Final Report

DEVELOPMENT OF 2012 OIL AND GAS EMISSIONS PROJECTIONS FOR THE WIND RIVER BASIN

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INTRODUCTION

This document outlines the projection methodologies used in generating the 2012 emissions projections from oil and gas sources in the Wind River Basin. These methodologies will use as a starting point the 2006 baseline Wind River Basin oil and gas emissions inventory, described in the baseline emissions report entitled "Development of Baseline 2006 Emissions from Oil and Gas Activity in the Wind River Basin".

This methodology description is broken down into subsections which describe:

- Projected parameters – five basic parameters are projected forward to 2012 for purposes of developing scaling factors: total well counts, spud counts, total gas production, oil production and condensate production
- Scaling factors and developing uncontrolled emissions projections – the projected parameters are used to develop scaling factors (incorporating geographic groupings), and these scaling factors are applied to the 2006 baseline emissions
- Application of "on-the-books" regulations and control measures – existing regulations are summarized for their impacts on the future year emissions and applied to adjust the uncontrolled 2012 inventory.

It should be noted that this methodology does not include a description of the geographic groupings of the projections, because the Wind River Basin has been defined to wholly include only Fremont County. Therefore projections were made for the entire Wind River Basin, and not for any geographic subset of the basin.

Projections for years beyond 2012 (not addressed in this methodology) will likely include additional parameters and will be based on these 2012 projections as the start year. The methodology for developing far future year projections will be detailed in a separate analysis.

Following the discussion of the methodology, the results of the 2012 emissions projections for the Wind River Basin are presented in graphical and tabular formats.

PARAMETERS PROJECTED

The 2012 projections for oil and gas emissions in the South San Juan Basin rely on scaling 5 parameters:

- Total well counts
- Spud counts
- Total gas production
- Oil production
- Condensate production

These five parameters are considered because each parameter applies to the emissions projections of one or more source categories. Note that the analysis uses data from the IHS database, which defines condensate production as liquid hydrocarbon production from wells which are classified as gas wells. Similarly, oil production is defined as liquid hydrocarbon production from wells which are classified as oil wells. The classification of gas vs. oil wells in the IHS database is based on the gas-oil ratio (GOR) of the well, using a cutoff GOR defined by the Wyoming Oil and Gas Conservation Commission (WYOGCC, 2010). This is the only distinction made between condensate and oil production.

The mapping of source category to projection parameter is shown below in Table 1.

Table 1. Scaling parameter for each oil and gas source category considered in this inventory.

Source	SCC	Description	Projection Parameter
Unpermitted	2310000100	Heaters	Total Well Count
Unpermitted	2310000220	Drill rigs	Spud Count
Unpermitted	2310000230	Workover rigs	Total Well Count
Unpermitted	2310000300	Pneumatic devices	Total Well Count
Unpermitted	2310000700	Unpermitted Fugitives	Total Well Count
Unpermitted	2310000801	Gas Well Truck Loading	Condensate Production
Unpermitted	2310000802	Oil Well Truck Loading	Oil Production
Unpermitted	2310000820	Gas Plant Truck Loading	Gas Well Condensate Production
Unpermitted	2310001610	Venting - initial completions	Spud Count
Unpermitted	2310001611	Initial completion Flaring	Spud Count
Unpermitted	2310001620	Venting - recompletions	Spud Count
Unpermitted	2310001630	Venting - blowdowns	Total Gas Production
Unpermitted	2310001640	Venting - Compressor Startup	Total Gas Production
Unpermitted	2310001650	Venting - Compressor Shutdown	Total Gas Production
Unpermitted	2310002230	Condensate tank	Condensate Production
Unpermitted	2310002240	Oil Tank	Oil Production
Unpermitted	2310002231	Condensate tank flaring	Condensate Production
Unpermitted	2310003100	Miscellaneous engines	Total Well Count
Unpermitted	2310003200	Pneumatic pumps	Total Well Count
Unpermitted	2310020600	Compressor engines	Total Gas Production
Unpermitted	2310021410	Dehydrator	Total Gas Production
Unpermitted	2310022000	Amine Units	Total Gas Production
Unpermitted	2310000330	Artificial Lift	Oil Production
Unpermitted	2310001631	Blowdown Flaring	Total Gas Production
Unpermitted	2310002241	Oil Tank Flaring	Oil Production
Unpermitted	2310021411	Dehydrator Flaring	Total Gas Production
Permitted Sources	20200202	Compressor engines	Total Gas Production

Source	SCC	Description	Projection Parameter
Permitted Sources	31000205	Natural Gas Production, Flares	Total Gas Production
Permitted Sources	31000220	Natural Gas Production, All Equipt Leak Fugitives	Total Gas Production
Permitted Sources	31000404	Process Heaters	Total Gas Production
Permitted Sources	40400301	Permitted Tank Losses	Condensate Production
Permitted Sources	20200200	Compressor engines	Total Gas Production
Permitted Sources	20200252	Compressor engines	Total Gas Production
Permitted Sources	20200253	Compressor engines	Total Gas Production
Permitted Sources	31000215	Natural Gas Production, Flares Combusting Gases >1000 BTU/scf	Total Gas Production
Permitted Sources	31000227	Dehydrator	Total Gas Production
Permitted Sources	31000301	Dehydrator	Total Gas Production
Permitted Sources	31000302	Dehydrator	Total Gas Production
Permitted Sources	31000502	Liquid Separator	Total Gas Production
Permitted Sources	31088800	Permitted Fugitives	Total Gas Production
Permitted Sources	20200202	Compressor engines	Total Gas Production
Permitted Sources	31000203	Compressor engines	Total Gas Production
Permitted Sources	31000205	Natural Gas Production, Flares	Total Gas Production
Permitted Sources	31000302	Dehydrator	Total Gas Production
Permitted Sources	20101020	Compressor Blowdown	Total Gas Production
Permitted Sources	31000299	Natural Gas Production, Other Not Classified	Total Gas Production
Permitted Sources	20200204	Compressor Start Ups	Total Gas Production
Permitted Sources	31000201	Natural Gas Processing Facilities, Gas Sweeting: Amine Process	Total Gas Production

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PROJECTION METHODOLOGIES FOR THE WIND RIVER BASIN

For the Wind River Basin, the methodology for obtaining the 2012 value of each projection parameter (total well counts, spud counts, total gas production, oil production, and condensate production) is described below. In general, total well count projections for each year between 2008 and 2012 were developed through discussions with the major oil and gas companies operating in the basin (2007 well counts were obtained directly from the IHS database). The historic rate of success of drilling in the basin was used to determine the spud count projections from the well count projections. A representative gas well decline curve was obtained from data provided by multiple oil and gas companies, and this was used in combination with the well counts to project gas production. Condensate production projections were assumed to follow the trends for gas production. Both oil production and the limited amount of CBM gas production that occurs in the Wind River Basin were conservatively projected to remain constant throughout this period.

The IHS database is a tool to query oil and gas statistical well and production data, and uses as its reference data the databases maintained by various state OGCC's (or equivalent).

Total Well Counts

Total well counts in the Wind River Basin have been plotted for the years 1970 – 2006 below in Figure 1, including projections to 2012.

