

Final Report**DEVELOPMENT OF 2009 OIL AND GAS EMISSIONS UPDATES
FOR WYOMING BASINS**

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TABLE OF CONTENTS

	Page
INTRODUCTION.....	4
METHODOLOGY.....	5
2009 Oil and Gas Production Statistics	5
Survey Data Updates	14
Midstream Facility and Stationary Engine Updates	16
Summary Inventories	18
RESULTS	19
Wind River Basin.....	19
Powder River Basin.....	23
Southwest Wyoming Basin	29
REFERENCES.....	34

LIST OF TABLES

Table 1.	2006 and 2009 production statistics for the Wyoming Basins.	5
Table 2.	2009 well count by well type, by county and by tribal and non-tribal designation for the Wind River Basin.	6
Table 3.	2009 production by production type, by county and by tribal and non-tribal designation for the Wind River Basin.	6
Table 4.	2009 spud counts by county for the Wind River Basin.	7
Table 5.	2009 well count by well type, by county and by tribal and non-tribal designation for the Powder River Basin.	7
Table 6.	2009 production by production type, by county and by tribal and non-tribal designation for the Powder River Basin.	8
Table 7.	2009 spud counts by county for the Powder River Basin.	9
Table 8.	2009 well count by well type and by county for the Southwest Wyoming Basin.	10
Table 9.	2009 production by production type and by county for the Southwest Wyoming Basin.	10
Table 10.	2009 spud counts by county for the Southwest Wyoming Basin.	10
Table 11.	Percentage ownership of basin-wide production by survey respondents for the Wind River Basin	14
Table 12.	Percentage ownership of basin-wide production by survey respondents for the Powder River Basin.	15
Table 13.	Percentage ownership of basin-wide production by survey respondents for the Southwest Wyoming Basin.	15
Table 14.	Summary results for the 2009 update for the Wind River Basin and comparison to 2006 baseline.	19

Table 15.	2009 emissions of all criteria pollutants by county for the Wind River Basin	19
Table 16.	2009 NOx emissions by source category for the Wind River Basin.	20
Table 17.	2009 VOC emissions by source category for the Wind River Basin.	20
Table 18.	Summary results for the 2009 update for the Powder River Basin and comparison to 2006 baseline.	23
Table 19.	2009 emissions of all criteria pollutants by county for the Powder River Basin.	23
Table 20.	2009 NOx emissions by source category for the Powder River Basin.	25
Table 21.	2009 VOC emissions by source category for the Powder River Basin.	26
Table 22.	Summary results for the 2009 update for the Southwest Wyoming Basin and comparison to 2006 baseline.	29
Table 23.	2009 emissions of all criteria pollutants by county for the Southwest Wyoming Basin.	30
Table 24.	2009 NOx emissions by source category for the Southwest Wyoming Basin.	31
Table 25.	2009 VOC emissions by source category for the Southwest Wyoming Basin.	31

LIST OF FIGURES

Figure 1.	Wind River Basin boundaries overlaid with 2009 oil and gas well locations.	11
Figure 2.	Powder River Basin boundaries overlaid with 2009 oil and gas well locations.	12
Figure 3.	Southwest Wyoming Basin boundaries overlaid with 2009 oil and gas well locations.	13
Figure 4.	WYDEQ Upper Green River Basin (UGRB) proposed ozone designation area boundaries overlaid with 2009 oil and gas well locations.	17
Figure 5.	2009 NOx emissions by tribal and non-tribal land in the Wind River Basin.	21
Figure 6.	2009 VOC emissions by tribal and non-tribal land in the Wind River Basin.	21
Figure 7.	Wind River Basin 2009 NOx emissions proportional contributions by source category.	22
Figure 8.	Wind River Basin 2009 VOC emissions proportional contributions by source category.	22
Figure 9.	2009 NOx emissions by county and by source category in the Powder River Basin.	27
Figure 10.	2009 VOC emissions by county and by source category in the Powder River Basin.	27
Figure 11.	Powder River Basin 2009 NOx emissions proportional contributions by source category.	28

Figure 12. Powder River Basin 2009 VOC emissions proportional contributions by source category.	28
Figure 13. 2009 NOx emissions by county and by source category in the Southwest Wyoming Basin.	32
Figure 14. 2009 VOC emissions by county and by source category in the Southwest Wyoming Basin.	32
Figure 15. Southwest Wyoming Basin 2009 NOx emissions proportional contributions by source category.	33
Figure 16. Southwest Wyoming Basin 2009 VOC emissions proportional contributions by source category.	33

INTRODUCTION

This document outlines the methodologies and results for updating the WRAP Phase III 2006 baseline inventories for oil and gas activity in Wyoming basins to a new base year of 2009. The new 2009 oil and gas basin-level inventories are referred to in this report as “2009 updates” and constitute a Phase IV of the WRAP oil and gas inventories. These 2009 updates are planned for all oil and gas basins for which inventories were developed under WRAP Phase III, beginning with the 3 Wyoming basins covered in this report: (1) the Wind River Basin; (2) the Powder River Basin; and (3) the Southwest Wyoming (Greater Green River) Basin. Further triennial updates to 2012, 2015 and other future years may be conducted in later phases of this project.

The 2009 updates in Phase IV represent an important tool to track changes in oil and gas activity and emissions. The on-shore oil and gas exploration and production sector is dynamic and changes in activity patterns, types of production, and geographic areas of production can affect emissions. Regulatory requirements at the state and federal levels can also impact emissions. Future triennial updates will allow for tracking of the impacts of oil and gas development activities and regulations on emissions from this sector.

The 2009 updates described in this report and the methodologies used to generate these updates are intended to be less data-intensive than the initial development of the 2006 baseline inventories for each basin. The updates are formulated by allowing participating oil and gas companies to update the basic equipment, activity and emission factor assumptions used in the 2006 baseline to reflect 2009 practices and conditions, and to update oil and gas production activity at the basin level. The level of detail used to develop the 2009 updates is therefore in between that of the baseline and the midterm projected inventories. For some categories, if no 2009 updated input data is provided the category emissions are updated to 2009 using methodologies resembling those of the midterm projections. For other categories, if new detailed 2009 input data is provided the category emissions are recalculated in a new bottom-up calculation resembling those of the baseline projections. This report describes the methodology and results of the 2009 updates, and in cases where a new calculation is made using updated 2009 input data the methodologies used are identical to those described for each basin in the baseline 2006 technical reports. These methodologies are referenced here, but are not described in detail in this document.

METHODOLOGY

The 2009 updates for oil and gas emissions in the Wyoming basins are developed in four primary steps:

- (1) Updates to oil and gas statistics – the IHS database is used to develop production statistics for 2009 including active well counts, spud counts, gas production (by type) and oil production (by type);
- (2) Updates to survey data – companies that participated in the baseline 2006 inventory are provided the opportunity to update survey data used to develop emissions estimated for sources whose emissions are estimated bottom-up;
- (3) Updates to permit data – new permit data are requested from the Wyoming Department of Environmental Quality (WYDEQ) for calendar year 2009 and are incorporated into the inventory in place of 2006 permitted sources data;
- (4) Aggregation of data and summaries – the survey-based emissions estimations are aggregated by company and scaled to basin-wide emissions using surrogates and combined with the permitted data to generate the 2009 updated inventories for each basin;

Each of these steps is described in more detail below.

2009 Oil and Gas Production Statistics

The oil and gas production statistics were compiled using the IHS Enerdeq database, queried via online interface. This database develops high quality oil and gas production statistics using data from the Wyoming Oil and Gas Conservation Commission (WYOGCC) and other sources. The methodology for using the IHS database and extracting the oil and gas production statistics has been described previously in the development of the 2006 baseline inventories for the Wyoming basins (Bar-Ilan, et al., 2012a; Bar-Ilan, et al., 2011; Bar-Ilan, et al., 2010).

Table 1 below presents an overview of the 2009 production statistics in the Wyoming Basins, with a comparison to the 2006 baseline production statistics.

Table 1. 2006 and 2009 production statistics for the Wyoming Basins.

	Wind River Basin		Powder River Basin		Southwest Wyoming Basin	
	2006	2009	2006	2009	2006	2009
Gas Production (mcf)	198,190,024	163,702,027	452,813,743	622,594,717	1,468,167,385	1,750,353,786
Condensate Production (bbl)	479,547	428,008	518,300	476,648	9,785,073	11,961,101
Oil Production (bbl)	2,563,912	2,614,448	19,144,596	18,002,318	6,324,849	5,215,747
Well Count	1,350	1,389	25,652	26,671	9,173	11,580
Spud Count	98	37	3,275	530	1,146	689

For the Wind River Basin, gas production has declined by approximately 17% from 2006 to 2009, while total oil production has remained essentially unchanged (slight decrease in

condensate production, slight increase in oil production). Total well counts in the Wind River Basin are also essentially unchanged from 2006 to 2009, however spud counts in 2009 are approximately 62% lower than in 2006 perhaps indicating a slow-down in the rate of development in the Wind River Basin.

For the Powder River Basin, gas production substantially increased from 2006 to 2009 by approximately 37% while total oil production slightly decreased by approximately 6% during this period (decreases in both condensate and oil production). Active well counts increased slightly by approximately 4%, but there was a significant reduction in drilling during this period with a drop of approximately 84% in the spud count from 2006 to 2009. This is reflected in the trends observed in the 2015 projections for the Powder River Basin (Bar-Ilan, et al., 2012b).

For the Southwest Wyoming Basin, gas production increased from 2006 to 2009 by approximately 19%, and total oil production increased by approximately 7% (increase in condensate production, decrease in oil production). Active well counts increased by approximately 26%, and spud counts decreased by approximately 40%. These statistics show continued steady growth in oil and gas activity in the Southwest Wyoming Basin.

Tables 2-10 below present the detailed updated 2009 production statistics for the Wind River Basin, Powder River Basin and Southwest Wyoming Basin. Figures 1-3 below show the 2009 distribution of active wells in the three Wyoming basins.

Table 2. 2009 well count by well type, by county and by tribal and non-tribal designation for the Wind River Basin.

County	Well Count		
	Conventional Oil	Conventional Gas	CBM Gas
Activity Data on Non-Tribal Land			
Fremont Non-Tribal	227	743	6
Activity Data on Tribal Land			
Fremont Tribal	332	69	12
Basin-Wide Activity Data			
Fremont County-Wide	559	812	18

Table 3. 2009 production by production type, by county and by tribal and non-tribal designation for the Wind River Basin.

County	Oil Production [bbl]		Gas Production [mcf]		Water Production [bbl]
	Oil	Condensate	Conventional Gas	CBM Gas	
Activity Data on Non-Tribal Land					
Fremont Non-Tribal	924,340	417,722	156,636,786	1,064,766	66,647,162
Activity Data on Tribal Land					
Fremont Tribal	1,690,108	9,559	3,844,569	2,155,906	105,269,855
Basin-Wide Activity Data					
Fremont County-Wide	2,614,448	427,281	160,481,355	3,220,672	171,917,017

Table 4. 2009 spud counts by county for the Wind River Basin.

County	Total Number of Spuds in 2006
Activity Data on Non-Tribal Land	
Fremont Non-Tribal	37
Activity Data on Tribal Land	
Fremont Tribal	0
Basin-Wide Activity Data	
Fremont County-Wide	37

Table 5. 2009 well count by well type, by county and by tribal and non-tribal designation for the Powder River Basin.

County	Well Count		
	Conventional Oil	Conventional Gas	CBM Gas
Activity Data on Non-Tribal Land			
Campbell (WY)	1,924	128	12,073
Converse (WY)	983	59	7
Crook (WY)	472	6	0
Johnson (WY)	295	7	3,234
Natrona (WY)	1,708	282	1
Niobrara (WY)	270	9	0
Sheridan (WY)	13	6	2,925
Weston (WY)	1,252	11	0
Big Horn (MT)	0	48	847
Powder River (MT)	56	2	0
Non-Tribal Total	6,973	558	19,087
Activity Data on Tribal Land			
Campbell (WY)	0	0	0
Converse (WY)	0	0	0
Crook (WY)	0	0	0
Johnson (WY)	0	0	0
Natrona (WY)	0	0	0
Niobrara (WY)	0	0	0
Sheridan (WY)	0	0	0
Weston (WY)	0	0	0
Big Horn (MT)	38	15	0
Powder River (MT)	0	0	0
Tribal Total	38	15	0
Basin-Wide Activity Data			
Campbell (WY)	1,924	128	12,073
Converse (WY)	983	59	7
Crook (WY)	472	6	0
Johnson (WY)	295	7	3,234
Natrona (WY)	1,708	282	1
Niobrara (WY)	270	9	0
Sheridan (WY)	13	6	2,925
Weston (WY)	1,252	11	0
Big Horn (MT)	38	63	847
Powder River (MT)	56	2	0
TOTAL	7,011	573	19,087

Table 6. 2009 production by production type, by county and by tribal and non-tribal designation for the Powder River Basin.

