

Health Risk Evaluation of Site-Specific Ambient Air Measurements in Garfield County, Colorado (January - March 2019)

(Resumen en español)

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Prepared for:

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Summary

About this report

Garfield County Public Health collected samples of the air near an oil and gas site in Battlement Mesa, Colo. from April 2017 through March 2019. The county collected the samples to measure chemicals that may be from oil and gas operations or from other sources. These chemicals are called volatile organic compounds (VOCs). The county asked the Colorado Department of Public Health and Environment to look at how these chemicals might affect people's health. This report is about what we found from samples the county collected from January through March 2019. There are earlier reports for other samples. You can find these reports at garfield-county.com/air-quality/documents.aspx.

What we found

State and federal government agencies have guidelines that tell us what levels of VOCs might cause health effects. They are different for health effects that are “short-term,” and ones that are “long-term.” For the air samples we studied from Garfield County, we found:

- The levels of VOCs were below what we expect would cause long-term health effects that are not cancer. This is true whether people breathed in one chemical at a time or all of them at the same time.
- VOCs levels were generally higher in the samples collected downwind of the oil and gas operation than those collected upwind.
- Two of the VOCs measured in the samples, benzene and ethylbenzene, may cause cancer. But breathing in the levels of benzene and ethylbenzene in the amounts Garfield County measured does not increase the risk of cancer above what is considered “acceptable” by the U.S. Environmental Protection Agency (EPA).

These results don't include health effects from other chemicals or substances that may come from nearby oil and gas operations. Also, the county collected most of the samples when the wind was blowing from the direction of the oil and gas operation, but not when the wind was blowing from other directions.

More information

The Colorado Department of Public Health and Environment has done seven of these health risk reports for Garfield County Public Health since April 2017 using air samples collected near the Ursa Pad in Battlement Mesa, Colo.

- In all the reports, the amount of each VOC was below the guidelines for long-term health effects that are not cancer.
- The amount of VOCs measured also has never been over the amount that the U.S. EPA says is an “acceptable” risk for cancer.
- Overall, the two years of monitoring air tells us that there is a low risk of developing harmful health effects from VOCs near this oil and gas operation.
- The state health department does not recommend any further evaluation of this site.

For questions about this report, please contact:

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Resumen

Acerca de este informe

Salud Pública del condado de Garfield recolectó muestras de aire cerca de un establecimiento de gas y petróleo en Battlement Mesa, Colorado, entre abril de 2017 y marzo de 2019. El condado recolectó las muestras para medir los químicos que pueden provenir de operaciones de gas y petróleo o de otras fuentes. Estos químicos se denominan compuestos orgánicos volátiles (VOC, por su sigla en inglés). El condado le solicitó al Departamento de Salud Pública y Medio Ambiente de Colorado que analizara de qué forma estos químicos pueden afectar la salud de las personas. Este informe se trata de los hallazgos en las muestras que recolectó el condado entre enero y marzo de 2019. Asimismo, hay informes anteriores de otras muestras que se pueden encontrar en garfield-county.com/air-quality/documents.aspx.

Los hallazgos

Los organismos gubernamentales estatales y federales tienen pautas que nos indican qué niveles de compuestos orgánicos volátiles pueden tener efectos sobre la salud. Estos son diferentes para aquellos que son “a corto plazo” y aquellos que son a “largo plazo”. En lo que respecta a las muestras de aire del condado de Garfield que analizamos, encontramos lo siguiente:

- Los niveles de compuestos orgánicos volátiles estaban por debajo de lo que se espera que pudiera causar efectos sobre la salud a largo plazo que no fuera cáncer. Esto es válido independientemente de que las personas respiraren un químico a la vez o todos al mismo tiempo.
- Los niveles de compuestos orgánicos volátiles por lo general eran más elevados en las muestras recolectadas con viento a favor del establecimiento que operaba con gas y petróleo que aquellas recolectadas con viento en contra.
- Dos de los compuestos orgánicos volátiles que se midieron en las muestras, benceno y etilbenceno, pueden causar cáncer. No obstante, inhalar los niveles de benceno y etilbenceno en las cantidades que midió el condado de Garfield no aumenta el riesgo de cáncer por encima de lo que la Agencia de Protección Ambiental (EPA) considera “aceptable”.

