugitives	Permitted Fugitives	Condensate Tanks	Pneumatic Devices	Pneumatic Pumps	Venting – Blowdowns	Venting - Initial Completions	Venting - Recompletions	Glycol Dehydrator	Other Categories	Totals
Chaffee	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Delta	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Eagle	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Garfield	1,465	344	996	254	4,705	1,876	715	2,838	15,281	2,020	1,455	727	**32,675**
Gunnison	35	0	2	0	1	2	1	7	9	1	41	7	**107**
Lake	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Mesa	197	48	114	95	340	222	82	206	2,112	279	138	72	**3,905**
Moffat	82	5	65	52	514	128	41	103	201	27	1,040	306	**2,564**
Pitkin	0	0	0	0	0	0	0	0	0	0	25	0	**25**
Rio Blanco	401	40	257	342	1,438	552	143	243	1,792	237	307	525	**6,278**
Routt	0	0	3	0	144	11	0	0	0	0	0	0	**160**
Totals	**2,181**	**436**	**1,438**	**743**	**7,142**	**2,792**	**983**	**3,397**	**19,396**	**2,564**	**3,006**	**1,637**	**45,714**

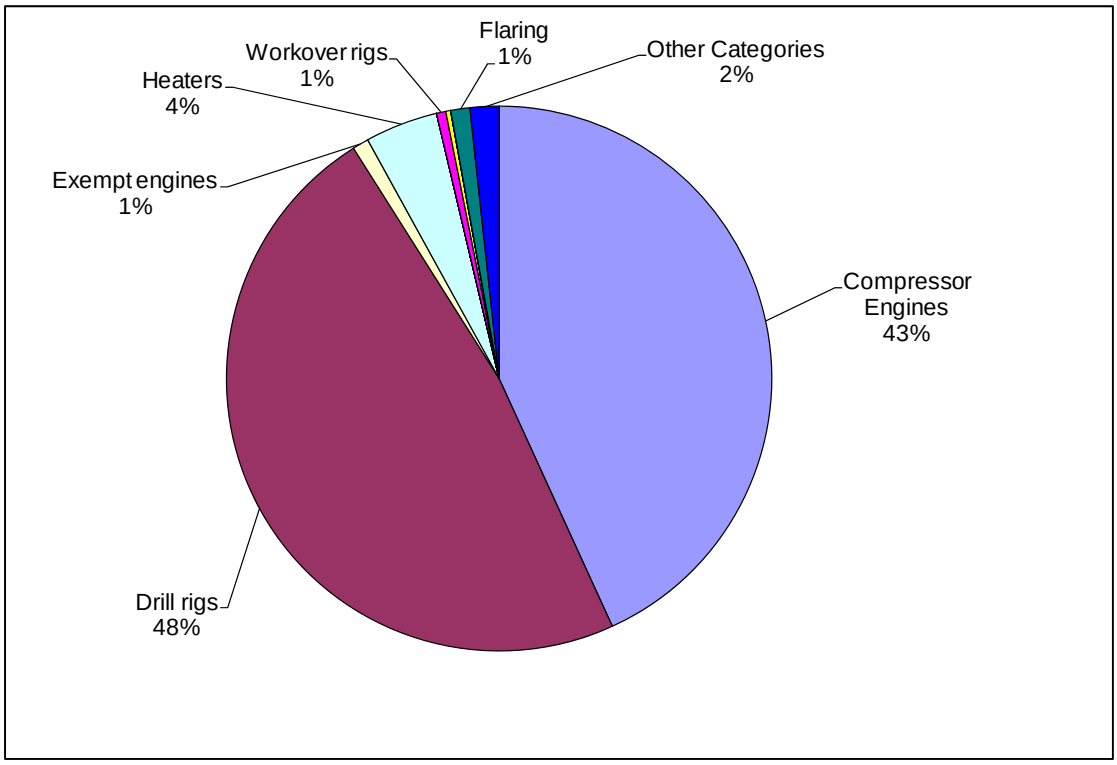

Figure 5. 2008 Piceance Basin projected NOx emissions by source category.

