GREATER SAN JUAN BASIN O&G EMISSION INVENTORY DEVELOPMENT

John Grant, Amnon Bar-Ilan, Ralph Morris

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OUTLINE

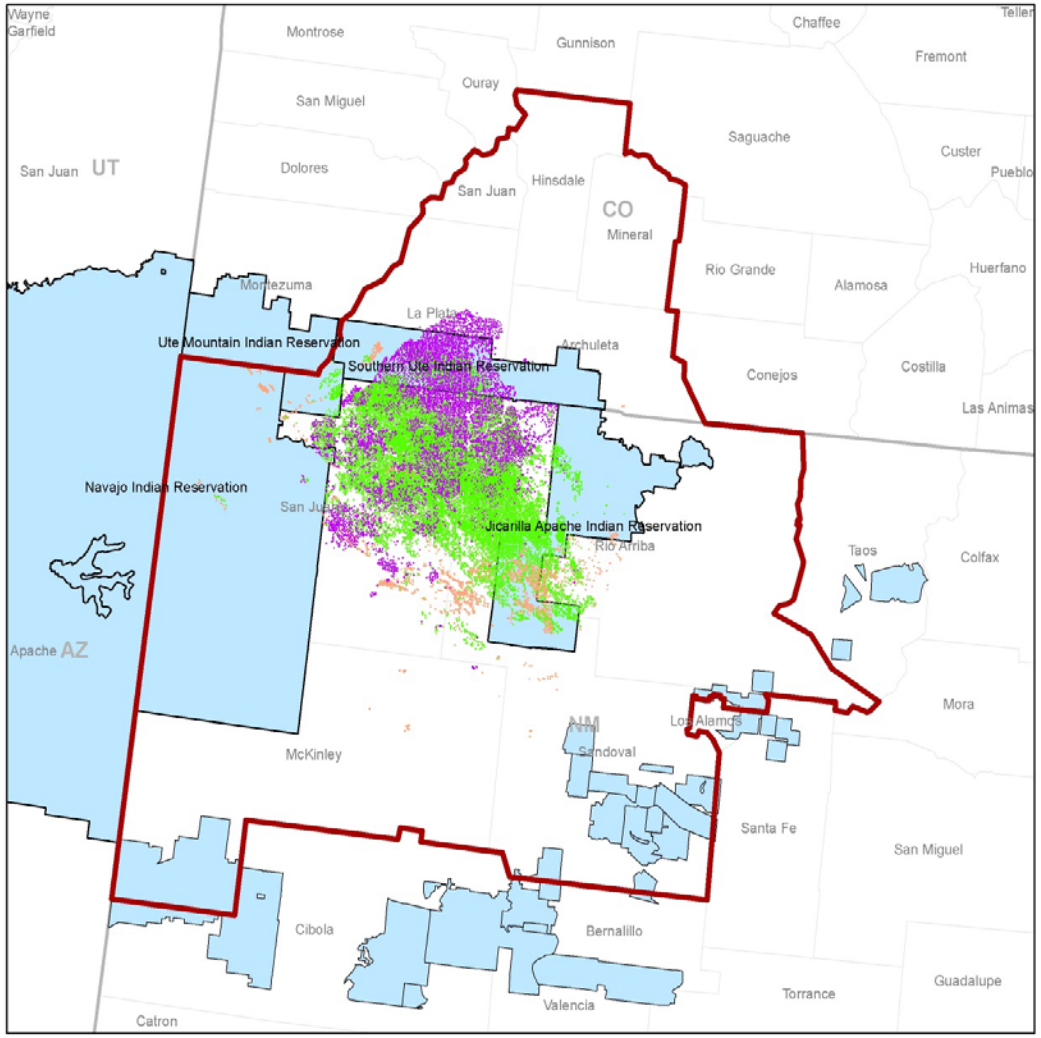
- San Juan Basin Well Locations and Sub-basins
- Well-site surveys
- Subpart W
- Tribal data
- State permit and inventory data

KEY QUESTIONS

- Does it makes sense to break the basin up into these sub-basins?
- Which source categories would be more accurately characterized by sub-basin level data?
- What data does your company collect for Subpart W that could be used to replace or supplement the survey?

