

Health Risk Evaluation of Volatile Organic Compounds in Ambient Air near a Well-Pad Operated By URSA Operating Company, LLC

Prepared for:

Garfield County Public Health
195 West 14th Street
Rifle, Colorado 81650

Prepared by:



COLORADO

**Oil & Gas Health Information
& Response**

Department of Public Health & Environment

Phone: (303) 389-1687

Email: cdphe_oghealth@state.co.us

www.colorado.gov/oghealth

October 3, 2017

Executive Summary

Garfield County Public Health (GCPH) collected samples between April-July 2017, near a newly developed oil and gas well in Battlement Mesa. GCPH requested the Oil and Gas Health Information and Response (OGHIR) Program at the Colorado Department of Public Health and Environment (CDPHE) to conduct a health evaluation of these VOC air samples.

The purpose of this assessment was to evaluate the health risks from the measured volatile organic compounds (VOCs). The measured VOC levels were compared to health guideline values set by federal and state agencies. The results for the 79 VOCs analyzed indicated that the measured levels of VOCs were well below health guideline values. Based on the results from this study, there is a low risk of harmful health effects to the measured VOCs.

Background

Garfield County Public Health (GCPH) collected samples between April-July 2017, near a newly developed oil and gas well in Battlement Mesa operated by URSA Operating Company, LLC. GCPH requested the Oil and Gas Health Information and Response (OGHIR) Program at the Colorado Department of Public Health and Environment (CDPHE) to conduct a health evaluation of these VOC air samples.

Purpose

The purpose of this assessment was to evaluate the health risks from the measured volatile organic compounds (VOCs).

Methods

VOC air sampling

GCPH contracted Air Resource Specialists (ARS) to design and build a conditional sampler to collect air samples south of the URSA well pad in Battlement Mesa. One sample per month from April to June 2017 (total of three samples) was collected by GCPH staff over a week long period with the conditional sampler designed to collect ambient air samples when prevailing winds were coming from the direction of the well-pad (termed downwind). An upwind sample was simultaneously collected to provide background measurements (termed upwind). Samples were analyzed for VOC's following EPA's Method TO-12. Details of the VOC sampling study can be found in the ARS report "Site Specific Conditional Sampler, Garfield County, Colorado August 31, 2017).

Health risk evaluation

A health risk evaluation was performed in accordance with the US Environmental Protection Agency guidance¹.

1. Exposure Evaluation

Because these samples were collected over approximately 1-2 weeks, they more likely represent long-term average exposures rather than short-term (i.e. one hour or less) exposures. Although the emissions from the monitored oil and gas site during the current phase of operation will be much less than a lifetime of exposure, long-term exposure assumes a person lives or stays near a given monitoring location for 24 hours per day, 365 days per year, for a lifetime (i.e., 70 years). It also assumes the measured concentrations of the VOCs in the air remain constant over the entire 70-year exposure period.

2. Health Effect Evaluation

Non-cancer health effects: A non-cancer health guideline value (HGV) is defined by the US EPA as the exposure level that is likely to be without appreciable risk of adverse non-cancer health effects in an exposed population, including sensitive individuals. The HGV for each VOC is expressed as a concentration in units of parts per billion. There were no long-term HGV's for 1-dodecene, 1-nonene, 1-octene, 1-undecene, cis-2-hexene, cyclopentene and n-tridecane and therefore, these VOCs were not evaluated in this health risk assessment.

Cancer health effects: For VOCs that could cause cancer, VOC concentrations associated with 1×10^{-6} (one in one million) to 1×10^{-4} (one in ten thousand) cancer risk levels were used as comparison values. For example, a risk level of one in a million (1×10^{-6}) implies that up to 1 out of one million

¹ US EPA (2004). Air Toxics Technical Resource Manual, EPA-453-K-04-001A.

equally exposed people could contract cancer if exposed continuously (i.e. 24 hours per day) to the specific concentration over a lifetime (i.e. 70 years). This would be in addition to those cancer cases that would normally occur in an unexposed population of one million people. The level of cancer risk that is of concern is a matter of individual, community, and regulatory judgment. However, the EPA typically considers risks below 1×10^{-6} to be so small as to be negligible. Therefore, the EPA uses a cancer risk of one in a million (1×10^{-6}) as a regulatory goal, which means that regulatory programs are generally designed to try to reduce risk to this level. However, the EPA considers all cancer risks lower than 1 in 10,000 (1×10^{-4}) to be “acceptable”.

