

# VOC concentration increases near oil and gas well drilling, completion, and production operations

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Department of Public  
Health & Environment





# O&G air emissions

## ➤ Hydraulic fracturing

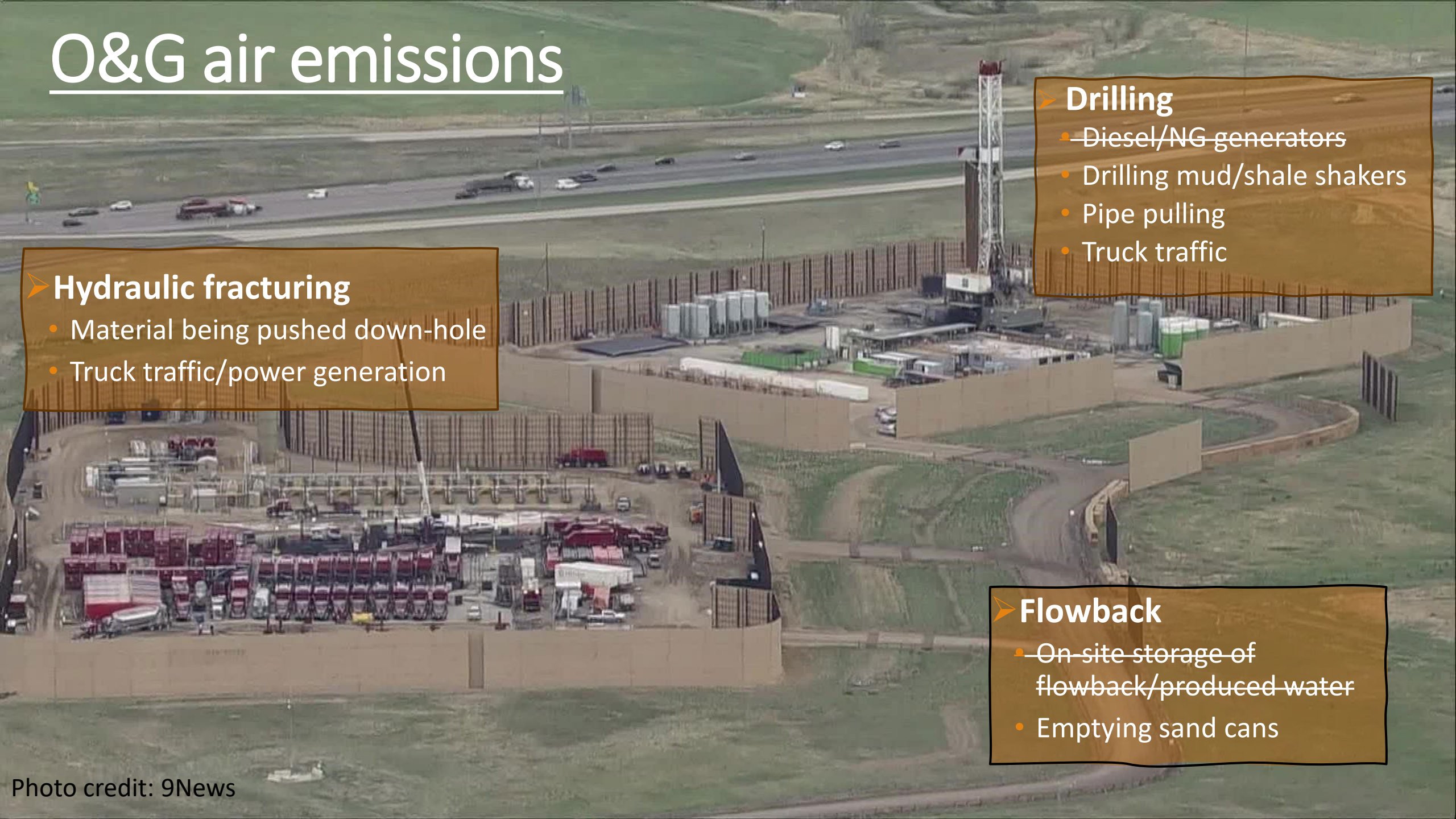
- Material being pushed down-hole
- Truck traffic/power generation