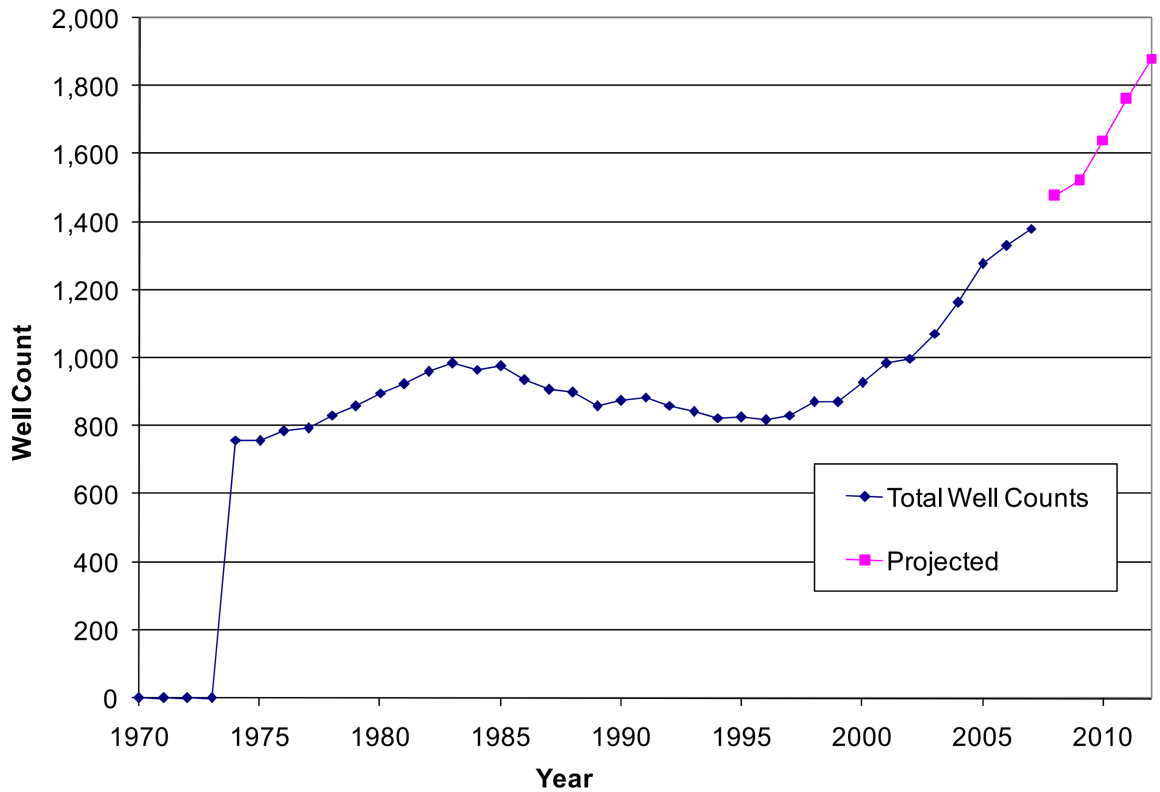

Figure 1. Total well count historical data (from the IHS database) for the Wind River Basin and projections to 2012.[1]

Conventional gas well count projections were developed for the period 2007 – 2012 through a combination of data sources. For calendar year 2007, active (producing) well counts were obtained directly from the IHS database. For calendar years 2008 and 2009, well count data were obtained directly from the Wyoming Oil and Gas Conservation Commission (WYOGCC) database (WYOGCC, 2009). This data was queried in December 2009, and therefore the data had to be extrapolated to obtain a projection for total well counts in the complete 2009 calendar year. As shown in Figure 1, the data for the period 2007-2009 showed a decrease in the number of new active wells added in each of those years, which is likely a reflection of economic conditions at the time. For calendar years 2010-2012, participating oil and gas companies were queried directly for their drilling plans and based on this query it was conservatively assumed that well count growth would increase again to the average rate of growth in the 2000-2006 period. The well count growth was estimated at 120 wells per year in the period 2010-2012.

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

Spud Counts

Spud counts in the Wind River Basin have been plotted for the years 1970 – 2006 below in Figure 2, including projections to 2012.

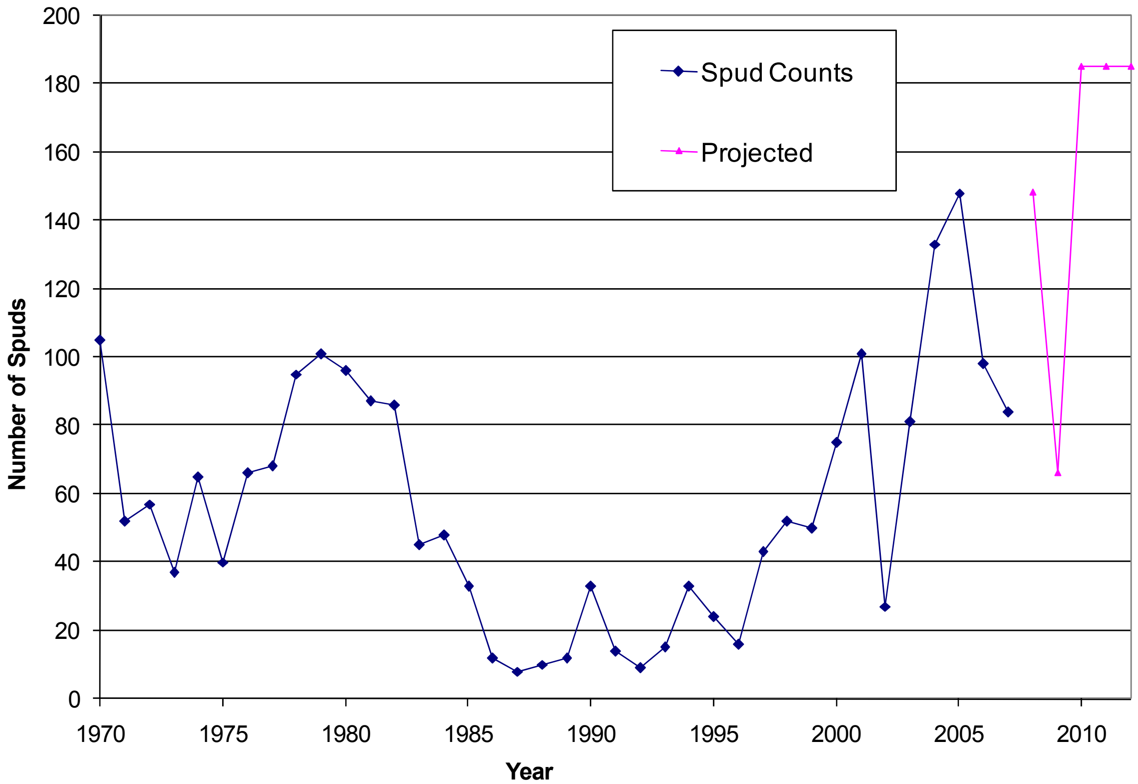

Figure 2. Spud count historical data (from the IHS database) for the Wind River Basin and projections to 2012.[2]

Spud counts were projected based on the projected well counts. The historic data on spuds and active well counts was examined during the period 2002-2006, which reflects the recent period of oil and gas exploration and production activity in the Wind River Basin. The ratio of the number of spuds in each year in the period 2002-2006 to the number of new active wells added in each year was estimated and assumed to be the drilling success rate. The drilling success rate in this period was estimated to be 1.54. This value was used to scale the number of new active wells projected for each year from 2007-2012 in Figure 1 to produce the number of projected spuds in each year during this period.

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

Total Gas Production

Gas production in the Wind River Basin has been plotted for the years 1970 – 2006 below in Figure 3, including projections to 2012.

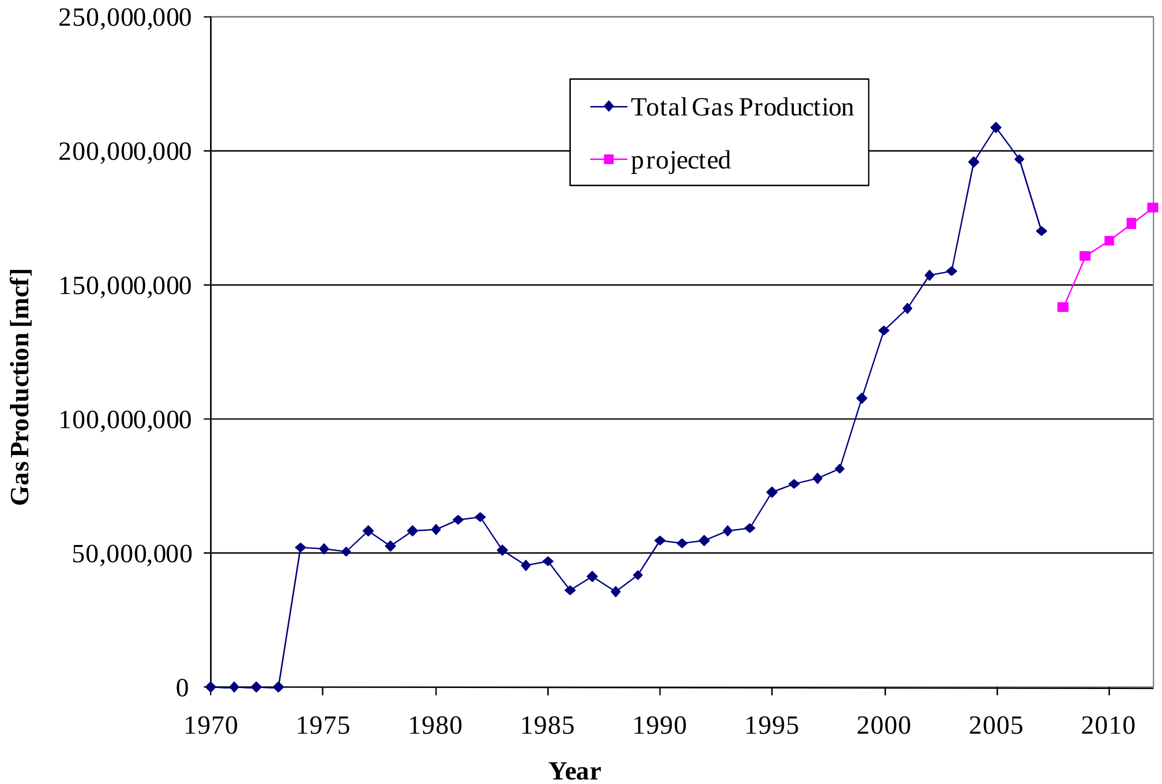

Figure 3. Total gas production historical data (from the IHS database) for the Wind River Basin and projections to 2012. [3]