3. Risk Characterization

Non- cancer health effects

Individual VOCs: A hazard quotient (HQ) was determined for each individual VOC that had an established HGV. This ratio is a risk estimate that compares the maximum or average air concentration for each VOC to long-term HGV. HQs are an indication of whether there is potential cause for concern for adverse health effects.

Combined VOCs: When simultaneous exposures to multiple chemicals in the air can occur, it is important to evaluate the potential for risks to human health from combined exposures. To evaluate the combined risk, a Hazard Index or HI is used. An HI is calculated by adding together all of the individual HQs. This total HI is a conservative approximation of the total potential non-cancer risk for exposure to all of the VOCs.

HQs and HIs are calculated as follows:

$$\text{HQ} = \frac{\text{air measurement}}{\text{HGV}}$$

HQ = Hazard Quotient
HGV = Health Guideline Value

$$\text{HI} = \text{HQ}_1 + \text{HQ}_2 + \text{HQ}_3 + \dots$$

HQs and HIs are evaluated as follows:

- If HQ or HI is less than 1, no further evaluation is necessary and it can generally be concluded that potential for adverse health effects from the exposures measured in this study is low.
- If HQ or HI is greater than or equal to 1, further evaluation is recommended.

Cancer health effects:

To estimate the potential for increased cancer risks, the VOC concentration at each risk level within the generally “acceptable” risk range (1×10^{-4} to 1×10^{-6}) was compared to the exposure measurements. Combined cancer risks were also evaluated for all known cancer causing VOCs. This approach assumes the combined effect of each of the VOCs is additive.

Results

- All air concentrations of individual and combined VOCs were below long-term non-cancer health guideline values (Table 2).
 - Benzene had the highest hazard estimate of approximately 0.19 for the background sample collected on June 28, 2017. This means that the benzene level was about five times below the non-cancer long term health guideline value.
 - All other VOCs were at least 100 times below their respective non-cancer long term health guideline value.
- Cancer risks estimates for benzene and ethylbenzene individually or together were within the acceptable risk range of 1×10^{-6} to 1×10^{-4} (Table 3).
- In general, the non-cancer and cancer risk estimates were similar for both downwind and background samples.

Limitations

The following limitations must be considered when interpreting the results from this air sampling:

- This air sampling represents a “snapshot” of VOC concentrations from all emission sources in the area for only a single week long period. Samples collected under different conditions could have different results.
- Other substances may be emitted from oil and gas that were not sampled in this study and exposure to these substances may result in additional health risk.

Conclusions

Although these data are limited, the evaluation of the air samples during this time indicates a low risk of short or long-term harmful health effects due to VOC exposure in the vicinity of this oil and gas operation.

Table 1. Air measurements compared to non-cancer long-term health guideline values (HGV). All values are in ppbV.