## ➤ Drilling

- Diesel/NG generators
- Drilling mud/shale shakers
- Pipe pulling
- Truck traffic

## ➤ Flowback

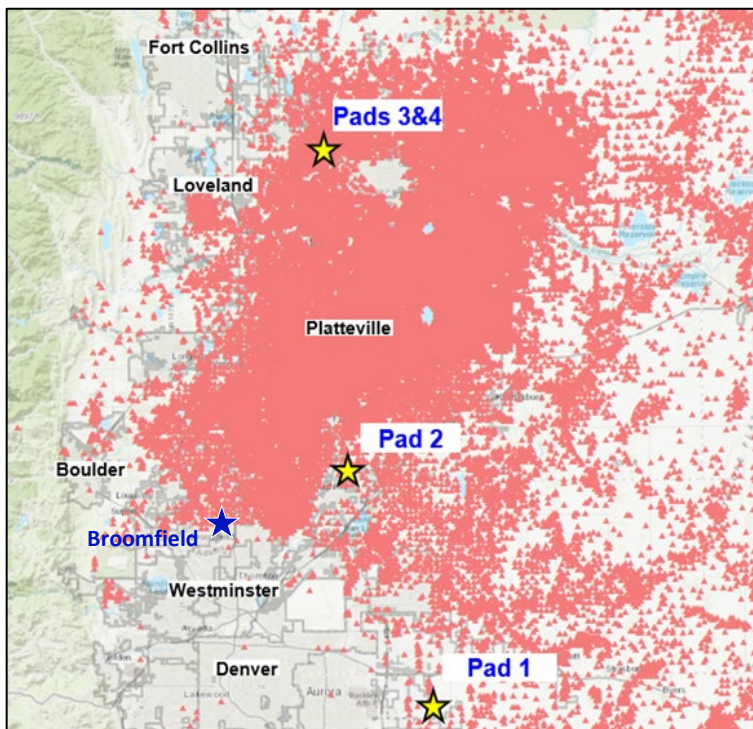
- On-site storage of flowback/produced water
- Emptying sand cans