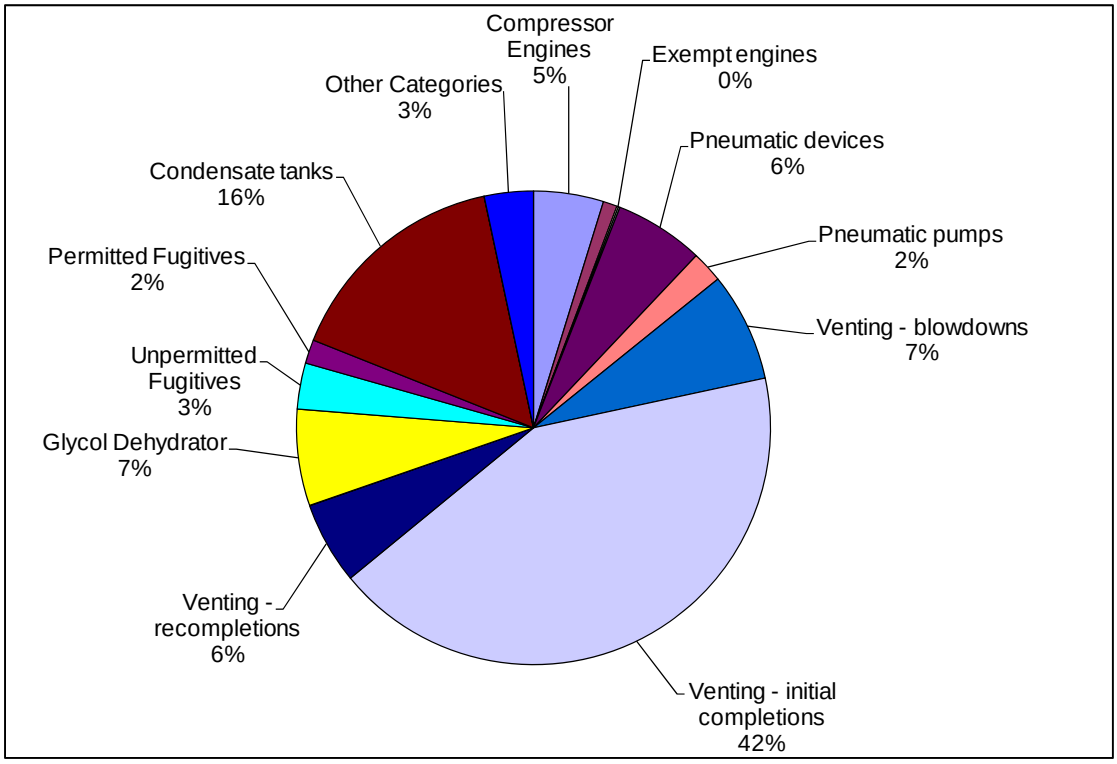

Figure 6. 2008 Piceance Basin projected VOC emissions by source category.