O&G WELLS AND TRIBAL LANDS

San Juan Basin



Legend

- San Juan Basin
- Tribal Lands
- Gas Wells
- CBM Wells
- Oil Wells

N

0 15 30 60 90 120 Kilometers

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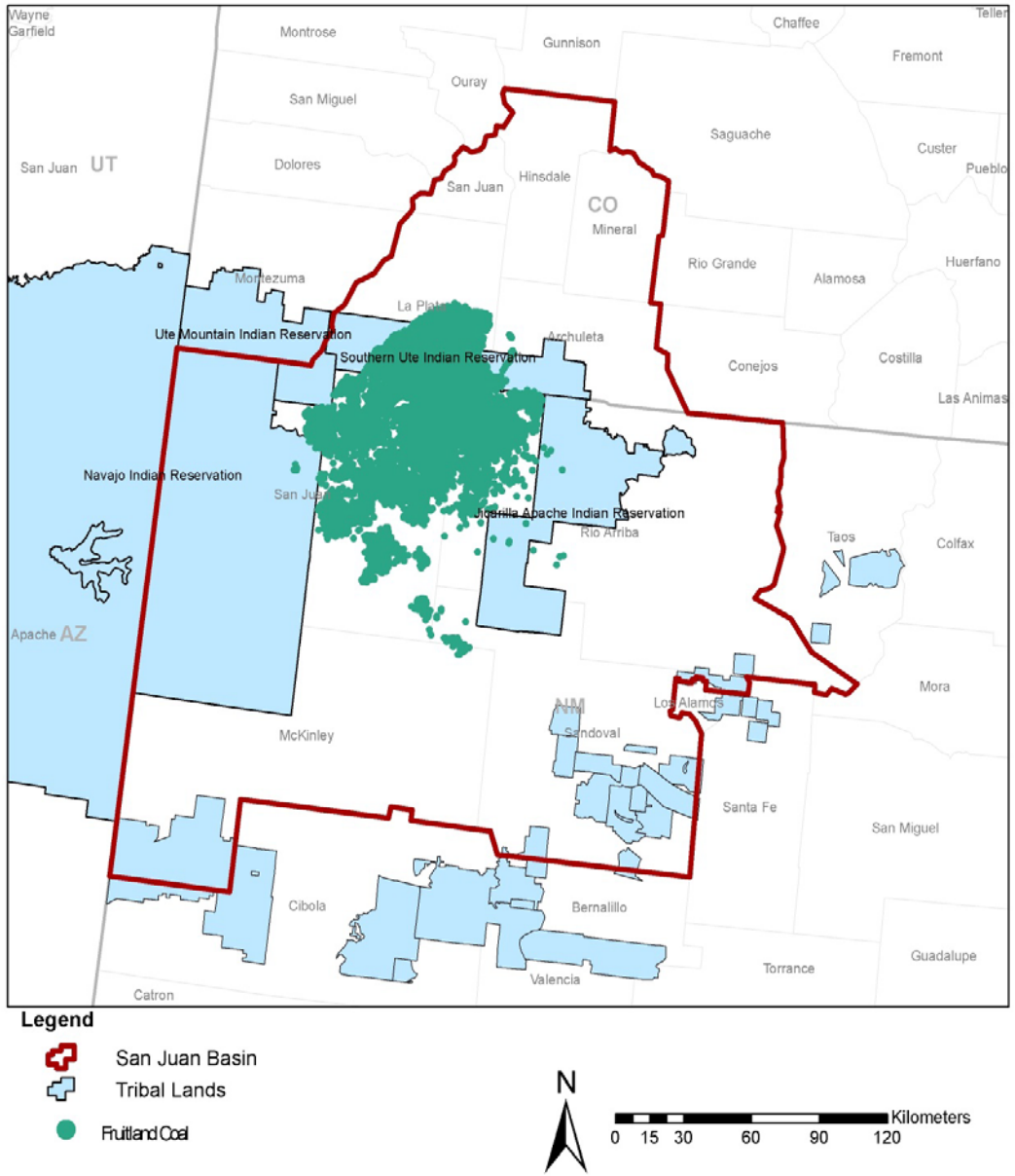
DRAFT GREATER SAN JUAN SUB-BASINS

CBM Wells
Fruitland Coal
Gas Wells
Dakota Sandstone
Mesaverde Group
Pictured Cliffs Sandstone
Mancos Shale
Oil Wells
Gallup
Gallup-Dakota
Mancos

- The listed sub-basins capture the vast majority (>90%) of O&G activity metrics (i.e. well count, oil production, and gas production) in the Greater San Juan Basin
- Sub-basin specific data will not necessarily be collected for all well site emission source categories
- Sub-basin specific data expected to be collected for gas composition, tanks, and dehydrators
- Whether data is collected by sub-basin for additional source categories is still being decided

