

# Evaluation of Air Exposures and Health Risks in a Community During Oil and Gas Development

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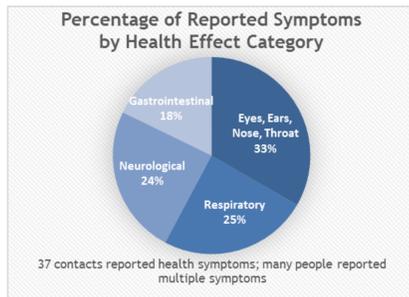
## Introduction

Unconventional oil and gas (O&G) activity is growing in Colorado, primarily in areas with rapidly growing suburban populations. People living near O&G sites have reported multiple acute health symptoms, frequently coinciding with noticeable odors during drilling and completion activities. While Colorado conducts regional air quality monitoring in OG regions, local scale air monitoring of volatile organic compounds (VOCs) near active O&G sites are limited. This information is critical to adequately characterize public health risks from O&G related exposures, especially during times when communities report health symptoms and odors.

The Oil and Gas Health Information and Response (OGHIR) Program at the Colorado Department of Public Health and Environment (CDPHE) received odor and health concern reports from approximately 50 residents in neighborhoods near a newly operating O&G site. Residents reported eye, nose and throat irritation, nosebleeds, respiratory effects such as lung irritation and difficulty breathing, headaches, and nausea (Figure 1). OGHIR documented that many of these health and odor concerns occurred at the time when drilling operations were ongoing at the site, and when wind direction was coming from the direction of the well pad.

In response to reported health and odor concerns, we deployed the Colorado Air Monitoring Mobile Laboratory (CAMML) in the community to collect air data and meteorology for a total of 55 days (Figure 2).

Figure 1. Summary of health symptoms reported to OGHIR



## Study Objective

To evaluate community level health risks from exposures to O&G related VOCs emitted during different development activities.

## Methods

- The CAMML was stationed ~1,000 feet downwind from the well pad between the well pad and neighborhood (Figure 3).
- 64 volatile organic compounds (VOCs) and select criteria air pollutants were measured.
- Add methods of collection (GC-MS)

Activity	Total Days	Total Hours
Drilling	19	300
Hydraulic Fracturing	14	200
Flowback	22	400

- One-hour averages were aggregated to derive means and maximum values of each VOC during each phase.
- Acute and chronic non-cancer and cancer risk estimates for the VOCs were evaluated.

## Results

Figure 2. The Colorado Air Monitoring Mobile Laboratory (CAMML) with an onboard GC-MS and meteorological capabilities.



Figure 4. Air measurements of VOCs during three phases of oil and gas development at the O&G site. Box and whisker plot shows the minimum, 25th percentile, median, 75th percentile and maximum concentrations on a log scale for each substance.

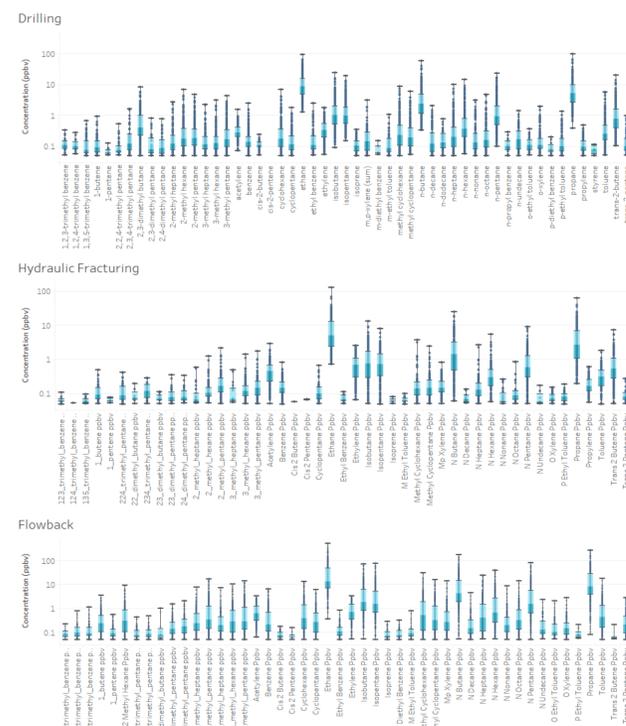


Figure 6. Acute and chronic hazard indices during three different operation types at the O&G site.