County	Oil Production [bbl]		Gas Production [mcf]		Water Production [bbl]
	Oil	Condensate	Conventional Gas	CBM Gas	
Activity Data on Non-Tribal Land					
Campbell (WY)	7,371,754	135,063	11,732,589	128,704,069	395,379,592
Converse (WY)	1,723,578	156,624	8,185,673	96,719	6,077,379
Crook (WY)	1,513,319	22,818	42,162	0	27,987,030
Johnson (WY)	1,018,394	8,023	386,439	365,215,888	167,069,869
Natrona (WY)	4,447,000	148,515	28,996,435	565	286,229,344
Niobrara (WY)	516,104	0	2,074,612	0	12,398,567
Sheridan (WY)	25,620	0	157,383	62,772,925	116,260,911
Weston (WY)	903,610	5,605	1,861,328	0	3,873,766
Big Horn (MT)	0	0	316,017	11,949,755	34,831,790
Powder River (MT)	423,953	0	61,288	0	16,523,733
Non-Tribal Total	17,943,332	476,648	53,813,926	568,739,921	1,066,631,981
Activity Data on Tribal Land					
Campbell (WY)	0	0	0	0	0
Converse (WY)	0	0	0	0	0
Crook (WY)	0	0	0	0	0
Johnson (WY)	0	0	0	0	0
Natrona (WY)	0	0	0	0	0
Niobrara (WY)	0	0	0	0	0
Sheridan (WY)	0	0	0	0	0
Weston (WY)	0	0	0	0	0
Big Horn (MT)	58,986	0	40,870	0	2,272,753
Powder River (MT)	0	0	0	0	0
Tribal Total	58,986	0	40,870	0	2,272,753
Basin-Wide Activity Data					
Campbell (WY)	7,371,754	135,063	11,732,589	128,704,069	395,379,592
Converse (WY)	1,723,578	156,624	8,185,673	96,719	6,077,379
Crook (WY)	1,513,319	22,818	42,162	0	27,987,030
Johnson (WY)	1,018,394	8,023	386,439	365,215,888	167,069,869
Natrona (WY)	4,447,000	148,515	28,996,435	565	286,229,344
Niobrara (WY)	516,104	0	2,074,612	0	12,398,567
Sheridan (WY)	25,620	0	157,383	62,772,925	116,260,911
Weston (WY)	903,610	5,605	1,861,328	0	3,873,766
Big Horn (MT)	58,986	0	356,887	11,949,755	37,104,543
Powder River (MT)	423,953	0	61,288	0	16,523,733
TOTAL	18,002,318	476,648	53,854,796	568,739,921	1,068,904,734

Table 7. 2009 spud counts by county for the Powder River Basin.

County	Total Number of Spuds in 2006
Activity Data on Non-Tribal Land	
Campbell (WY)	182
Converse (WY)	6
Crook (WY)	38
Johnson (WY)	155
Natrona (WY)	65
Niobrara (WY)	16
Sheridan (WY)	34
Weston (WY)	12
Big Horn (MT)	21
Powder River (MT)	0
Non-Tribal Total	529
Activity Data on Tribal Land	
Campbell (WY)	0
Converse (WY)	0
Crook (WY)	0
Johnson (WY)	1
Natrona (WY)	0
Niobrara (WY)	0
Sheridan (WY)	0
Weston (WY)	0
Big Horn (MT)	0
Powder River (MT)	0
Tribal Total	1
Basin-Wide Activity Data	
Campbell (WY)	182
Converse (WY)	6
Crook (WY)	38
Johnson (WY)	156
Natrona (WY)	65
Niobrara (WY)	16
Sheridan (WY)	34
Weston (WY)	12
Big Horn (MT)	21
Powder River (MT)	0
TOTAL	530

Table 8. 2009 well count by well type and by county for the Southwest Wyoming Basin.

County	Well Count		
	Conventional Gas	Conventional Oil	CBM Gas
Albany (WY)	2	38	0
Carbon (WY)	1447	182	264
Lincoln (WY)	1,353	93	0
Sublette (WY)	3,987	401	0
Sweetwater (WY)	2,975	314	20
Teton (WY)	0	0	0
Uinta (WY)	349	93	1
Daggett (UT)	16	0	0
Summit (UT)	31	14	0
TOTAL	10,160	1,135	285

Table 9. 2009 production by production type and by county for the Southwest Wyoming Basin.

County	Oil Production [bbl]		Gas Production [mcf]		Water Production [bbl]
	Condensate	Oil	Conventional Gas	CBM Gas	
Albany (WY)	0	54,239	6,531	0	4,137,842
Carbon (WY)	1,147,137	639,296	107,741,173	19,668,040	24,682,263
Lincoln (WY)	610,165	206,798	83,343,777	0	1,274,201
Sublette (WY)	7,517,775	426,845	1,193,775,264	0	3,640,698
Sweetwater (WY)	2,056,923	3,125,629	229,045,298	500,593	53,507,298
Teton (WY)	0	0	0	0	0
Uinta (WY)	527,465	593,018	107,393,365	69,969	2,987,999
Daggett (UT)	411	0	588,648	0	1,010
Summit (UT)	101,225	169,922	8,221,128	0	6,263,282
TOTAL	11,961,101	5,215,747	1,730,115,184	20,238,602	96,494,593

Table 10. 2009 spud counts by county for the Southwest Wyoming Basin.

County	Total Number of Spuds in 2009
Albany (WY)	1
Carbon (WY)	81
Lincoln (WY)	3
Sublette (WY)	392
Sweetwater (WY)	197
Teton (WY)	0
Uinta (WY)	14
Daggett (UT)	1
Summit (UT)	0
TOTAL	689

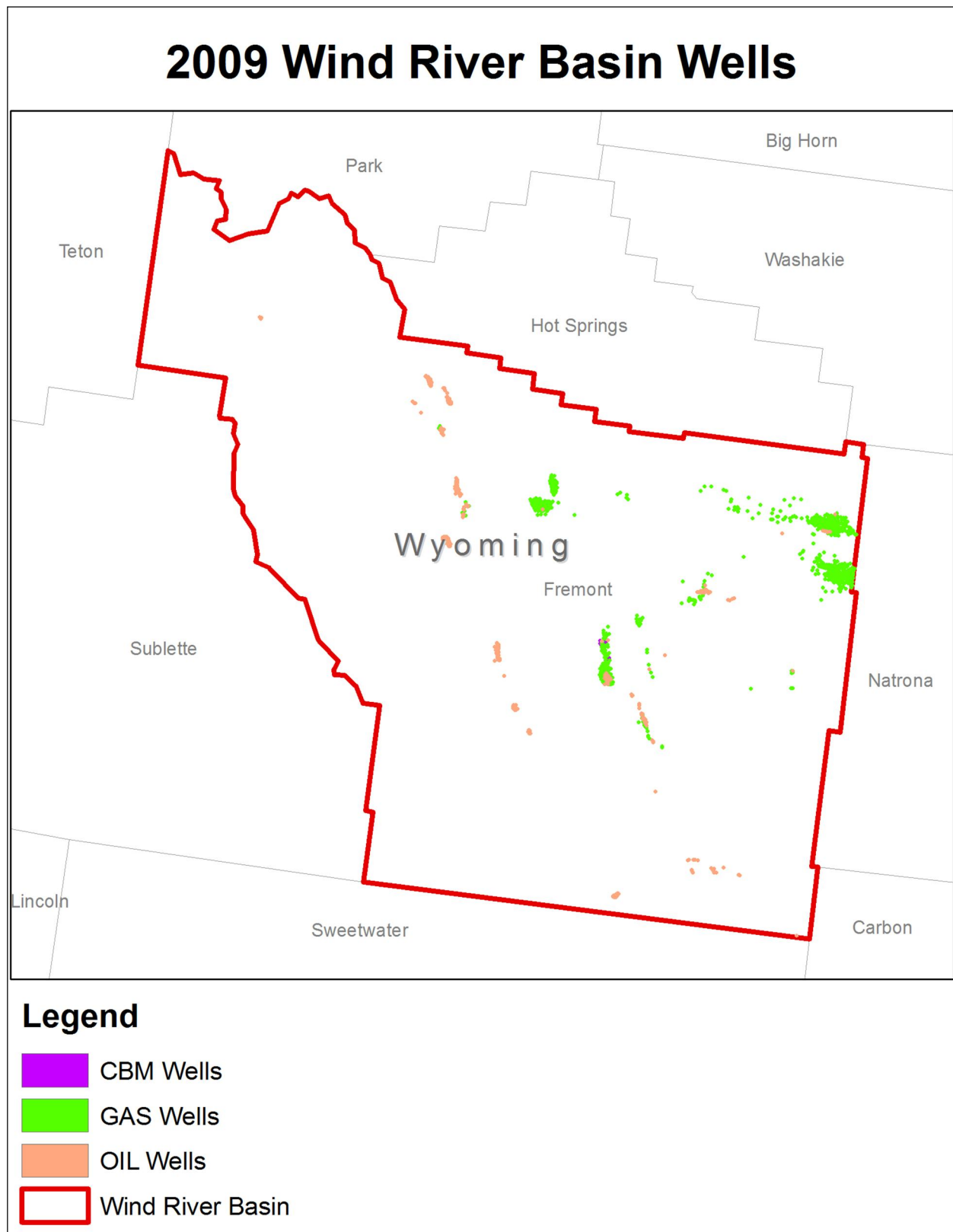
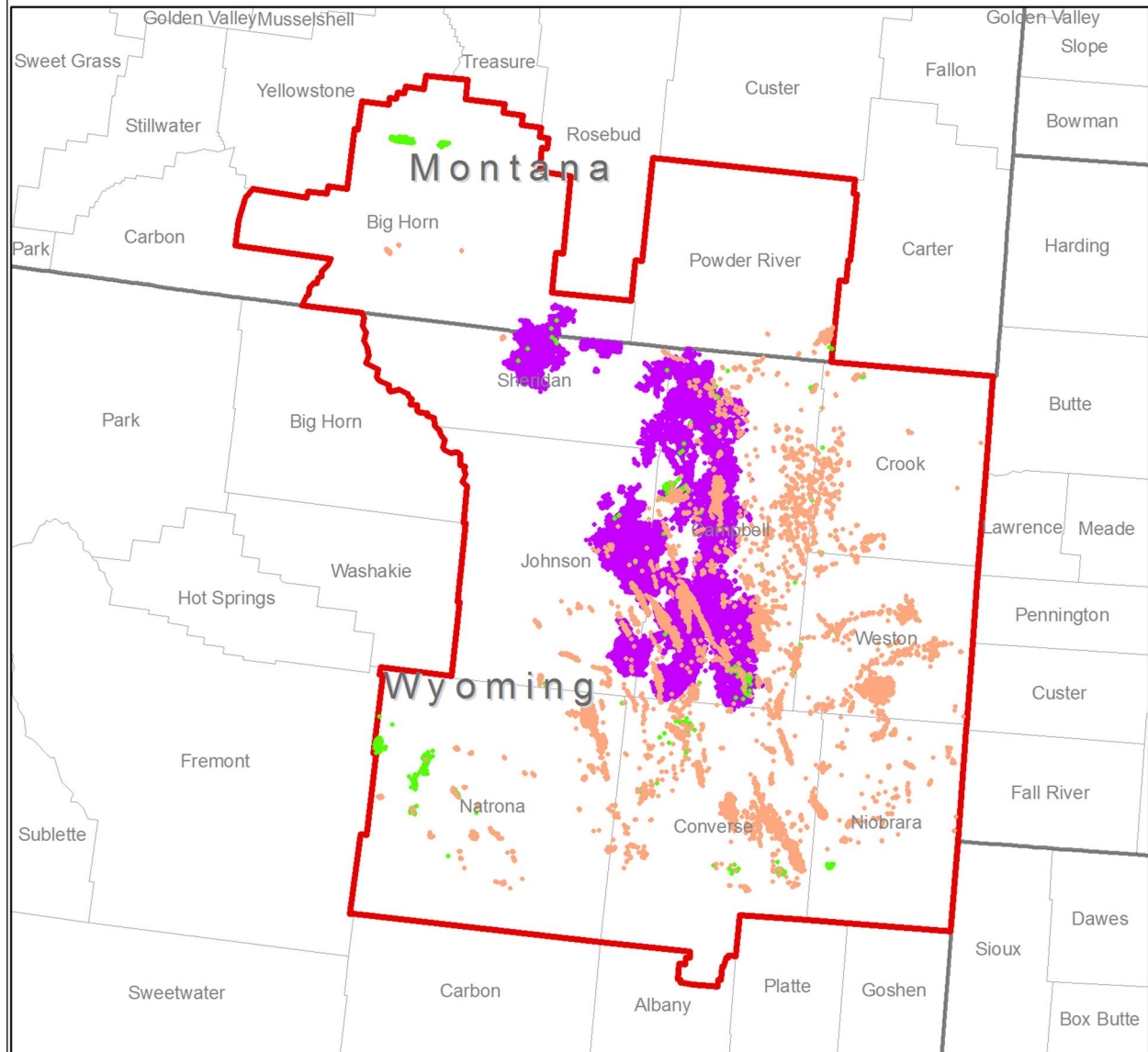


Figure 1. Wind River Basin boundaries overlaid with 2009 oil and gas well locations.¹

¹ Includes data supplied by IHS Inc., its subsidiary and affiliated companies; Copyright (2009) all rights reserved.

