

OIL AND GAS AREA SOURCE EMISSIONS

OVERVIEW

The WRAP Stationary Sources Joint Forum (SSJF) has funded a WRAP region-wide emissions inventory of area and point sources for use in regional haze modeling. In the Western States, oil and gas development make up a significant portion of the total emissions in this region. The Phase I oil and gas area source inventory was the first to identify oil and gas area sources, which are largely drilling rigs, small compressor engines located at the wellhead, and other wellhead processes. Prior to this Phase I inventory, no comprehensive inventory had ever addressed these oil and gas area sources.

This work represents a Phase II oil and gas area source emissions inventory effort. With rapidly increasing oil and gas development in recent years, and increasing regulatory scrutiny by states and the federal government, there was a need to improve the oil and gas emissions inventory to better understand the contribution of this industry to regional emissions inventories. The Phase II work represents an effort to improve the methodology and data sources used to generate the oil and gas area source emissions inventory. The improvements in the inventory are better able to reflect the rapid change in this sector and the variability in emissions and operations from region to region.

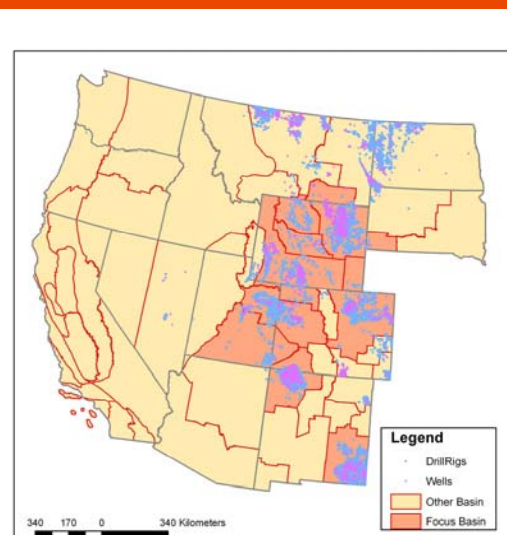
BACKGROUND

- ENVIRON completed Phase I emissions inventory of oil and gas area sources, including wellhead and mobile source emissions not previously included in any oil and gas inventory. The focus was regional haze, although NO_x, VOC and SO_x emissions were estimated where possible.
- Updated Phase II emission inventory scope:
 - Pollutants: NO_x, SO_x, VOC (limited), CO (limited)
 - Oil and gas area sources (primarily drilling rigs and compressors were updated, but inventory includes other sources)
 - Geographic resolution: WRAP states and tribes, county level
 - Temporal resolution: 2002 and 2005 base years, 2018 emissions projections

KEY POINTS

- Oil and gas development in the western regional U.S. in the past 15 years has exploded
 - Between 2000-2004 over 5,000 new oil and gas leases have been issued covering 4.8 million acres of land in the western U.S.
 - Between 2001-2003 an average of 3,700 new drilling permits have been issued per year
- Previous Phase I inventory represented the first ever oil and gas area source emissions inventory in the western regional U.S., and has estimated over 100,000 tpy of NO_x from oil and gas operations in 2002 that were previously unreported
- This inventory represents a "Phase II" region-wide emissions inventory
- Phase II included improved estimates of drilling rig and compressor engine emissions, better geographic specificity, and updated production/drilling data
- Phase II estimated both 2002 and 2005 baseline emissions, as well as improved estimates for 2018 emissions projections
- Many incorrect assumptions from Phase I were addressed in the Phase II effort

WRAP region (excluding Alaska) showing locations of oil and gas wells and boundaries of major producing basins, including those in the focus basin list



METHODS

- General approach was to calculate NO_x emissions from compressor engines and drilling rigs by engine count, not production
- Equipment and assumptions represented averages by major oil and gas producing basins
- Conducted detailed survey of major oil and gas producers to obtain detailed data on engines and usage
 - Compressor engine makes/models, usage hours, load factors, emissions factors
 - Wellhead compressor engine usage vs. lateral or central compressor engine usage, by major geographic basins
 - Drilling rig engine makes/models, usage hours, load factors, fuel consumption rates, emissions factors of NO_x, SO_x, CO, VOC and PM where available
 - Drilling rig configuration – number of engines, types of auxiliary engines and usage
- Combined detailed equipment information by basin with state Oil and Gas Conservation Commission (OGCC) databases of well counts, production and drilling counts by county
- Used this information to estimate 2002 baseline emissions, and state OGCC databases to scale up 2002 emissions to 2005 using well count or production, where appropriate
- Conducted detailed analysis of potential emissions control technologies for drilling rigs and compressor engines, as well as some wellhead VOC sources
 - Used pilot studies, EPA/CARB studies and direct information from producers
 - Determined both emissions reduction potential and NO_x cost-effectiveness for drilling rig and compressor engine controls
- Developed scaling factors to project emissions to 2018 based on Resource Management Plans (RMPs), Environmental Impact Reports (EIRs), and the Annual Energy Outlook published by DOE
 - GIS analysis to determine geographic coverage area of RMPs/EIRs
 - Average well count estimates from RMPs
 - Merged RMP and EIA predictions using well-count weighted averages
- Conducted survey of major oil and gas processing plant operators to revise SO₂ projections from these plants for 2018
 - Surveyed Title V permits and interviewed plant operators
 - Incorporated in-use or planned control equipment into emission projections for 2018

Current and future regulations affecting drilling rigs and compressor engines, and estimated range of costs and NO_x cost-effectiveness of controls for drilling rigs and compressor engines.