The analysis to determine the total gas production projection in the Wind River Basin relied on representative well production data provided by the companies which was used to develop a production decline curve for typical gas wells in the basin. The well decline curve is shown below in Figure 4. As seen in Figure 4 the gas production of a new well brought on-line peaks in the first year of operation of the well and then declines following an approximately exponential decline curve. The methodology used to determine future year gas production in the basin is shown below in Equation (1):

Equation (1) $$P_i = \left[\left(N_{wells,i} - N_{wells,i-1}\right) \times 0.5 \times V_{Decline,0} + \sum_{j=0}^{30} \left(N_{wells,j} - N_{wells,j-1}\right) \times V_{Decline,j} \right] \times f$$

where:

P_i is the gas production in the basin in future year i [mscf]

$N_{wells,i}$ is the number of wells in the basin in future year i [# of wells]

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

$V_{Decline,0}$ is the first-year predicted production per well following the Wind River Basin typical gas well decline curve [mscf/well]
$V_{Decline,j}$ is the predicted production per well following the Wind River Basin typical gas well decline curve for year j [mscf/well]
j tracks the years of life of a well in the Wind River Basin, assumed to be a maximum of 20
f is a correlation factor for wells that are plugged and abandoned and producing well fields that differ from the typical gas well decline curve (assumed to be 1.09 for the Wind River Basin)

Equation (1) uses the total well count predictions of Figure 1 for a period of 20 previous years, assuming the same typical decline curve for all new wells added, and provides a prediction of the total gas production in the basin in a future year as the sum of these production values for each of the previous 20 years. The factor of 0.5 in Equation (1) is to account for the fact that in any current year new wells are added throughout the year. The correlation factor *f* was introduced to account for wells that are no longer active (e.g. plugged and abandoned) throughout the 20-year past calculation for each future year and also to account for production variances between well fields and the typical decline curve.

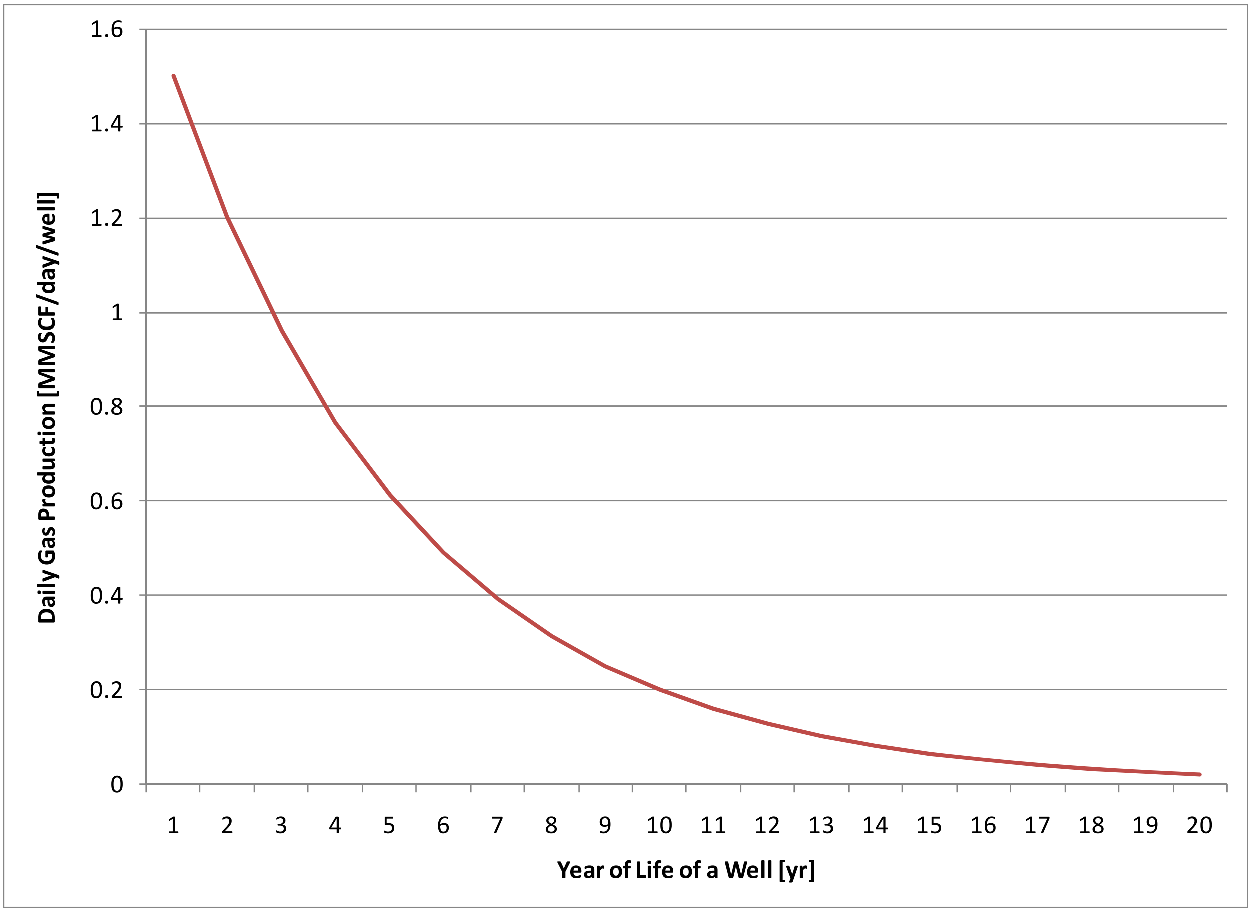

Figure 4. Typical gas well production decline curve for the Wind River Basin.

As was done in previous basins for which a well decline curve analysis was used in the production projections, an analysis was conducted in the Wind River Basin to justify the use of the specific decline curve and to determine whether this decline curve was sufficiently accurate to be representative of the basin generally. The analysis was conducted by using Equation (1) to predict Wind River Basin gas production for years prior to 2007, for which IHS data was already available and could be used to compare the accuracy of this method. The results are shown below in Table 2 for calendar years 2001 – 2006 and show that this method, with the specific correlation factor selected, is reasonably accurate in predicting past county-level gas production volumes.

Table 2. Comparison of actual and predicted gas production volumes for the Wind River Basin for the years 2001-2007 using a typical gas well decline curve projection analysis.

Year	Actual Wind River Basin Gas Production [MCF]	Predicted Wind River Basin Gas Production [MCF]	Percentage Difference
2001	141,431,734	138,052,529	2.4%
2002	153,614,449	146,484,786	4.6%
2003	155,454,192	159,123,859	2.4%
2004	195,792,715	161,027,719	17.8%
2005	208,862,860	202,810,792	2.9%
2006	197,166,868	216,308,524	9.7%
2007	170,440,970	204,197,324	19.8%

As Table 2 shows there is reasonable agreement between the predicted gas production in the Wind River Basin using the typical gas well decline curve method of Equation (1) and the actual gas production in the basin as obtained from the IHS database for the years 2001-2007. Only 2004 and 2007 were observed to be outlier years in which the deviation of the projected gas production from the actual historical gas production was greater than 10%. However there is no systematic bias towards overprediction or underprediction, and the well decline curve methodology was therefore selected as the only reasonable and tractable means to develop the gas production projections.

It should be noted that gas production projections in 2008 and later years show a significant decline from the peak production in the Wind River Basin. This is consistent with the findings that in 2007, 2008 and 2009, fewer new active wells were developed in the basin than in the recent development expansion of the basin since 2001. Indeed, in 2006 and 2007, actual production data shows a decline from a peak in 2005. This projection assumes that this decline in production continues through 2009, after which drilling rates are conservatively projected to recover, and thus gas production begins to increase.

Oil Production

Oil production in the Wind River Basin has been plotted for the years 1970 – 2006 below in Figure 5, including projections to 2012.