Estos resultados no incluyen los efectos sobre la salud de otros químicos o sustancias que pueden provenir de establecimientos cercanos que operan con gas y petróleo. Asimismo, el condado recolectó la mayoría de las muestras cuando el viento soplaba desde la dirección donde se encuentra dicho establecimiento, pero no cuando el viento soplaba desde otras direcciones.

Más información

Desde abril de 2017, el Departamento de Salud Pública y Medio Ambiente de Colorado ha realizado, para Salud Pública del condado de Garfield, siete de estos informes sobre riesgos para la salud y, para ello, se sirvió de muestras de aire recolectadas cerca de Ursa Pad en Battlement Mesa, Colorado.

- En todos los informes, la cantidad de cada compuesto orgánico volátil estaba por debajo de las pautas de efectos sobre la salud a largo plazo que no fueran cáncer.
- Asimismo, la cantidad de los compuestos orgánicos volátiles medidos nunca ha estado por encima de la cantidad que la Agencia de Protección Ambiental de Estados Unidos indica como un riesgo “aceptable” de cáncer.
- En resumen, los dos años de control de la calidad del aire nos indican que existe un bajo riesgo de desarrollar efectos nocivos en la salud cerca de este establecimiento de gas y petróleo.
- El Departamento de Salud del estado no recomienda evaluaciones posteriores de este establecimiento.

En caso de tener preguntas sobre este informe, ponerse en contacto con el:

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Salud Pública del condado de Garfield:
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Background

Garfield County Public Health (GCPH) is conducting an ongoing evaluation of the air quality near an oil and gas site in Battlement Mesa, Colorado. GCPH requested the Oil and Gas Health Information and Response (OGHIR) Program at the Colorado Department of Public Health and Environment (CDPHE) conduct a health risk evaluation of the measured volatile organic compounds (VOCs) from the first quarter air sampling period of 2019.

Purpose

The purpose of this assessment was to evaluate whether people living near this site were at risk of harmful health effects from exposures to VOCs in the air.

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 January to March 2019 was collected over a week long period with a conditional sampler designed to collect ambient air samples when the wind was coming from the direction of the oil and gas site (termed downwind). A grab sample was also collected once in January 2019. Samples were analyzed for VOC's following U.S. Environmental Protection Agency's (EPA) Method TO-12. Details of the VOC sampling study are available via GCPH/ARS. Forty-nine VOCs were quantified in samples collected during the first quarter of 2019 and therefore assessed in this evaluation.

Health risk evaluation

This screening level health risk evaluation is consistent with the EPA guidance¹.

1. Exposure Evaluation

The objective of an exposure evaluation is to select air monitoring data that most closely represent the amount of the VOC that would be inhaled by a person living in the area. Because these samples were integrated over approximately one to two weeks, they more likely represent long-term exposures rather than short-term (i.e. one hour or less) exposures. For the purposes of this screening level assessment, long-term exposure conservatively 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. Since the conditional samplers are activated from wind direction, this exposure would also assume a constant wind direction.

2. Health Effect Evaluation

Non-cancer health effects

A non-cancer health guideline value (HGV)² is defined 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 by volume (ppbV). Long-term (chronic) HGVs were used to compare to the air measurements. There were no long-term HGV's for 1-nonene, 1-octene and cyclopentene and therefore, these VOCs were not evaluated in this health risk assessment. Ethane and

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

² McMullin et al. (2018). Int. J. Environ. Res. Public Health 15(7). doi: 10.3390/ijerph15071500

propane are simple asphyxiates with no systemic toxicity and therefore, had no HGVs and, therefore, were also not evaluated.