# Air monitoring approach

## Denver-Julesburg basin wells



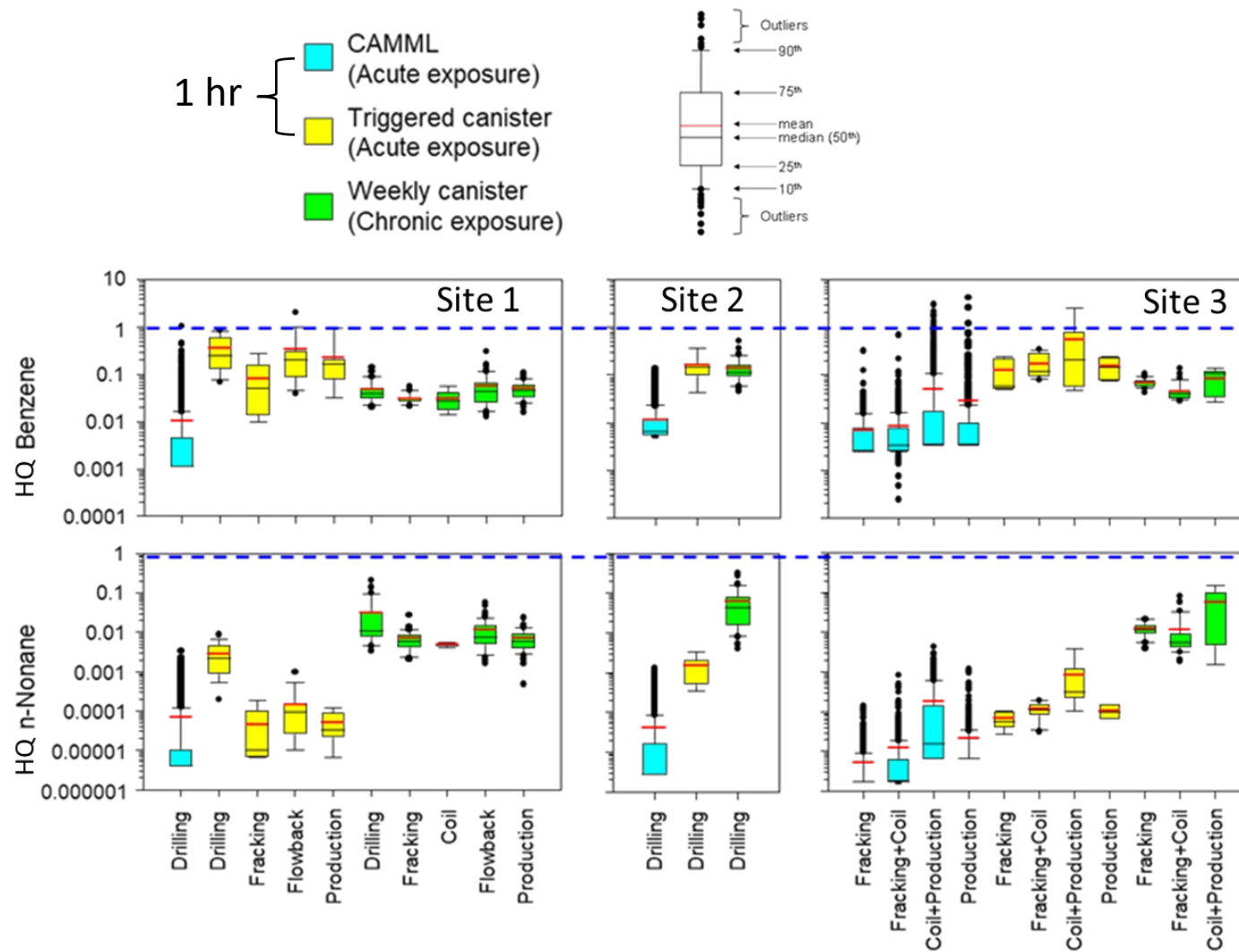
- 3 locations, 4 well pads, > 2 yrs
  - 3 O&G operators
- CDPHE CAMML
  - Hourly speciated VOCs + CH<sub>4</sub>, NO<sub>x</sub>, PM<sub>2.5</sub>
- Weekly integrated VOC canisters
  - 51 speciated VOCs + CH<sub>4</sub>
  - 2 near-pad locations + background site
- Continuous PID VOC monitors with event-triggered canister samples
  - 2 near-pad locations
- Mobile measurements
  - CH<sub>4</sub> and VOCs
- Prior monitoring data from Broomfield

- Typically modest increases in **weekly average concentrations** near pad
- **Concentrations in transient plumes** much higher than weekly averages
  - Plume durations at sensor typically 10s of minutes
- Strong local enhancements of **C<sub>8</sub>-C<sub>10</sub> alkanes** (from synthetic Neoflo drilling mud volatilization) during drilling and millout
  - Nonane is an air toxic
  - Potential effects on O<sub>3</sub> formation