CBM WELLS BY SUB-BASIN

San Juan Basin CBM Wells Sub-basin



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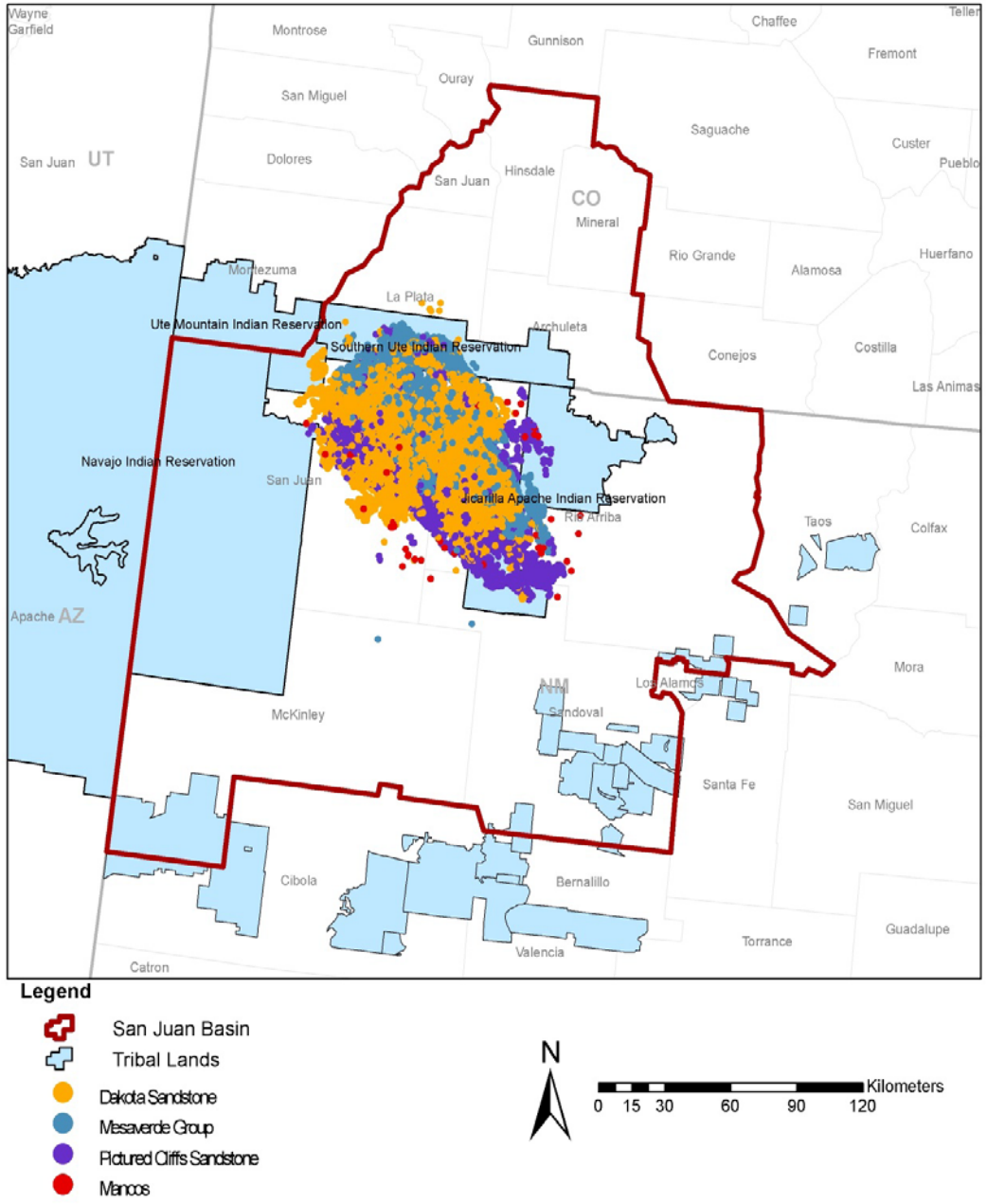
GAS WELLS BY SUB-BASIN