Cancer health effects

An inhalation unit risk (IUR) is an estimate of the increased excess cancer risk from inhalation exposure to a VOC for a lifetime. Two VOCs had IURs derived by either the EPA (benzene) or the California EPA (ethylbenzene) and are evaluated in this assessment.

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 average air concentration for each VOC to its established 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 (HI) is used. An HI is calculated by adding together all of the individual HQs. This HI is a conservative approximation of the total non-cancer risk for exposure to all of the VOCs.

How HQs and HIs are calculated:

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

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 one, 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 one, further evaluation is recommended.

Cancer health effects

For VOCs that could cause cancer, VOC concentrations associated with 1×10^{-6} (one in one million) to 1×10^{-4} (100 in one million) excess 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 one out of one million equally exposed people could develop 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. 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 100 in one million (1×10^{-4}) to be “acceptable.” 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 VOCs were below long-term non-cancer health guideline values established by state and federal agencies (Table 1). Four of the 49 quantified VOCs did not have health guideline values and therefore, were not evaluated. The hazard indices for all VOCs combined also did not indicate potential health risk.
- Although all individual VOCs were below health guideline values, the non-cancer hazard quotients were generally higher in the downwind samples and grab sample compared to the upwind samples (Table 2). The maximum downwind hazard index was ten times higher than the maximum upwind hazard index.
- Cancer risk estimates for benzene and ethylbenzene individually were within the EPA generally acceptable risk range of one to 100 in a million (Table 3). The combined cancer risk estimated from the exposure to the maximum measured levels of these two substances was 3×10^{-5} .

Limitations

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

- The conditional air sampling represents a “snapshot” of VOC concentrations from all sources in the area during separate week long periods. This sampling technique may not accurately capture peak exposures, and samples collected under different conditions and times may have different results.
- Other substances that may be emitted from oil and gas operations were not sampled in this study and exposure to these substances may result in additional health risk.

Conclusions

This sampling period: January to March 2019

The evaluation of the air samples during this time indicates a low risk of long-term harmful health effects due to VOC exposure in the vicinity of this oil and gas operation. Our conservative approach to adding all VOCs together, regardless of toxic effect, to calculate hazard indices also supports the conclusion of low risk because no hazard index exceeded one. Evaluation of long-term trends of this air sampling is recommended to continue to monitor risks from chronic exposures.

Two years of sampling: April 2017 to March 2019

Since April 2017, air samples have been collected near the Ursa Pad in Battlement Mesa, Colorado and six health risk evaluations previous to this current one were performed by CDPHE for Garfield County Public Health. These reports are available on [GCPH's website](#). All air concentrations of individual VOCs were below long-term non-cancer health guideline values. Benzene, n-nonane or isoprene exhibited the highest hazard quotients during different sampling periods but were always below one. Hazard indices, calculated on using conservative approach, only exceeded one once (fourth quarter of 2018) but likely did not represent ongoing chronic conditions. Cancer risk estimates never exceeded EPA's acceptable risk range. Based on the data collected over the two

year period, long term exposure to VOCs in the vicinity of this oil and gas operation is unlikely to cause harmful health effects.

Table 1. Downwind air measurements in 2019 compared to non-cancer long-term (chronic) health guideline values (HGV).

