

Abstract for HEI Workshop, Denver, CO, July 11-12, 2018

Air Toxics Inhalation – Screening Level Health Hazard Assessment in Area with High Concentration of Natural Gas Production

Roger O. McClellan^a and M. Burton Snipes^b
Albuquerque, NM

The Pinedale Anticline, Sublette County, WY, has in recent decades been a site of major development and production activity for gas and oil making extensive use of hydraulic fracturing and directional drilling. In response to local concerns for air quality impacts, the Sublette County Human Health Risk Assessment Air Toxics Project was conducted by Sublette County and the Wyoming Department of Environmental Quality in 2009-2010. The concentrations of 49 chemicals were measured at 14 locations over a one-year period using vacuum canisters or sorbent samplers with samples taken for 24 hours every 6 days. The samples were analyzed using EPA recommended methods. The ambient air concentrations measured represented contributions from multiple sources, including gas and oil production activities, diesel engines and forest fires. The Air Toxics Project data were made available to the public. The authors were engaged by Shell Exploration and Production to conduct a screening level Health Hazard Assessment using EPA recommended methodology. The average ambient air concentration data for each of the 14 sites was compared to human chronic health hazard indicators obtained from public sources to yield a Hazard Quotient. All of the calculated Hazard Quotients were less than 1.0. Of the 49 chemicals identified, 3 have been categorized as human carcinogens (benzene, butadiene and vinyl chloride), 8 as probable human carcinogens, and 3 as possible human carcinogens. The calculated excess cancer risks for each of the chemicals at each site were less than 1 in 10,000. These results suggested that additional investigation, focusing on potential health hazard from exposure to mixtures of chemicals in the ambient air, were not warranted. The results of this very extensive monitoring campaign should be considered in planning any potential monitoring, risk assessment or epidemiological investigations related to gas and oil production, including use of so-called “unconventional methods.”

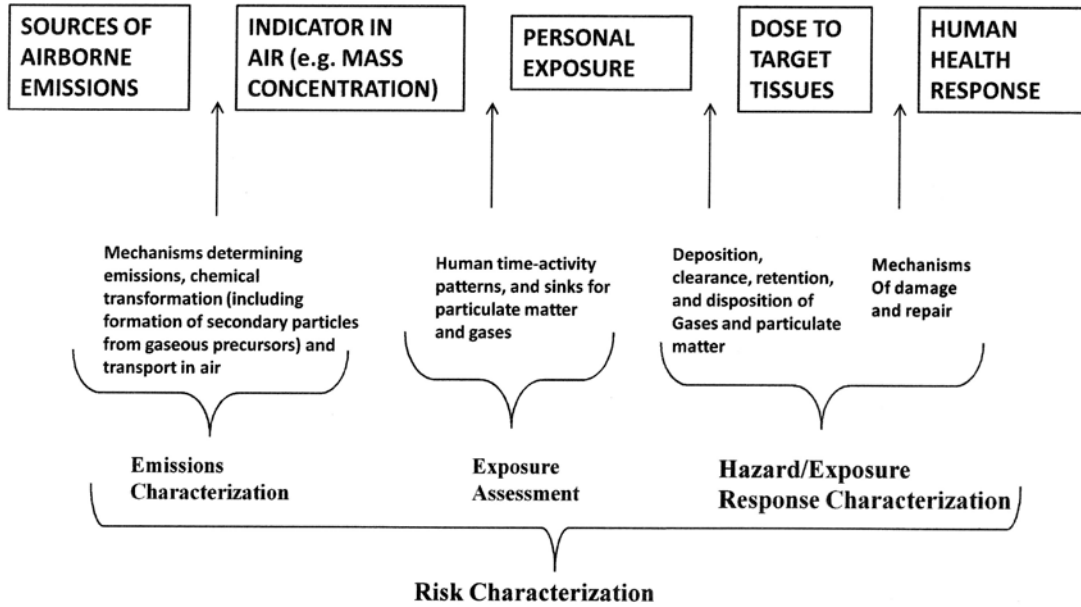
^aAdvisor, Inhalation Toxicology and Risk Assessment, Albuquerque, NM 87111

