HEI STATEMENT

Synopsis of Research Report 232

Measuring and Modeling Air Pollution and Noise Exposure Near Unconventional Oil and Gas Development in Colorado

BACKGROUND

Unconventional oil and natural gas development has been associated with a wide range of potential exposures to chemical and nonchemical agents. The rapid expansion of unconventional oil and gas development activities in recent decades has given rise to concerns about potential effects on human health. In August 2020, HEI Energy issued Request for Applications *E20-1*: Community Exposures Associated with Unconventional Oil and Natural Gas Development. The goal was to better understand the nature, extent, and frequency of potential exposures related to unconventional oil and gas development on air quality and noise.

This Statement highlights a study led by Dr. Jeffrey L. Collett Jr. at Colorado State University and his colleagues. Collett and colleagues proposed to improve the characterization of exposures related to unconventional oil and gas development over the life cycle of several wells in an important US oil and gas region in Colorado. The team examined relationships between air quality and noise monitoring data and unconventional oil and gas development operational data provided by well pad operators to understand linkages between specific unconventional oil and gas development processes and effects on air quality and noise. They developed an emissions model to predict volatile organic compound concentrations in ambient air. Together, monitoring data and model results contribute to an improved understanding of potential exposures for populations near unconventional oil and gas development.

APPROACH

The Collett research team sought to assess population exposure to chemical emissions and noise associated with unconventional oil and gas development in the Northern Front Range region of Colorado, which is located within the Denver-Julesburg Basin. Colorado's changing regulatory environment has driven

What This Study Adds

- Dr. Collett and colleagues measured hazardous air pollutants, other air pollutants, and noise associated with unconventional oil and gas development in the Denver-Julesburg Basin of Colorado over a 2-year period from October 2022 to August 2024.
- With unconventional oil and gas development operators supplying well pad activity logs, Collett and colleagues were able to link air pollutant concentrations and noise levels with specific unconventional oil and gas development operations (e.g., drilling and hydraulic fracturing) over the life cycle of unconventional oil and gas development wells on four multi-well pads in three locations within the Denver-Julesburg Basin, providing a detailed view of emissions from different operational phases.
- Most of the air pollutants and noise levels varied considerably within and among different unconventional oil and gas development operations, with some brief occurrences of high concentrations (spikes) presenting a potential concern for the health of nearby populations.
- The investigators developed the TRACER (TRAcking Community Exposures and Releases) model that can predict hazardous air pollutant and other volatile organic compound emissions from unconventional oil and gas development operations at distances relevant to understanding local population exposures for planned drilling and completion operations and to assess specific efforts or interventions to reduce unconventional oil and gas development effects on air quality.

This Statement, prepared by HEI Energy, summarizes a research project funded by HEI Energy and conducted by Dr. Jeffrey L. Collett Jr. at Colorado State University and his colleagues. Research Report 232 contains the detailed Investigators' Report and a Commentary on the study prepared by the HEI Energy Review Committee.

innovation to better protect human health and the environment, making the study location valuable for comparing with previous observations to assess whether new operational practices have reduced effects on air quality, and by extension, exposures in surrounding communities.

Collett and colleagues monitored emissions from unconventional oil and gas development well pads at fine spatial and temporal scales over the life cycle of wells using fixed-site and mobile monitoring methods from October 2022 to August 2024. The team conducted a specific study of emissions from the use of synthetic drilling muds, which have been used to reduce odors associated with conventional, petroleum-based drilling muds.

The research team deployed a noise monitoring platform to simultaneously measure A- and C-weighted noise along with octave band measurements and noise-level-based triggered recording at two locations relevant to Colorado regulations. This approach provided a more complete picture of noise exposure than would have been generated by traditional A-weighted measurements alone.

To assess health risk for local populations, the research team compared observed concentrations of hazardous air pollutants and noise levels with established health-based guidelines. They developed and evaluated the TRACER model, designed to be a practical, user-friendly tool to predict the effect of unconventional oil and gas development preproduction activities on air quality.

KEY RESULTS

Collett and colleagues linked air quality and noise monitoring results and activities using time stamps for each sample and activity logs provided by well pad operators that describe the corresponding unconventional oil and gas development operations underway. With operator-provided samples of drilling mud, the research team quantified emissions and concluded that the composition “fingerprint” provides a tool for identifying the influence of emissions from synthetic drilling muds.

Monitoring data from this study were collected over time and spatial scales that are relevant to understanding exposures to air pollution and noise that could be experienced by nearby populations. Observed hazardous air pollutants concentrations varied considerably among unconventional oil and gas development operations, with the highest concentrations associated with intermittent plumes. The research team assessed the significance of hazardous air pollutants monitoring data for health by estimating screening-level noncancer chronic and acute health hazards for nearby residents potentially exposed to hazardous air pollutants emissions from unconventional oil and gas development operations. The research team did not estimate cancer risk given the relatively short durations of the studied operations.

They did not identify any chronic health hazards, but they noted some potential for noncancer health concerns in a few instances, primarily during coil tubing/millout and other production operations that produced concentration spikes.. The research team set out to determine whether Colorado’s 2,000-foot setback requirement separating unconventional oil and gas development from residences, schools, and other sensitive land uses would protect against the potential for noncancer health effects among members of nearby populations. Because benzene dominated noncancer hazard calculations, they combined benzene concentration observations to model benzene concentrations at various distances from a well pad (Statement Figure). The results suggest that, for the operations at the four well pads included in this study, the 2,000-foot setback requirement is protective for all investigated unconventional oil and gas development operations.

