WRAP Phase III Inventories of Upstream Oil and Gas Activities in Wyoming

Amnon Bar-Ilan, Ron Friesen, John Grant, Alison Pollack, Ralph Morris
ENVIRON International Corporation

Doug Henderer
Buys & Associates

Kathleen Sgamma
Western Energy Alliance

Tom Moore, Lee Gribovicz
Western Regional Air Partnership (WRAP)

ENVIRON

Overview

- History of oil and gas EI development
- Current effort
- Temporal and geographic scope
- Source categories
- Methodology
- Results
- Future work

History and Significance of O&G Emissions

WRAP Phase I
- Limited source categories
- No industry data
- Lower quality production statistics

WRAP Phase II
- Selective improvement of some source categories
- Limited industry data
- Lower quality production statistics

WRAP Phase III
- Expanded source categories
- Significant industry participation
- High quality production statistics

- Why such a focus on the O&G industry sector?
  - Recent modeling in Colorado ozone NAA indicates O&G sector could account for up to 50% of VOC and 10% of NOx in nonattainment areas
  - Percentages could be even higher in other Rocky Mountain States
- More work is needed to understand and quantify O&G emissions

ENVIRON

Evolution of O&G Emissions Knowledge

- Steady progression of O&G emissions projects has improved inventories but also identified data needs/limitations
- State agencies & EPA increasingly tracking O&G emissions
  - Permit data and special studies by states
  - EPA reporting requirements
- Collaboration and regional data are essential
  - O&G development areas cross state lines
  - SIP and regional haze modeling need access to regional O&G emissions data

Goal of WRAP Phase III:

provide a regionally consistent, comprehensive O&G point and area source inventory for Rocky Mountain region

Current Phase III Effort

- Considers every major oil and gas production basin in the Rocky Mountain states, including New Mexico, Utah, Colorado, Wyoming, Montana and North Dakota
- Considers nearly all major oil and gas source categories and all major criteria pollutants: NOx, VOC, CO, PM, SOx
- Updated, regionally consistent methodology which combines state permitted sources databases with direct industry survey for some source categories
- Makes use of latest oil and gas production and well statistics from commercially available IHS database
- **Most detailed oil and gas emissions inventory to date**

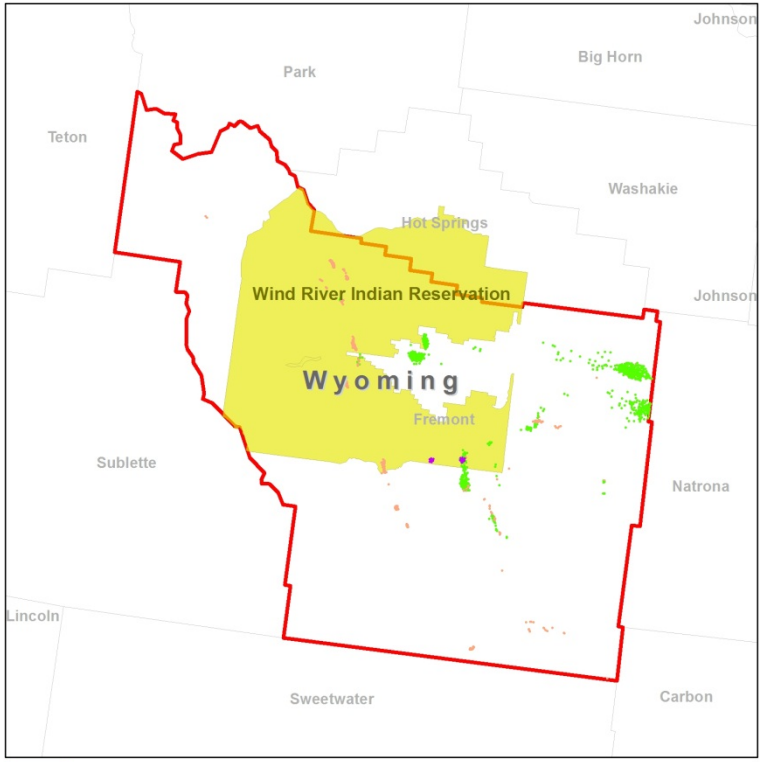
Phase III – Source Categories

- **Large Point Sources (Gas plants, compressor stations)**
- **Drill Rigs**
- **Wellhead Compressor Engines**
- **CBM Pump Engines**
- **Heaters**
- **Pneumatic Devices**
- **Condensate and Oil Tanks**
- **Dehydrators**
- **Completion Venting**