^bConsultant, Inhalation Toxicology, Tijeras, NM 87059

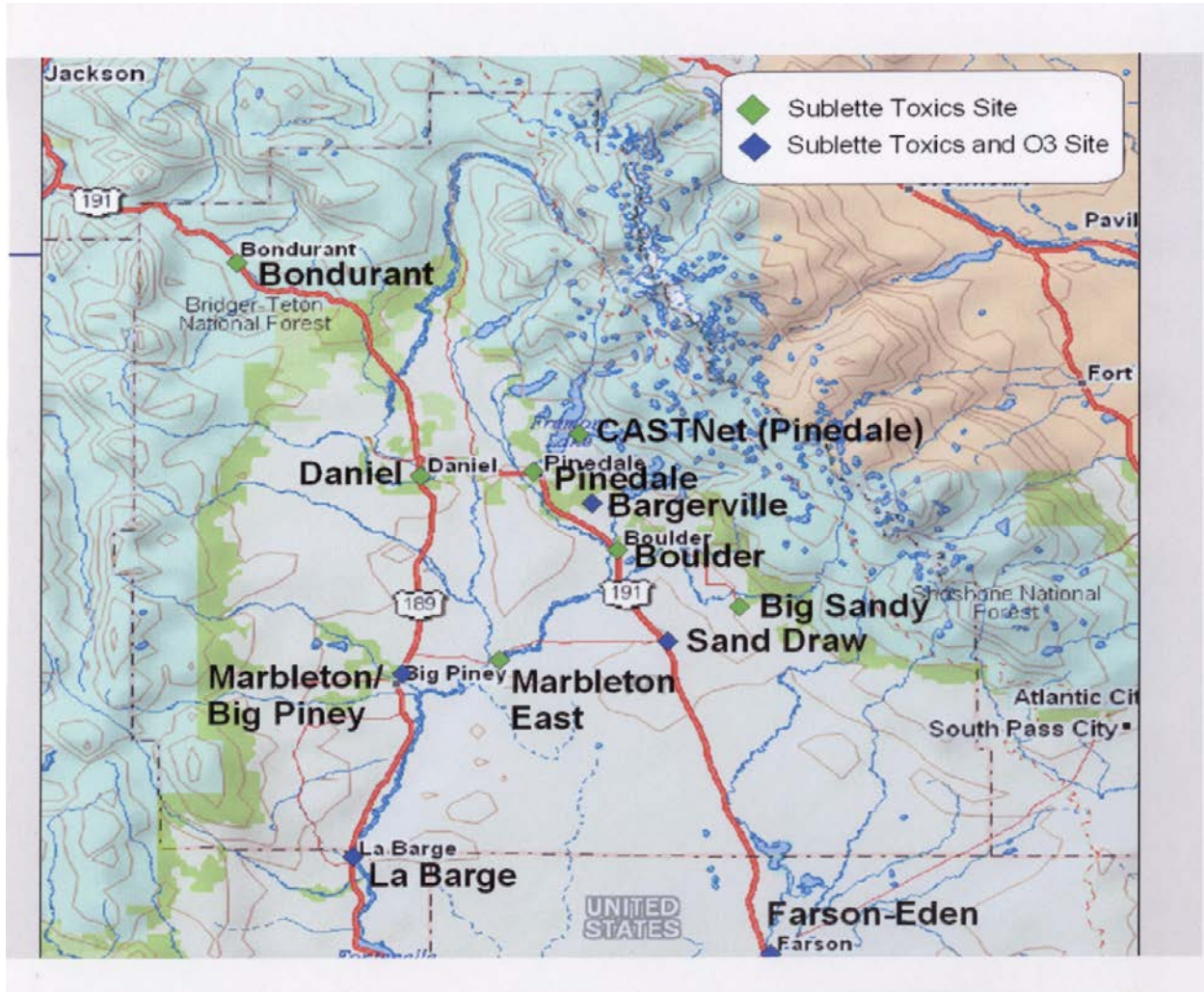
OBJECTIVES

- **Address citizen concerns for potential health effects from air toxics and ozone related to gas and oil production**
- **Conduct extensive air sampling at 12 locations, 24 hr samples every 6 days on 61 occasions during 2009-2010**
- **Measured 48 chemicals by GC/MS and acetaldehyde and formaldehyde by HPLC**
- **Measurements for chemicals of potential concern compared to EPA inhalation health reference concentrations**
- **Excess lifetime cancer risks calculated for chemicals**
- **Cost of ~ \$1.5 million**

