Air sampling at Apache County, Arizona oil well sites, 2019 and 2021. Summary prepared by Nadia Steinzor, Senior Policy Analyst, Earthworks. August 2021

Project overview

In October 2019 and May 2021, Diné C.A.R.E. and Earthworks conducted optical gas imaging (OGI) and air sampling at oil well sites operated by Capitol Operating Group in Apache County, Arizona. We used OGI cameras to identify pollution releases at the sites and then deployed Summa canisters to capture air samples near the source of emissions.

The 2019 samples were "grab" ones that lasted several seconds at each of three selected well sites. In 2021, we repeated the grab sampling at the same three sites, plus three other ones; in addition, a longer-term air sample (lasting several hours) was taken near a residence.

A certified laboratory provided the canisters and analyzed the results using the TO-3 test for methane and TO-15 test for volatile organic compounds (VOCs) developed by the US Environmental Protection Agency (US EPA), as well as ASTM International standard test D 5504-12 for sulfur compounds in oil and gas.

The pollution sources at all the well sites where grab samples were taken appeared to be ground-level surface casing vents, which are designed to release gas as it flows from underground to the surface. At the time of our visits, Diné C.A.R.E. and Earthworks staff detected strong odors and reported health effects such as headaches and eye irritation, and detailed those in complaints submitted to the Navajo Nation Environmental Protection Agency (NN EPA).

Results: a potential health emergency

The air sampling results were dramatic and sobering, with clear risks to health for anyone exposed to pollution at or near the sites. The concentrations of all the VOCs and sulfur compounds detected far exceeded the Effects Screening Levels (ESL), or levels likely to trigger health symptoms.[1]

The actual health impacts on nearby residents, workers, and anyone who visits these sites would depend on such factors as proximity and wind direction. However, the ESLs were exceeded by tens, hundreds, thousands, and even tens of thousands of times--making this an extreme situation by any measure.

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All of the chemicals detected have scientifically established health effects, many of which are related to inhalation, i.e., exposure through air. There was remarkable consistency in the compounds detected across nearly all of the sites where sampling occurred, as well as in the concentration levels--indicating that similar products were being used and produced at all sites that resulted in the same mix of pollutants.

The data table below details sampling results for the three sites where repeat air sampling occurred (i.e., in both 2019 and 2021). Most notably:

- Hydrogen sulfide levels were in line with what the US Occupational Safety and Health Administration (OSHA) considers dangerous for acute (short-term) exposure, such as what workers, inspectors, or anyone visiting the site could experience.[2] At the Navajo 19 site, the concentration of H2S (170 parts per million (ppm) in 2019 and 180 ppm in 2021) was high enough to cause loss of sense of smell and close to the level (200 ppm) that would cause eye and respiratory irritation; with prolonged exposure, this concentration of H2S could cause fluid buildup in the lungs.
- At the Navajo 14 and 25 sites in 2019, the H2S concentrations (440 and 410 ppm respectively) were just under the level (500 ppm) for acute exposure that OSHA has determined can cause "staggering, collapse in 5 minutes. Serious damage to the eyes in 30 minutes. Death after 30-60 minutes." Even though the H2S concentrations were somewhat lower for these and other sites at the time of sampling in 2021, they remained many times higher than the levels that OSHA considers hazardous to health.
- Some of the other sulfur compounds detected, including thiophene and mercaptans, are scientifically established to be associated with nausea, vomiting, headache, and eye, nose, throat, and skin irritation.[3]
- The sampling at all three sites detected benzene, a known carcinogen, and ethylbenzene, a possible carcinogen. Several other VOCs were detected that are scientifically established to be associated with eye, nose, and throat irritation, dizziness, irregular heartbeat, and changes to the kidney and liver.

For several years, Earthworks has conducted air sampling at dozens of sites in oil and gas producing areas in California, Pennsylvania, and Texas. The concentrations of chemicals detected at the Apache County sites exceeded by orders of magnitude the results of any of our previous sampling--including those from much larger facilities, such as processing plants and compressor stations.

Earthworks' sampling at the compression and processing facilities in other states occurred further away from the pollution sources than was the case with the Apache County sites, which would logically result in the detection of lower concentrations. Yet even considering the influence of close proximity between the pollution source (casing vents) and the sampling

device (the Summa canister), the concentrations at the Apache County well sites can be considered extreme, including when compared to results from much larger facilities with multiple sources of pollution that could all result in sampling detections.