HQ = Measured Concentration/Health Guideline Value

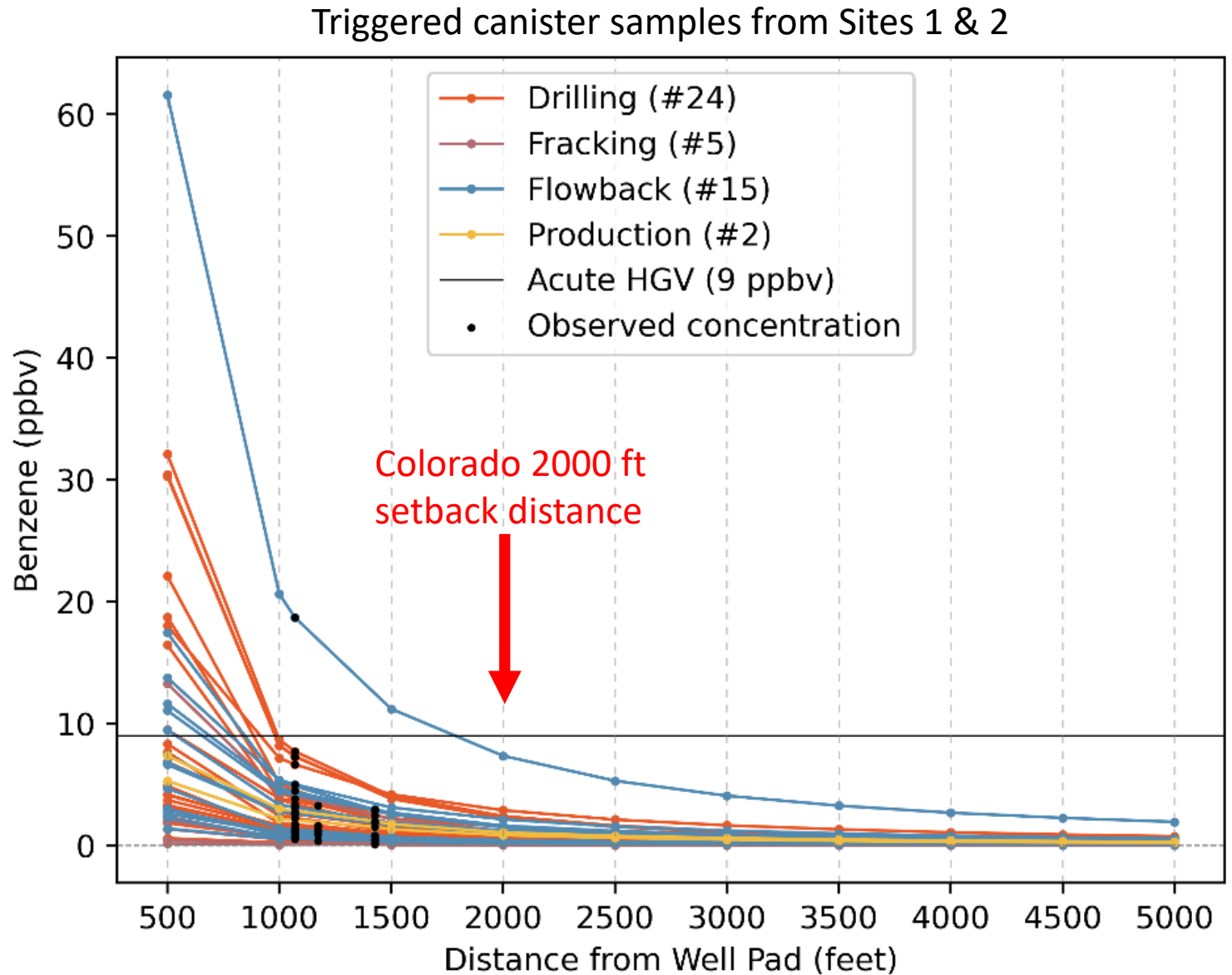


## Acute and chronic non-cancer exposure risk screening

- Chronic exposure Health Guideline Values (HGVs) not exceeded
  - Benzene and n-nonane had largest HQ values
- 1-hr benzene levels occasionally exceeded acute exposure HGVs across UOGD operation types
- Reinforces findings from other recent DJ Basin measurements (Ku et al., 2024) and simulations (Holder et al., 2019)