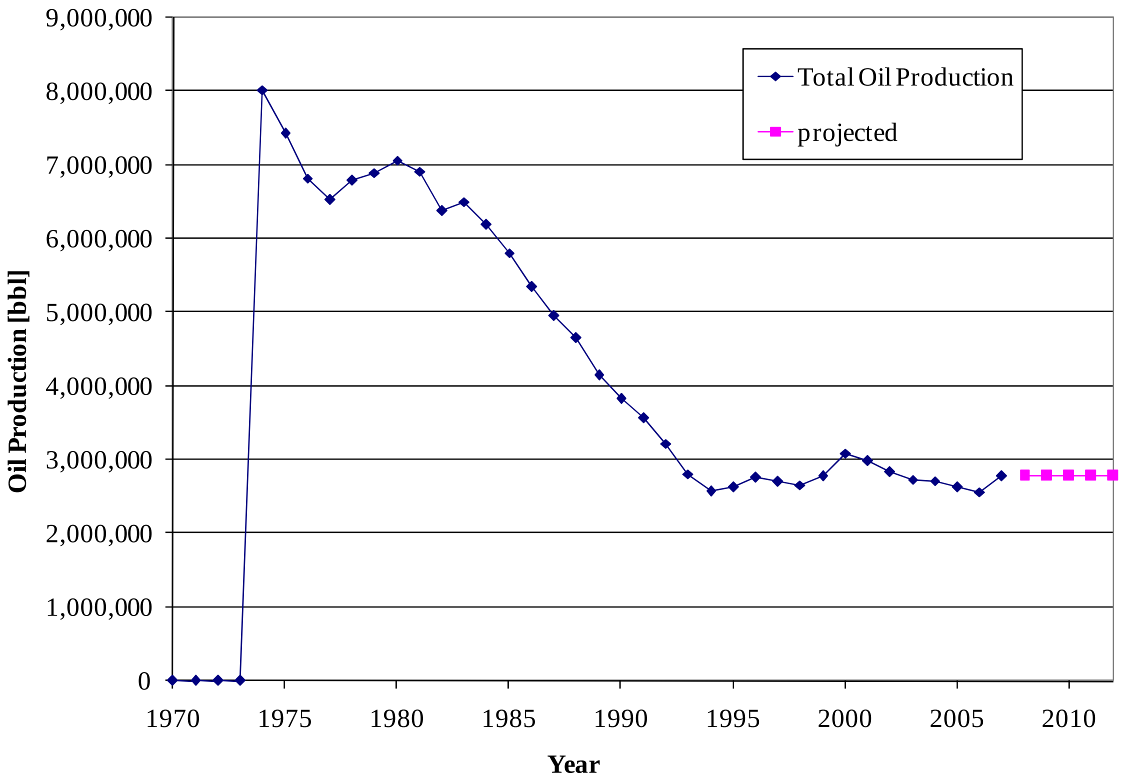

Figure 5. Oil production historical data (from the IHS database) for the Wind River Basin and projections to 2012.[4]

Oil production has been in significant decline in the Wind River Basin since a peak in the mid-1970's and is expected to continue to decline. This analysis projects no new oil wells as part of development activities in the Wind River Basin in the period 2006-2012. Given this historic decline, it was conservatively projected that oil production would remain at 2007 levels in the period through 2012.

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

Condensate Production

Condensate production in the Wind River Basin has been plotted for the years 1970 – 2006 below in Figure 6, including projections to 2012.

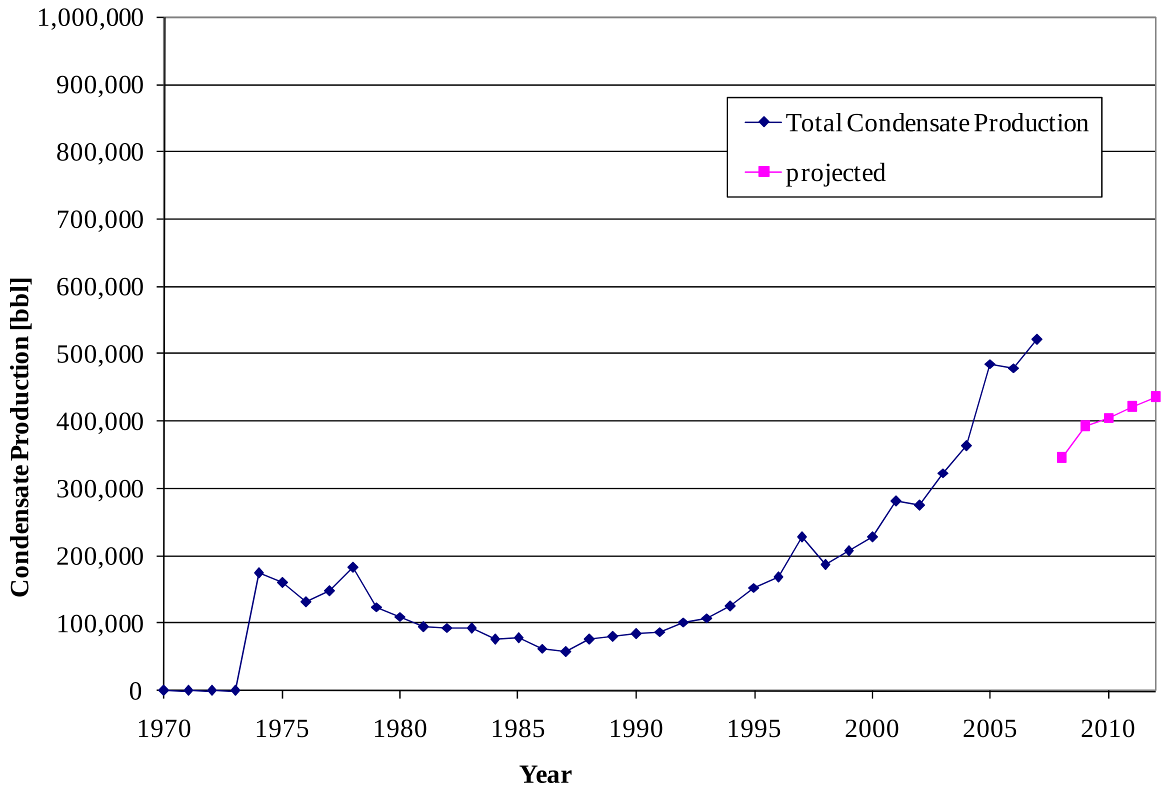

Figure 6. Condensate production historical data (from the IHS database) for the Wind River Basin and projections to 2012.

As with other basin projection analyses, condensate production in the Wind River Basin is projected to directly track gas production since the condensate is a by-product of the gas production. The fractional year-to-year change in the gas production in the period 2007-2012 was calculated based on the projection analysis described above. This fractional change was then applied to the condensate production in 2007 and used to project condensate production through 2012. As expected from this methodology, the trend line for condensate production matches that of the gas production.

SCALING FACTOR DEVELOPMENT AND UNCONTROLLED 2012 EMISSIONS

Scaling factors were generated for the Wind River Basin as a whole, for each parameter considered here: total well counts, spud counts, total gas production, condensate production and oil production. These are presented below for the Wind River Basin. The ratio of the value of each of these parameters in 2012 to their values in 2006 is the scaling factor for that parameter for purposes of this projection. This is shown in Equation 2 below:

Equation (2) $f_i = W_{2012} / W_{2006}$

where:

f_i is the scaling factor for the Wind River Basin for parameter *i* (total well counts, spud counts, total gas production, condensate production, or oil production)
W_{2006} is the value of parameter *i* in 2006
W_{2012} is the projected value of parameter *i* in 2012

The scaling factor based on the appropriate parameter is selected for each source category as described in Table 1. The scaling factors for the five parameters used in this analysis for the Wind River Basin are presented in Table 3 below. Note that because oil production is projected to remain constant at 2007 production levels, the ratio of 2006 to 2012 production is not uniquely 1.0.

Table 3. Scaling factors for the five parameters used in the projection analysis for the Wind River Basin.

Geographic Grouping	Total Well Count	Spud Count	Total Gas Production	Condensate Production	Oil Production
Fremont County	1.40	1.89	0.92	0.91	1.1

CONTROLLED 2012 EMISSIONS

This methodology considered any “on-the-books” federal or state regulations that would affect the uncontrolled 2012 emissions projections described above.

Table 4 below lists the “on-the-books” federal and state regulations that affect emissions source categories in the oil and gas industry, and the action taken to adjust the 2012 emissions inventory appropriately. A more detailed description follows of the methodology used to address each of these regulations as they affected the uncontrolled 2012 Wind River Basin emissions projections. In the case of the Wind River Basin, the Wyoming Department of Environmental Quality’s (WYDEQ) Revised Permitting Guidance for Oil and Gas Production Facilities (WYDEQ, 2010), released in March 2010, was used to determine controls requirements for individual source categories.

Table 4. Summary of federal and state “on-the-books” regulations affecting the oil and gas source categories considered in this inventory.