Responsible agencies are unresponsive

Earthworks' OGI and air sampling investigations reveal severe operational problems at all three Apache County sites and the apparent failure of Capitol Operating Group to maintain and fix its equipment for prolonged periods of time.

Starting in 2018, Earthworks and Diné C.A.R.E have conducted several rounds of fieldwork in Red Valley and filed 22 complaints. Seven additional complaints are being filed in 2021. All of these complaints have been filed with Navajo Nation EPA (several of which were also filed with US EPA). Earthworks observed the same surface casing vents leaking in 2018, 2019, and 2021. In November 2018, NN EPA released a draft report in response to complaints filed earlier that year, but to date there has been no response to the complaints filed on these three well sites (as well as others nearby) from late 2018 to the present.

Since 2018, both Diné C.A.R.E and Earthworks have contacted multiple levels of state, federal, and Navajo Nation agencies and departments for information and documentation of operations, permits, inspections, and emission reports from the wells at the Dineh Bikeyah (DBK) Oil Field and connected Nacogdoches Helium Processing Facility. Diné C.A.R.E. and Earthworks continue to request outstanding documents from these sites.

The pollution has broad consequences

Allowing the pollution documented to go unabated poses a threat to local air quality and the health and safety of nearby residents and any workers or inspectors who visit the sites.

The importance of stopping pollution problems before they get worse is the reason why the US EPA adopted VOC control rules for the oil and gas sector in 2012 and expanded those rules to specifically cover methane, a potent greenhouse gas, in 2016. Some states have also adopted their own pollution control rules specifically for the oil and gas sector. Both federal and state rules require operators to conduct leak detection and repair (LDAR), a process designed to catch and abate pollution leaks in a timely manner.

The US EPA methane rules considers releases of 500 ppm by volume (ppmV) to be a "leak" that requires repair. Some of the pollution releases documented by Diné C.A.R.E. and Earthworks were many times higher. For example, the leak at the Navajo 25 site had a methane concentration more than 100 times that level in 2019 (51,000 ppmV), while the leaks at the Navajo 19 and 14 sites were more than 300 times as high (161,000 ppmV) in 2019 and 200-300 times as high (150,000 and 120,000 ppm respectively) in 2021.

Because of the severe impacts of methane leaks this size, California's 2017 methane control rule requires that leaks with measured total hydrocarbon concentrations greater than or equal to 50,000 ppmV have to be repaired or the leaking equipment removed from service within two calendar days of the initial detection of the leak. For its part, New Mexico is poised to adopt rules to limit methane and VOC pollution at oil and gas sites that would require any leaks detected with OGI to be repaired within 7 days, and leaks detected with other methods within 15 days.[4]

The leaks we documented could have a considerable impact on air quality and climate, particularly because they have occurred at least periodically, and perhaps consistently, for months on end. Using Quantitative Optical Gas Imaging (QOGI) at a similar Capitol Operating Group site in Apache County (the Navajo 9 well), Earthworks measured the volume of pollution being released from a similar open well pipe using methane as a proxy gas.

The results indicate a potentially significant problem: an average of 18 pounds per hour, which if left unabated, would add up to 80 tons per year. That's the same as the fossil fuel combustion of 340 average Americans, or more than 1,300 passenger cars driven for a year, or more than 700 US homes' worth of energy for a year.

While the actual volume of pollution might be different since many other compounds besides methane are clearly being released, it is nonetheless evident that a single pipe leaking at a single site has the potential to release high levels of pollution. The impact is exacerbated when pollution is left unaddressed by operators and regulators for an extended period of time--as is the case with these Capitol Operating Group sites.