2009 Powder River Basin Wells



Legend

- CBM Wells
- GAS Wells
- OIL Wells
- Powder River Basin

Figure 2. Powder River Basin boundaries overlaid with 2009 oil and gas well locations.²

² Includes data supplied by IHS Inc., its subsidiary and affiliated companies; Copyright (2009) all rights reserved.

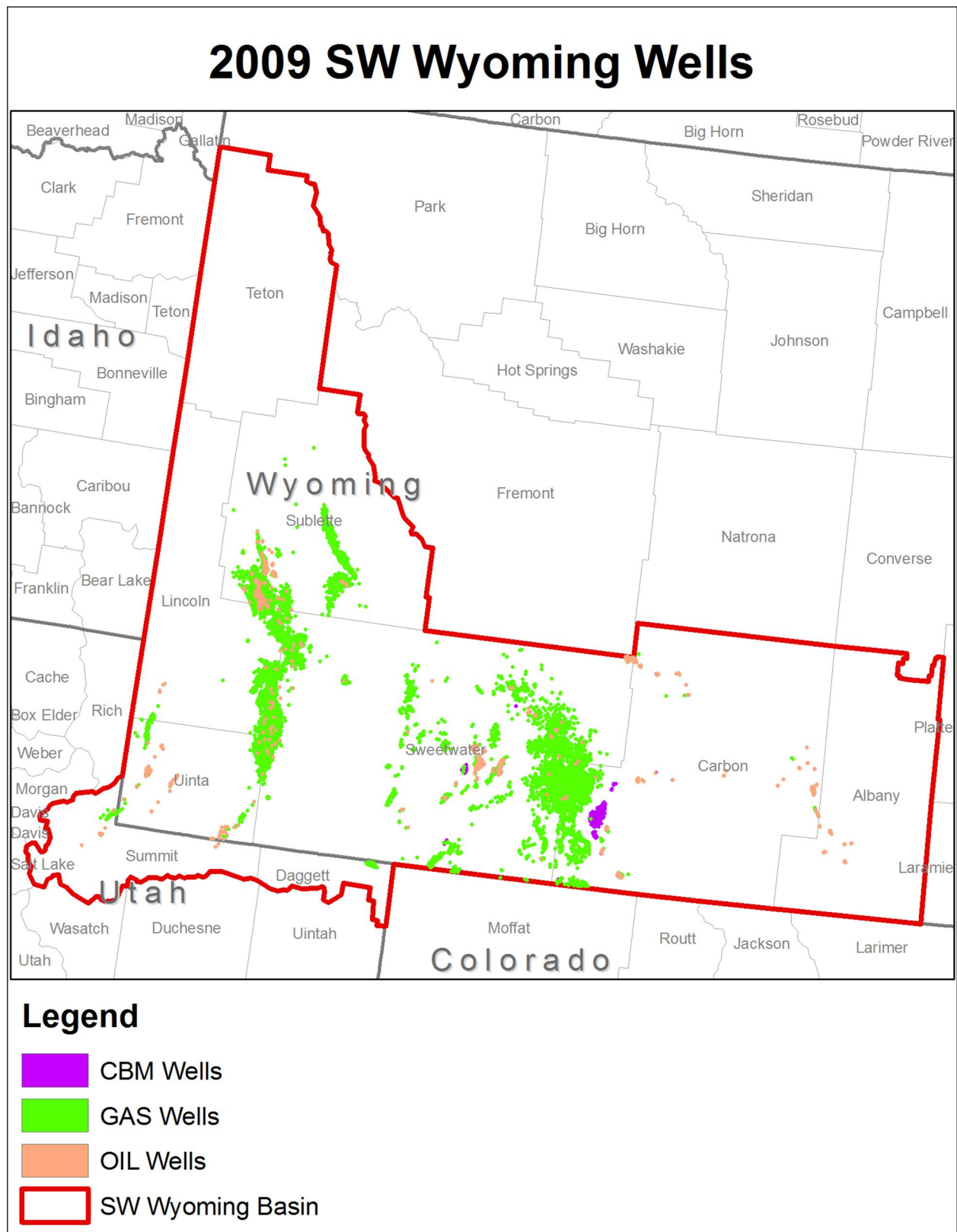


Figure 3. Southwest Wyoming Basin boundaries overlaid with 2009 oil and gas well locations.³

³ Includes data supplied by IHS Inc., its subsidiary and affiliated companies; Copyright (2009) all rights reserved.

Survey Data Updates

Survey requests were sent to the group of operators who participated in the baseline 2006 inventory development for each basin. Operators responding to the 2009 survey update requests were provided the opportunity to update basic equipment assumptions, activity assumptions, process assumptions (for categories such as well venting, and gas dehydration), and controls assumptions. If a 2009 survey update was not provided by the operator, it was assumed that the activity/process/equipment data for that operator remained unchanged from their 2006 baseline data. The survey instrument developed for the 2009 updates was essentially identical to that developed for the 2006 baseline, and included all source categories which were estimated based on survey data and natural gas compositions in each basin. For the three Wyoming Basins this included the following source categories:

<u>Wind River Basin</u>	<u>Powder River Basin</u>	<u>Southwest Wyoming Basin</u>
Amine Units	Artificial Lift	Well Blowdown
Artificial Lift	Well Blowdown	Well Completions/Recompletions
Well Blowdown	CBM Pump Engines	Compressor Startups/Shutdowns
Well Completions/Recompletions	Well Completions/Recompletions	Dehydrators
Compressor Engines	Wellhead Compressors	Drilling Rigs
Compressor Startups/Shutdowns	Compressor Startups/Shutdowns	Flaring
Dehydrators	Dehydrators	Fugitives
Drilling Rigs	Drilling Rigs	Heaters
Flaring	Flaring	Oil and Gas Well Truck Loading
Fugitives	Fugitives	Pneumatic Devices
Heaters	Heaters	Pneumatic Pumps
Miscellaneous Engines	Miscellaneous Engines	Oil and Condensate Tanks
Oil and Gas Well Truck Loading	Oil and Gas Well Truck Loading	Workover Rigs
Pneumatic Devices	Pneumatic Devices	
Pneumatic Pumps	Pneumatic Pumps	
Oil and Condensate Tanks	Oil and Condensate Tanks	
Workover Rigs	Workover Rigs	

As noted in the development of the 2006 baseline emissions inventory for the Southwest Wyoming Basin, data and emissions for engine categories (compressor engines and miscellaneous engines) for this basin were obtained directly from permit data.

Tables 11-13 show the percentage ownership of production and well counts represented by survey respondents for the 2006 baseline, and 2009 updates for all Wyoming basins.

Table 11. Percentage ownership of basin-wide production by survey respondents for the Wind River Basin

	Percent Ownership of Basin-Wide Production – Wind River Basin		
	2006 Participating Companies	2009 Survey Update Respondents	2009 All Companies ^a
Well Count	54%	35%	52%
Gas Production	97%	20%	96%
Oil Production	23%	23%	25%

a – all companies includes those responding to the 2009 survey update request and those companies for which baseline 2006 survey data was used

Table 12. Percentage ownership of basin-wide production by survey respondents for the Powder River Basin.

	Percent Ownership of Basin-Wide Production – Powder River Basin		
	2006 Participating Companies	2009 Survey Update Respondents	2009 All Companies ^a
Well Count	30%	20%	34%
Gas Production	46%	33%	55%
Oil Production	24%	29%	38%

a – all companies includes those responding to the 2009 survey update request and those companies for which baseline 2006 survey data was used

Table 13. Percentage ownership of basin-wide production by survey respondents for the Southwest Wyoming Basin.

	Percent Ownership of Basin-Wide Production – Southwest Wyoming Basin		
	2006 Participating Companies ^a	2009 Survey Update Respondents	2009 All Companies ^b
Well Count	60%	14%	61%
Gas Production	78%	6%	78%
Oil Production	59%	6%	62%

a – participating companies in the 2006 baseline inventory included those providing survey data and all companies that provided data to the WYDEQ for the Jonah-Pinedale inventory

b – all companies includes those responding to the 2009 survey update request, those companies for which baseline 2006 survey data was used, and those companies that provided data to the WYDEQ for the Sublette County inventory

In the Wind River Basin, it is noted that percentages of well count and oil production ownership do not reach the 70% targets set for the Phase III basins, but as with the baseline inventory for the Wind River it was determined that the inventory would proceed with the survey responses received. The percentage ownership representation for the 2009 update for the Wind River Basin does not change substantially from the 2006 baseline. Similarly for the Powder River Basin, neither the 2006 baseline nor 2009 updates achieve the 70% targets, but it is noted that there is an increase in the percentage ownership representation for oil production and gas production in the 2009 Powder River Basin update. Percentage ownership in the Southwest Wyoming Basin is considered reasonable for both the 2006 baseline and 2009 updates. It is noted that this percentage ownership representation is achieved in part by making use of the WYDEQ's extensive surveys and inventories for the Jonah-Pinedale Anticline Development (JPAD) area in the 2006 baseline, and the expanded WYDEQ inventory for all of Sublette County in the 2009 update. These are described more below.

Similar to the 2006 baseline inventory, the 2009 updated survey data for responding companies were combined with 2006 survey data for non-responding companies and aggregated. The aggregation used a by-company weighted average methodology, and the weighting factor was assigned based on the surrogate cross-reference for each source category (i.e. gas production, well count, oil production, etc.) similar to the methodology for the 2006 baseline inventory. Surrogates were assigned to operators based on their percentage ownership of the surrogate in the basin in 2009.

Similar to the 2006 baseline inventory methodology, the basin-wide emissions for survey-based source categories were estimated by scaling the aggregated survey data from participating companies by the appropriate basin-wide surrogate. For tribal land in the Wind River and Powder River Basins, the allocation of emissions to tribal land was based on the fraction of the surrogate occurring on tribal land for each source category.

Midstream Facility and Stationary Engine Updates

Data on midstream facilities and stationary engines previously obtained from the WYDEQ for the 2006 baseline inventories for each basin were updated to 2009 data. The methodology for querying permitted sources and inventory databases were identical to those used in the 2006 baseline inventories for all three Wyoming basins. There are four principal sources of information for these sources which were utilized. These are listed below with a description of the methodology by which they were incorporated:

- (1) **WYDEQ Permitted Sources Data** – this database contained by-facility and by-source emissions for all permitted facilities in the three Wyoming basins. Excluded from this were production site sources for which emissions were generally estimated using the survey-based calculations described above. This also included all Title V sources within the boundaries of the three Wyoming Basins.
- (2) **Engines Data from WYDEQ Inventory Database** – in addition to the permitted sources data, WYDEQ provided emissions from an inventory database for engines operating throughout the three Wyoming basins. These engine emissions were used in place of engines at the permitted facilities described in (1) above, with the exception of Title V sources for which emissions from the permitted sources data were retained. This engine emissions data was used for the compressor engine and miscellaneous engine source categories.
- (3) **WYDEQ UGRB Inventory** – for the analysis of ozone impacts in the Southwest Wyoming Basin, the WYDEQ compiled a highly detailed comprehensive inventory of all oil and gas sources (production site and midstream) for the Upper Green River Basin (UGRB), which is defined in Figure 4 below. The WYDEQ UGRB inventory included all sources in Sublette County, and portions of Uinta and Sweetwater Counties. Because of the difficulty in reconciling the partial WYDEQ inventories in Uinta and Sweetwater Counties with the sources in the remaining parts of these counties, the WYDEQ UGRB inventory was used only for Sublette County in its entirety.
- (4) **EPA Part 71 Sources on Tribal Land** – a request was made to EPA for any updates to the permit data provided by EPA for Part 71 sources in the Wind River and Powder River Basins for the 2006 baseline inventories. No updates were indicated, and therefore the emissions from the 2006 baseline inventories were used directly in the 2009 updates.

As noted in data source (3) above, the WYDEQ developed a highly detailed and comprehensive inventory for the UGRB for 2009. The definition of the UGRB is shown below in Figure 4. The UGRB inventory covers portions of Uinta and Sweetwater Counties, however it was determined to be difficult to reconcile these partial inventories with the bottom-up estimates of emissions for the remainder of these counties. Therefore the UGRB inventory was not used for Uinta and Sweetwater Counties. The UGRB inventory was used in its entirety for Sublette County. The UGRB inventory is described in this report under the “permitted sources” category, but it should be noted that the inventory includes all production-site and midstream sources in Sublette County.