Source Category	Regulation	Enforcing Agency	Effective Date	Implementation in the 2012 Wind River Basin Emissions Projections
Federal				
Drill Rigs, Workover Rigs	Nonroad engine Tier standards (1-4) (EPA, 2005)	US EPA	Phase in from 1996 - 2014	EPA NONROAD model used to create county-level control factors for the drill rig SCC to account for fleet turnover.
Drill Rigs, Workover Rigs	Nonroad diesel fuel sulfur standards (EPA, 2006)	US EPA	Phase in beginning in 2010	Assume 15 ppm sulfur in nonroad diesel fuel throughout South San Juan Basin. Control factors derived from EPA NONROAD model (see above).
All New Spark-Ignited Stationary Engines	New Source Performance Stds. (NSPS) (EPA, 2008)	US EPA	Phase in from 2008 - 2011	Control factors developed considering the specific composition of engines in the inventory and relationship to NOx emissions requirement from WYDEQ BACT rule (described in more detail below).
State				
Wellhead compressors	Best Available Control Technology (BACT) for stationary spark-ignited engines (WYDEQ, 2010)	WY DEQ	2006	Control factors developed considering the specific composition of engines in the inventory and tracking of this rule in combination with federal NSPS (described in more detail below).
Pneumatic Devices	Low- or no-bleed pneumatics installed in new facilities (WYDEQ, 2010)	WY DEQ	2010	Implemented for new devices installed after 2010
Pneumatic Pumps	98% control of pneumatic pump emissions or routed to closed-loop system (WYDEQ, 2010)	WY DEQ	2010	Implemented for new pumps installed after 2010
Condensate/Oil Tanks	98% control of tank flashing emissions when emissions ≥ 8 TPY VOC (WYDEQ, 2010)	WY DEQ	2010	Implemented for condensate tank emissions associated with condensate production growth; implemented for all oil tanks

Source Category	Regulation	Enforcing Agency	Effective Date	Implementation in the 2012 Wind River Basin Emissions Projections
Dehydrators	98% control of dehydrator emissions when emissions ≥ 8 TPY VOC (WYDEQ, 2010)	WY DEQ	2010	Implemented for dehydrator emissions associated with gas production growth, for all dehydrators

The uncontrolled 2012 emissions were adjusted based on the proposed actions or control factors developed for each regulation described in Table 4 to account for how these regulations may affect any oil and gas source category considered in this inventory.

Nonroad Diesel Engine Standards and Fuel Sulfur Standards

The EPA NONROAD2005 model was run with fuel inputs based on a 2002 study entitled "WRAP Mobile Sources Emission Inventory Update" (Pollack, et al., 2006). The model outputs were used to develop county-level emissions per unit population for "other oil field equipment" (SCC 2270010010) for the calendar year 2006, and then separately for the calendar year 2012. These emissions per unit population reflect the predicted fleet mix of engines – for various tier standards from baseline uncontrolled engines through Tier IV engines – and are used as a representation of fleet turnover for drilling rigs and workover rigs. The ratios of the per unit emissions in 2012 to those in 2006 for each county of interest were taken to be the control factors accounting for federal non-road tier standards.

In addition, the NONROAD model runs with the fuel inputs used for developing the tier standards control factors were also used to develop the control factors for SOx emissions factors for drilling rigs and workover rigs. The model is capable of tracking the expected reduction in fuel sulfur content from the baseline 2006 year – assumed to be the same as the WRAP 2002 inventory – and the 2012 future year. A similar approach was used as for the federal tier standards to develop control factors. The ratio of per unit SOx emissions in 2012 to those in 2006 were taken to be a control factor to apply to uncontrolled 2012 SOx emissions for drilling rigs and workover rigs to account for federal non-road diesel fuel standards.

New Source Performance Standards for Stationary Spark-Ignited Engines and WYDEQ BACT NOx Requirements for Wellhead Compressors

A combined analysis was undertaken to implement both the US EPA NSPS and the NOx emissions standards required in Wyoming through the state-wide BACT rules that would apply to spark-ignited natural gas-fired wellhead compressor engines, since both of these rules affect the same source category and had overlapping requirements in some cases. In previous basin analyses of NSPS application (Bar-Ilan, et al., 2009a; Bar-Ilan, et al., 2009b; Bar-Ilan, et al., 2009c; Bar-Ilan, et al., 2008), it was assumed that a flat or declining gas production projection would indicate no need for additional horsepower of compression. This was coupled with the assumption that there would be negligible turnover of engines during the period of the projections to conclude that controls did not need to be applied to existing engines in the 2006 inventory. Only during a period of gas production growth was an analysis conducted to determine the impact of the NSPS and WY BACT requirements on the wellhead compressor inventory. Note that this analysis conservatively does not consider any impact of these rules on midstream (compressor station and gas processing plant) engines because insufficient information was available to determine the emissions factor of existing 2006 engines.

In the case of the Wind River Basin, engine emissions from tribal and non-tribal land were treated separately. For tribal land, it was conservatively assumed that tribal land only experienced an overall decline in gas production (rather than tracking both a period of decline and a subsequent period of growth). The decline in gas production was the value estimated in the projections analysis and summarized in Table 3. Therefore the tribal portion of total wellhead compressor emissions was not subject to any controls analysis.

For non-tribal wellhead compressor emissions, a special analysis was conducted to develop controlled non-tribal emissions considering both the decline in gas production from 2006-2008, and the subsequent growth in projected gas production from 2009-2012. For the period 2006-2008, the ratio of gas production in 2008 to gas production in 2006 was calculated to develop a decline factor. This was applied to the total non-tribal horsepower of compression from the producer-supplied data in the 2006 baseline inventory to develop the estimated total non-tribal utilized horsepower of compression in 2008. Similarly, the non-tribal emissions from wellhead compressors in 2006 were also declined using this decline factor. The resulting emissions were considered the 2008 non-tribal wellhead compressor emissions, without any further controls analysis. For the period 2008-2012, the ratio of gas production in 2012 to gas production in 2008 was calculated to develop a growth factor. The growth factor was applied to the total non-tribal horsepower of compression in 2008 to develop an estimate of the "added" horsepower of compression during this period. This added compression horsepower was assumed to be subject to both NSPS and the WY BACT requirements. The WY BACT requirements for NOx were a 1.0 g/bhp-hr emissions standard, while the NSPS requirements for NOx were phased from a 2.0 g/bhp-hr standard beginning July 2008 to a 1.0 g/bhp-hr standard beginning January 2011. Because the WY BACT requirement is more stringent, all added compression horsepower was assumed to meet the 1.0 g/bhp-hr NOx standard. NOx emissions associated with the added horsepower of compression were estimated at the WY BACT standard and summed with the 2008 non-tribal wellhead compressor NOx emissions to estimate total 2012 non-tribal wellhead compressor NOx emissions. For VOC and CO emissions, the WY BACT requirement does not apply, but the NSPS requires engines to meet specific VOC and CO emissions standards (as described below). These standards were applied to the added horsepower of compression, and VOC and CO emissions from the added horsepower of compression were estimated. These added emissions were summed with the 2008 non-tribal wellhead compressor VOC and CO emissions to estimate total 2012 non-tribal wellhead compressor VOC and CO emissions.

As a final step, the tribal and non-tribal emissions were summed to arrive at the total basin-wide wellhead compressor emissions for all pollutants. Pollutants not affected by either the NSPS or WY BACT requirements (PM and SO_2) were only scaled up or down by gas production without any controls analysis.

A detailed description of the requirements of the federal NSPS is provided below.

NSPS Regulations

The EPA has promulgated a new regulation covering new stationary, spark-ignited engines of various horsepower classes. The regulation is assumed to apply to central compressor engines, wellhead and lateral compressor engines, and artificial lift engines as well as any other miscellaneous APEN exempt engines that are stationary, spark-ignited natural gas engines. The regulation requires new engines of various horsepower classes to meet increasingly stringent NOx and VOC emission standards over the phase-in period of the regulation.

For engines less than 25 horsepower, Table 5 shows the requirements of the NSPS regulation.

Table 5. Federal NSPS emissions standards for engines less than 25 horsepower.

HP Range[a]	Emissions Standards Requirement in (g/hp-hr)[b]		
	HC + NOx	NMHC + NOx[c]	CO
≤ 25 Hp			
Class I	16.1 (12.0)	14.8 (11.0)	610 (455)
Class I -A	50-37	-	-
Class I -B	40 (30)	37 (27.6)	
Class II	12.1 (9.0)	11.3 (8.4)	

[a] Class I-A: Engines with displacement less than 66 cubic centimeters (cc); Class 1-B: Engines with displacement greater than or equal to 66cc and less than 100cc; Class I: Engines with displacement greater than or equal to 100 cc and less than 225 cc

[b] Modified and reconstructed engines manufactured prior to July 1, 2008, must meet the standards applicable to engines manufactured after July 1, 2008

[c] NMHC+NOX standards are applicable only to natural gas fueled engines at the option of the manufacturer, in lieu of HC+NOX standards

For engines in the horsepower range 25 – 100 horsepower, Table 6 shows the requirements of the NSPS regulation.