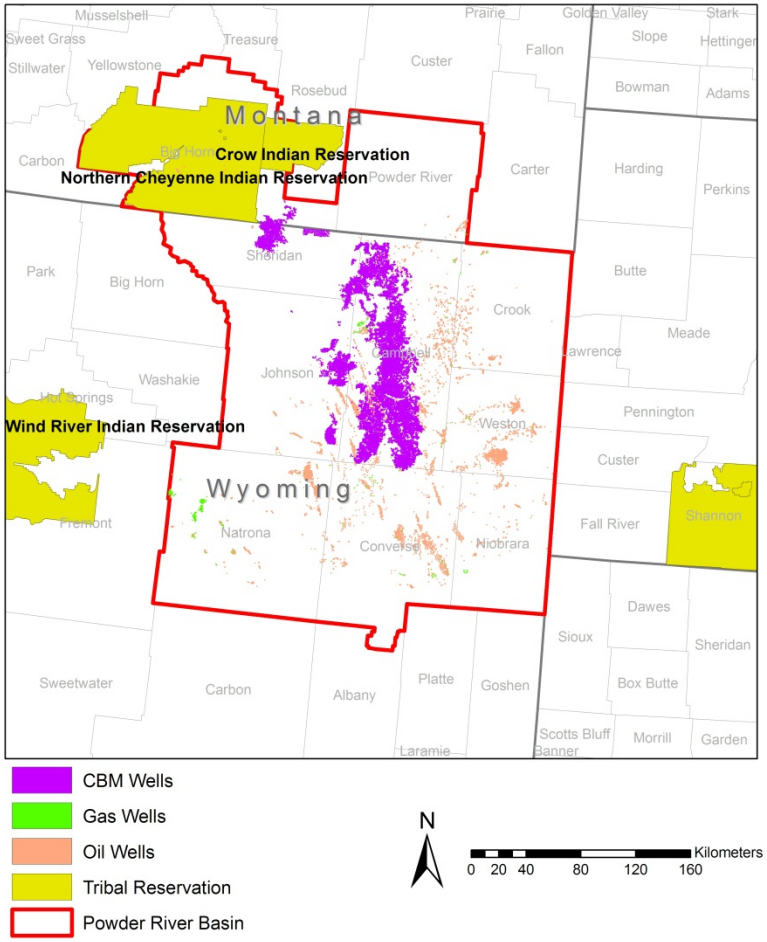
- **Lateral compressor engines**
- **Workover Rigs**
- **Salt-Water Disposal Engines**
- **Artificial Lift Engines (Pumpjacks)**
- **Vapor Recovery Units (VRU's)**
- **Miscellaneous or Exempt Engines**
- **Flaring**
- **Fugitive Emissions**
- **Well Blowdowns**
- **Truck Loading**
- **Amine Units (acid gas removal)**
- **Water Tanks**

Geographic and Temporal Scope

Wind River Basin

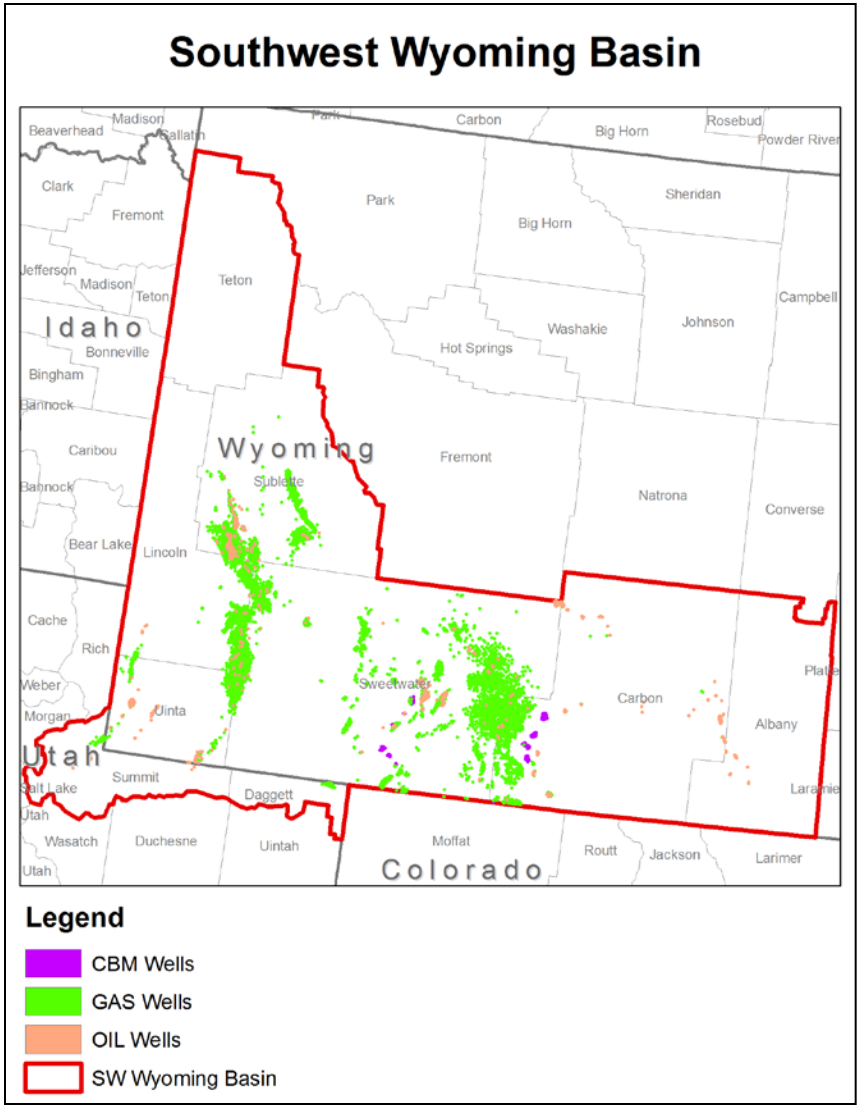


Powder River Basin



ENVIRON

Geographic and Temporal Scope



- Wyoming Basins being presented here – Wind River Basin, Powder River Basin, Southwest Wyoming (Greater Green River) Basin
- For all basins the boundaries of the basins have been aligned with county boundaries
- All basins are analyzed for tribal and non-tribal inventories (where applicable)
- Baseline inventories developed for 2006 with midterm projections to 2012 or 2015 (2012 for Wind River Basin) and 2009 updates developed for Wyoming basins