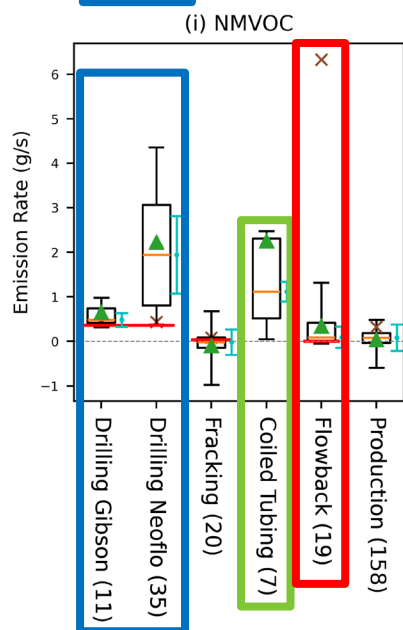
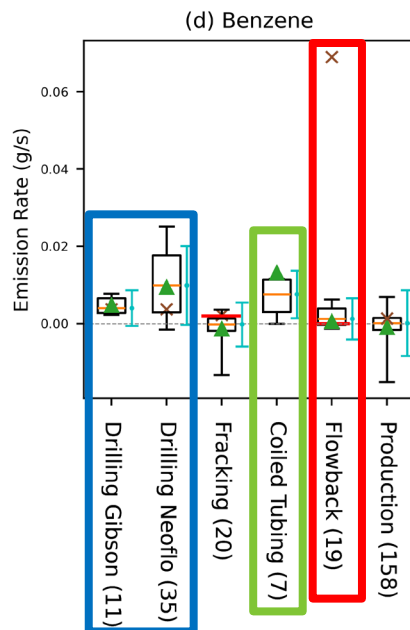
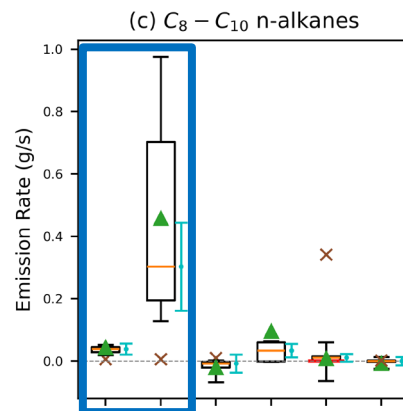
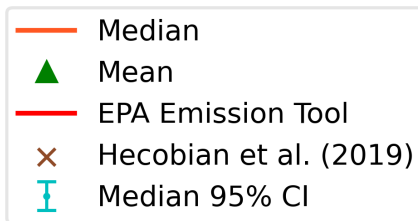
# Exposure vs. distance

- Observationally-constrained AERMOD dispersion simulations used to examine concentration vs. distance
- Colorado's 2,000-foot presumptive setback distance helps reduce exposure levels