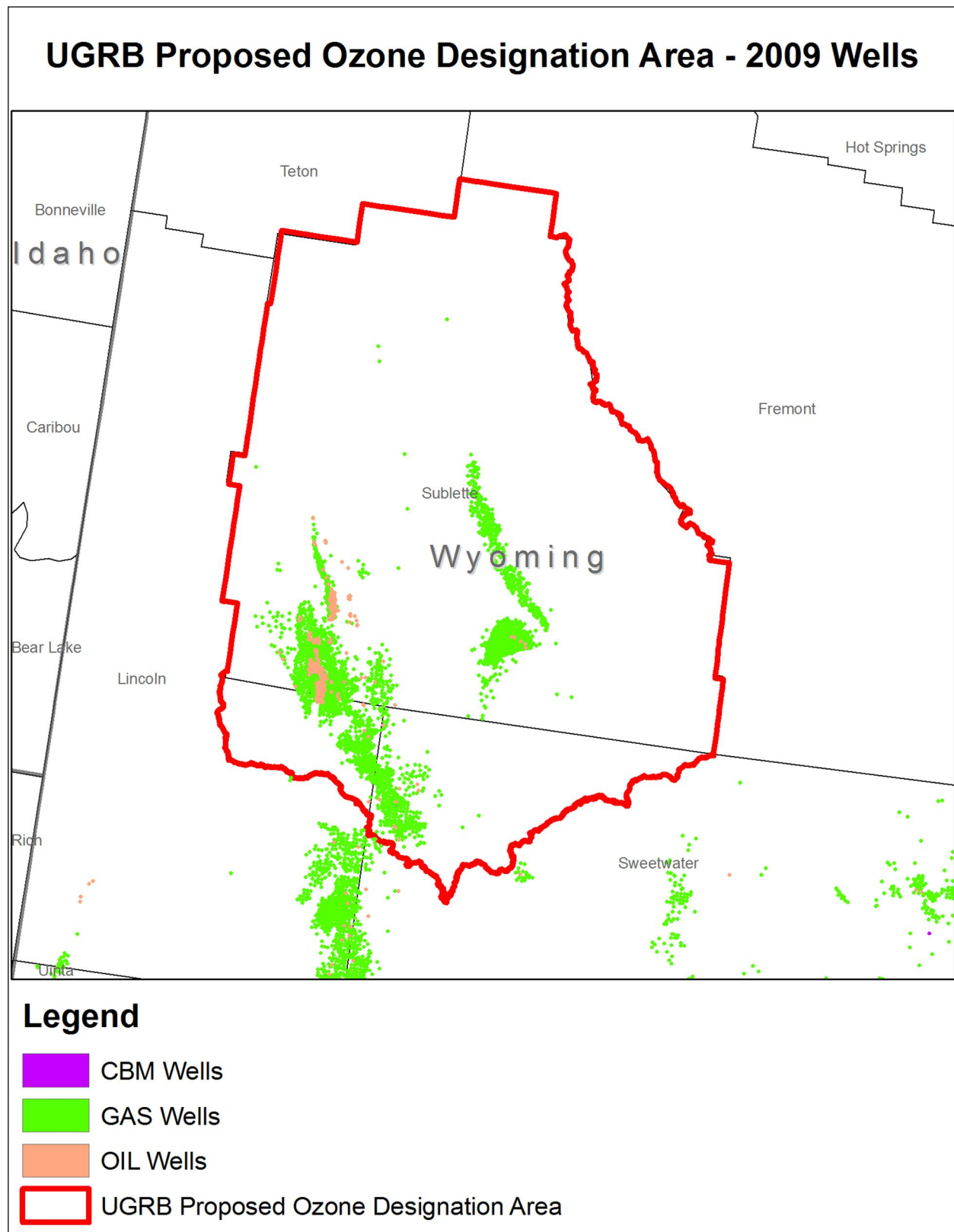


Figure 4. WYDEQ Upper Green River Basin (UGRB) proposed ozone designation area boundaries overlaid with 2009 oil and gas well locations.⁴

⁴ Includes data supplied by IHS Inc., its subsidiary and affiliated companies; Copyright (2009) all rights reserved.

Summary Inventories

The permitted sources emissions and estimated basin-wide survey-based sources emissions are summed together to develop complete basin-wide inventories for each of the three Wyoming basins. County-level emissions are developed by allocating fractions of the basin-wide emissions to each county based on the fraction of each surrogate occurring in that county. As noted above, Sublette County in the Southwest Wyoming Basin is an exception in that the complete WYDEQ UGRB inventory for Sublette is used in place of any other emissions estimates for that county.

RESULTS

Results are presented below for the 2009 updated inventories for the Wind River Basin, Powder River Basin and Southwest Wyoming Basin. For each basin, the summary inventory results are compared to the 2006 inventories and trends are discussed. Detailed results are presented by source category, by county, and by tribal and non-tribal land.

Wind River Basin

Table 14 below shows the summary results of the 2009 updated Wind River Basin inventory in comparison to the original 2006 baseline inventory. Gas production has declined in the Wind River Basin during this period, and this decline is observed in the VOC emissions reductions. Changes in NO_x emissions are primarily the result of the improvements in the accuracy and completeness of the WYDEQ permitted sources data, as most of the NO_x emissions in the Wind River Basin are from engines for which emissions were obtained from the WYDEQ engines database. SO_x emissions in the Wind River Basin in both 2009 and 2006 are primarily from the Lost Cabin Gas Plant, and increases are the result of updates to the actual emissions from this facility in the WYDEQ permit database.

Table 14. Summary results for the 2009 update for the Wind River Basin and comparison to 2006 baseline.

	NO _x [tpy]	VOC [tpy]	CO [tpy]	SO _x [tpy]	PM [tpy]
2009 Update	1,886	11,289	4,296	2,484	32
2006 Baseline	1,814	11,981	2,840	1,792	37
% Change	+4.0%	-5.8%	+51.3%	+38.6%	-12.9%

Table 15 below shows the breakdown of 2009 updated emissions for the Wind River Basin by tribal and non-tribal land in Fremont County. The majority of sources are located on non-tribal land in the Wind River Basin, but there is a significant fraction of VOC emissions occurring on tribal land. These are mainly driven by the oil and condensate production on tribal land. Tables 16 and 17 show the 2009 NO_x and VOC emissions by source category, respectively, in the Wind River Basin.

Table 15. 2009 emissions of all criteria pollutants by county for the Wind River Basin.

County	NO _x [tons/yr]	VOC [tons/yr]	CO [tons/yr]	SO _x [tons/yr]	PM [tons/yr]
Fremont (Tribal)	411	2,447	484	80	5
Fremont (Nontribal)	1,475	8,843	3,812	2,404	27
Fremont Total	1,886	11,289	4,296	2,484	32

Figures 5 and 6 show the Wind River Basin 2009 tribal and non-tribal emissions of NO_x and VOC respectively, and Figures 7 and 8 show the Wind River Basin 2009 NO_x and VOC emissions distributions by source category respectively. 2009 NO_x emissions in the Wind River Basin are dominated by compressor engines, similar to the findings of the 2006 baseline inventory. 2009 VOC emissions in the Wind River Basin are a combination of pneumatic devices, venting from well blowdowns and dehydration, accounting for approximately 79% of total 2009 basin-wide VOC emissions.

Table 16. 2009 NOx emissions by source category for the Wind River Basin.

County	Compressor Engines	Drill Rigs	Heaters	Workover Rigs	Artificial Lift	Dehydrators	Other Categories	Total
Fremont (Tribal)	330	0	30	19	28	1	3	411
Fremont (Nontribal)	1,078	54	96	44	16	7	181	1,475
Fremont Total	1,408	54	126	62	44	8	184	1,886

Table 17. 2009 VOC emissions by source category for the Wind River Basin.

County	Compressor Engines	Drill Rigs	Heaters	Pneumatic Devices	Pneumatic Pumps	Venting - Blowdowns	Dehydrators	Condensate Tanks	Oil Tanks	Fugitives	Other Categories	Total
Fremont (Tribal)	14	0	1	1,638	99	86	36	15	296	122	140	2,447
Fremont (Nontribal)	310	6	5	3,870	234	2,251	959	662	162	229	154	8,843
Fremont Total	324	6	6	5,507	333	2,337	996	677	458	352	294	11,289

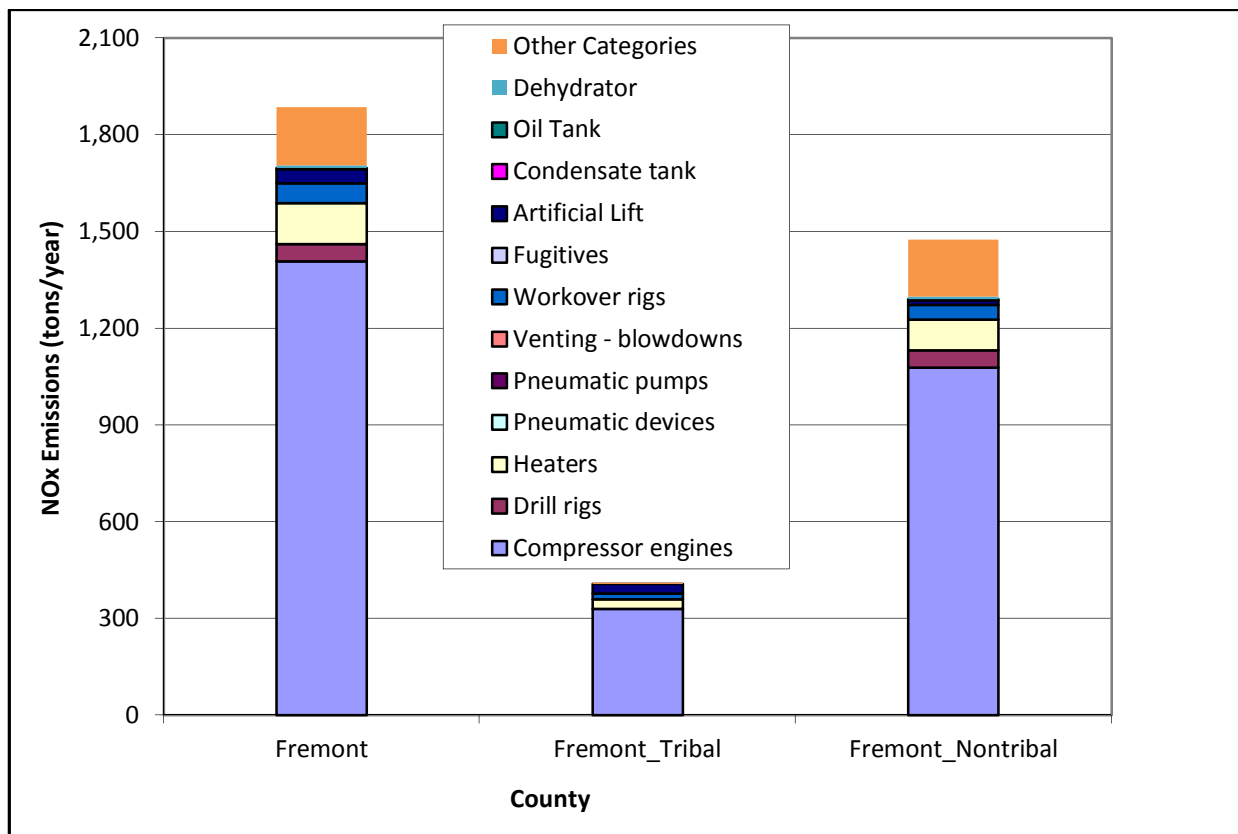


Figure 5. 2009 NOx emissions by tribal and non-tribal land in the Wind River Basin.