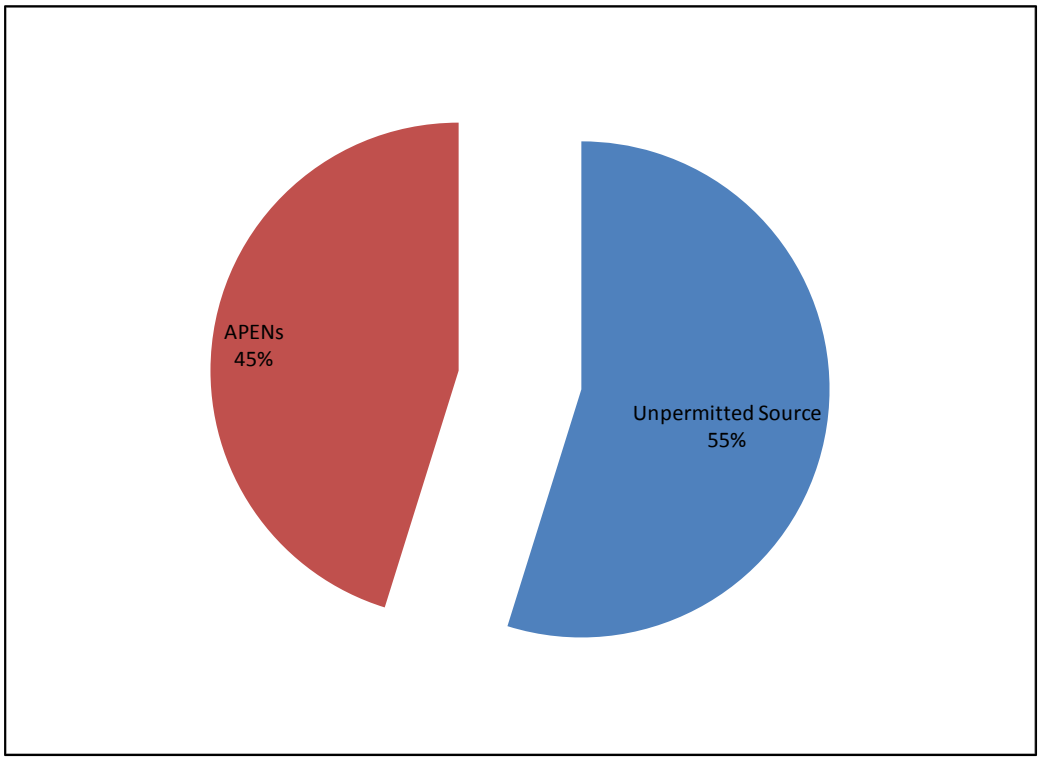

Figure 7. 2008 Piceance Basin projected NOx emissions by permitted vs. unpermitted source categories.