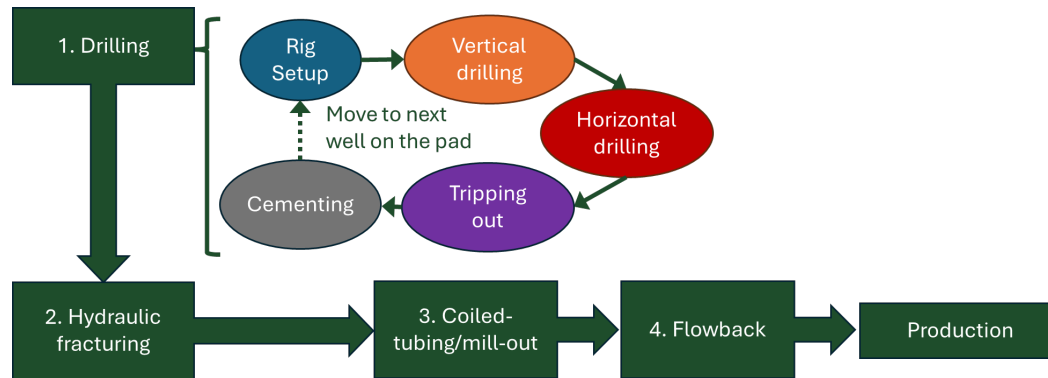
# UOGD VOC emission rates



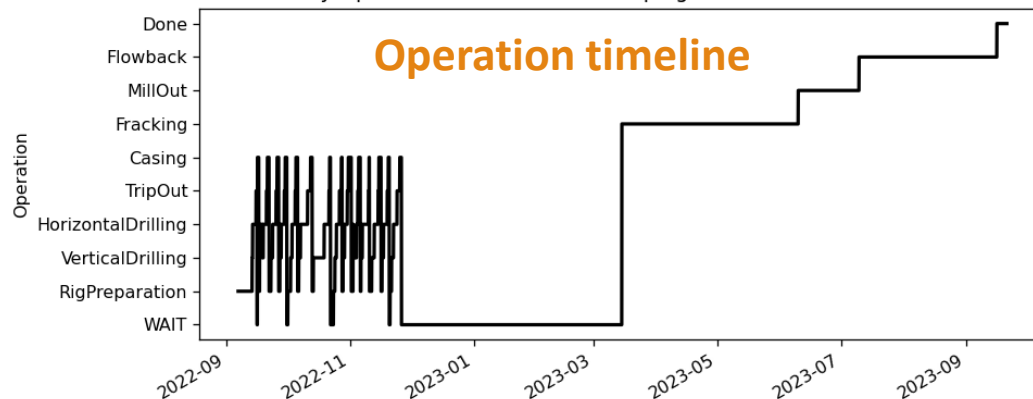
- Utilized extensive VOC observations during development of 6 well pads in Broomfield, Colorado
- Largest average benzene and VOC emissions during drilling and coil tubing/millout operations
- Modern estimates for drilling mud volatilization, including synthetic Neoflo with its large C<sub>8</sub>-C<sub>10</sub> alkane fraction
- First VOC emission estimates for coil tubing/millout operations
- >95% reduction in average VOC and benzene emissions from flowback using closed loop, tankless systems vs. other green completions

# TRACER pre-production model

User-friendly model to  
examine local air quality  
impacts from well pad  
development and evaluate  
potential benefits of BMPs



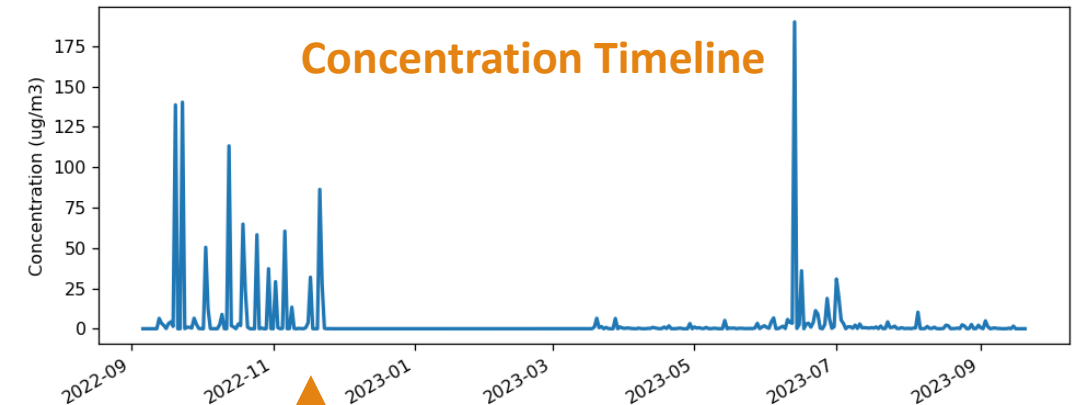
Hourly Operation Timeline of Developing 14 wells from 1 simulations