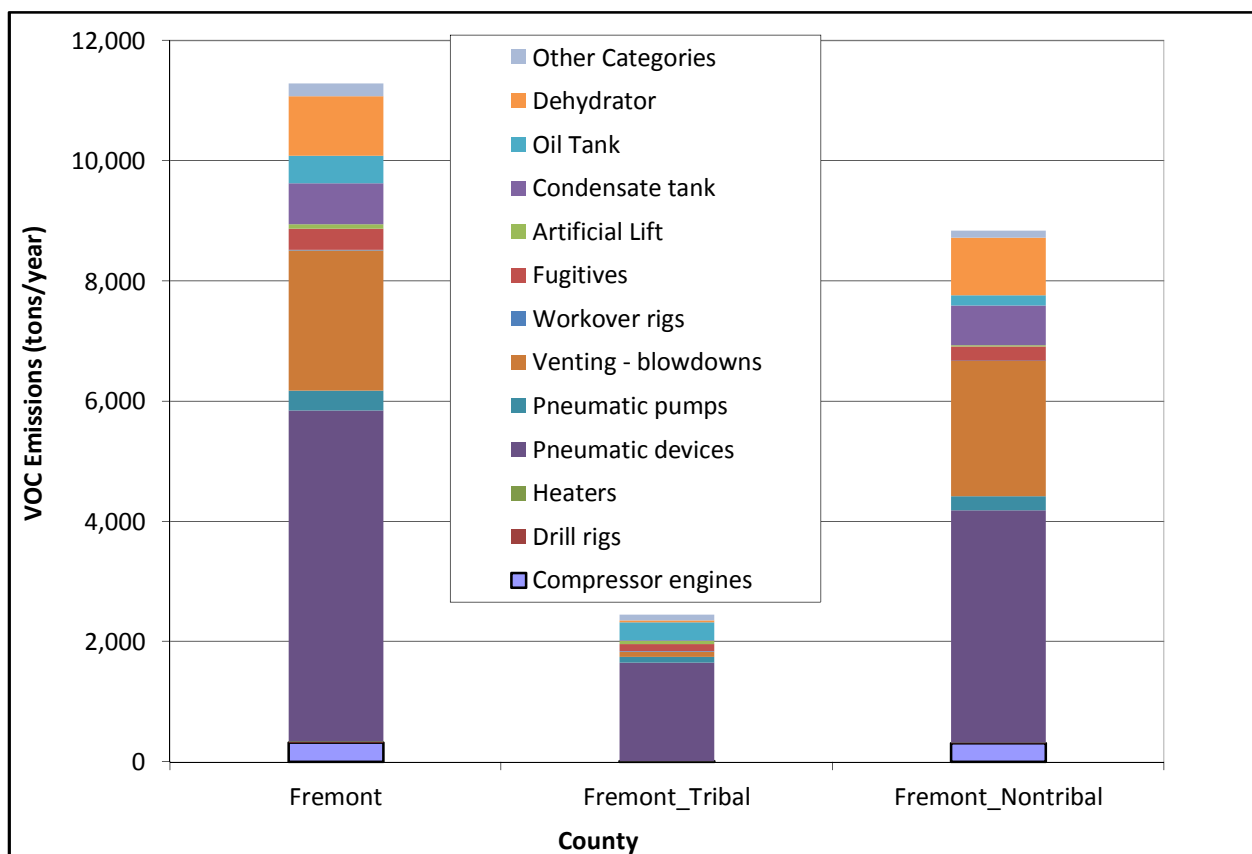


Figure 6. 2009 VOC emissions by tribal and non-tribal land in the Wind River Basin.

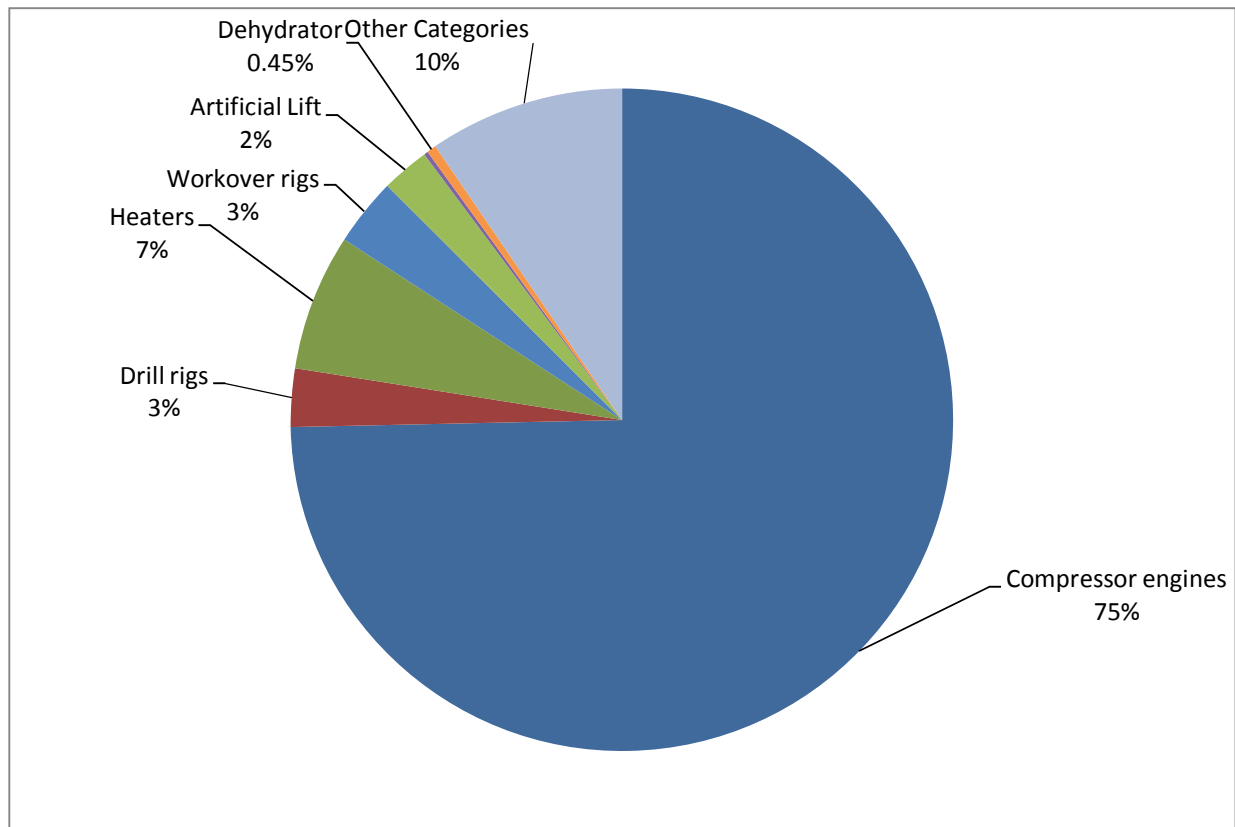


Figure 7. Wind River Basin 2009 NOx emissions proportional contributions by source category.

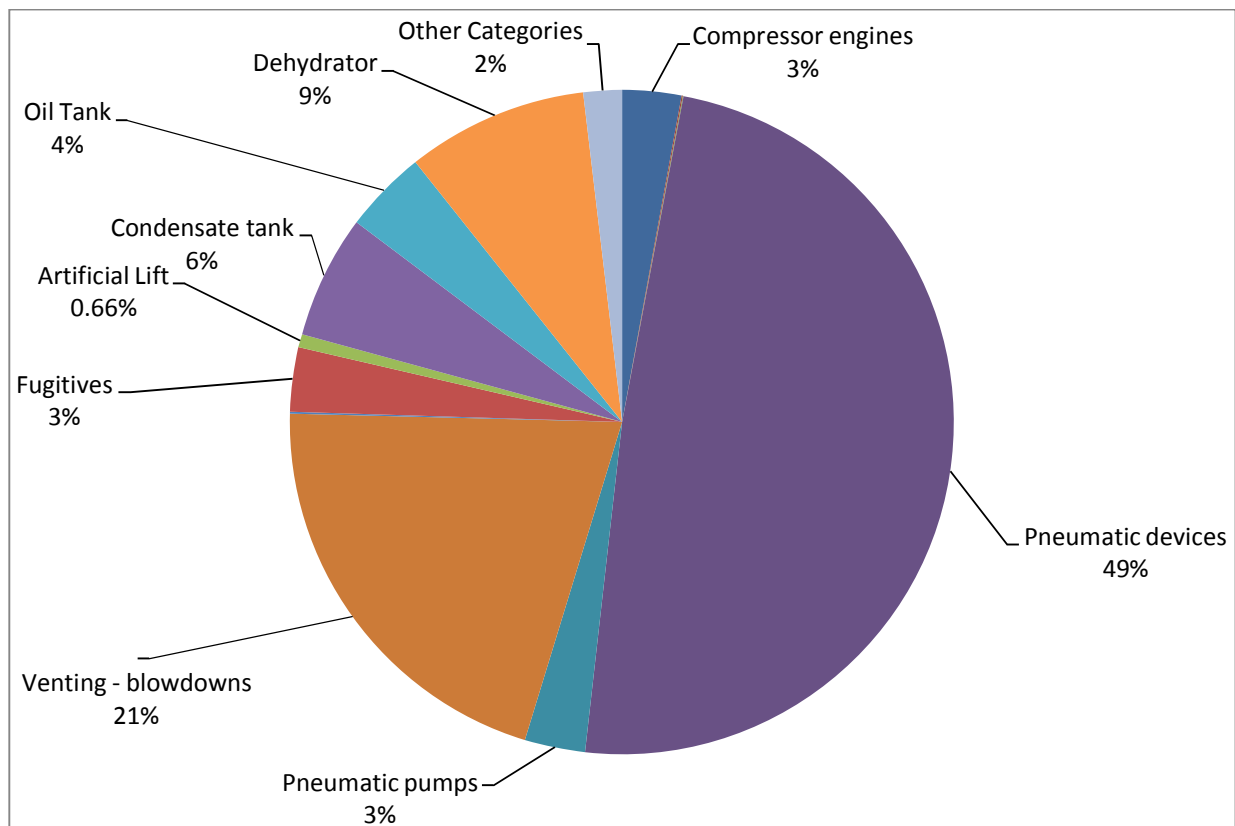


Figure 8. Wind River Basin 2009 VOC emissions proportional contributions by source category.

Powder River Basin

Table 18 below shows the summary results of the 2009 updated Powder River Basin inventory in comparison to the original 2006 baseline inventory. Gas production has increased significantly in the Powder River Basin during this period. Although the Wyoming BACT requirements for engines require new and modified engines to meet the 2 g/bhp-hr or 1 g/bhp-hr NO_x standards during this period, NO_x emissions increases are observed. This may be due to a combination of improved data accuracy and completeness in the 2009 engine inventory data compiled by WYDEQ, under-utilization of engines in 2006 such that the increase in gas production did not lead to new engine installation, and some growth in the overall population of engines due to increases in the number of wells from 2006 to 2009. VOC emissions increases are seen to largely track the increases in gas production, although the minor increases in oil and condensate production have significant impact on the VOC emissions since the primary gas production in the Powder River Basin is low-VOC CBM gas. Drilling has declined significantly from 2006 to 2009 in the Powder River Basin. SO_x emissions are dominated by drilling rigs and therefore a significant decrease in SO_x emissions basin-wide are observed in this period.

Table 18. Summary results for the 2009 update for the Powder River Basin and comparison to 2006 baseline.

	NO _x [tpy]	VOC [tpy]	CO [tpy]	SO _x [tpy]	PM [tpy]
2009 Update	31,647	22,136	25,151	93	578
2006 Baseline	21,086	14,367	12,873	609	681
% Change	+50.1%	+54.1%	+95.4%	-84.7%	-15.2%

Table 19 below shows the breakdown of 2009 updated emissions for the Powder River Basin by county and by tribal and non-tribal land. The vast majority of sources and emissions are located on non-tribal land in the Powder River Basin, consistent with the findings of the 2006 baseline inventory. Tables 20 and 21 show the 2009 NO_x and VOC emissions by source category, respectively, in the Powder River Basin.

Table 19. 2009 emissions of all criteria pollutants by county for the Powder River Basin.

County	NO _x [tons/yr]	VOC [tons/yr]	CO [tons/yr]	SO _x [tons/yr]	PM [tons/yr]
Campbell (WY)	16,089	10,314	12,303	44	283
Converse (WY)	2,320	1,400	1,904	3	22
Crook (WY)	131	342	113	2	11
Johnson (WY)	6,160	3,987	3,989	16	95
Natrona (WY)	1,734	2,549	1,261	9	48
Niobrara (WY)	144	239	134	1	6
Sheridan (WY)	4,091	2,132	3,745	9	59
Weston (WY)	359	900	372	4	24
Big Horn (MT)	599	220	1,312	5	27
Powder River (MT)	19	54	17	0	1
Big Horn (MT) Non-Tribal	371	184	1,186	5	25
Big Horn (MT) Tribal	228	36	126	0	2
Totals	31,647	22,136	25,151	93	578
Total Tribal	228	36	126	0	2
Total Nontribal	31,419	22,100	25,024	93	576

Figures 9 and 10 show the Powder River Basin 2009 by-county emissions of NO_x and VOC respectively, and Figures 11 and 12 show the Powder River Basin 2009 NO_x and VOC emissions distributions by source category respectively. 2009 NO_x emissions in the Powder River Basin are dominated by compressor engines. Due to the significant reduction in drilling activity in the basin in 2009, drilling rigs are a much smaller portion of the total basin-wide NO_x emissions in the 2009 updated inventory than in the 2006 baseline inventory. 2009 VOC emissions in the Powder River Basin are also dominated by compressor engine exhaust VOC emissions, with additional VOC emissions from pneumatic devices and fugitive emissions. This differs from the findings in the 2006 baseline inventory, in which compressor engine exhaust emissions were a significantly smaller portion of the basin-wide VOC and pneumatic devices were a significantly larger portion. This may be due to a combination of the increase in compressor emissions and updated information on the use of low-bleed pneumatic devices in 2009.