ENVIRON

Basin Oil and Gas Statistics

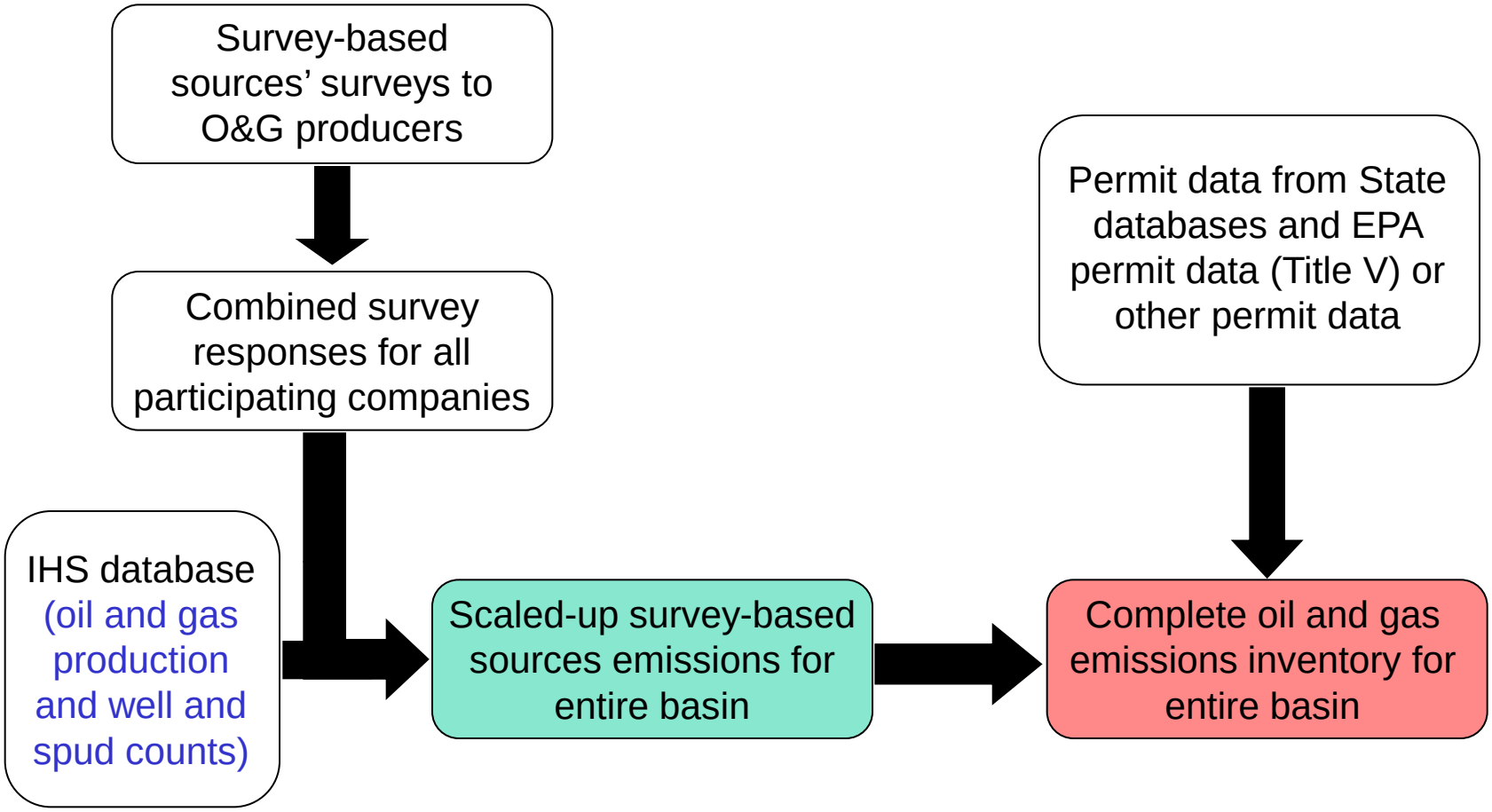
Basin	Well Count			Oil Production (bbl)			Gas Production (MCF)			Spud Counts
	Total	Conv	CBM	Total	Oil Well Oil	Gas Well Condensate	Total	Conv	CBM	Total
D-J Basin	16,774	16,774	0	14,242,088	0	14,242,088	234,630,779	234,630,779	0	1500
Uinta Basin	6,881	6,018	863	11,528,121	9,758,247	1,769,874	331,844,336	254,219,432	77,624,904	1069
Piceance Basin	6,315	6,255	60	7,158,305	5,755,076	1,403,229	421,358,666	420,165,237	1,193,429	1186
North San Juan Basin	2,676	1,009	1,667	32,529	27,962	4,567	443,828,500	28,642,418	415,186,082	127
South San Juan Basin	20,649	16,486	4,163	2,636,811	1,002,060	1,634,751	1,020,014,851	520,060,869	499,953,982	919
Wind River Basin	1,350	1,330	20	3,043,459	2,563,912	479,547	198,190,024	197,166,868	1,023,156	98
Powder River Basin	25,652	7,793	17,859	19,662,896	19,144,596	518,300	452,813,743	64,019,159	388,794,584	3,275
SW Wyoming Basin	9,173	9,019	154	16,109,922	6,324,849	9,785,073	1,468,167,385	1,461,271,032	6,896,353	1,146