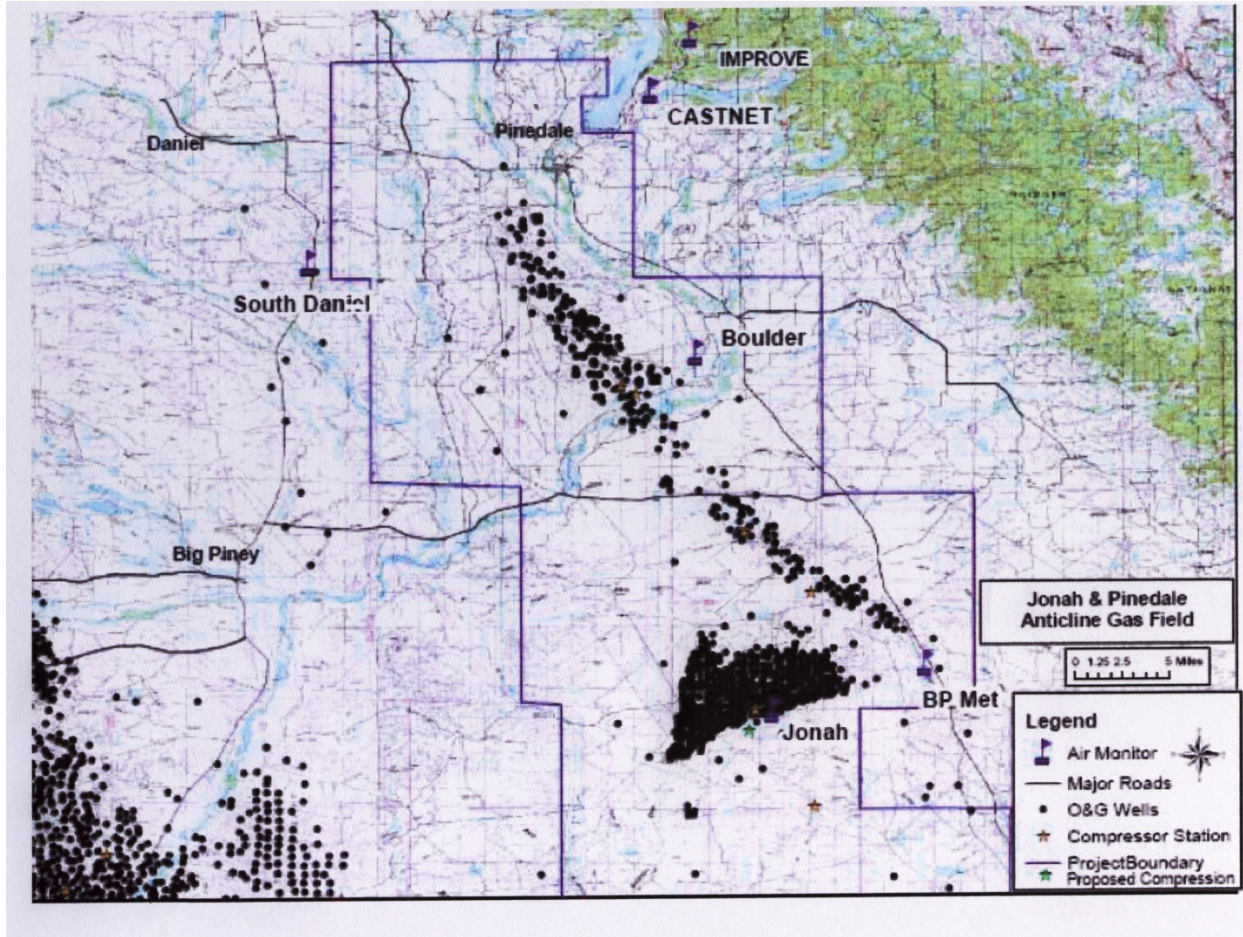
RISK CHARACTERIZATION PARADIGM



Monitoring Locations



Area Monitors



RESULTS

- 50 chemicals identified as Chemicals of Potential Concern (COPC) compared to Acute and Chronic Inhalation Health Reference Concentrations
- Hazard Quotients were all less than 1.0 indicating that the ambient concentrations did not pose unacceptable health risks
- 6 chemicals known to cause human cancer or having potential to cause human cancer were detected
- The calculated excess lifetime cancer risk for all 6 chemicals at the 12 sites were less than 1 in 10,000
- In special study, additional 78 chemicals were identified and characterized as Tentatively Identified Compounds (TIC)
- None of COPC or TIC chemicals were unique to Sublette County or oil and gas operations. Data are not sufficient to determine various sources:
- (a) oil and gas operations, (b) biogenic sources, including fires, or (c) other sources within the county or upwind
- Results of this extensive study should be considered in planning any future ambient monitoring, hazard screening and/or epidemiological studies related to oil and gas production

PINEDALE #1: Ambient Air Concentrations and Health Reference Concentrations for Chemicals of Potential Concern