Substance ¹	January (ppbV)	January ² (ppbV)	February (ppbV)	March (ppbV)	Chronic HGV (ppbV)
1,2,3-Trimethylbenzene	ND	0.02	ND	ND	12 ³
1,2,4-Trimethylbenzene	0.03	0.08	0.02	ND	12 ³
1,3,5-Trimethylbenzene	0.02	0.08	0.01	0.01	12 ³
1-Hexene	0.01	0.01	ND	0.02	50 ⁴
1-Pentene	0.03	0.03	ND	0.03	560 ⁴
2,2-Dimethylbutane	0.09	0.61	0.05	0.06	100 ⁴
2,3-Dimethylbutane	0.16	1.13	0.09	0.09	99 ⁴
2,3-Dimethylpentane	0.06	0.39	0.04	0.04	2,200 ⁴
2,4-Dimethylpentane	0.05	0.34	0.03	0.03	2,200 ⁴
2-Methyl-2-butene	ND	0.02	ND	ND	560 ⁴
2-Methylheptane	0.10	0.60	0.06	0.06	390 ⁴
2-Methylhexane	ND	1.53	0.17	0.20	2,200 ⁴
2-Methylpentane	0.64	3.82	0.35	0.39	99 ⁴
3-Methylheptane	0.08	0.48	0.05	0.05	390 ⁴
3-Methylhexane	0.23	1.33	0.14	0.14	2,200 ⁴
3-Methylpentane	0.37	2.27	0.21	0.22	100 ⁴
Acetylene	0.62	0.35	0.58	0.44	2,500 ⁴
Benzene	0.28	1.16	0.21	0.24	4 ⁵
Cyclohexane	0.63	3.77	0.38	0.38	1,743 ³
Cyclopentane	0.09	0.61	0.06	0.06	120 ⁴
Ethylbenzene	0.02	0.08	0.01	0.01	9 ⁶
Ethylene	0.71	0.74	0.76	0.90	5,300 ⁴
Isobutane	1.99	11.20	1.26	1.49	10,000 ⁴
Isopentane	ND	12.38	ND	ND	8,000 ⁴
Isoprene	ND	ND	0.01	ND	2 ⁴
Methylcyclohexane	1.11	6.34	0.66	0.66	400 ⁴
Methylcyclopentane	0.51	3.00	0.31	0.30	75 ⁴
m-Ethyltoluene	0.02	0.05	0.01	0.01	25 ⁴
m-Xylene/p-Xylene	0.15	0.80	0.10	0.10	23 ³
n-Butane	2.46	14.68	1.59	1.71	10,000 ⁴
n-Decane	0.04	0.15	0.02	ND	175 ⁴
n-Dodecane	ND	0.01	ND	ND	4 ⁷

Substance ¹	January (ppbV)	January ² (ppbV)	February (ppbV)	March (ppbV)	Chronic HGV (ppbV)
n-Heptane	0.47	2.70	0.29	0.27	2,200 ⁴
n-Hexane	0.86	5.23	0.53	0.49	199 ³
n-Nonane	0.07	0.35	0.04	0.05	4 ⁷
n-Octane	0.26	1.43	0.16	0.17	124 ⁷
n-Pentane	1.22	7.94	0.75	0.74	8,000 ⁴
n-Propylbenzene	ND	0.02	ND	ND	51 ⁴
n-Undecane	0.01	0.04	ND	0.01	55 ⁴
o-Ethyltoluene	0.01	0.04	ND	ND	25 ⁴
o-Xylene	0.03	0.12	0.02	0.03	23 ³
Propylene	0.14	0.25	0.08	0.15	1,743 ⁸
Toluene	0.47	1.94	0.33	0.45	1,327 ³
trans-2-Butene	ND	ND	ND	0.08	700 ⁴

¹ Only substances that were quantified in at least one sample and had a health guideline value are reported in Table 1.

² Denotes grab sample.

³ EPA Integrated Risk Information System Values.

⁴ Texas Commission on Environmental Quality Air Monitoring Comparison Values.

⁵ Determined using the EPA inhalation unit risk factor of 7.8×10^{-6} per $\mu\text{g}/\text{m}^3$ at a risk level of 100 in one million.

⁶ Determined using the California EPA inhalation unit risk factor of 2.5×10^{-6} per $\mu\text{g}/\text{m}^3$ at a risk level of 100 in one million.

⁷ EPA Provisional Peer Reviewed Toxicity Values (PPRTVs).