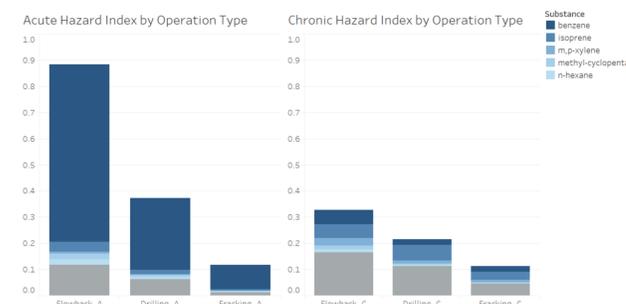


Figure 3. CAMML location (orange star) stationed approximately 1000 feet from OG pad O&G well pad (red arrow) between well pad and the neighborhood reporting symptoms.



Figure 5. Short-term and long-term risk estimates (hazard quotients) for each VOC for non-cancer health effects during flowback activities at the O&G site.

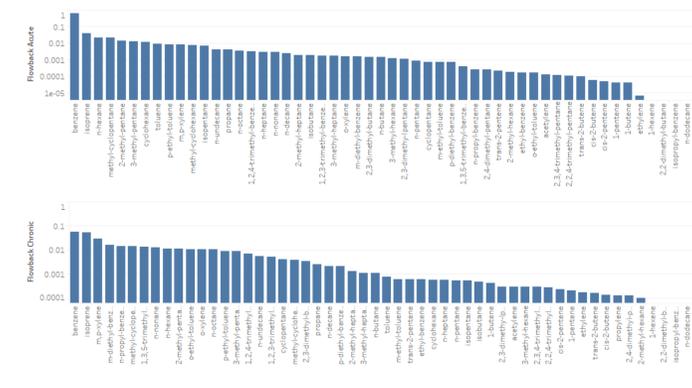


Table 1. Cancer risk estimates for one classified carcinogen. The upper bound IUR estimate of  $7.8 \times 10^{-6}$  for benzene was conservatively selected for this assessment.

Substance	Average Air Measurement (ppbV)	Cancer Risk Estimate		
		Air Concentration at $1 \times 10^{-6}$ (ppbV)	Air Concentration at $1 \times 10^{-4}$ (ppbV)	Air Concentration at $1 \times 10^{-2}$ (ppbV)
Benzene	Drilling: 0.20 HF: 0.17 Flowback: 0.56	0.041	0.41	4.1

- High level of variability (5-100-fold) in individual VOC air concentrations
- All VOCs during all development activities were below health guideline levels for acute and chronic non-cancer health effects.
  - Benzene, isoprene, hexane, methylcyclopentane, and xylenes contribute the greatest proportion of risk during development activities. All other VOCs have negligible contributions.
  - Of all VOCs, benzene is the primary risk driver for both acute and chronic exposures during all operations other than drilling for a chronic exposure timeframe. Benzene was the only VOC with an acute hazard quotient between 0.1-1 during drilling and flowback (Fig. 5 and 6).
- Combined Risk: Flowback > Drilling > Hydraulic Fracturing (fig. 6)
- Average benzene measurements were above the midpoint of EPA's excess cancer risk range during flowback and below for all other phases.

## Limitations

- This air sampling represents VOC concentrations from all emission sources in the area. Samples collected under different conditions could have different results.
- Other substances that may be emitted from O&G or other nearby facilities were not sampled in this study and exposure to these substances may result in additional health risk or contribute to the reported health symptoms and odors.
- Whether the VOCs in the air will have a harmful effect on an individual's health depends upon many factors that are not all measured in this risk assessment. These include non-chemical factors such as age, family traits (i.e. genetics), and lifestyle behaviors.
- Odor concerns cannot be fully evaluated due to the lack of information regarding odor thresholds associated with physical symptoms and the combined effects of odors from multiple substances.

## Conclusions

- The evaluation of the air samples during this time indicated a low risk of acute and chronic health effects due to VOC exposures in the vicinity of these oil and gas operations.
- Evaluation of health concerns reported by residents in the vicinity of the O&G site suggest upper respiratory irritation and other physiological responses to odors.
  - Many of these concerns occurred temporally with drilling operations on the site when residents reported that wind direction was coming from the direction of the well pad.
- Continued regional air quality monitoring along with additional site-specific community level air sampling is needed to target exposure characterization and risk assessment in potentially exposed communities.
- Air monitoring studies like these that continuously measure concentrations of a sub-set of high priority VOCs, during multiple phases of operations, and during times when citizens are experiencing health symptoms will provide additional important exposure information.

## CDPHE Official Report

The official report from the Oil and Gas Health Information and Response Program can be found at:

<https://www.colorado.gov/oghealth>