Select  
Emission  
Factor

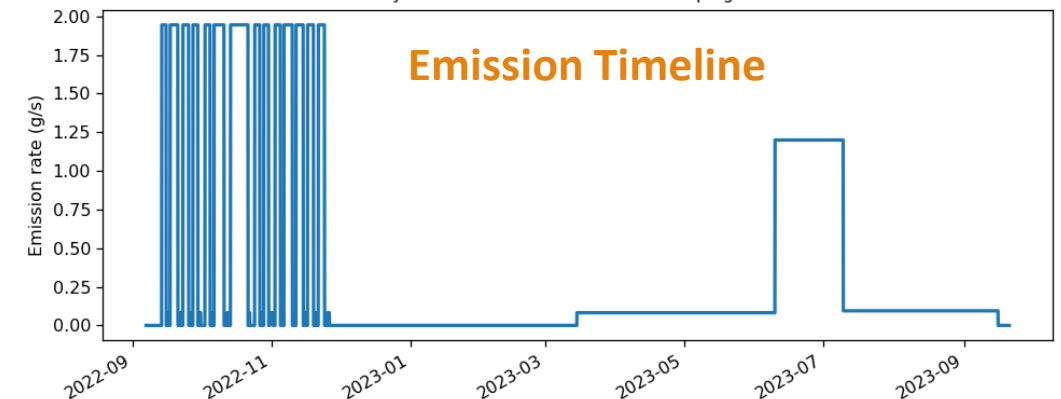


Daily Concentration Timeline of Developing 14 wells, AERMOD Model



Couple with dispersion model

Hourly Emission Rate Timeline of Developing 14 wells



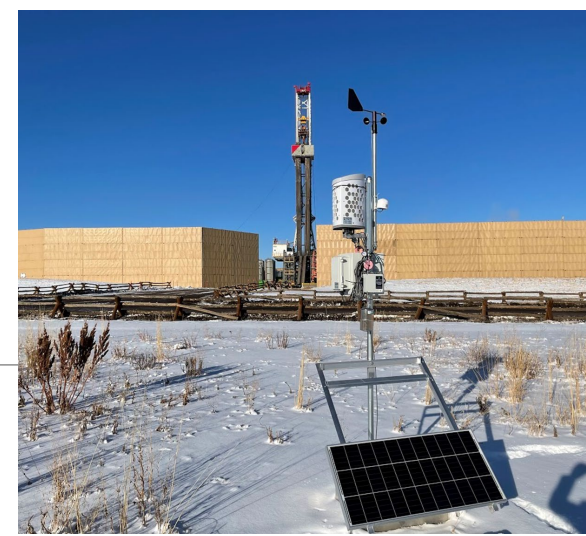
See Monday poster #20 for more about the model