San Juan Basin Gas Wells Sub-basin



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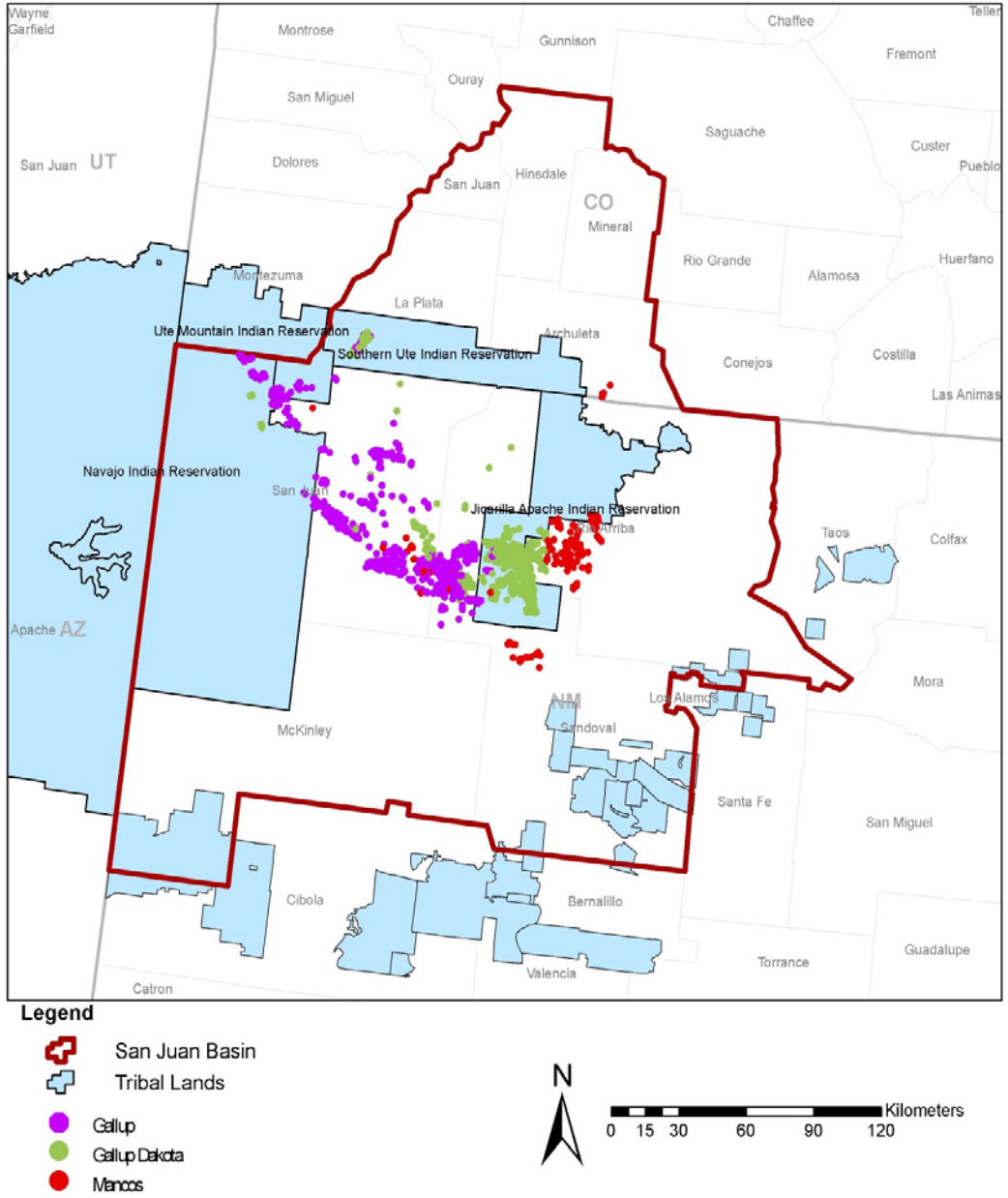
OIL WELLS BY SUB-BASIN

San Juan Basin Oil Wells Sub-basin



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SURVEY-BASED EMISSION SOURCES BY WELL TYPE

Phase	Survey-based Source Category	Gas	CBM	Oil
Drilling & Completion Phase	Drill Rigs	x	x	x
	Completions and Recompletion Venting and Flaring	x	x	x
	Fracing Engines	x	x	x
	Mud Degassing	x	x	x
Production Phase	Blowdowns	x	x	x
	Condensate and Oil Tanks	x		x
	Dehydrators	x	x	x
	Oil and Condensate Well site Truck Loading	x		x
	Heaters	x	x	x
	Fugitives Devices	x	x	x
	Pneumatic Controllers	x	x	x
	Pneumatic Pumps	x	x	x
	Compressor Engines (exhaust, startup/shutdown, fugitives)	x	x	x
	Workover Rigs	x	x	x
	Artificial Lift Engines			x
	CBM water pump/dewatering engines		x	
	Miscellaneous engines	x	x	x