Table 20. 2009 NOx emissions by source category for the Powder River Basin.

County	Compressor Engines	Drill Rigs	Heaters	Miscellaneous Engines	Artificial Lift	Dehydrators	Other Categories	Total
Campbell (WY)	13,027	61	396	2,051	125	18	410	16,089
Converse (WY)	1,972	2	89	152	29	5	70	2,320
Crook (WY)	0	13	12	69	26	0	11	131
Johnson (WY)	5,174	52	97	514	17	20	287	6,160
Natrona (WY)	1,221	22	61	289	76	8	56	1,734
Niobrara (WY)	75	5	7	41	9	1	6	144
Sheridan (WY)	3,462	11	74	428	0	2	114	4,091
Weston (WY)	94	4	33	183	15	1	28	359
Big Horn (MT)	184	7	25	138	1	0	244	599
Powder River (MT)	1	0	1	8	7	0	1	19
Big Horn (MT) Non-Tribal	184	7	23	130	0	0	27	371
Big Horn (MT) Tribal	0	0	1	8	1	0	217	228
Totals	25,211	178	795	3,873	306	55	1,228	31,647
Total Tribal	0	0	1	8	1	0	217	228
Total Nontribal	25,210	178	794	3,866	305	55	1,011	31,419

Table 21. 2009 VOC emissions by source category for the Powder River Basin.

County	Compressor Engines	Drilling Rigs	Venting - Initial Completion	Venting - Recompletion	Fugitives	Misc. Engines	Dehydrator	Oil Well Truck Loading	Pneumatic Devices	Oil Tanks	Condensate Tanks	Other Categories	Totals
Campbell (WY)	7,737	9	13	200	473	247	225	230	514	158	130	376	10,314
Converse (WY)	288	0	0	3	304	18	113	54	261	37	94	226	1,400
Crook (WY)	0	2	1	10	92	8	1	47	120	33	14	16	342
Johnson (WY)	3,607	8	2	25	66	62	6	32	76	22	17	65	3,987
Natrona (WY)	376	3	4	69	406	35	418	139	499	96	147	357	2,549
Niobrara (WY)	5	1	0	2	73	5	29	16	70	11	1	26	239
Sheridan (WY)	1,961	2	0	0	4	51	2	1	5	1	24	81	2,132
Weston (WY)	42	1	1	8	242	22	26	28	317	19	158	37	900
Big Horn (MT)	130	1	0	1	20	17	8	2	25	1	0	15	220
Powder River (MT)	0	0	0	0	11	1	1	13	15	9	0	4	54
Big Horn (MT) Non-Tribal	130	1	0	1	9	16	7	0	12	0	0	8	184
Big Horn (MT) Tribal	0	0	0	0	10	1	1	2	13	1	0	8	36
Totals	14,147	27	21	319	1,691	466	827	561	1,901	387	585	1,203	22,136
Total Tribal	0	0	0	0	10	1	1	2	13	1	0	8	36
Total Nontribal	14,147	27	21	319	1,681	465	827	560	1,888	386	585	1,195	22,100

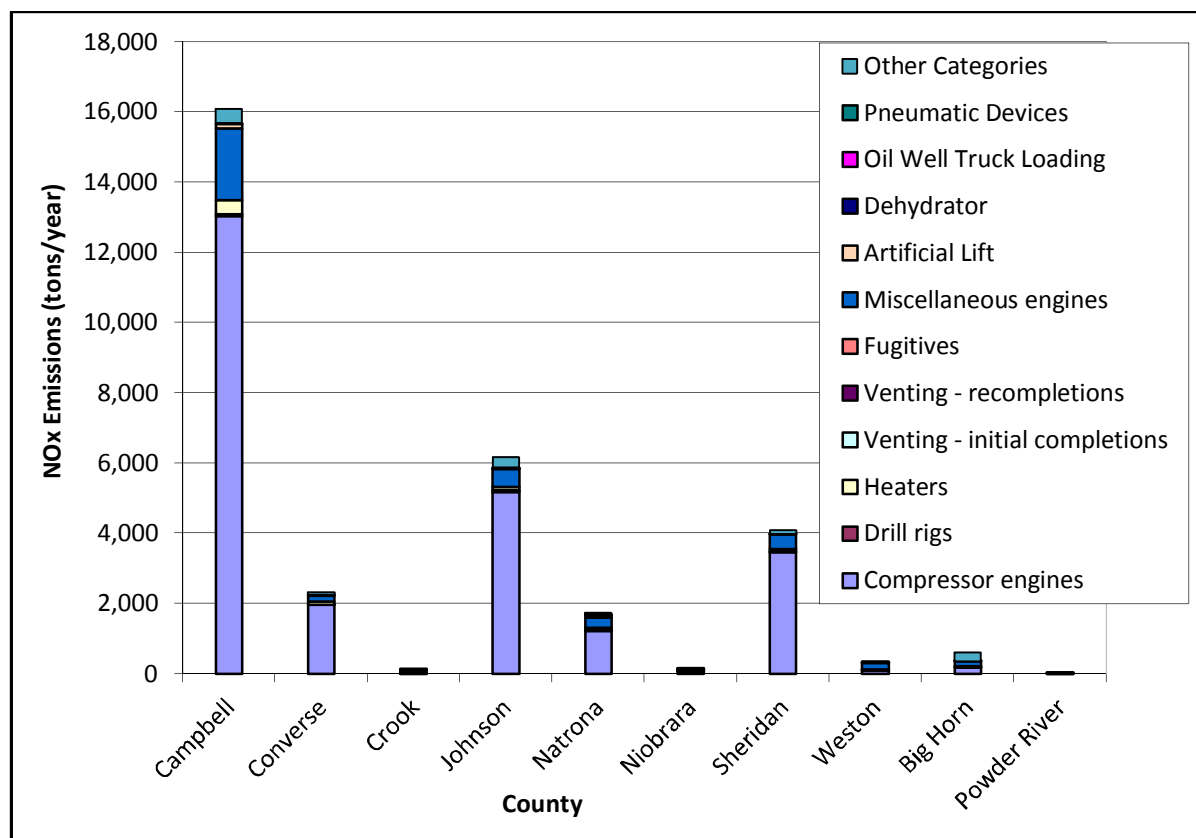


Figure 9. 2009 NOx emissions by county and by source category in the Powder River Basin.

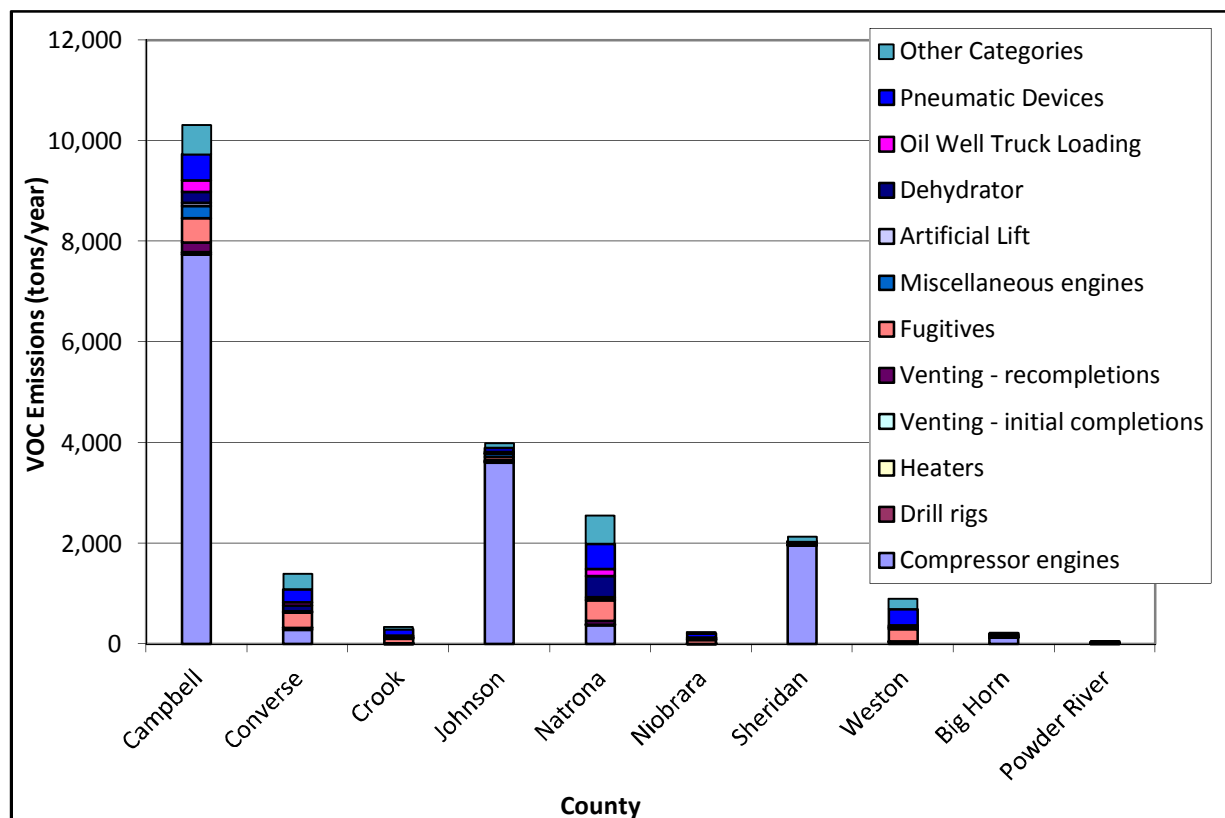


Figure 10. 2009 VOC emissions by county and by source category in the Powder River Basin.

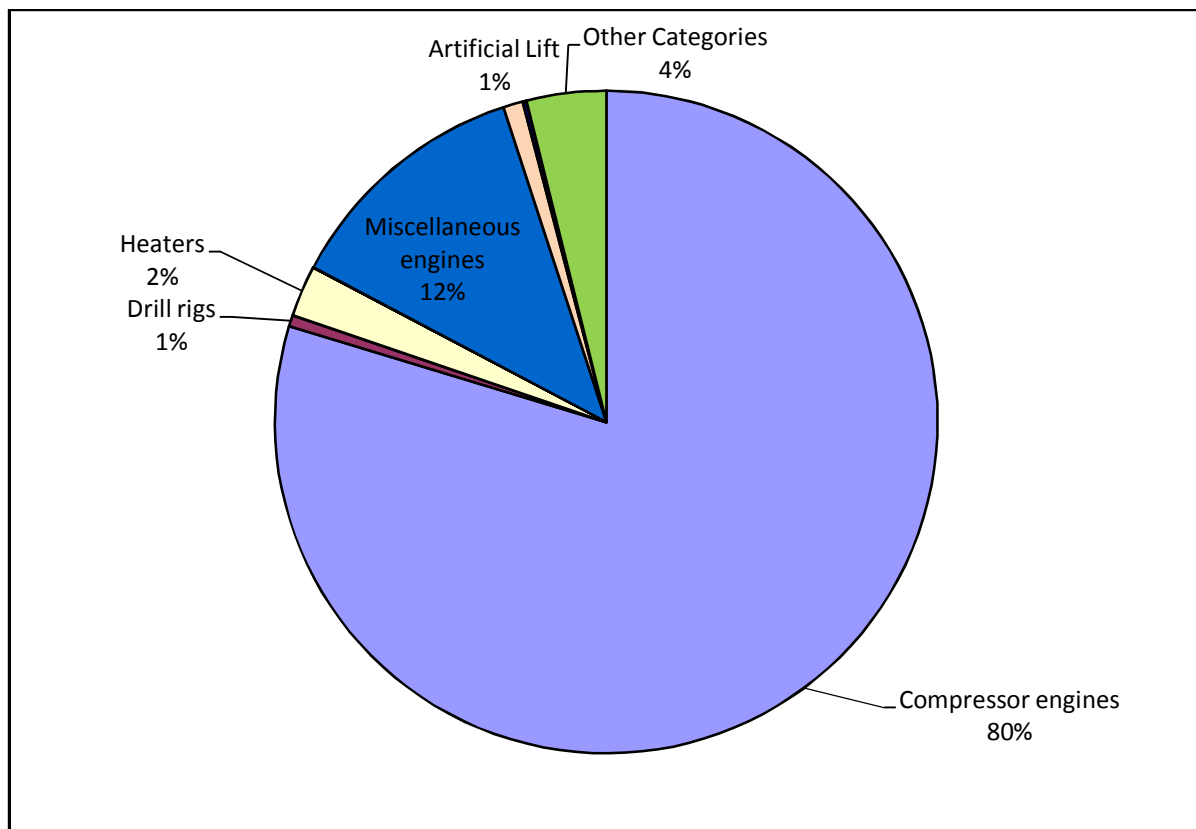


Figure 11. Powder River Basin 2009 NOx emissions proportional contributions by source category.