Red figures are greatest value in each column, showing spatial variation in O&G E&P operations

- **Wide variation in total production of gas and oil/condensate among basins**
- **Spud counts are surrogate for where significant O&G activity was occurring**

ENVIRON

Phase III Baseline Methodology Diagram



2009 Updates in Wyoming (Phase IV)

- Participating companies surveyed for updates to baseline 2006 survey data previously provided
  - Updates to equipment, configuration, processes and controls
  - If no 2009 update provided previous submission used
- Data obtained from state/federal permit databases updated
- Wyoming DEQ Upper Green River Basin (UGRB) expanded inventory used for Sublette County

	Percent Ownership of Basin-Wide Production (Southwest Wyoming)		
	2006 Participating Companies	2009 Survey Update Respondents	2009 All Companies
Well Count	54%	35%	52%
Gas Production	97%	20%	96%
Oil Production	23%	23%	25%

Midterm Projections (2012/2015)

- Baseline inventories projected to 2015 for Powder River Basin and Southwest Wyoming Basin, 2012 for Wind River Basin

- Projections use a three-step approach

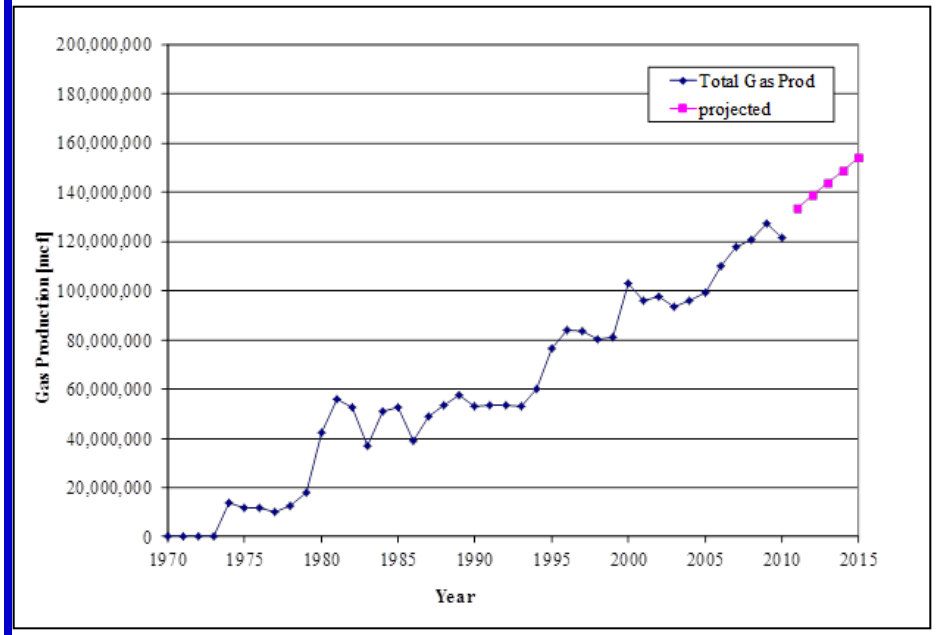
  1. Activity scaling factors
  2. "Uncontrolled" projections
  3. Wyoming state and federal regulations

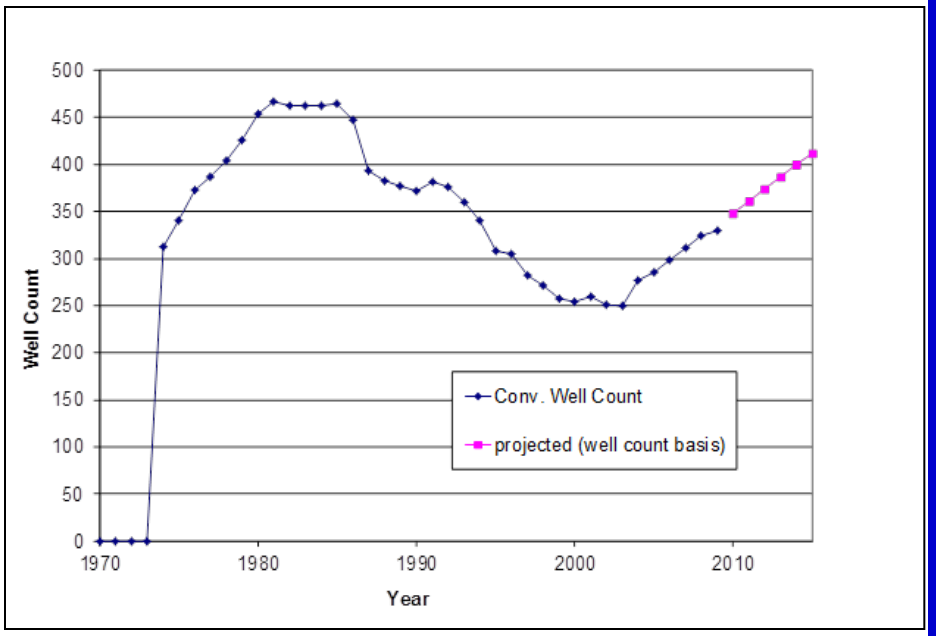
- Wyoming controls requirements include:

  - Engine NOx requirements
  - Control of dehydrator emissions
  - Control of tank flashing emissions
  - Control of pneumatic pump emissions
  - Low-bleed pneumatic devices

Midterm Projections (2012/2015)

- Operators queried for planned drilling activities
- Well decline data gathered to generate basin-average curves
- Production projections constructed from operator data/historic trends





ENVIRON

Results – Criteria Pollutant Emissions

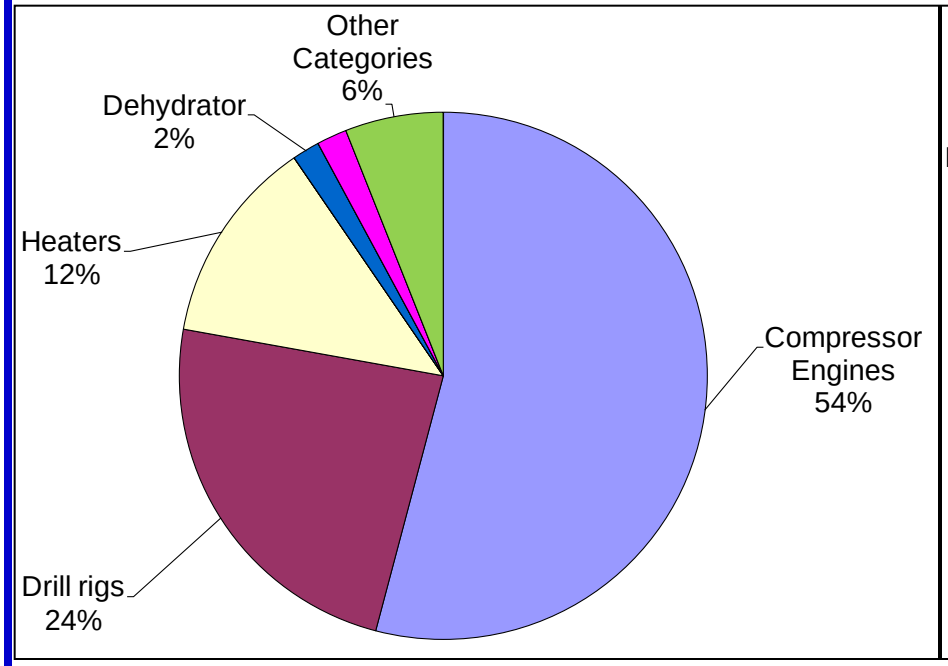
- SW WY Basin the largest and most significant O&G basin in WY
- Powder River Basin produces mainly low-VOC CBM gas but uses significant compression
- Wind River Basin produces significant amount of gas from few high-producing wells
- Trends from 2006 through 2015 are a combination of growth in activity and control of source emissions through state regulations

Basin	Emissions (tons/yr)				
	NOx	VOC	CO	SOx	PM
2006 Baseline					
Wind River Basin	1,814	11,981	2,840	1,792	37
Powder River Basin	21,086	14,367	12,873	609	681
SW Wyoming Basin	21,569	94,013	13,150	5,259	541
2009 Update					
Wind River Basin	1,886	11,289	4,296	2,484	32
Powder River Basin	31,647	22,136	25,151	93	578
SW Wyoming Basin	15,991	84,964	8,596	1,813	398
2012/2015 Projection					
Wind River Basin*	1,758	12,480	2,738	1,618	39
Powder River Basin	25,920	19,994	27,157	604	744
SW Wyoming Basin	21,136	105,498	13,158	5,486	611