* Gas composition data will be collected and used to estimate venting source emissions

SURVEY – VENTING/LOSS SOURCES

- **Gas compositions**: Operators asked to provide representative lab analyses by sub-basin
- **Tank emissions**: Operators asked to provide representative model input/output and information on controls by sub-basin
- Operators asked to provide representative data for most other sources (samples below)

Sample: Blowdowns

Parameter	Sample Data		
	Blowdown Method		
	Manual	Automatic	With Plunger-lift
Percent of active wells for which blowdowns were performed	15%	10%	5%
For wells where blowdowns were performed, please provide:			
Annual number of blowdowns (events/well/year)	18	5	1
Total volume of gas vented per blowdown event (MCF/event)	0.25	0.25	0.25
Is all of the blowdown gas flared?	N	N	N
If all vented gas is NOT flared, what fraction is flared?	10%	10%	10%

Sample: Pneumatic Controllers:

Survey ID	No. of Devices Per Typical Well	Device Type	Device Type Description *if selected device type "other"*	Bleed rating	Bleed Rate (cfh) *if available*
Sample Data	10	pressure controller		low bleed	6

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SURVEY – WELL SITE ENGINES & HEATERS

- Operators asked to provide representative data for each source category

Sample: Well Site Engines

		Sample Data
Engines per Well		0.2
Engine Function		Wellhead Compressor Engine
Rated Horsepower (hp)		100
Load Factor (%)		90%
Hours of Operation (hours/year/engine)		645
Percent of Engines with Control		100%
Type of Engine Emission Control (if applicable)		NSCR
Fuel Type		Natural Gas
If Natural Gas Fuel Type, Percent of Engines	Lean Burn	100%
	Rich Burn	-
Actual Emission Factors (if available) (g/bhp-hr)	Source	Manufacture's Data Sheet
	NOx	1
	CO	1.25
	VOC	1.2
	PM10	0.22

Sample: Well Site Heaters

	Sample Data	Separator	Tank	Reboiler	Line	Others
Number of Heaters per well	2					
Heater MMBtu Rating (MMBtu/hr)	0.5					
Annual Heater Usage (hrs)	8760					
Heater Cycling (fraction of the time the heater is doing work when it is turned on)	1					

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SURVEY – RIG ENGINES

- Operators asked to provide more than one rig configuration, if applicable
- Similar information requested for drilling rigs, fracing setups, and workover rigs

		Engine No. 1	Engine No. 2	Engine No. 3	Engine No. 4
Drill Rig Configuration - Sample Data					
Engine Function		draw works	draw works	mud pump	-
Number of Engines		1	2	2	-
Rated Horsepower Per Engine (hp)		1500	825	625	-
Load Factor (%)		60%	60%	60%	-
Hours of Operation (hours/engine/spud)		650	650	650	-
Fuel Type		Diesel	Diesel	Diesel	-
Percent of Engines by Tier Level	Uncontrolled	-	-	-	-
	Tier 1	100%	100%	100%	-
	Tier 2	-	-	-	-
	Tier 3	-	-	-	-
	Tier 4	-	-	-	-
Actual Emission Factors (if available) (g/bhp-hr)	Source	EPA Tier Standards	EPA Tier Standards	EPA Tier Standards	-
	NOx	6.9	6.9	6.9	-
	CO	8.5	8.5	8.5	-
	VOC	0.99	0.99	0.99	-
	PM10	0.03	0.03	0.03	-

SUBPART W

- Detailed data expected to be available for reported source categories (for companies that reported)
- Subpart W data can be used to:
  - Facilitate survey completion by operators
  - Submitted in place of certain survey data
- We want to work with operators to make efficient use of available Subpart W data (whether reported or unreported)
- This inventory is focused on criteria pollutants – even for Subpart W reported sources, additional information may be needed

Subpart W Well-site Sources
Pneumatic Controllers & Pumps
Tanks*
Blowdowns*
Completions & Workovers*
Dehydrators
Compressors
Fugitive Components