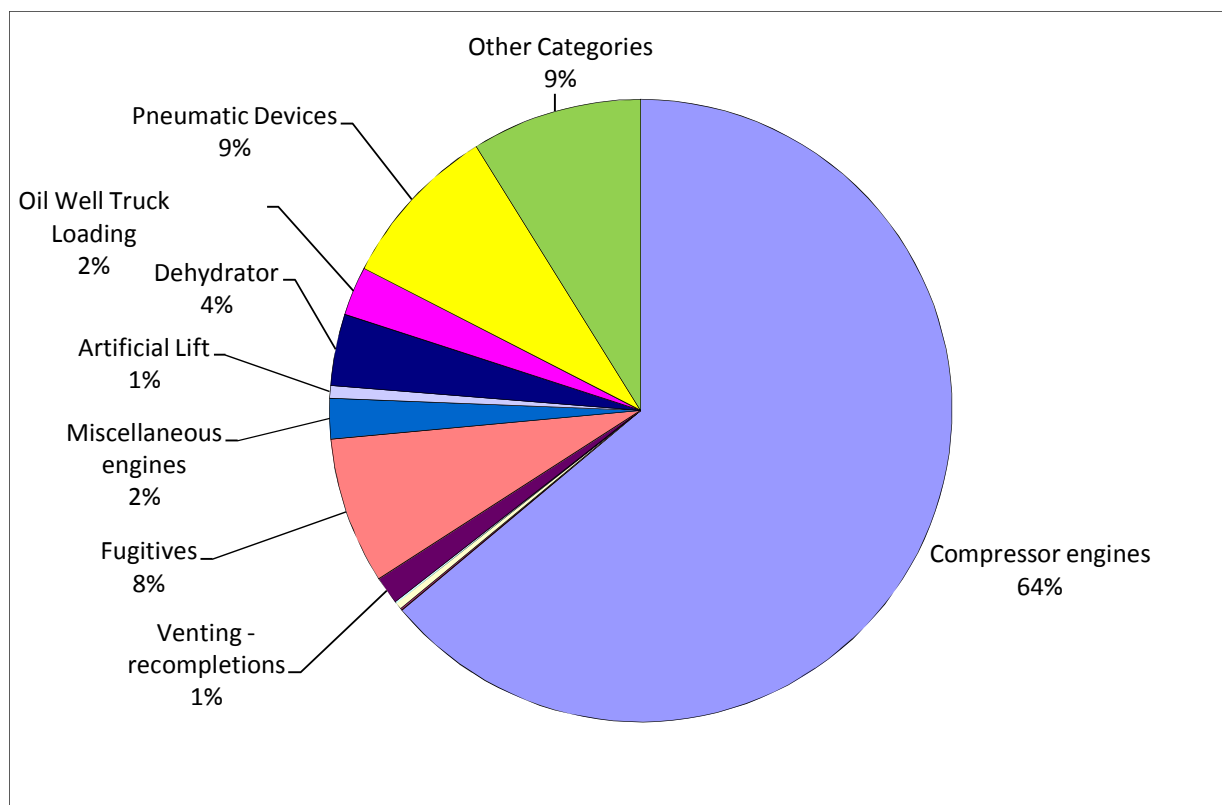


Figure 12. Powder River Basin 2009 VOC emissions proportional contributions by source category.

Southwest Wyoming Basin

Table 22 below shows the summary results of the 2009 updated Southwest Wyoming Basin inventory in comparison to the original 2006 baseline inventory. Gas production has increased significantly in the Southwest Wyoming Basin during this period. Although gas production increased from 2006 to 2009 for this basin, NO_x emissions from compressor engines have decreased over the same period. NO_x emission reductions may be due to combination of new and modified engines meeting the Wyoming BACT requirements which requires new and modified engines to meet the 2 g/bhp-hr, 1 g/bhp-hr NO_x, or 0.5 g/bhp-hr NO_x standards during this period or 2009 WYDEQ engine inventory data may more accurately reflect on-the-ground operation and control. Outside of Sublette County, decreases in spud counts and representative drill rig emissions from survey updates resulted in significant decreases in NO_x emissions from drill rigs. The UGRB inventory for Sublette County shows a similar trend of decreases in NO_x emissions from the drill rig category.

Pneumatic pump VOC emissions outside Sublette County increased from 2006 mainly due to an increase in well counts and an increase in average survey vented gas volume relative to 2006. The UGRB inventory also shows 18% increases in VOC emissions for pneumatic pumps. Similar to pneumatic devices, fugitive VOC emissions outside of Sublette County increased by 51% due to growth in well counts and updated fugitive device counts. In contrast, VOC emissions from the UGRB inventory for fugitives show a 40% reduction for Sublette County. The decline in gas production outside Sublette County and updated surveys resulted in a 45% decrease in VOC emissions from dehydrators while the Sublette County VOC emissions from the WYDEQ UGRB inventory show 42% decreases. Condensate tank VOC emissions from Sublette County and outside Sublette County decreased significantly; decline in condensate production outside of Sublette County resulted in an 11% decrease in emissions while the UGRB inventory shows 78% decreases for Sublette County.

SO_x emissions in the Southwest Wyoming Basin in both 2009 and 2006 are primarily from the Whitney Canyon Gas Plant and Shute Creek Treating Facility, and decreases are the result of updates to the actual emissions from these facilities in the WYDEQ permit database.

Table 22. Summary results for the 2009 update for the Southwest Wyoming Basin and comparison to 2006 baseline.

	NO _x [tpy]	VOC [tpy]	CO [tpy]	SO _x [tpy]	PM [tpy]
2009 Update	15,991	84,964	8,596	1,813	398
2006 Baseline	21,569	94,013	13,150	5,259	541
% Change	-25.9%	-9.6%	-34.6%	-65.5%	-26.4%

Table 23 below shows the breakdown of 2009 updated emissions for the Southwest Wyoming Basin by county (note that there is no tribal land in the Southwest Wyoming Basin). NO_x emissions are concentrated in Sublette, Sweetwater, and Carbon Counties, with additional significant NO_x emissions in Uinta and Lincoln Counties. VOC emissions are concentrated in Sweetwater County, with additional significant emissions in Carbon, Lincoln and Sublette Counties. Tables 24 and 25 show the 2009 NO_x and VOC emissions by source category, respectively, in the Southwest Wyoming Basin.

Table 23. 2009 emissions of all criteria pollutants by county for the Southwest Wyoming Basin.

County	NOx [tons/yr]	VOC [tons/yr]	CO [tons/yr]	SOx [tons/yr]	PM [tons/yr]
Albany (WY)	711	319	141	1	9
Carbon (WY)	2,887	15,182	1,560	58	48
Lincoln (WY)	1,808	15,666	905	1,116	89
Sublette (WY)	4,998	12,897	2,891	86	147
Sweetwater (WY)	4,214	29,767	2,396	342	86
Teton (WY)	0	0	0	0	0
Uinta (WY)	1,352	9,643	687	208	18
Daggett (UT)	6	100	4	0	0
Summit (UT)	15	1,391	12	1	1
Total	15,991	84,964	8,596	1,813	398

Figures 13 and 14 show the Southwest Wyoming Basin 2009 by-county emissions of NOx and VOC respectively, and Figures 15 and 16 show the Southwest Wyoming Basin 2009 NOx and VOC emissions distributions by source category respectively. 2009 NOx emissions in the Southwest Wyoming Basin are dominated by compressor engines. Due to the significant reduction in drilling activity in the basin in 2009, drilling rigs are a much smaller portion of the total basin-wide NOx emissions in the 2009 updated inventory than in the 2006 baseline inventory. 2009 VOC emissions in the Southwest Wyoming Basin are dominated by fugitives and condensate tanks VOC emissions, with additional VOC emissions from pneumatic devices, and pneumatic pump emissions. The major categories contributions to basin-wide VOC emissions are similar to 2006 baseline inventory.,

Table 24. 2009 NOx emissions by source category for the Southwest Wyoming Basin.

County	Compressor Engines	Drill Rigs	Heaters	Dehydrators	Other Categories	Total
Albany (WY)	696	1	14	0	0	711
Carbon (WY)	2,071	56	659	24	77	2,887
Lincoln (WY)	1,184	2	465	23	134	1,808
Sublette (WY)	1,313	1,180	979	22	1504	4,998
Sweetwater (WY)	2,661	136	1,237	52	127	4,214
Teton (WY)	0	0	0	0	0	0
Uinta (WY)	696	10	463	22	161	1,352
Daggett (UT)	0	1	5	0	0	6
Summit (UT)	0	0	13	1	1	15
Total	8,621	1,386	3,835	144	2,005	15,991

Table 25. 2009 VOC emissions by source category for the Southwest Wyoming Basin.

County	Condensate Tanks	Oil Tanks	Fugitives	Pneumatic Devices	Pneumatic Pumps	Dehydrators	Compressor Engines	Drill Rigs	Venting – Initial Completions	Venting – Recompletions	Other Categories	Totals
Albany (WY)	0	25	152	53	27	0	56	0	0	0	5	319
Carbon (WY)	3,840	100	6,316	2,327	1,095	544	542	7	52	49	311	15,182
Lincoln (WY)	6,431	97	5,605	1,909	972	364	108	0	2	1	177	15,666
Sublette (WY)	1,169	0	3,529	0	3,088	3,025	863	66	99	0	1,057	12,897
Sweetwater (WY)	6,879	487	12,803	4,355	2,210	1,148	597	18	233	220	816	29,767
Teton (WY)	0	0	0	0	0	0	0	0	0	0	0	0
Uinta (WY)	5,352	277	2,061	584	297	618	150	1	2	2	297	9,643
Daggett (UT)	4	0	61	21	11	2	0	0	0	0	1	100
Summit (UT)	991	79	171	59	30	33	0	0	0	0	26	1,391
Total	24,667	1,065	30,698	9,309	7,730	5,734	2,316	93	388	273	2,690	84,964

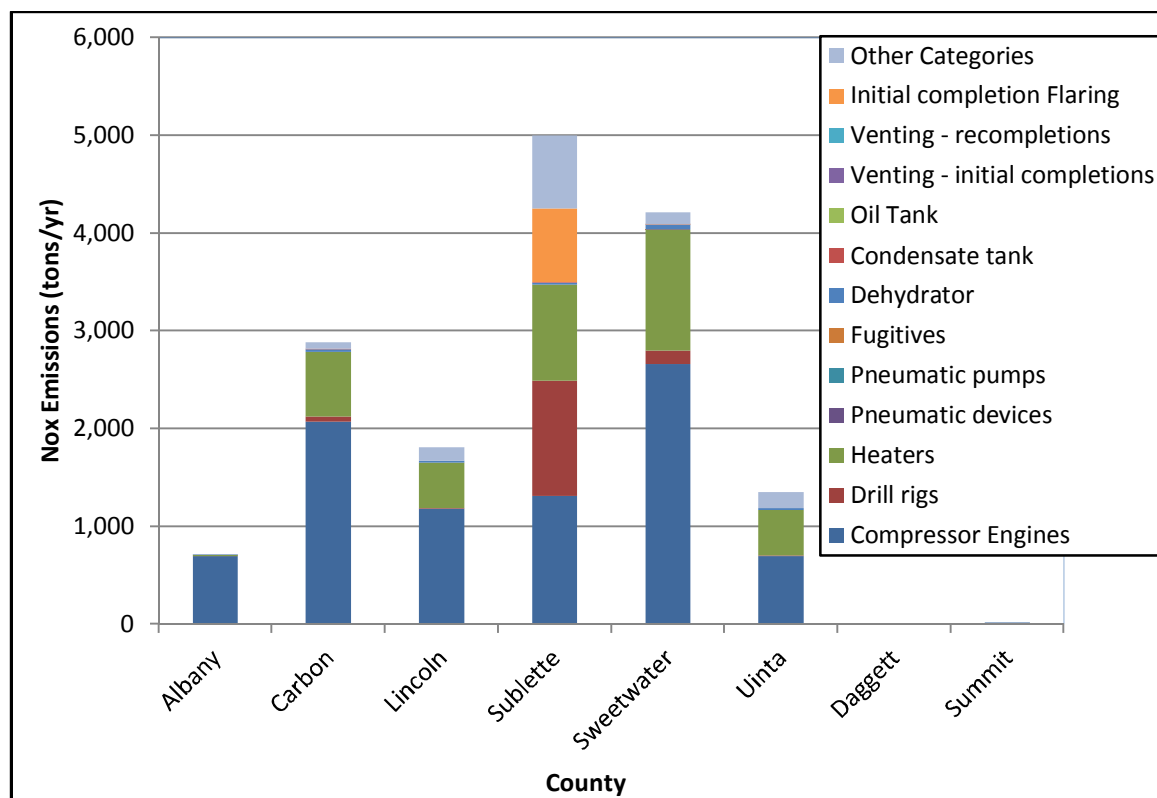


Figure 13. 2009 NOx emissions by county and by source category in the Southwest Wyoming Basin.