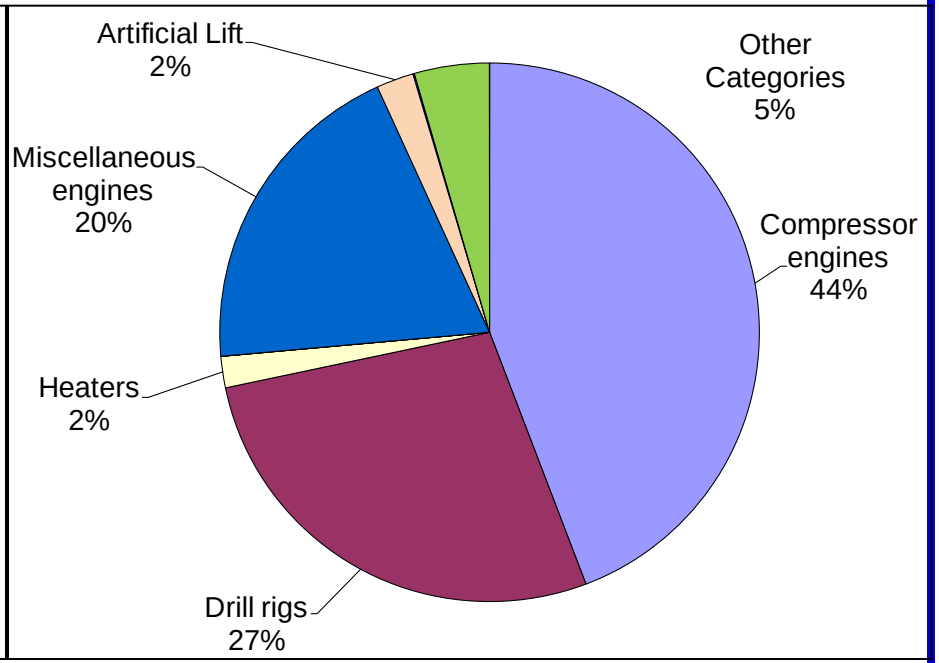
*Wind River Basin midterm projection is for 2012
Red figures are greatest value, showing spatial variation in O&G E&P emissions

ENVIRON

Results – Example NOx Emissions Breakdown By Source Category



Southwest Wyoming Basin

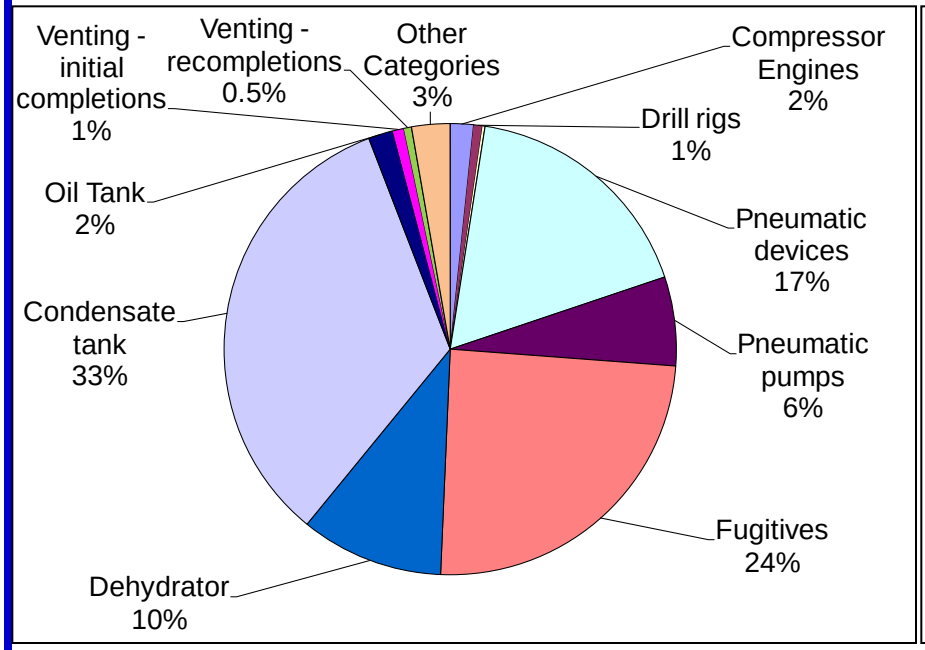


Powder River Basin

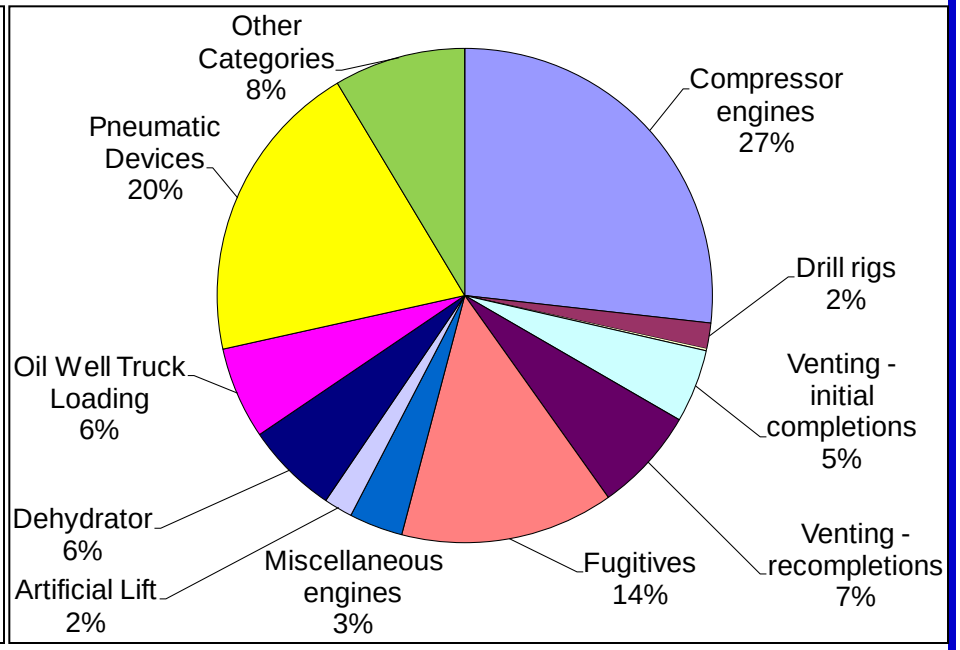
- NOx emissions – compressor engines, drill rigs, heaters, other engine types