**reported at GHGRP sub-basin level*

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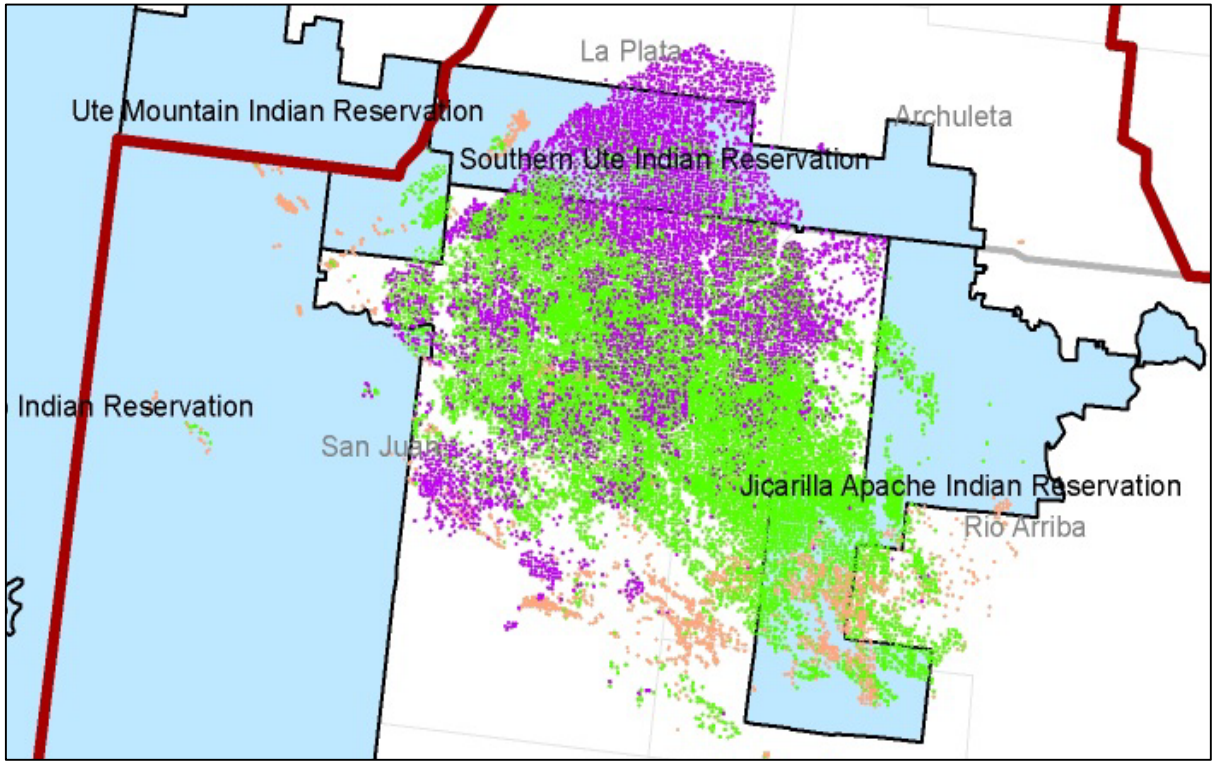
TRIBAL EMISSIONS DATA

- Well-sites
  - Operator Surveys
  - Supplemented by Tribal MNSR data
- Midstream Facilities
  - Tribal MNSR data
  - Title V / Part 71 Sources



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TRIBAL MINOR NEW SOURCE REVIEW REGISTRATIONS

- Mine data from available MNSR registrations
- Example analysis for the Fort Berthold Indian Reservation (Williston Basin)
  - Over 150 well site registrations randomly sampled
  - Input data for emission calculations
    - Artificial lift engines
    - Casinghead gas
    - Wellhead compressors
    - Fugitives
    - Miscellaneous engines
    - Water tanks
    - Heaters
    - Oil Tanks
    - Truck loading of oil
    - Gas compositions

OIL TANKS				
Parameter		Survey	Tribal MNSR	Units
Representative Input Factors				
% of Tanks	Uncontrolled	10%	0%	-
	Flare	70%	0%	-
	VRU	13%	0%	-
	Enclosed Combustor	6%	99%	-
VOC Emission Factor		5.6	5.4	lb VOC/bbl
		68.2	65.9	SCF/bbl
VOC Mole Fraction		55%	79%	-
Per Surrogate Emissions				
VOC		0.97	0.11	lb/bbl

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QUESTIONS

Emission Inventory Technical

Amnon Bar-Ilan
abarilan@environcorp.com
(415-899-0732)

John Grant
jgrant@envirocorp.com
(415) 899-0706