Table 6. Federal NSPS emissions standards for engines greater than 25 horsepower but less than 100 horsepower.

HP Range	Manufacture Date	Emissions Standards Requirement (g/hp-hr)	
		HC + NOx	CO
25<HP<100	1-Jul-08	3.8	6.5
	1-Jul-08 (severe duty)	3.8	200

For engines in the horsepower range 100 – 1,350 horsepower, Table 7 shows the requirements of the NSPS regulation.

Table 7. Federal NSPS emissions standards for engines greater than 25 horsepower but less than 100 horsepower.

Engine Type and Fuel	HP Range	Manufacture Date	Emissions Standards Requirement (g/hp-hr)		
			NOx	CO	VOC
Non-Emergency SI Natural Gas and Non-Emergency SI Lean Burn LPG	100≤HP<500	1-Jul-08	2	4	1
		1-Jan-11	1	2	1
Non-Emergency SI Lean Burn Natural Gas and LPG	500≥HP<1350	1-Jan-08	2	4	1
		1-Jul-10	1	2	1
Non-Emergency SI Natural Gas and Non-Emergency SI Lean Burn LPG (except lean burn 500≥HP<1350)	HP≥500	1-Jul-07	2	4	1

Pneumatic Devices

The WYDEQ Permitting Guidance for Oil and Gas Production Facilities included a control requirement for pneumatic devices beginning in 2010. The guidance requires new devices installed to be low- or no-bleed. As with compressor engines, new pneumatic devices were only assumed to be installed if well count growth occurred during a specific period. This analysis conservatively assumed that no turnover of existing pneumatic devices occurred during the period 2006-2012. This analysis was applied only to non-tribal pneumatic device VOC emissions. Tribal pneumatic device VOC emissions were assumed to increase with the growth factor in well counts shown in Table 3.

The well count growth in the period 2006-2010 was used to determine a growth factor (ratio of well counts in 2010 to well counts in 2006), and the growth factor was applied to 2006 non-tribal pneumatic device VOC emissions. This was considered the final 2010 non-tribal pneumatic device VOC emissions. The well count growth in the period 2010-2012 was used to determine a growth factor (ratio of well counts in 2012 to well counts in 2010) and this growth factor was used to determine the final uncontrolled 2012 non-tribal pneumatic device VOC emissions. The difference between the 2012 and 2010 non-tribal pneumatic device VOC emissions was determined to be the "added" emissions in the period 2010-2012. These added emissions were subject to the WYDEQ rule, however it was assumed that some of these devices would already be low-bleed. The fraction of the total pneumatic device count that was low-bleed devices was determined from the 2006 producer-supplied data. This fraction was applied to the added emissions and assumed to represent the added emissions from low-bleed devices. Similarly, the fraction of the total pneumatic device count that was high-bleed devices was determined and applied to the added emissions. This was assumed to represent the added emissions from high-bleed devices. The added emissions from high-bleed devices was controlled by a factor which was the ratio of the average bleed rate of low-bleed pneumatic devices to high-bleed pneumatic devices, across all device types. This represented the controlled high-bleed pneumatic device VOC emissions.

The controlled high-bleed pneumatic device VOC emissions were added to the low-bleed pneumatic device added VOC emissions, to obtain the combined "added" emissions, now including control. These were added to the 2010 non-tribal emissions to obtain total 2012 non-tribal pneumatic device VOC emissions. These were added to the tribal emissions to obtain total 2012 pneumatic device VOC emissions.

Pneumatic Pumps

The WYDEQ Permitting Guidance for Oil and Gas Production Facilities included a control requirement for pneumatic pumps beginning in 2010. Pump emissions were required to be controlled by 98% or to have pump vent streams routed to a closed-loop system (effectively a 100% control). This analysis conservatively used only the 98% control requirement. This analysis was applied only to non-tribal pneumatic pump VOC emissions. Tribal pneumatic pump VOC emissions were assumed to increase with the growth factor in well counts shown in Table 3.

Similar to pneumatic devices, non-tribal VOC emissions for pneumatic pumps in 2010 were determined by applying a growth factor (the ratio of 2010 well counts to 2006 well counts) to the 2006 non-tribal pneumatic pump VOC emissions. The 2012 non-tribal uncontrolled pneumatic pump VOC emissions were then determined by applying a growth factor (the ratio of 2012 well counts to 2010 well counts) to the 2010 non-tribal pneumatic pump VOC emissions. The difference between the 2012 and 2010 emissions were taken to be the added pneumatic pump VOC emissions. These added emissions were controlled by 98%, and then added back to the 2010 emissions. The resulting emissions were considered the controlled 2012 non-tribal pneumatic pump VOC emissions for non-tribal sources. These were added to the 2012 tribal pneumatic pump VOC emissions to obtain total 2012 pneumatic pump VOC emissions.

Condensate and Oil Tanks

The WYDEQ Permitting Guidance for Oil and Gas Production Facilities included a revised control requirement for flashing emissions from condensate and oil tanks beginning in 2010, requiring control of flash emissions by 98%. The revision lowered the uncontrolled emissions threshold for which the controls requirements would be applicable from 20 tpy to 10 tpy. However, the analysis to develop the baseline 2006 inventory for tanks in the Wind River Basin did not consider emissions from individual tanks. The inventory used an emissions factor and total production of condensate or oil to determine total emissions. Thus it was not possible to determine the fraction of tanks that would be subject to the revised or previous rule by meeting the uncontrolled emissions thresholds. For condensate tanks, this rule was applied to all condensate tank emissions beginning in 2010, assuming that before 2010 condensate tanks would not meet the rule requirements and after 2010 all condensate tanks would meet the rule requirements. For oil tanks, all oil tanks were assumed to meet the rule requirements and the rule was applied.

For condensate tanks, an analysis similar to that for compressor engines was used. Tribal condensate tank emissions were estimated separately from non-tribal emissions. The tribal condensate tank emissions were declined following the condensate production decline factor in Table 3. The non-tribal condensate tank emissions were first declined from 2006 to 2010 using a decline factor (the ratio of condensate production in 2010 to condensate production in 2006). These were considered the 2010 non-tribal condensate tank emissions. The 2010 non-tribal condensate tank emissions were then grown to 2012 using a growth factor (the ratio of 2012 condensate production to 2010 condensate production), to generate 2012 uncontrolled non-tribal condensate tank emissions. The difference between the 2012 uncontrolled non-tribal condensate tank emissions and the 2010 non-tribal condensate tank emissions were considered the “added” emissions. The added emissions were controlled by 98% and then summed with the 2010 non-tribal condensate tank emissions to generate total 2012 non-tribal condensate tank emissions. These were then added to the tribal emissions, to generate total 2012 condensate tank emissions.

For oil tanks, the tribal and non-tribal emissions were also estimated separately. Tribal oil tank emissions were grown by the oil production growth factor in Table 3. For non-tribal oil tanks the difference between the uncontrolled 2012 emissions and the baseline 2006 emissions were taken to be the added emissions. These were controlled by 98% and added to the 2006 baseline emissions to obtain the non-tribal 2012 oil tank emissions. These were then added to the tribal emissions to obtain the total 2012 oil tank emissions.

Dehydrators

The WYDEQ Permitting Guidance for Oil and Gas Production Facilities included a revised control requirement for emissions from dehydrators beginning in 2010, requiring control of dehydrator emissions by 98%. The revision lowered the uncontrolled emissions threshold for which the controls requirements would be applicable from 15 tpy VOC to 8 tpy. As with tank emissions, the baseline 2006 emissions inventory for dehydrators was not developed for individual units. Therefore there was no way to determine whether dehydrators met the threshold requirements for application of the rule. As with other source categories that are scaled by gas production, it was assumed that new dehydrator units would only be installed if gas production growth occurred. In the Wind River Basin the growth in gas production occurs between 2008 and 2012, and during this period the WYDEQ rule is assumed to apply to all dehydrators.

Tribal dehydrator emissions were estimated separately from non-tribal dehydrator emissions. Tribal dehydrator emissions were declined from 2006 to 2012 using the decline factor in Table 3. Non-tribal dehydrator emissions were declined from 2006 to 2008 using a decline factor (the ratio of 2008 gas production to 2006 gas production). This was determined to be the 2008 non-tribal dehydrator emissions. The 2008 non-tribal dehydrator emissions were then grown from 2008 to 2012 using a growth factor (the ratio of 2012 gas production to 2008 gas production). The difference between the 2012 and 2008 non-tribal dehydrator emissions was determined to be the “added” emissions. These added emissions were controlled by 98%, and added to the 2008 non-tribal dehydrator emissions to determine the 2012 non-tribal dehydrator emissions. These were added to the tribal dehydrator emissions to obtain the total 2012 dehydrator emissions.