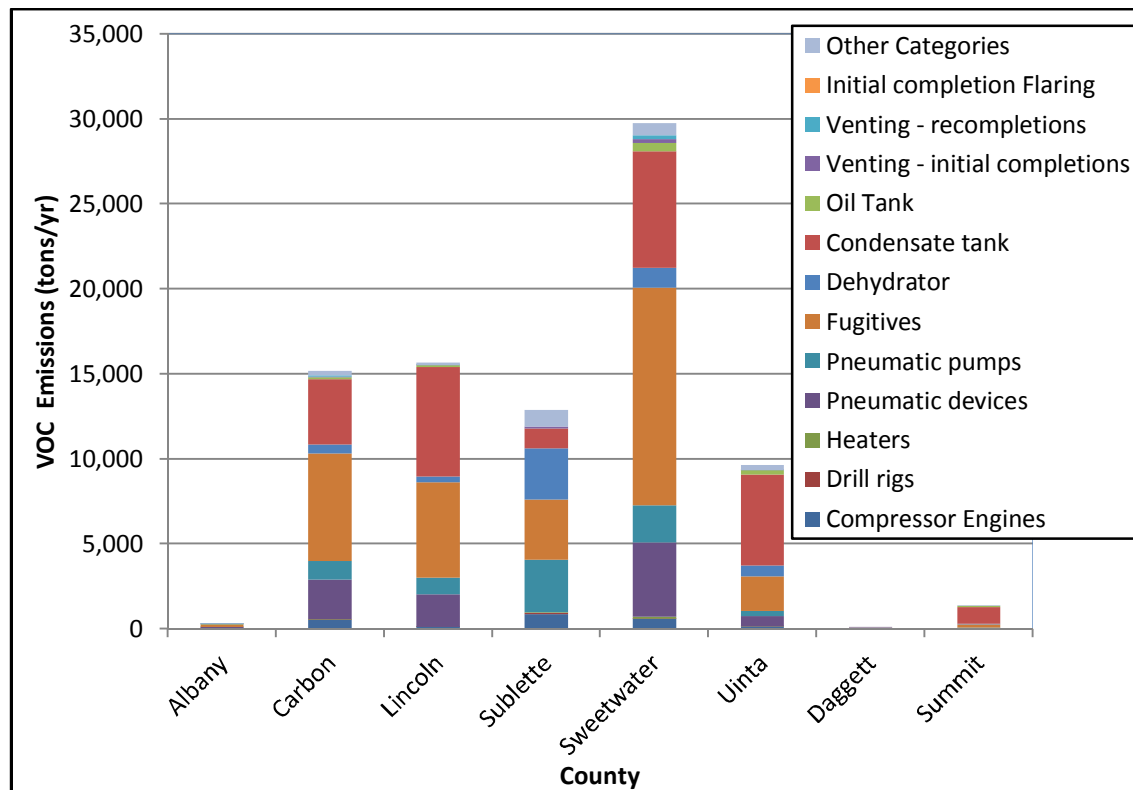


Figure 14. 2009 VOC emissions by county and by source category in the Southwest Wyoming Basin.

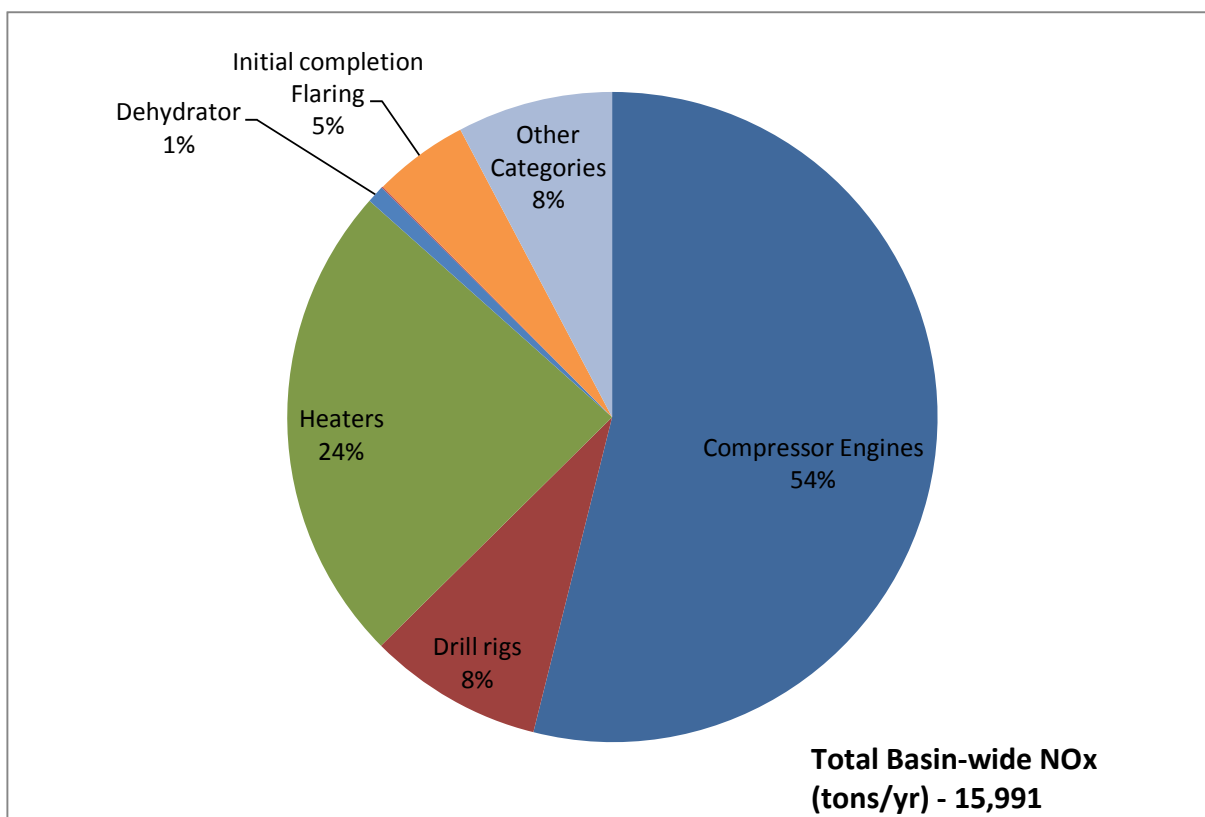


Figure 15. Southwest Wyoming Basin 2009 NOx emissions proportional contributions by source category.

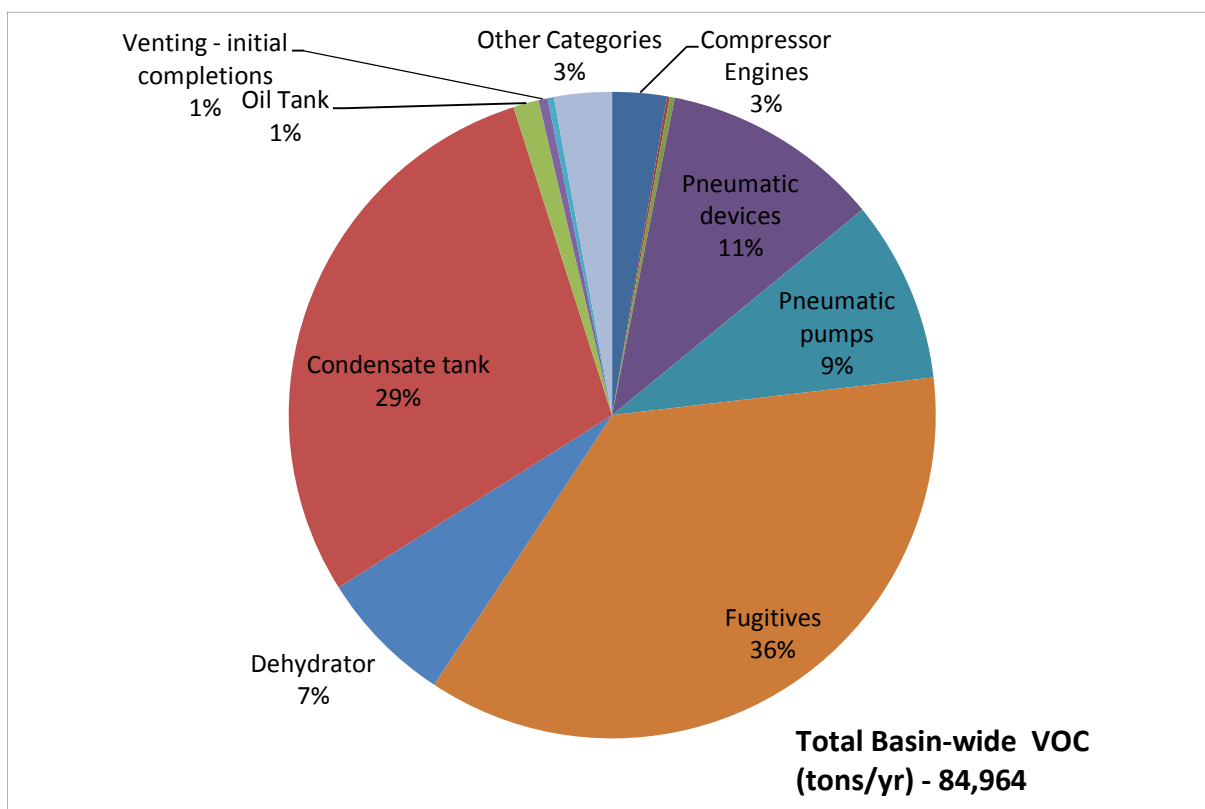


Figure 16. Southwest Wyoming Basin 2009 VOC emissions proportional contributions by source category.

REFERENCES

- Bar-Ilan, A., J. Grant, R. Parikh, A. Pollack, D. Henderer, D. Pring, K. Sgamma, 2010. "Development of Baseline 2006 Emissions from Oil and Gas Activity in the Wind River Basin" Prepared for Western Governor's Association. Prepared by ENVIRON International Corporation, Novato, CA. http://www.wrapair.org/forums/ogwg/documents/2010-07_%2706%20Baseline;%20Wind%20RiverBasin%20Technical%20Memo%20%2807-14%29.pdf
- Bar-Ilan, A., J. Grant, R. Parikh, A. Pollack, D. Henderer, D. Pring, K. Sgamma, 2011. "Development of Baseline 2006 Emissions from Oil and Gas Activity in the Powder River Basin" Prepared for Western Governor's Association. Prepared by ENVIRON International Corporation, Novato, CA. http://wrapair2.org/pdf/2006_Baseline_Emiss_Powder_River_Basin_092311.pdf
- Bar-Ilan, A., J. Grant, R. Parikh, A. Pollack, D. Henderer, D. Pring, K. Sgamma, 2012a. "Development of Baseline 2006 Emissions from Oil and Gas Activity in the Southwest Wyoming Basin" Prepared for Western Governor's Association. Prepared by ENVIRON International Corporation, Novato, CA. (*in print*)
- Bar-Ilan, A., J. Grant, R. Parikh, A. Pollack, D. Henderer, D. Pring, K. Sgamma, 2012b. "Development of 2015 Oil and Gas Emissions Projections for the Powder River Basin" Prepared for Western Governor's Association. Prepared by ENVIRON International Corporation, Novato, CA. (*in print*)
- EPA, 2008. "Standards of Performance for Stationary Spark Ignition Internal Combustion Engines and National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines; Final Rule," U.S. Environmental Protection Agency, Research Triangle Park, NC, January.
- EPA, 2006. "Direct Final Rule and Notice of Proposed Rulemaking for Amendments to the Nonroad and Highway Diesel Fuel Regulations," U.S. Environmental Protection Agency, Research Triangle Park, NC, April. <http://www.epa.gov/otaq/regs/fuels/diesel/420f06033.pdf>
- EPA, 2005. *Nonroad Diesel Equipment Regulations/Standards*, U.S. Environmental Protection Agency, July 7, 2005. Research Triangle Park, NC. <http://www.epa.gov/nonroad-diesel/regulations.htm>
- Pollack, A., L. Chan, P. Chandraker, J. Grant, C. Lindhjem, S. Rao, J. Russell, C. Tran, 2006. "WRAP Mobile Emission Inventories Update." Prepared for Western Governors' Association. May.
- WYDEQ, 2010. "Oil and Gas Production Facilities: Chapter 6, Section 2 Permitting Guidance," Wyoming Department of Environmental Quality, March 2010. Cheyenne, WY. [http://deq.state.wy.us/aqd/Oil and Gas/March 2010 FINAL O&G GUIDANCE.pdf](http://deq.state.wy.us/aqd/Oil%20and%20Gas/March%202010%20FINAL%20O&G%20GUIDANCE.pdf)
- WYOGCC, 2010. "Proposed OGCC Rules." Wyoming Oil and Gas Conservation Commission, Casper, WY. http://wogcc.state.wy.us/2009_proposed_rules_menu.cfm