	Drilling Rigs	Compressor Engines
Federal Regulations	Federal onroad diesel engine standards	Federal nonroad spark-ignition engine standards
	Federal mandates for non-road diesel fuel sulfur content	
State Regulations		
Wyoming		Best Available Control Technology (BACT) regulation requiring all permitted O&G sources in the state to emit no more than 1 g/bhp-hr NO _x emissions.
Utah		BACT regulation requiring all permitted O&G sources in the state to emit no more than 1 g/bhp-hr NO _x emissions.
Colorado^a		Regulation 7 requiring reductions in VOC emissions from oil and gas sources, controls requirements for compressor engines, tanks, and glycol dehydrators
Range of Control Costs (\$ per engine)	\$1,000 – \$310,000	\$300 - \$300,000
Range of NO_x Cost-Effectiveness (\$/ton-NO_x)	\$800/ton-NO _x – \$11,600/ton-NO _x	< \$100/ton-NO _x – \$31,000/ton-NO _x
Most Cost-effective Control Measure for NO_x Emissions Reduction	Exhaust Gas Recirculation (EGR) System	Ignition Timing Retardation (ITR) System

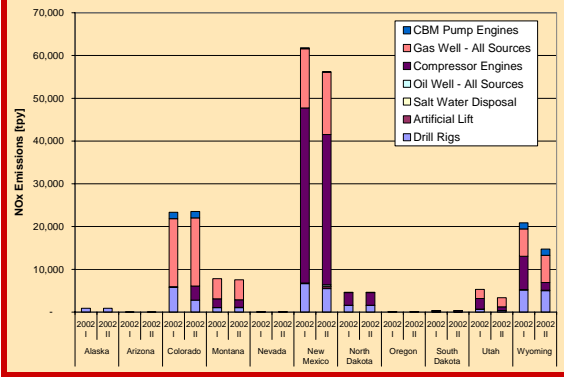
a – Colorado is currently revising Regulation 7 and may adopt additional measures under this regulation

2002 Oil and Gas NOx Area and Point Source Emissions Estimates

States	All Area Sources	All Point Sources	TOTAL
Alaska ^a	886	45,431	46,317
Arizona	17	642	659
California	8,070	10,809	18,879
Colorado ^b	23,518	25,219	48,737
Idaho		2,590	2,590
Montana	7,557	3,996	11,553
Nevada	62	83	145
New Mexico	55,640	56,900	112,540
N. Dakota	4,631	4,638	9,269
Oregon	85	1,182	1,267
S. Dakota	361	323	684
Utah	3,335	3,049	6,384
Washington		480	480
Wyoming	14,725	13,423	28,148
WRAP Total	118,887	168,765	287,652

a - Wellhead compressors in Alaska are permitted as part of a central station and counted in the state point source inventory
 b - Colorado's point source inventory threshold is 2 tpy NOx, which includes all wellhead compressors, therefore the only compressor emissions listed here for Colorado are those from the Southern Ute tribal lands.

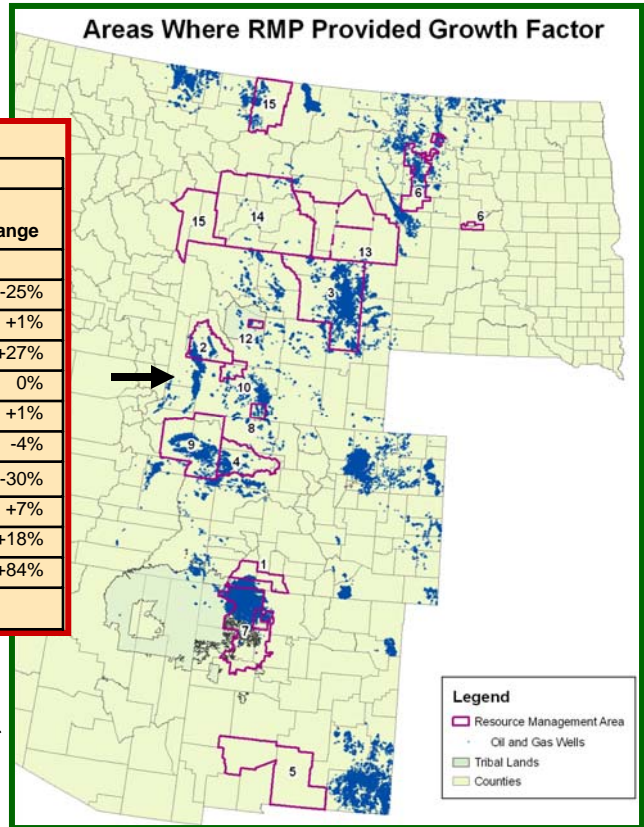
2002 NOx and SOx Area Source Emissions Estimates Comparison of Phase I and Phase II