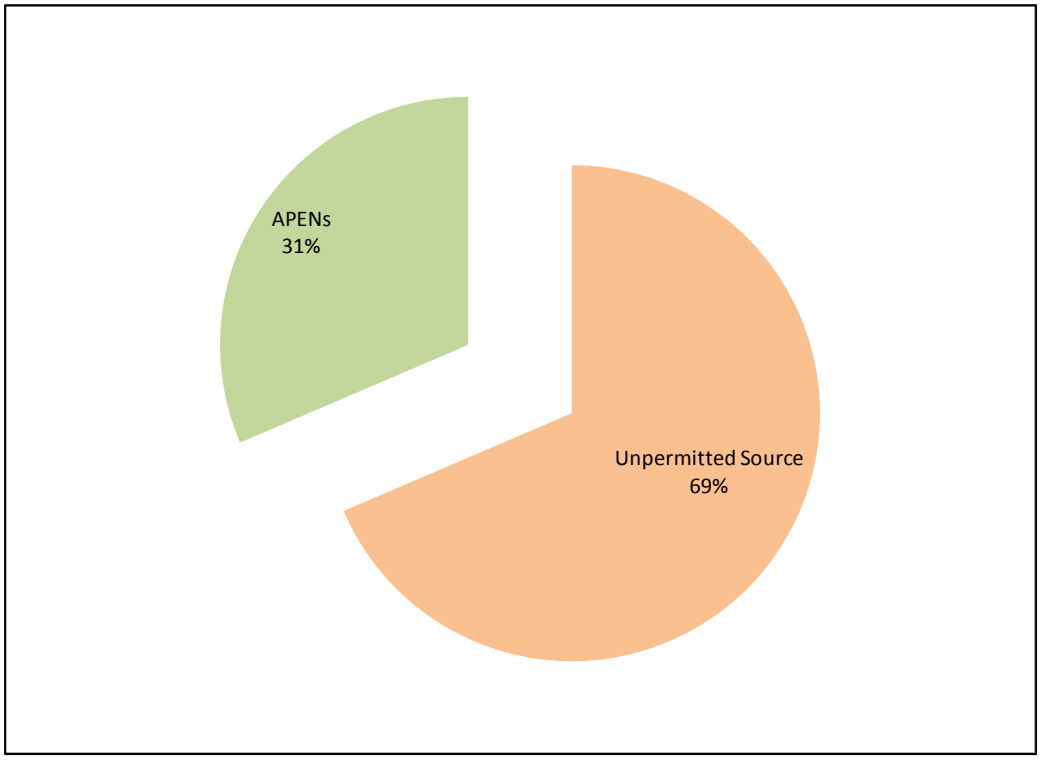

Figure 8. 2008 Piceance Basin projected VOC emissions by permitted vs. unpermitted source categories.

NORTH SAN JUAN BASIN – OBSERVATIONS AND RESULTS

The North San Juan Basin in Southwest Colorado consists of only Archuleta and La Plata Counties, and includes a large area of Southern Ute Indian Tribal (SUIT) land. The majority of oil and gas activity occurs on SUIT land, and thus the 2008 WestJump emissions inventory projection for this basin was conducted using a slightly modified methodology than the other Colorado basins. Two sets of scaling factors were applied: (1) the basin-wide tribal land scaling factors for production, well counts and spud counts were applied to only the emissions on tribal land; and (2) the basin-wide nontribal land scaling factors for production, well counts and spud counts were applied to only the emissions on nontribal land. Following the application of the scaling factors, separate control analyses were conducted for sources on tribal and nontribal land. It was assumed that sources on tribal land would be subject only to controls requirements from federal regulations, and that sources on nontribal land would be subject to federal and state regulations as shown in Table 6.

For the 2008 WestJump inventory for the nontribal portion of the North San Juan Basin, the previous 2006 point source data was wholly replaced with the 2008 APENs data provided directly by CDPHE, similar to the procedure described above for the D-J and Piceance Basins. Permitted point sources on tribal land in the 2006 Phase III baseline inventory consisted only of large Title V sources for which data was obtained from permits administered by EPA Region 8. Because gas production is projected to decline between 2006 and 2008 in the North San Juan Basin, no new major sources were expected to be constructed and operated in 2008 that would not already have been included in the 2006 permitted point sources for tribal land. Therefore no additional data on permitted sources on tribal land was requested from EPA Region 8.

Similar to the other Colorado basins, condensate tank emissions in the nontribal portion of the North San Juan Basin were adjusted to reflect the 75% capture efficiency factor described above for condensate tanks where a flaring control system was indicated. The capture efficiency correction for the condensate tanks was not applied to tanks located on SUIT land, as there was insufficient information on whether individual tanks were controlled or uncontrolled and therefore no tractable methodology to apply the capture efficiency factor.

Results

The 2008 projected O&G emissions for the North 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 16 below provides an overall summary of the North San Juan Basin emissions on a basin-wide level with comparison to the 2006 inventory. Gas production has remained relatively unchanged between 2006 and 2008 with only a slight decline. Well counts have increased between 2006 and 2008 by approximately 10%. This accounts for the relatively minor change in NOx emissions between 2006 and 2008. Oil production has increased by approximately 20% between 2006 and 2008, but there is very little oil production in the North San Juan Basin relative to other basins. Therefore VOC emissions increases are driven mainly by the increase in gas production. However it should be noted that gas production in the North San Juan Basin consists mainly of CBM gas which has a low VOC content. Therefore VOC emissions increases are minor and do not directly track the total gas production increase. PM and SOx increases are primarily driven by the increase in spud counts between 2006 and 2008, although the absolute increase in spuds (99 spuds) is minor.

Table 16. Comparison of overall 2008 WestJump inventory for the North San Juan Basin with 2006 WRAP Phase III inventory[14].