Compound (selected)	**Health effects ***	**Long-term ESL (annual averaging; TCEQ 2020) ****	**Navajo 19; Nov. 2019**	**Navajo 19; May 2021**	**Navajo 25; Nov. 2019**	**Navajo 25; May 2021**	**Navajo 14; Nov. 2019**	**Navajo 14; May 2021**
# sulfur compounds detected (of 20 analyzed)			*16*	*16*	*15*	*10*	*15*	*14*
Hydrogen sulfide	Lack of oxygen/asphyxiation; respiratory arrest; skin/eye/nose/respiratory irritation	n/a	170,000 ppbV	180,000 ppbV	410,000 ppbV	17,000 ppbv	440,000 ppbV	330,000 ppbv
Methyl mercaptan	Eye/skin/respiratory irritation; headache, nausea, dizziness	0.5 ppbV	190 ppbV	150 ppbv	130 ppbV	15 ppbv	240 ppbV	130 ppbv
Ethyl mercaptan	Respiratory arrest, dizziness, nausea; similar effects as H2S	0.5 ppbV	36,000 ppbV	27,000 ppbv	15,000 ppbV	600 ppbv	53,000 ppbV	32,000 ppbv
Isopropyl mercaptan	Hazardous on contact.	1.8 ug/m3	37,000 ug/m3	26,000 ug/m3	19,000 ug/m3	780 ug/m3	72,000 ug/m3	10,000 ppbv
tert-Butyl Mercaptan	Eye/skin/respiratory irritation; headache, nausea, dizziness.	0.49 ppbV	630 ppbV	450 ppbv	120 ppbV	ND	510 ppbV	420 ppbv
n-Propyl mercaptan	Eye/skin/nose irritant.	0.5 ppbV	34,000 ppbV	23,000 ppbv	5,100 ppbV	110 ppbv	18,000 ppbV	14,000 ppbv
Ethyl Methyl	Eye & skin damage	14 ug/m3	3,000	ND	800	41 ug/m3	2,700	ND

Sulfide	(inhalation)		ug/m3		ug/m3		ug/m3	
Thiophene	Nausea, vomiting, headache, eye/nose/throat/skin irritation	57 ug/m3	38,000 ug/m3	23,000 ug/m3	6,700 ug/m3	170 ug/m3	26,000 ug/m3	16,000 ug/m3
Isobutyl mercaptan	Eye/skin/respiratory irritant; headache, nausea, dizziness	1.8 ug/m3	7,000 ug/m3	5,300 ug/m3	2,400 ug/m3	150 ug/m3	7,400 ug/m3	1,400 ug/m3
Diethyl sulfide	Skin/eye/nose/throat/skin irritation	14 ug/m3	270,000 ug/m3	220,000 ug/m3	52,000 ug/m3	2,400 ug/m3	220,000 ug/m3	170,000 ug/m3
n-Butyl mercaptan	Eye/skin/respiratory irritant; headache, nausea, dizziness	0.49 ppbV	8,200 ppbV	2,900 ppbv	720 ppbV	ND	2,700 ppbV	1,300 ppbv
3-methylthiophene	Skin/eye/oral irritant	57 ug/m3	2,800 ug/m3	1,600 ug/m3	800 ug/m3	ND	3,900 ug/m3	1,900 ug/m3
Tetrahydrothiophene	Headache, nausea, dizziness, palpitations	50 ppbV	500 ppbV	240 ppbv	ND	ND	ND	ND
2,5-Dimethylthiophene	Eye irritation	10 ug/m3	9,400 ug/m3	2,500 ug/m3	1,300 ug/m3	ND	5,200 ug/m3	1,500 ug/m3
2-Ethylthiophene	Contact & inhalation toxicity	57 ug/m3	4,600 ug/m3	2,300 ug/m3	550 ug/m3	ND	3,700 ug/m3	1,400 ug/m3
Diethyl Disulfide	Nose/throat/skin/eye/respiratory irritant	14 ug/m3	1,700 ug/m3	1,500 ug/m3	580 ug/m3	41 ug/m3	1,700 ug/m3	500 ug/m3
# of VOCs detected (of 50 analyzed)			*9*	*9*	*11*	*10*	*10*	*9*