SUMMARY RESULTS

The scaling factors were applied to the baseline 2006 inventory, and "on-the-books" regulations were applied to the uncontrolled 2012 emissions projections to generate the final 2012 emissions projections and results are presented below.

Figures 7 and 8 show the NOx and VOC emissions by source category, respectively, from tribal and non-tribal land in Fremont County. For NOx emissions, the tribal portion of emissions accounts for approximately 20% of the basin-wide total NOx, up from 19% in the 2006 baseline emissions. This is likely a result of some control of projected NOx emissions through federal and state regulations which reduces the non-tribal contribution of the total basin-wide NOx emissions. For VOC emissions, the tribal portion of emissions accounts for approximately 32% of the basin-wide total VOC, up from 27% in the 2006 baseline emissions. As with the NOx emissions, this is likely due to the impact of regulations controlling some of the 2012 VOC emissions on non-tribal land.

Figures 9 and 10 provide a detailed breakdown of the 2012 NOx and VOC emissions by source category. Consistent with the 2006 baseline emissions analysis, compressor engines remain the dominant NOx source category in the Wind River Basin, although their percentage contribution to the total NOx inventory has decreased due to controls on compressor emissions. As a result, drilling rig emissions are more significant than in the baseline 2006 inventory. VOC emissions by source category remain relatively unchanged from the breakdown in the 2006 baseline inventory. Pneumatic devices, well blowdowns and dehydrator emissions remain the dominant source categories – accounting for approximately 83% of VOC emissions. Despite controls requirements from the new WY permitting guidance, these controls are generally implemented late in the 2006-2012 time period and do not have a major effect on the overall basin-wide 2012 VOC emissions. It should be noted that this finding is highly dependent on the conservative assumptions used in developing the controls analysis.

The numerical inventory results for all pollutants are provided for the basin as a whole, and broken down by source category in Tables 8-10. The total 2012 NOx emissions in the Wind River Basin have decreased by 3% from the 2006 levels. The total 2012 VOC emissions in the Wind River Basin have increased by 4% from the 2006 levels.

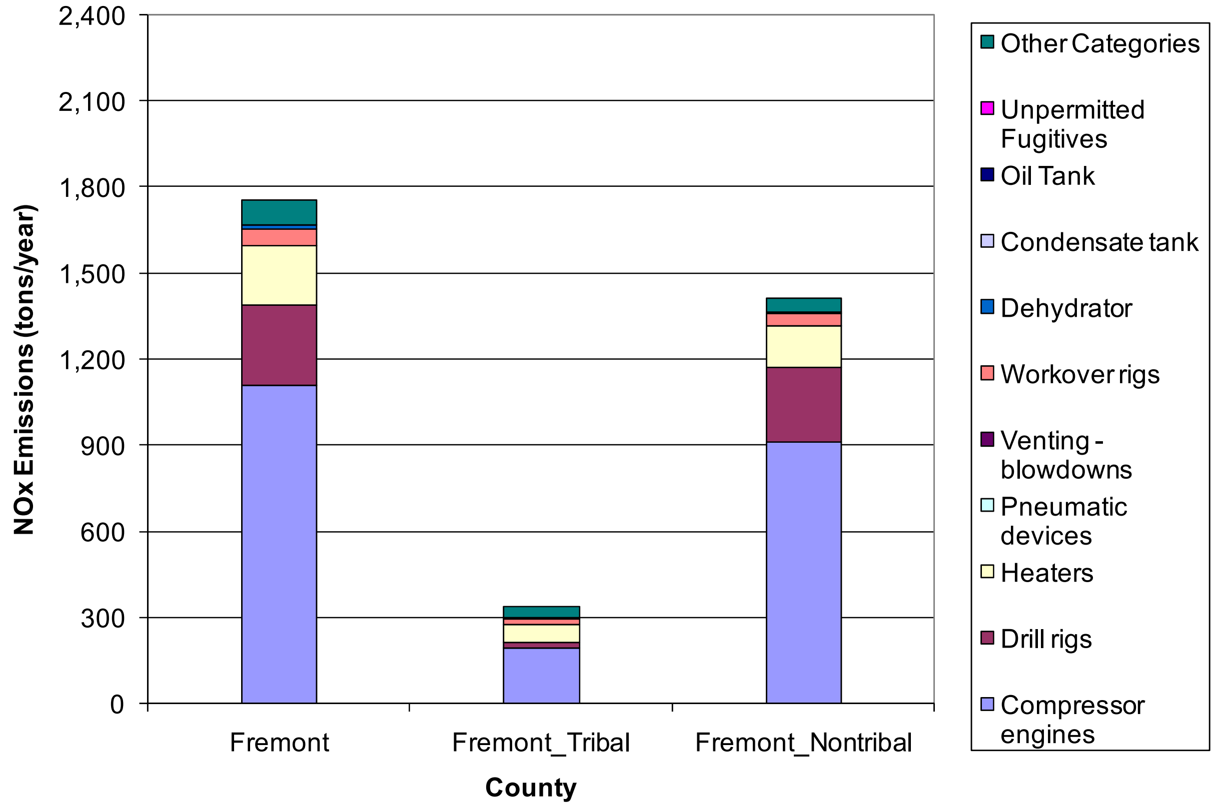

Figure 7. 2012 NOx emissions by tribal and non-tribal land in the Wind River Basin.

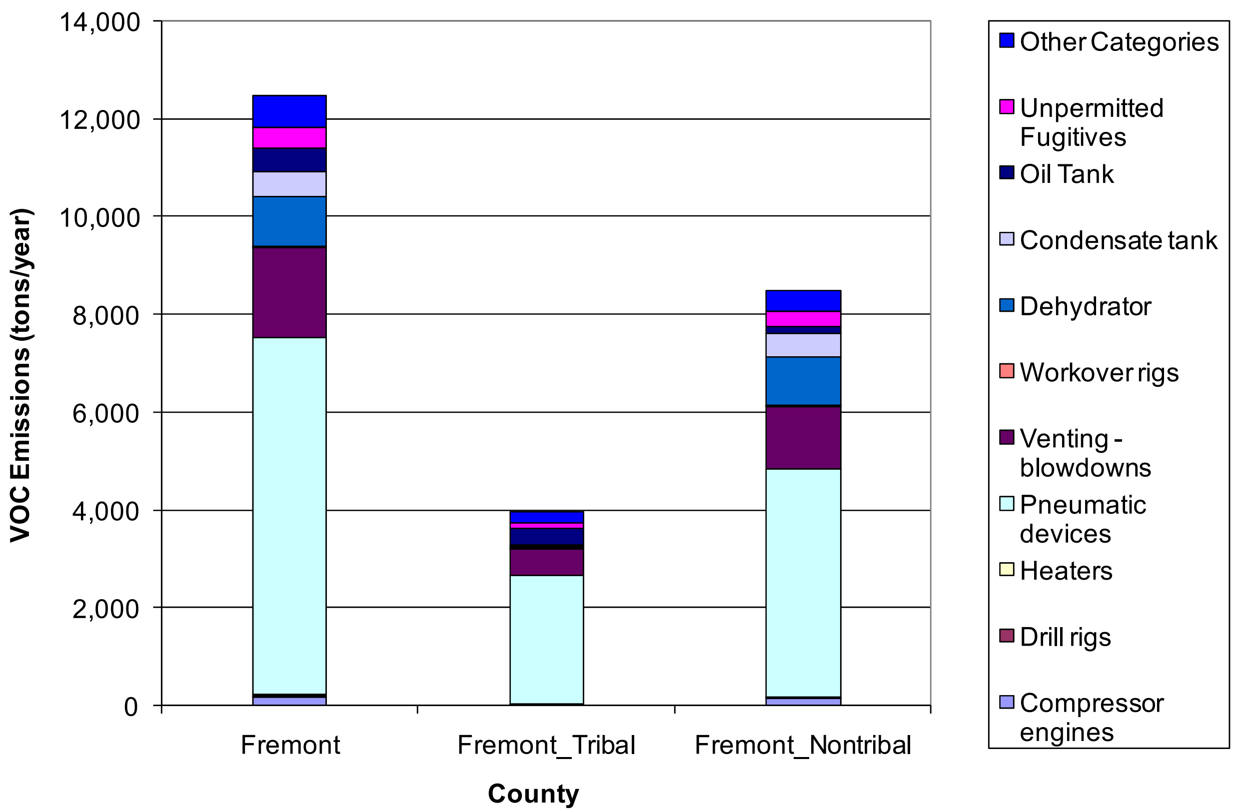

Figure 8. 2012 VOC emissions by tribal and non-tribal land in the Wind River Basin.