⁸ California EPA Office of Environmental Health Hazard Assessment Reference Exposure Level Values.

ND = not detected

Table 2. Non-cancer long-term risk estimates for individual and combined VOCs for the highest hazard indices of both downwind and upwind samples. The risk estimate (or hazard quotient (HQ)) is the ratio that compares the air concentration for each VOC to the corresponding long-term HGV (see methods). A value below one indicates that the air concentration was below the HGV.

Substance ¹	Downwind HQ (January ²)	Upwind HQ (January)
1,2,3-Trimethylbenzene	0.00	N/A
1,2,4-Trimethylbenzene	0.01	0.00
1,3,5-Trimethylbenzene	0.01	N/A
1-Hexene	0.00	0.00
1-Pentene	0.00	0.00
2,2-Dimethylbutane	0.01	0.00
2,3-Dimethylbutane	0.01	0.00
2,3-Dimethylpentane	0.00	0.00
2,4-Dimethylpentane	0.00	0.00
2-Methyl-2-butene	0.00	N/A
2-Methylheptane	0.00	0.00
2-Methylhexane	0.00	N/A
2-Methylpentane	0.04	0.00
3-Methylheptane	0.00	0.00
3-Methylhexane	0.00	0.00
3-Methylpentane	0.02	0.00
Acetylene	0.00	0.00
Benzene	0.29	0.04
Cyclohexane	0.00	0.00
Cyclopentane	0.01	0.00
Ethylbenzene	0.01	0.00
Ethylene	0.00	0.00
Isobutane	0.00	0.00
Isopentane	0.00	N/A
Isoprene	N/A	N/A
Methylcyclohexane	0.02	0.00
Methylcyclopentane	0.04	0.00
m-Ethyltoluene	0.00	0.00
m-Xylene/p-Xylene	0.03	0.00
n-Butane	0.00	0.00
n-Decane	0.00	0.00
n-Dodecane	0.00	N/A

Substance ¹	Downwind HQ (January ²)	Upwind HQ (January)
n-Heptane	0.00	0.00
n-Hexane	0.03	0.00
n-Nonane	0.09	0.01
n-Octane	0.01	0.00
n-Pentane	0.00	0.00
n-Propylbenzene	0.00	N/A
n-Undecane	0.00	0.00
o-Ethyltoluene	0.00	N/A
o-Xylene	0.01	0.00
Propylene	0.00	0.00
Toluene	0.00	0.00
trans-2-Butene	N/A	N/A
Hazard Index (HI)	0.64	0.06

¹ Only substances that were quantified in at least one sample and had a health guideline value are reported in Table 2.

² Denotes grab sample.

N/A = not applicable

Table 3. Summary of air measurements compared to the lowest VOC concentration at each risk level within the generally “acceptable”¹ cancer risk range (1 to 100 in a million).

Substance	Range of Air Measurement ² (ppbV)	Cancer Risk Estimate		
		Air Concentration at 1 in a million (ppbV)	Air Concentration at 10 in a million (ppbV)	Air Concentration at 100 in a million (ppbV)
Benzene ³	0.11 - 1.16	0.041	0.41	4.1
Ethylbenzene ⁴	0.01 - 0.08	0.092	0.92	9.2

¹ A one in a million cancer risk (1×10^{-6}) is considered a minimal cancer risk. A 100 in a million cancer risk (1×10^{-4}) is considered the upper limit of the EPA “acceptable” range.

² Range of air measurements of all samples (upwind and downwind).

³ Risk estimates determined using the EPA inhalation unit risk of 7.8×10^{-6} per $\mu\text{g}/\text{m}^3$ (2.4×10^{-6} per ppbV).

⁴ Risk estimates determined using the California EPA inhalation unit risk of 2.5×10^{-6} per $\mu\text{g}/\text{m}^3$ (6.0×10^{-7} per ppbV).