	NOx [tpy]	VOC [tpy]	CO [tpy]	PM [tpy]	SOx [tpy]
2008 WestJump	5,917	2,187	6,456	72	30
2006 Phase III	5,700	2,147	6,450	52	15
% Change	+3.8%	+1.9%	+0.1%	+36.6%	+97.4%

Tables 17, 18 and 19 below show the 2008 O&G emissions in the North San Juan Basin by-county and by-source-category respectively (for NOx and VOC emissions only). Figures 9 and 10 show the breakdown of the 2008 NOx and VOC emissions for the North San Juan Basin by source category. Figures 11 and 12 show the breakdown of the 2008 NOx and VOC emissions by permitted and unpermitted emission sources.

Emissions from O&G activities in the North San Juan Basin are almost entirely concentrated in La Plata County with some additional production activity in Archuleta County as was observed in the WRAP Phase III baseline 2006 inventory for the North San Juan Basin. NOx emissions are dominated by compressor engines with some additional NOx emissions from drilling rigs. Drilling activity is relatively limited in the North San Juan Basin as compared to other basins. Relative to the Phase III 2006 baseline inventory, drilling rig emissions have increased slightly as a portion of the total basin-wide NOx, reflecting the increase in drilling activity.

VOC emissions are also dominated by compressor engines as exhaust VOC emissions. This is consistent with the Phase III baseline 2006 inventory for the North San Juan Basin, and reflects the large fraction of CBM gas produced in the North San Juan Basin as a function of the total gas production in the basin. CBM gas produced in the North San Juan Basin has a very low VOC content as determined in the Phase III 2006 baseline inventory.

It should be noted that the North San Juan Basin has a high fraction of emissions from unpermitted sources as shown in Figures 11 and 12. This is due to the high levels of activity on SUIT land for which no minor source permits are required and compiled in the APENs database. APENs sources are only included in the inventory for the minor portion of activity in the basin that occurs outside of SUIT land. 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.

[14].WRAP Phase III technical memorandum for the 2006 baseline emissions for the North San Juan Basin: http://www.wrapair.org/forums/ogwg/documents/NSanJuanBasin/2009-09_06_Baseline_and_12_Midterm_Emissions_N_San_Juan_Basin_Technical_Memo_09-01.pdf

Table 17. Summary of the projected 2008 O&G emissions by county and Tribal/Nontribal Land in the North San Juan Basin.

County	NOx [tons/yr]	VOC [tons/yr]	CO [tons/yr]	SOx [tons/yr]	PM [tons/yr]
Archuleta	139	46	121	3.51	4
La Plata	5,778	2,141	6,335	26.60	67
San Juan	0	0	0	0.00	0
Hinsdale	0	0	0	0.00	0
Mineral	0	0	0	0.00	0
Archuleta (Tribal)	112	36	114	1.93	3
La Plata (Tribal)	4,880	2,065	5,992	20.67	51
Archuleta (Nontribal)	27	11	7	1.58	2
La Plata (Nontribal)	898	76	343	5.93	16
Totals	**5,917**	**2,187**	**6,456**	**30.11**	**72**

Table 18. NOx emissions by source category for the 2008 Projected O&G emission inventory in the North San Juan Basin.

County	Compressor Engines	Drill Rigs	Misc. Engines	Heaters	Dehydrators	Flaring	Other Categories	Totals
Archuleta	74	53	1	10	0	0	1	**139**
La Plata	4,808	396	53	502	4	3	13	**5,778**
Archuleta (Tribal)	73	29	1	9	0	0	0	**112**
La Plata (Tribal)	4,058	313	47	445	3	3	13	**4,880**
Archuleta (Nontribal)	1	24	0	2	0	0	1	**27**
La Plata (Nontribal)	750	83	6	58	0	0	0	**898**
Totals	**4,882**	**449**	**54**	**512**	**4**	**3**	**14**	**5,917**

Table 19. VOC emissions by source category for the 2008 projected O&G emission inventory in the North San Juan Basin.