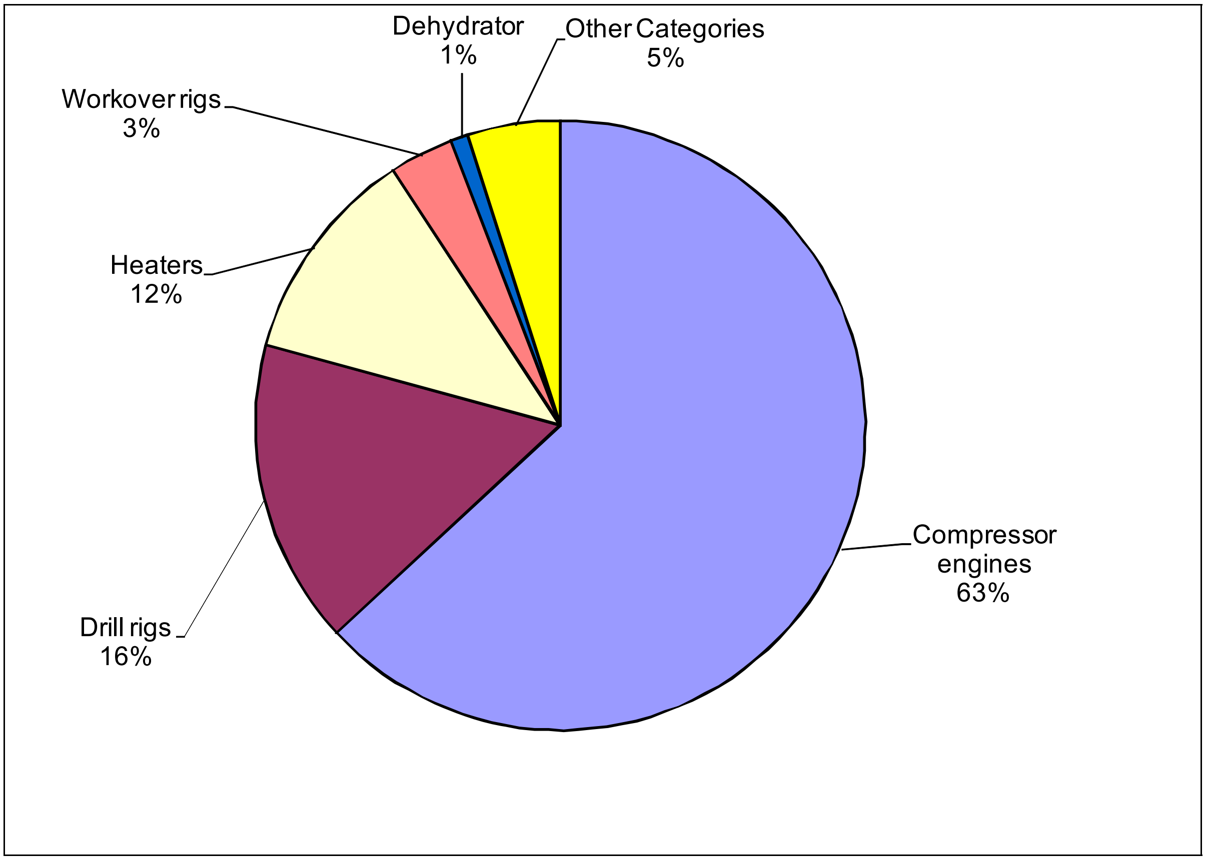

Figure 9. 2012 NOx emissions contributions by source category in the Wind River Basin.

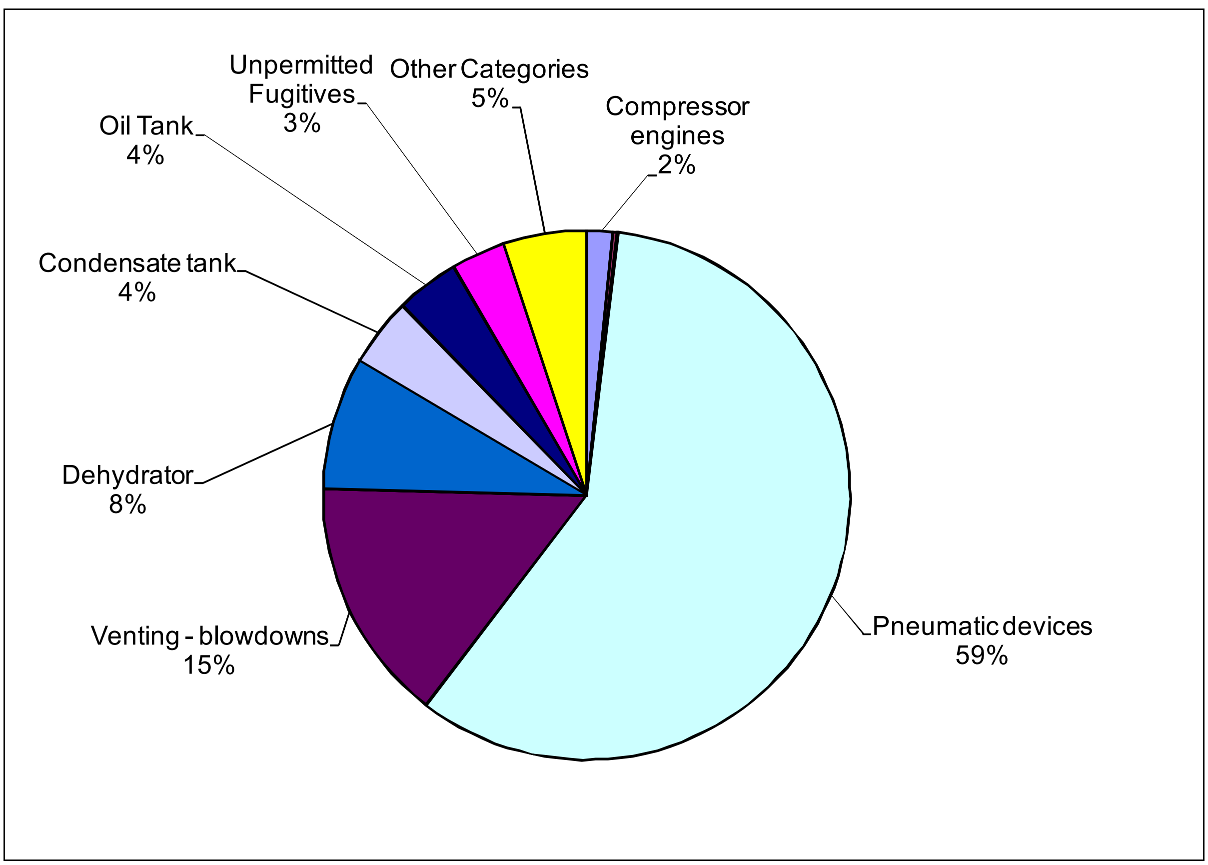

Figure 10. 2012 VOC emissions contributions by source category in the Wind River Basin.

Table 8. 2012 emissions of all criteria pollutants by county for the Wind River Basin**.**

County	NOx [tons/yr]	VOC [tons/yr]	CO [tons/yr]	SOx [tons/yr]	PM [tons/yr]
Fremont (Tribal)	343	3,979	429	81	8
Fremont (Non-Tribal)	1,416	8,501	2,309	1,537	31
Fremont Total	**1,758**	**12,480**	**2,738**	**1,618**	**39**

Table 9. 2012 NOx emissions by source category for the Wind River Basin.

County	Compressor Engines	Drill Rigs	Heaters	Workover Rigs	Dehydrator	Other Categories	Total
Fremont (Tribal)	197	20	60	18	9	39	343
Fremont (Non-Tribal)	913	264	143	42	7	48	1,416
Fremont Total	**1,109**	**284**	**203**	**60**	**16**	**87**	**1,758**

Table 10. 2012 VOC emissions by source category for the Wind River Basin.

County	Compressor Engines	Drill Rigs	Heaters	Pneumatic Devices	Venting – Blowdowns	Workover Rigs	Dehydrators	Condensate Tanks	Oil Tanks	Unpermitted Fugitives	Other Categories	Totals
Fremont (Tribal)	45	2	3	2,647	553	2	33	23	340	123	208	3,979
Fremont (Non-Tribal)	156	26	8	4,656	1,308	6	977	496	146	292	430	8,501
Fremont Total	**201**	**28**	**11**	**7,303**	**1,861**	**8**	**1,010**	**519**	**486**	**415**	**637**	**12,480**

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