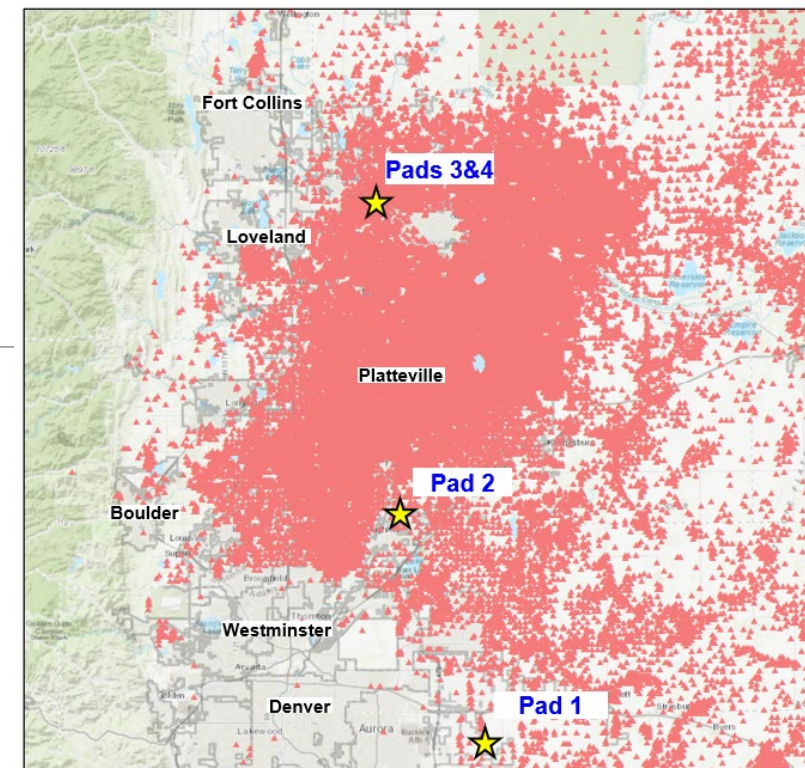
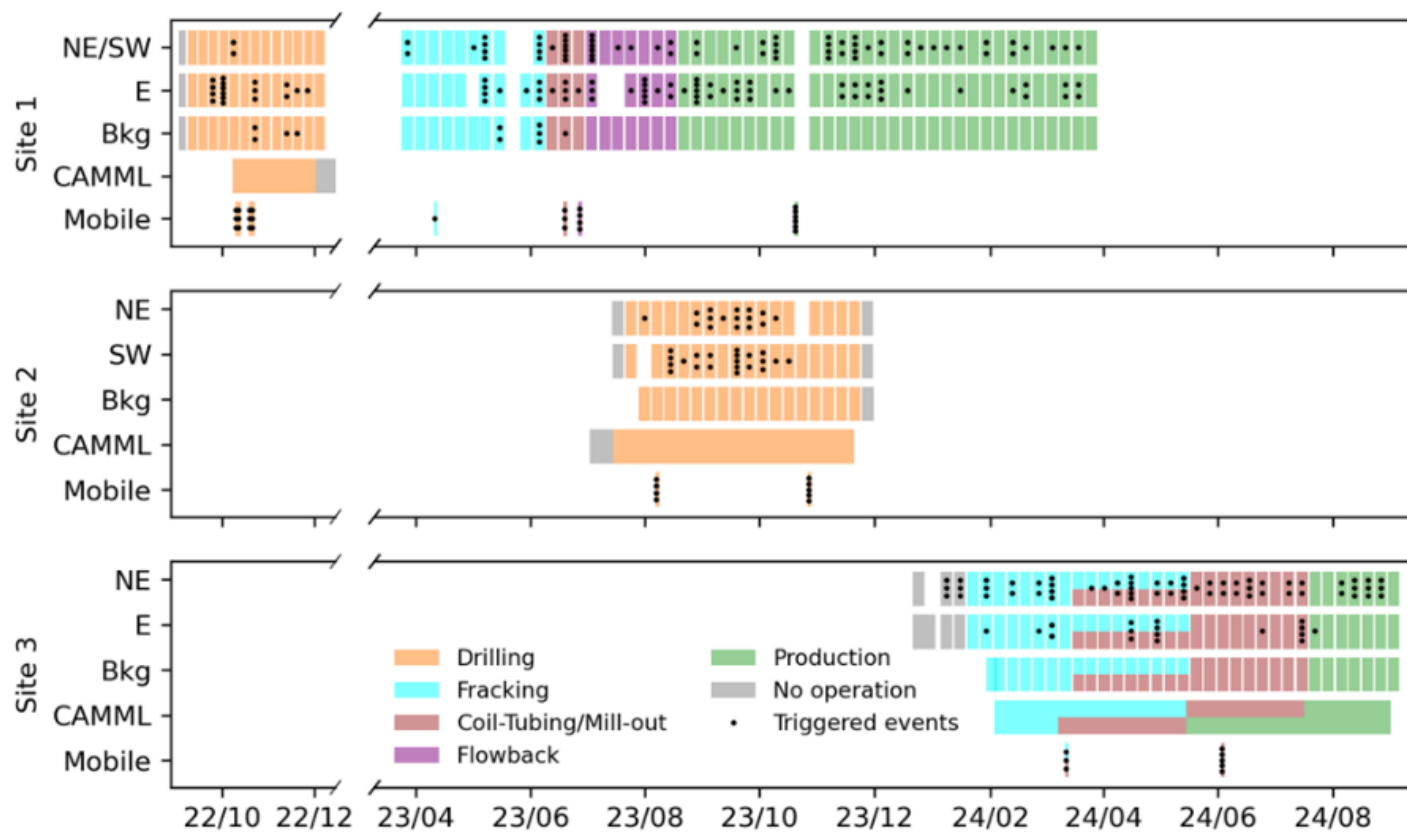
# Key findings

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- Transient plumes much more concentrated than weekly samples
  - 1-hr benzene acute HQ >1 values seen at monitors across most UOGD operation types
  - Colorado's 2000-foot setback distance helps limit exposure levels
  - Need high time resolution monitoring (~minutes) to capture periods of elevated exposure
- Largest average benzene & VOC emissions during drilling and coil tubing/millout
  - Grid-powered electrified drill rigs reduce emissions but outgassing from drilling mud remains major VOC source
  - Closed-loop, tankless flowback systems reduce average flowback benzene & VOC emissions >95% but we still see large, transient emission plumes during emptying of sand cans
- TRACER pre-production model enables stakeholders to predict downwind exposures and evaluate benefits associated with implementation of best management practices



# Air monitoring summary



- 3 locations (4 well pads)
  - near Aurora, Brighton, and Windsor
- 3 DJ Basin O&G Operators
- >50 air toxics and other VOCs