Detected Chemical (CAS Number)	Number of Detects	Number of Non-Detects	Mean Concentration (µg/m ³) ^a	95% UCL (µg/m ³) ^a	Max 1-Day Concentration (µg/m ³)	Acute Inhalation Reference Concentration (µg/m ³)	Computed Acute Inhalation HQ	Chronic Inhalation Reference Concentration (µg/m ³)	Computed Chronic Inhalation HQ
1,1,1-Trichloroethane (71-55-6)	1	57			0.39	10900	0.000036	5000	
1,1,2,2-Tetrachloroethane (79-34-5)	2	56			2.61	70	0.037	7	
1,1,2-Trichloroethane (79-00-5)	9	49			0.43	550	0.00078	55	
1,1-Dichloroethane (75-34-3)	39	19	0.34	0.53	1.46	4000	0.00013	400	0.0013
1,1-Dichloroethylene [1,1-DCE] (75-35-4)	3	55			0.10	210	0.00048	200	
1,2,4-Trimethylbenzene (95-63-6)	22	36	1.64	4.53	37.34	1250	0.0036	125	0.036
1,2-Dichloroethane (107-06-2)	42	16	0.36	0.55	1.58	160	0.0034	2430	0.00023
1,2-Dichloropropane (78-87-5)	2	56			1.34	230	0.0058	4	
1,3,5-Trimethylbenzene (108-67-8)	5	53			11.79	1250	0.0094	125	
1,3-Butadiene (106-99-0)	3	55			0.69	220	0.0031	2	
1,4-Dioxane (123-91-1)	0	58				7200		3600	
2,2,4-Trimethylpentane (540-84-1)	3	55			7.94	3500	0.0023	350	
2-Butanone (Methyl Ethyl Ketone) (78-93-3)	58	0	22.45	28.3	91.37	3900	0.0073	5000	0.0057
2-Hexanone (591-78-6)	4	54			5.73	40	0.14	30	
2-Propanol (67-63-0)	44	14	20.49	43.68	196.51	7850 [odor]	0.0056	785 [odor]	0.056
4-Ethyltoluene (622-96-8)	15	43	1.33	3.68	29.97	1250	0.0029	125	0.029
4-Methyl-2-pentanone (108-10-1)	23	35	0.93	1.63	4.91	2050	0.00080	3000	0.00054
Acetaldehyde (75-07-0)	61	0	1.54	2.10	5.16	90	0.023	9	0.23
Acetone (67-64-1)	58	0	174.7	222.7	902.11	61800	0.0036	30880	0.0072
Benzene (71-43-2)	58	0	2.11	4.07	19.80	29	0.14	30	0.14
Bromomethane (74-83-9)	2	56			1.51	190	0.0079	5	
Carbon Disulfide (75-15-0)	4	54			7.16	1000	0.0072	700	
Chloroethane [Ethyl chloride] (75-00-3)	10	48	6.32	8.53	50.1	39600	0.00022	10000	0.00085
Chloroform (67-66-3)	1	57			10.25	490	0.021	98	
Chloromethane [Methyl chloride] (74-87-3)	58	0	3.40	3.93	12.79	1030	0.0038	90.00	0.044
cis-1,2-Dichloroethylene (156-59-2)	1	57			0.13	210	0.00062	200	
Cumene (98-82-8)	0	58				500		400	
Cyclohexane (110-82-7)	8	50			2.27	1400	0.0016	6000	
Ethanol (64-17-5)	55	3	15.21	19.01	148.76	18800	0.0010	1880	0.010
Ethyl Benzene (100-41-4)	55	3	1.06	2.10	8.68	43400	0.000048	1000	0.0021
Formaldehyde (50-00-0)	61	0	1.57	1.72	3.77	49	0.035	10	0.17
Freon 11 [Trichlorofluoromethane] (75-69-4)	40	18	0.91	1.17	1.63	28000 [odor]	0.000042	2800 [odor]	0.00042
Freon 12 [Dichlorodifluoromethane] (75-71-8)	58	0	2.11	2.17	2.87	49500	0.000044	4950	0.00044
Heptane [n-Heptane] (142-82-5)	47	11	3.39	4.38	16.79	3500	0.0013	350	0.013
Hexane [n-Hexane] (110-54-3)	40	18	1.59	3.38	20.43	5300	0.00064	700	0.0048
m,p-Xylene (108-38-3/106-42-3) [1330-20-7]	55	3	5.09	11.98	78.11	8700	0.0014	100	0.12
Methylene Chloride [Dichloromethane] (75-09-2)	38	20	1.95	3.11	10.76	2100	0.0015	1040	0.0030
o-Xylene (95-47-6) [1330-20-7]	56	2	1.92	5.30	43.39	8700	0.00061	100	0.053
Propylbenzene (103-65-1)	3	55			1.82	1250	0.0015	125	
Styrene (100-42-5)	5	53			19.58	8500	0.0023	1000	
Tetrachloroethylene (127-18-4)	7	51			2.71	1360	0.0020	270	
Tetrahydrofuran (109-99-9)	0	58				5900		590	
Toluene (108-88-3)	58	0	6.90	14.46	79.09	3800	0.0038	5000	0.0029
Trichloroethylene (79-01-6)	0	58				10700		54	
Vinyl Chloride (75-01-4)	53	5	0.70	0.89	3.07	1300	0.00068	100	
Hazard Index (Sum of Hazard Quotients)							0.49		0.93
Hazard Index (Sum of Hazard Quotients, excluding HQ values based on odor)							0.48		0.87