1,3 Butadiene	Skin, eye/nose/throat irritation; respiratory distress	4.5 ppbV	ND	ND	3,300 ppbV	ND	ND	ND
n-Hexane	Dizziness, headaches, neuropathy	57 ppbV	1,600,000 ppbV	2,700,000 ppbv	380,000 ppbV	57,000 ppbv	2,600,000 ppbV	1,700,000 ppbv
Benzene	Dizziness, headaches, rapid heartbeat; carcinogen	1.4 ppbV	270,000 ppbV	360,000 ppbv	44,000 ppbV	6,400 ppbv	330,000 ppbV	190,000 ppbv
Cyclohexane	Eye/nose/throat irritation, dizziness, headache	100 ppbV	900,000 ppbV	1,300,000 ppbv	150,000 ppbV	20,000 ppbv	1,100,000 ppbV	680,000 ppbv
n-Heptane	Eye/nose/throat irritation, dizziness, headache, nausea	660 ppbV	770,000 ppbV	1,100,000 ppbv	100,000 ppbV	15,000 ppbv	980,000 ppbV	640,000 ppbv
Toluene	Eye/nose irritation, dizziness, kidney/liver damage	320 ppbV	300,000 ppbV	390,000 ppbv	37,000 ppbV	7,300 ppbv	490,000 ppbV	280,000 ppbv
n-Octane	Eye/nose/throat irritation, lightheadedness, headache	110 ppbV	230,000 ppbV	240,000 ppbv	24,000 ppbV	3,900 ppbv	370,000 ppbV	180,000 ppbv
Ethylbenzene	Eye/nose irritation, dizziness, kidney/liver damage; possible carcinogen	130 ppbV	33,000 ppbV	43,000 ppbv	3,800 ppbV	860 ppbv	64,000 ppbV	29,000 ppbv
m,p-Xylenes	Eye/nose/respiratory irritation, dizziness, irregular heartbeat,	41 ppbV	71,000 ppbV	100,000 ppbv	8,400 ppbV	1,900 ppbv	150,000 ppbV	66,000 ppbv

	kidney/liver changes							
o-Xylene	Eye/nose/respiratory irritation, dizziness, irregular heartbeat, kidney/liver changes	41 ppbV	20,000 ppbV	50,000 ppbv	2,600 ppbV	610 ppbv	46,000 ppbV	25,000 ppbv
n-Nonane	Nose/throat irritant, coughing, headache, dizziness	86 ppbV	ND	ND	6,400 ppbV	1,100 ppbv	170,000 ppbV	ND
	*** Sources:** the Agency for Toxic Substances and Disease Registry, Toxic Substances Portal: https://www.atsdr.cdc.gov/substances/index.asp; the National Institutes of Health Library of Medicine, https://www.nlm.nih.gov/; hazardous substances fact sheets from the NJ Department of Health, https://nj.gov/health/workplacehealthandsafety/right-to-know/hazardous-substances/index.sh	** Data results for air sampling are reported in both parts per billion by volume (ppbV) and micrograms per cubic meter (ug/m3). The Effects Screening Levels (ESL) from the TX Commission on Environmental Quality's 2020 list (https://www.tceq.texas.go						

	tml; and other governmental and industry information resources.	v/toxicology/esl) includes both measurements depending on the chemical.						

[1] This analysis is based on the Texas Council on Environmental Quality's (TCEQ) 2020 list of Effects Screening Levels (https://www.tceq.texas.gov/toxicology/esl). According to the TCEQ, ESLs "are used to evaluate the potential for effects to occur as a result of exposure to concentrations of constituents in the air. ESLs are based on data concerning health effects, the potential for odors to be a nuisance, and effects on vegetation." Note that these values are represented in concentrations, in contrast to the volumes used in determining allowable pollution levels in permits.

[2] US Department of Labor, Occupational Safety and Health Administration. Hydrogen Sulfide, Health Hazards, https://www.osha.gov/hydrogen-sulfide/hazards

[3] See hazardous substances fact sheets from the NJ Department of Health, https://nj.gov/health/workplacehealthandsafety/right-to-know/hazardous-substances/index.shtml; the Agency for Toxic Substances and Disease Registry, Toxic Substances Portal: https://www.atsdr.cdc.gov/substances/index.asp; and the National Institutes of Health Library of Medicine, https://www.nlm.nih.gov/.

[4] New Mexico Environment Department, Ozone Precursor Pollutant rule for the oil and gas sector, §20.2.50.116(E), Repair Times, https://www.env.nm.gov/air-quality/wp-content/uploads/sites/2/2021/03/Proposed-Part-20.2.50-May-6-2021-Version.pdf