Substance*	Air Measurements						Chronic HGV
	Canister 1			Canister 2			
	April	May	June	April	May	June	
1,2,3-Trimethylbenzene	0.02	0.12		0.04	0.05	0.08	12
1,2,4-Trimethylbenzene	0.25	0.20	0.11	0.33	0.16	0.26	12
1,3,5-Trimethylbenzene	0.05		0.04	0.04	0.04		12
1-Hexene	0.03	0.03	0.02	0.01	0.02	0.05	50
1-Pentene	0.06	0.07	0.06	0.04	0.07	0.13	560
2,2-Dimethylbutane	0.03	0.05	0.05	0.06	0.04		100
2,3-Dimethylbutane	0.05	0.07	0.08	0.09	0.07		99
2,3-Dimethylpentane	0.04	0.06	0.05	0.06	0.05		2200
2,4-Dimethylpentane	0.02	0.04	0.04	0.04	0.04	0.03	2200
2-Methylheptane	0.04	0.08	0.11	0.09	0.08		380
2-Methylhexane	0.19		0.15	0.24			2200
2-Methylpentane	0.24	0.41	0.45	0.36	0.41		90
3-Methylheptane	0.03	0.07	0.09	0.07	0.07	0.04	380
3-Methylhexane		0.16	0.18	0.19	0.14		2200
3-Methylpentane	0.10	0.21	0.20	0.21	0.17	0.10	100
Acetylene	0.57	0.35	0.17	0.59	0.27	0.14	2500
a-Pinene	0.01						63
Benzene	0.45	0.46	1.16	0.45	0.67	1.70	9
cis-2-Butene		0.02		0.01			700
Cyclohexane	0.26	0.44	0.57	0.45	0.48	0.40	1743
Cyclopentane	0.03	0.04	0.05	0.06	0.05	0.03	120
Ethane	20.10	24.25	17.95	30.25	15.30	7.60	NA
Ethylbenzene	0.12	0.14	0.14	0.12	0.18	0.26	230
Ethylene	0.98	1.62	1.48	0.85	1.26	2.43	5300
Isobutane	1.22	1.57	1.29	2.04	1.10	0.49	10000
Isoprene		0.01	0.09		0.02	0.10	2
Isopropylbenzene			0.16		0.02	0.03	81
m-Diethylbenzene						0.82	46
Methylcyclohexane	0.40	0.80	0.86	0.87	0.78	0.28	400
Methylcyclopentane	0.18	0.30	0.33	0.35	0.29	0.14	75
m-Ethyltoluene	0.19		0.29	0.23	0.20	0.27	25
m-Xylene/p-Xylene	0.21	0.22	0.23	0.23	0.27	0.20	23
n-Butane	1.25	1.64	1.40	2.09	1.24	0.61	10000
n-Decane	0.10	0.08	0.09	0.07	0.12	0.11	175
n-Dodecane	2.48	1.42	0.28	6.16	2.46	1.63	210
n-Heptane	0.17	0.29	0.36	0.36	0.33	0.17	2200
n-Hexane	0.31	0.47	0.58	0.58	0.51	0.33	198
n-Nonane	0.08	0.13	0.16	0.08	0.12	0.10	38
n-Octane	0.19	0.29	0.36	0.26	0.29	0.22	75
n-Pentane	0.44	0.60	0.62	0.68	0.57	0.32	8000
n-Propylbenzene	0.02	0.03	0.03	0.02	0.04	0.10	203
n-Undecane	0.67	0.18	0.11	0.85	0.51	0.34	55
o-Xylene	0.14	0.14	0.16	0.14	0.17	0.27	23
p-Diethylbenzene		0.02					46
p-Ethyltoluene	0.03				0.04	0.06	25
Propane	5.50	6.93	5.27	8.70	4.43	2.18	8000
Propylene	0.36	0.67	0.94	0.28	0.68	1.68	1743
Styrene	0.35				0.72		235
Toluene	3.73	2.81	6.80	2.41	11.64	32.57	1327
trans-2-Butene	0.01	0.02		0.01		0.10	700
trans-2-Pentene	0.01	0.02	0.02	0.01	0.02	0.08	560

*Only substances that were above the detection limit in at least one sample are listed in the table and had a health guideline value are reported in the table. I = US EPA; A = ATSDR (US Agency for Toxic Substances and Disease Registry); P= PPRTV (US EPA Provisional Peer Reviewed Toxicity Values); C= CalEPA (California Office of Environmental Health Hazard Assessment); T= TCEQ (Texas Commission on Environmental Quality); D = DOE (Department of Energy Temporary Emergency Exposure Limit); R = Read Across; NA = no health value available- substance is considered an asphyxiant at extremely high exposures with no other toxicological effects. NV = no value found.

Table 2. Non-cancer long-term risk estimates for individual VOCs for both downwind and upwind samples. The risk estimate is the ratio that compares the air concentration for each VOC to long-term HGV (see Table 1). A value below 1 indicates that the air concentration was below the HGV.