^a Mean concentration and 95% upper confidence level of the mean @ 25 °C, as determined by EPAs ProUCL software (version 4.00.05).

Calculated Excess Lifetime Cancer Risk for Chronic Exposure to Selected Chemicals of Potential Concern in Ambient Air Based on Mean Concentration (April 2009-March 2010)

Monitoring Sites	Selected Chemicals and Values for Unit Excess Cancer Risk												Total Excess Cancer Risk
	1,2-Dichloroethane (2.6E-5/ $\mu\text{g}/\text{m}^3$)		Acetaldehyde (2.2E-6/ $\mu\text{g}/\text{m}^3$)		Benzene (7.8E-6/ $\mu\text{g}/\text{m}^3$)		Formaldehyde (1.3E-5/ $\mu\text{g}/\text{m}^3$)		Methylene Chloride (4.7E-7/ $\mu\text{g}/\text{m}^3$)		Vinyl Chloride (4.4E-6/ $\mu\text{g}/\text{m}^3$)		
	Mean Conc. ^a ($\mu\text{g}/\text{m}^3$)	Excess Cancer Risk ^b	Mean Conc. ^a ($\mu\text{g}/\text{m}^3$)	Excess Cancer Risk ^b	Mean Conc. ^a ($\mu\text{g}/\text{m}^3$)	Excess Cancer Risk ^b	Mean Conc. ^a ($\mu\text{g}/\text{m}^3$)	Excess Cancer Risk ^b	Mean Conc. ^a ($\mu\text{g}/\text{m}^3$)	Excess Cancer Risk ^b	Mean Conc. ^a ($\mu\text{g}/\text{m}^3$)	Excess Cancer Risk ^b	
Bargerville			1.26	2.8E-6	1.64	13E-6	1.39	18E-6					34E-6
Big Sandy	0.52	14E-6	0.97	2.1E-6	2.53	20E-6	1.10	14E-6	3.80	1.8E-6	0.97	4.3E-6	56E-6
Bondurant			1.16	2.6E-6	1.30	10E-6	1.06	14E-6					27E-6
Boulder			0.93	2.0E-6	2.05	16E-6	0.93	12E-6					30E-6
CASTnet	0.08	2.1E-6	1.14	3.6E-6	2.42	19E-6	1.11	14E-6					39E-6
Daniel	0.17	4.4E-6	1.26	2.5E-6	1.26	9.8E-6	1.32	17E-6	1.11	0.52E-6	0.33	1.5E-6	36E-6
Farson-Eden			1.54	3.4E-6	1.85	14E-6	1.33	17E-6					34E-6
La Barge #1			1.55	3.4E-6	3.70	29E-6	1.90	25E-6					57E-6
Marbleton East			1.36	3.0E-6	1.97	15E-6	1.26	16E-6	0.76	0.36E-6			34E-6
Marbleton/Big Piney	0.26	6.8E-6	1.61	3.5E-6	1.49	12E-6	1.89	25E-6	1.50	0.71E-6	0.52	2.3E-6	50E-6
Pinedale #1	0.36	9.4E-6	1.54	3.4E-6	2.11	16E-6	1.57	20E-6	1.95	0.92E-6	0.70	3.1E-6	53E-6
Sand Draw	0.22	5.7E-6	1.46	3.2E-6	2.45	19E-6	1.80	23E-6	1.98	0.93E-6	0.41	1.8E-6	54E-6

^a Mean concentration, as determined using EPA's *ProUCL* software (version 4.00.05). Units are $\mu\text{g}/\text{m}^3$ at 25°C.

^b Product of (unit excess cancer risk) x (mean concentration).