The research team assessed the significance of A- and C-weighted noise monitoring data by comparing them to Colorado thresholds for chronic noise at two compliance points (350 feet and 1,975 feet from the center of the well pad) and applicable health thresholds from the US Environmental Protection Agency, European Environmental Agency, and World Health Organization. At the minimum compliance point, both A- and C-weighted noise consistently exceeded Colorado Energy and Carbon Management Commission thresholds for chronic noise as well as European Environmental Agency and World Health Organization health thresholds. Fewer exceedances were noted at the maximum compliance point.

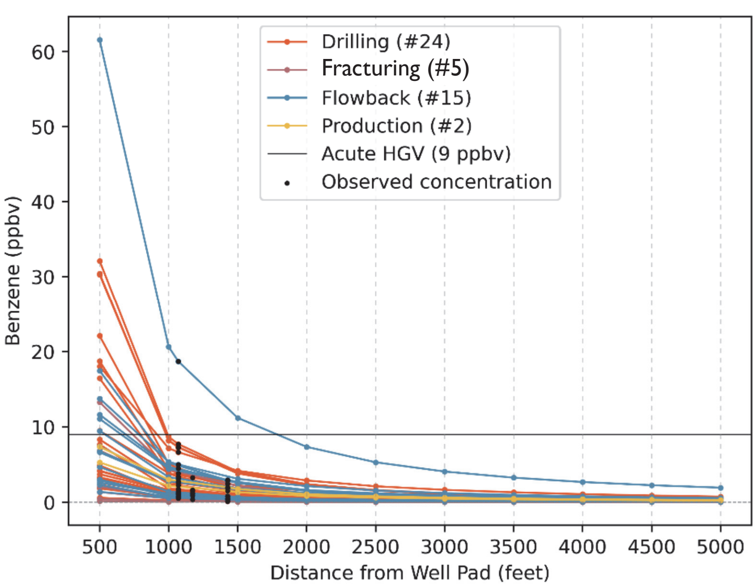
The research team developed the TRACER unconventional oil and gas development preproduction emission model to provide a tool that can predict hazardous air pollutants and other volatile organic compound emissions from unconventional oil and gas development operations at distances relevant to understanding local population exposures. This tool can be used to predict emissions from planned drilling and completion operations, and it can also be used to assess specific efforts or interventions to reduce unconventional oil and gas development effects on air quality. Users can select from a variety of unconventional oil and gas development preproduction activities, such as drilling and hydraulic fracturing, and adjust emission factors using data from a variety of sources.

Overall, the study contributes to an improved understanding of exposures related to unconventional oil and gas development experienced by local populations. Both the monitoring data and the TRACER model allow for quantifying links between air quality and noise monitoring data and specific unconventional oil and gas development operations. This knowledge, in turn, provides a mechanism for predicting exposures and assessing efforts to reduce unconventional oil and gas development emissions.

INTERPRETATION AND CONCLUSIONS

In its independent evaluation of the report, the HEI Energy Review Committee identified several strengths of the study design. One strength was the combination of continuous monitors and triggered canister samples over a multiyear period, which enabled the research team to capture both longer-term trends and short-term peak concentrations with detailed volatile organic compound profiles. Committee members were impressed with the research team's meticulous examination of air emissions during various phases of unconventional oil and gas development operations, providing valuable insights into how emissions vary across the lifecycle of a well pad. The cooperation of companies in sharing daily activity information strengthens the association between emissions and specific unconventional oil and gas development operations. The inclusion of both A- and C-weighted noise measurements provides a more complete understanding of the effects on local populations by addressing both audible and low-frequency noise concerns. Committee members concluded that the TRACER preproduction emissions model would be of broad interest and value to state and federal authorities, the oil and gas industry, research scientists, and local communities, and the team has already received requests from several stakeholders to participate in beta testing.

The study addresses a critical need identified in HEI Energy's original series of research planning workshops that resulted in the Request for Applications under which Dr. Collett was funded — the need for setback distances informed by scientific data rather than driven by arbitrary choices, as repeatedly requested by state officials, industry, and other stakeholders. This study contributes significantly to answering the underlying question about how close is too close, at least in the context of the Colorado-based unconventional oil and gas development operations involved in this study. It does so by highlighting unconventional oil and gas development operations that could be associated with exposures of potential concern for health. The research team observed findings similar to previous studies, specifically, acute exposures rather than chronic exposures are a potential health concern, and they modeled the geographic extent of acute health hazards. In doing so, the study not only improves understanding of population exposures associated with unconventional oil and gas development, but it also provides a data-driven assessment of Colorado's setback requirements.



Statement Figure. Predicted hourly benzene concentrations as a function of distance during 46 hours of plume-triggered canister collection at study sites 1 and 2. Results are shown by operation type. Concentrations are simulated using AERMOD at 500-foot intervals, along the plume centerline, with benzene emission rates constrained so that simulated and observed (black dots) concentrations align. Source: Investigators' Report Figure 10.