ENVIRON

Results – Example VOC Emissions Breakdown By Source Category



Southwest Wyoming Basin

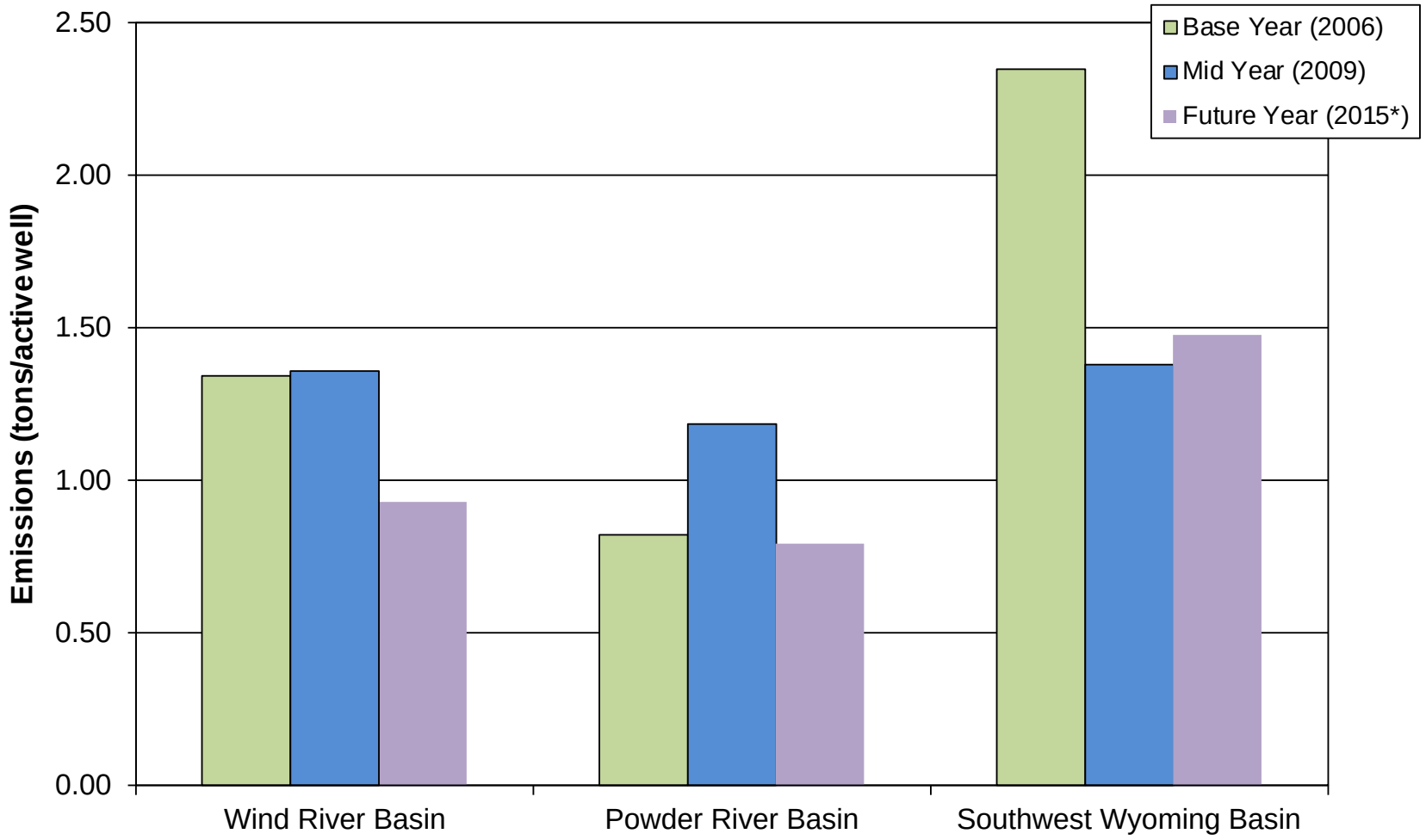


Powder River Basin

- VOC emissions – more complicated; tanks, pneumatics, fugitives, dehydration, compressor engines