County	Compressor Engines	Drill rigs	Misc. Engines	Heaters	Dehydrators	Oil Tanks	Flaring	Other Categories	Totals
Archuleta	32	4	0	0	0	8	0	0	**46**
La Plata	1,832	32	6	19	14	177	5	56	**2,141**
Archuleta (Tribal)	32	2	0	0	0	0	0	0	**36**
La Plata (Tribal)	1,774	25	5	16	12	177	5	49	**2,065**
Archuleta (Nontribal)	0	2	0	0	0	8	0	0	**11**
La Plata (Nontribal)	58	7	1	2	2	0	0	7	**76**
Totals	**1,865**	**36**	**6**	**19**	**14**	**186**	**5**	**56**	**2,187**

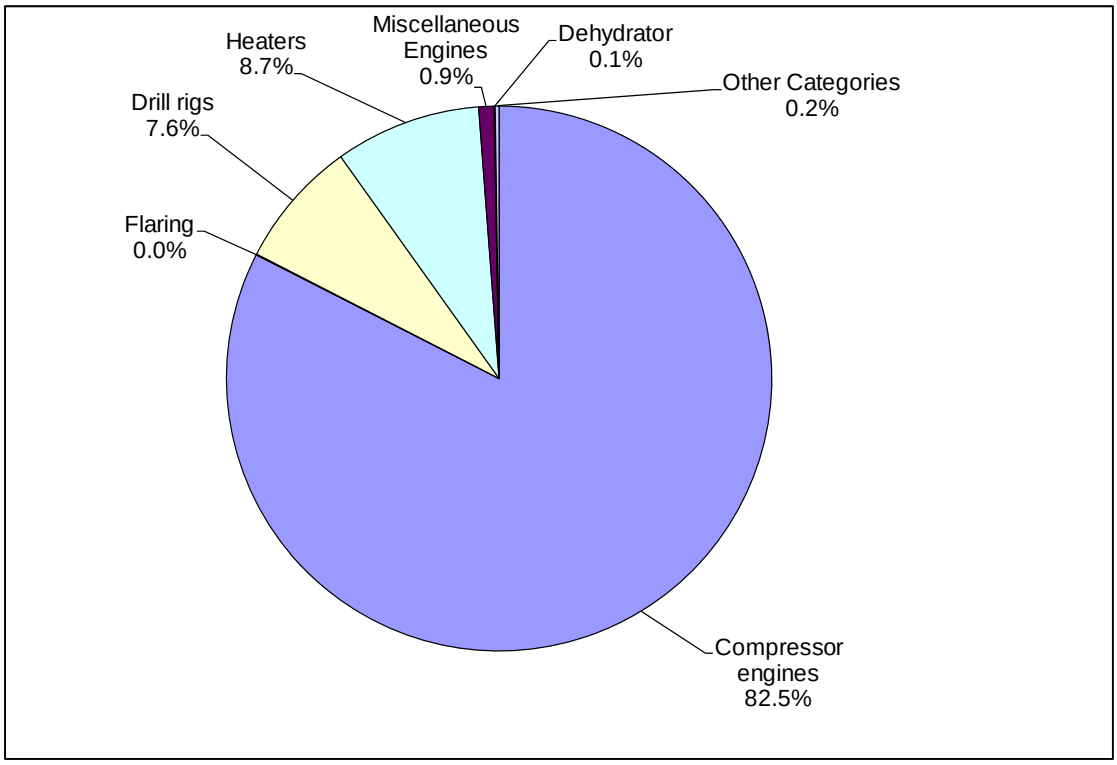

Figure 9. 2008 North San Juan Basin projected NOx emissions by source category.