2005 Drilling Rig and Compressor Engine NOx Emissions Estimates

State	Drill Rig Emissions			Compressor Emissions		
	NOx [tpy]		% Change	NOx [tpy]		% Change
	2002	2005		2002	2005	
AK	877	835	-5%			
AZ	0	0	0%	8	6	-25%
CO	2,803	8,000	+185%	3,271	3,302	+1%
MT	1,046	3,007	+187%	1,791	2,267	+27%
NV	24	37	+54%	33	33	0%
NM	5,476	8,640	+58%	35,140	35,345	+1%
ND	1,536	3,055	+99%	2,920	2,799	-4%
OR	0	0		73	51	-30%
SD	29	203	+600%	284	305	+7%
UT	334	2,888	+765%	843	996	+18%
WY	4,997	15,783	+216%	1,791	3,288	+84%
WRA	17,123	42,448		46,154	48,393	

a - Wellhead compressor emissions in Colorado are only those located on Southern Ute Tribal land; all other wellhead compressors are assumed to be part of Colorado's point source inventory and thus are not listed here.

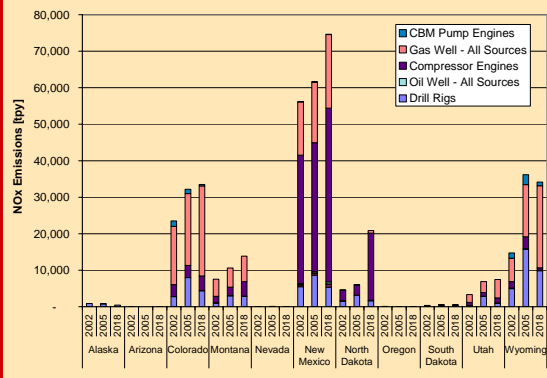


2018 Oil and Gas NOx Area and Point Source Emissions Estimates

States	All Area Sources	All Point Sources	TOTAL
Alaska ^a	453	36,382	36,835
Arizona	15	382	397
California		10109	10,109
Colorado ^b	33,517	14,825	48,342
Idaho		1,734	1,734
Montana	13,880	2,533	16,413
Nevada	63	47	110
New Mexico	73,714	36,320	110,034
North Dakota	20,869	3,928	24,797
Oregon	44	753	797
South Dakota	557	311	868
Utah	6,297	1,930	8,227
Washington		247	247
Wyoming	34,142	9,075	43,217
WRAP Total	183,551	118,576	302,127

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2018 NOx and SOx Area Source Emissions Projections from Phase I and Phase II



OTHER RELEVANT POINTS

Quality of inventory is limited by accuracy and completeness of equipment/emissions data provided by oil and gas producers.

Inventory is limited to the specific pollutants addressed: NO_x and to a lesser extent SO_x emissions; is incomplete for VOC emissions. Emissions projections are based on average foreseeable scenarios from RMPs and EIRs, but more detail is needed to better track actual well production vs. predictions in RMPs to improve accuracy of scaling factors. Inventory must be viewed alongside O&G point source inventory to get a full understanding of O&G contribution to overall emissions.

Projections are highly uncertain. Very fast-changing environment; RMPs are approved and further development often occurs.

RESEARCH/INFORMATION NEEDS

- More detailed equipment, activity, usage and emissions information from more oil and gas producers for all major oil and gas basins in the western U.S.

- Database of historical well development from the BLM to track the progress and accuracy of RMPs in predicting oil and gas activity for specific regions

- More detailed information on costs of control technologies should be obtained from control technology manufacturers and from oil and gas producers.

FUTURE WORK

- Emissions inventory development from Phase I to Phase II showed significant improvement in accuracy and coverage of emissions estimates by geographical region and source category – Phase II report recommends several areas where future work could improve the emission inventory
 - Other pollutant types should be addressed – VOC, PM – by obtaining producer data on PM emissions factors, VOC emissions factors, and VOC venting and fugitive emissions rates from typical well setups by major basin
 - Montana and North Dakota basins should be included in major focused basin list
 - SO₂ emissions from flaring/venting activities should be included
 - Future 2018 projections should include historical analysis of RMP predictions vs. actual well activity in key areas to provide guidance in using RMPs to predict 2018 activity.
 - Future analysis of control options and their costs will need a more consistent region-wide approach.

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WRAP Stationary Sources Joint Forum Oil and Gas Area Sources
<http://www.wrapair.org/forums/ssjf/documents/eictts/oilgas.html>