ENVIRON

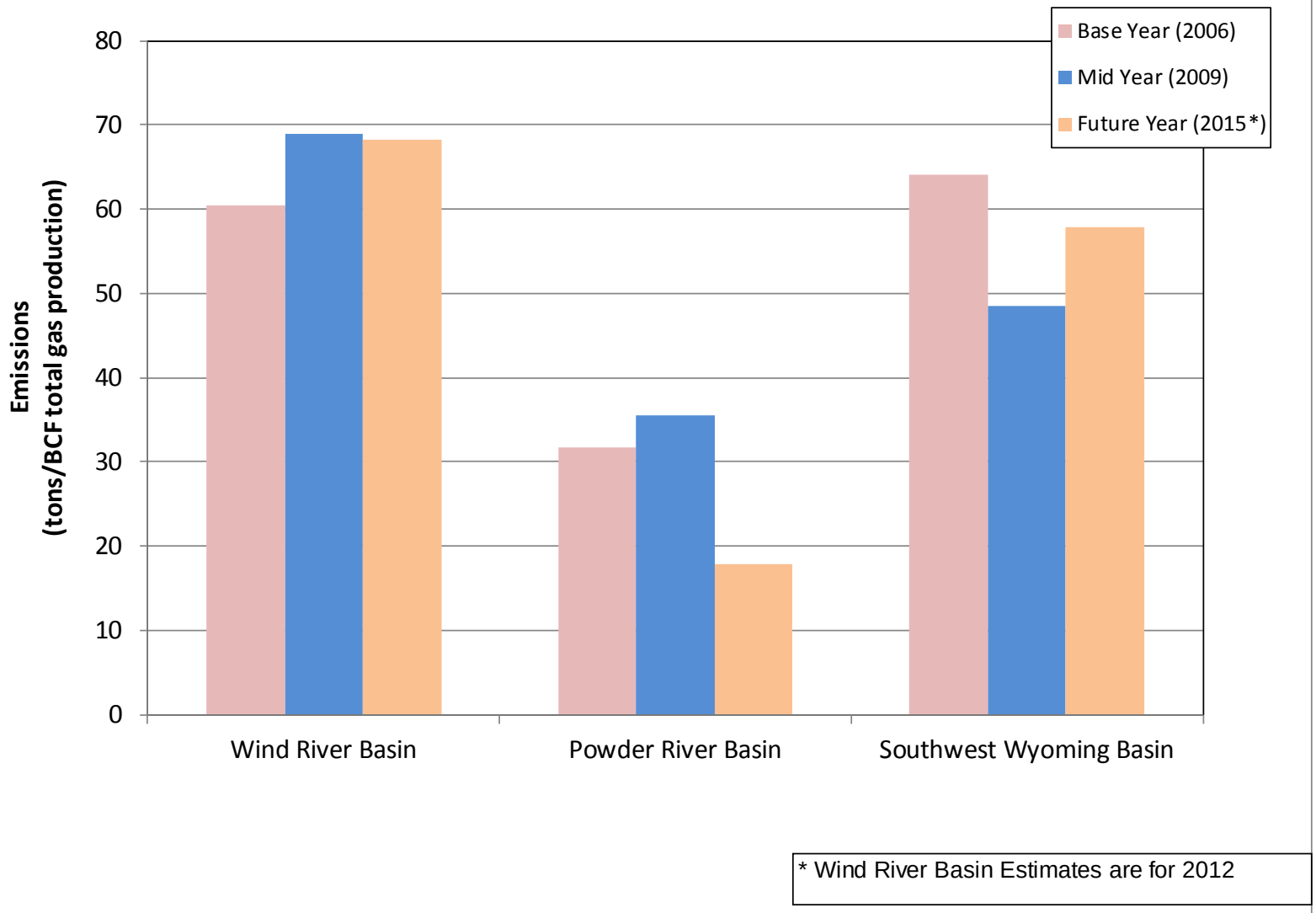
Results – Per-Well NOx Emissions



* Wind River Basin Estimates are for 2012

ENVIRON

Results – Per-Unit-Gas-Production VOC Emissions



Inventory Findings

- Wide range of NOx and VOC emissions among Wyoming Basins - Southwest Wyoming Basin largest gas production basin and highest emissions, Powder River has largest number of wells but produces primarily CBM gas, Wind River is smallest basin with large amount of gas production from relatively few wells

- Emissions trends from 2006 -> 2009 -> 2015 are a complex mix of growth in activity in some areas, decline in activity in others, and regulatory controls; NOx generally decreasing despite growth due to control of sources, VOC emissions more complicated but effects of regulatory requirements are observed in the inventories

- NOx emissions per well are relatively consistent among basins, driven by the number of active wells and number/size of equipment – differences in some basins are due to a combination of regulatory requirements for compressor engines and the relative level of activity of drilling rigs

- VOC emissions per unit gas production vary widely across basins – highest values are for the Wind River and Southwest Wyoming Basins which have significant oil and condensate production

Data Gaps and Future Work

- Piceance Pilot Project (P3) for Piceance Basin in northwest Colorado – expansion to other basins?
- Source categories not considered in Phase III – pipelines, evaporation ponds, mud degassing, minor sources on tribal land, mobile sources
- Reconciliation with measurement data such as NOAA studies
- Identifying high emitters or other missing source categories?
- Incorporation of findings from state air agencies such as CDPHE study of condensate tank emissions