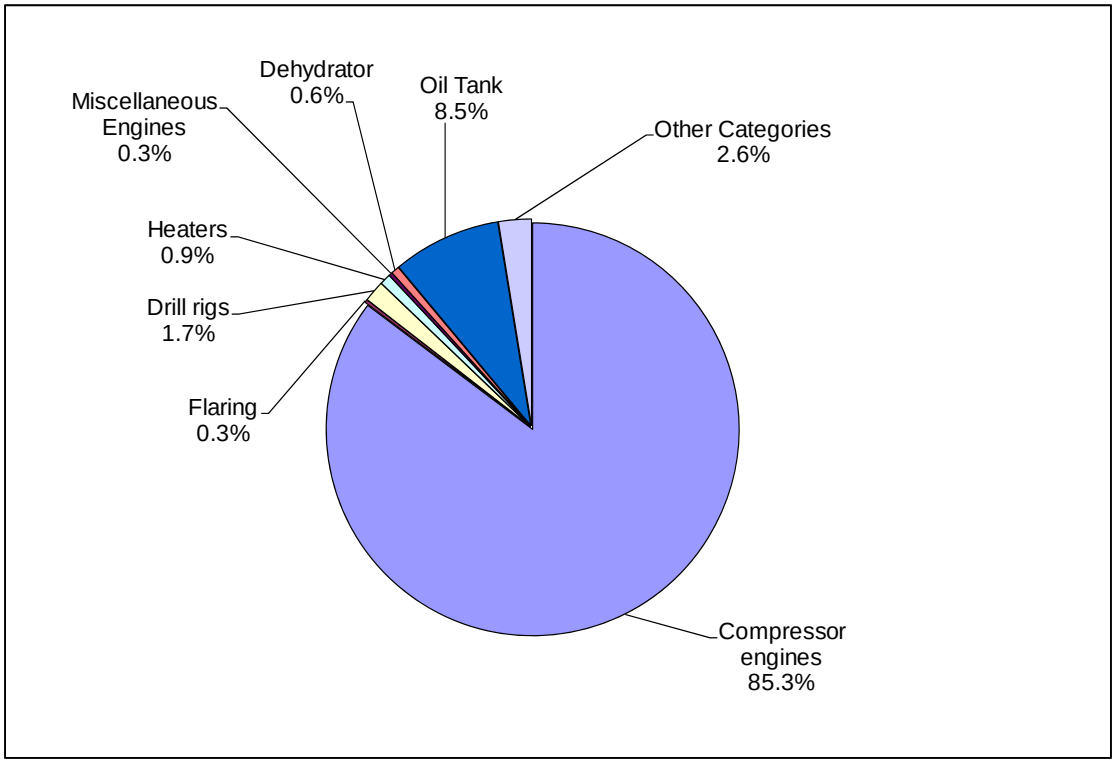

Figure 10. 2008 North San Juan Basin projected VOC emissions by source category.