Substance	Canister 1			Canister 2		
	April	May	June	April	May	June
1,2,3-Trimethylbenzene	0.001	0.010	0.000	0.003	0.005	0.007
1,2,4-Trimethylbenzene	0.021	0.017	0.009	0.028	0.013	0.022
1,3,5-Trimethylbenzene	0.004	0.000	0.003	0.003	0.003	0.000
1-Hexene	0.001	0.001	0.000	0.000	0.000	0.001
1-Pentene	0.000	0.000	0.000	0.000	0.000	0.000
2,2-Dimethylbutane	0.000	0.000	0.000	0.001	0.000	0.000
2,3-Dimethylbutane	0.000	0.001	0.001	0.001	0.001	0.000
2,3-Dimethylpentane	0.000	0.000	0.000	0.000	0.000	0.000
2,4-Dimethylpentane	0.000	0.000	0.000	0.000	0.000	0.000
2-Methylheptane	0.000	0.000	0.000	0.000	0.000	0.000
2-Methylhexane	0.000	0.000	0.000	0.000	0.000	0.000
2-Methylpentane	0.003	0.005	0.005	0.004	0.005	0.000
3-Methylheptane	0.000	0.000	0.000	0.000	0.000	0.000
3-Methylhexane	0.000	0.000	0.000	0.000	0.000	0.000
3-Methylpentane	0.001	0.002	0.002	0.002	0.002	0.001
Acetylene	0.000	0.000	0.000	0.000	0.000	0.000
a-Pinene	0.000	0.000	0.000	0.000	0.000	0.000
Benzene	0.050	0.051	0.129	0.050	0.074	0.189
cis-2-Butene	0.000	0.000	0.000	0.000	0.000	0.000
Cyclohexane	0.000	0.000	0.000	0.000	0.000	0.000
Cyclopentane	0.000	0.000	0.000	0.000	0.000	0.000
Ethylbenzene	0.001	0.001	0.001	0.001	0.001	0.001
Ethylene	0.000	0.000	0.000	0.000	0.000	0.000
Isobutane	0.000	0.000	0.000	0.000	0.000	0.000
Isoprene	0.000	0.007	0.044	0.000	0.011	0.048
Isopropylbenzene	0.000	0.000	0.002	0.000	0.000	0.000
Methylcyclohexane	0.001	0.002	0.002	0.002	0.002	0.001
Methylcyclopentane	0.002	0.004	0.004	0.005	0.004	0.002
m-Ethyltoluene	0.008	0.000	0.012	0.009	0.008	0.011
m-Xylene/p-Xylene	0.009	0.010	0.010	0.010	0.012	0.008
n-Butane	0.000	0.000	0.000	0.000	0.000	0.000
n-Decane	0.001	0.000	0.001	0.000	0.001	0.001
n-Dodecane	0.012	0.007	0.001	0.029	0.012	0.008
n-Heptane	0.000	0.000	0.000	0.000	0.000	0.000
n-Hexane	0.002	0.002	0.003	0.003	0.003	0.002
n-Nonane	0.002	0.003	0.004	0.002	0.003	0.003
n-Octane	0.003	0.004	0.005	0.004	0.004	0.003
n-Pentane	0.000	0.000	0.000	0.000	0.000	0.000
n-Propylbenzene	0.000	0.000	0.000	0.000	0.000	0.000
n-Undecane	0.012	0.003	0.002	0.016	0.009	0.006
o-Xylene	0.006	0.006	0.007	0.006	0.007	0.012
p-Ethyltoluene	0.001	0.000	0.000	0.000	0.002	0.003
Propane	0.001	0.001	0.001	0.001	0.001	0.000
Propylene	0.000	0.000	0.001	0.000	0.000	0.001
Styrene	0.001	0.000	0.000	0.000	0.003	0.000
Toluene	0.003	0.002	0.005	0.002	0.009	0.025
trans-2-Butene	0.000	0.000	0.000	0.000	0.000	0.000
trans-2-Pentene	0.000	0.000	0.000	0.000	0.000	0.000

Table 3. Summary of average air measurements collected by the CAMML compared to lowest VOC concentration at each risk level within the generally “acceptable”¹ risk range (1×10^{-4} to 1×10^{-6}).

Substance	Range of Air Measurement ² (ppb)	Cancer Risk Estimate		
		Air Concentration at 1×10^{-6} (ppb)	Air Concentration at 1×10^{-5} (ppb)	Air Concentration at 1×10^{-4} (ppb)
Benzene ³	0.45-1.70	0.041 ²	0.41 ²	4.1 ²
Ethylbenzene ⁴	0.12-0.26	0.092 ³	0.92 ³	9.2 ³

¹A one in a million cancer risk (1×10^{-6}) is considered a minimal cancer risk. A one in ten thousand cancer risk (1×10^{-4}) is considered the upper limit of the US EPA “acceptable” range.

²Range of air measurements of all samples (Canister 1 and 2).

³Determined using the US EPA inhalation unit risk of 7.8×10^{-6} per $\mu\text{g}/\text{m}^3$.

⁴Determined using the CalEPA inhalation unit risk of 2.5×10^{-6} per $\mu\text{g}/\text{m}^3$.