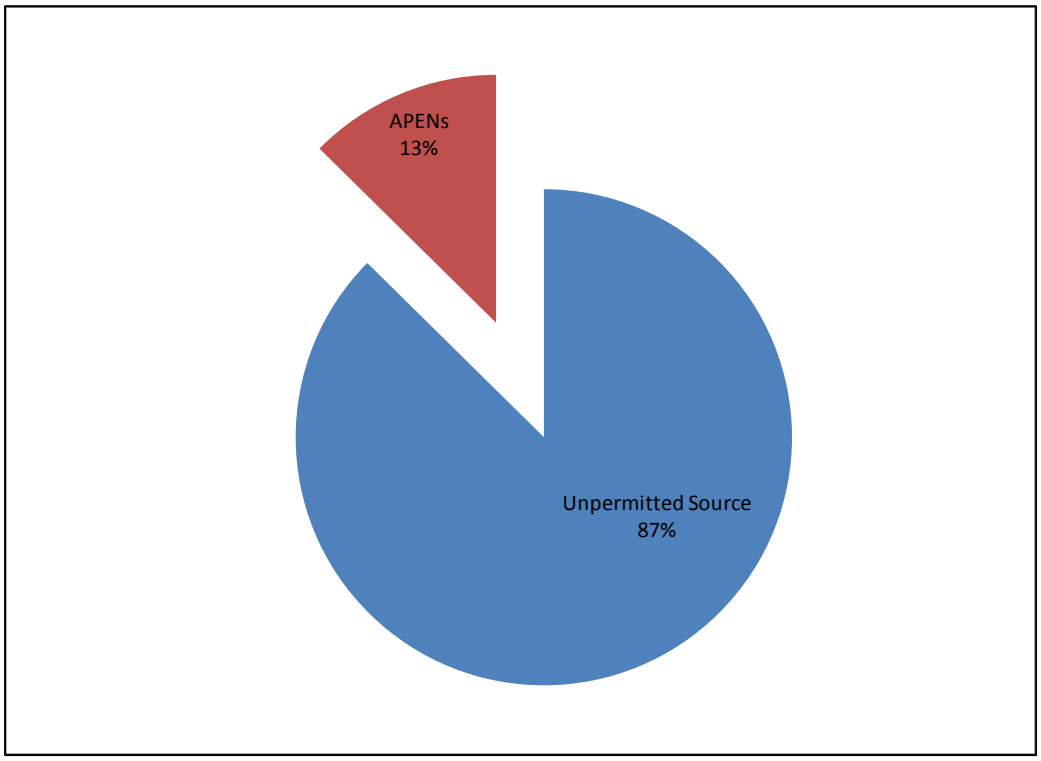

Figure 11. 2008 North San Juan Basin projected NOx emissions by permitted vs. unpermitted source categories.

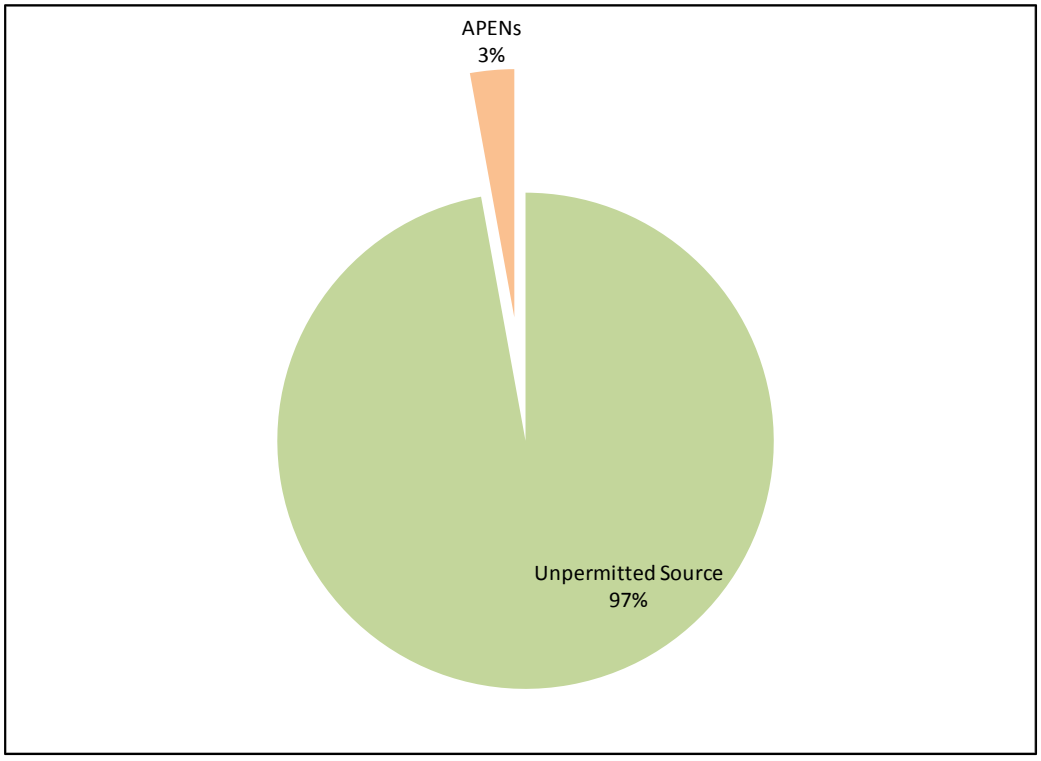

Figure 12. 2008 North San Juan Basin projected VOC emissions by permitted vs. unpermitted source categories.

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.