

A. Basis and Rational

A1. Background on Natural Gas Development

The United States holds large reserves of unconventional natural gas resources in coalbeds, shale, and tight sands. With recent technological advances, such as directional drilling and hydraulic fracturing, development of these resources is rapidly increasing. The number of producing unconventional natural gas wells rose from 18,485 in 2004 to 25,145 in 2007 and it is expected that expansion in the development of these unconventional resources will continue through 2020 (Vidas and Hugman 2008). With this expansion, it is becoming increasingly common for natural gas development (NGD) to occur near where people live, work, and play. Limited information is available on emissions of air pollutants from NGD or the risk these emissions may pose to public health. The U.S. Environmental Protection Agency (EPA) has identified the need to characterize emissions from various NGD activities as part of its review of New Source Performance Standards (NSPS) and National Emission Standards for Hazardous Air Pollutants (NESHAPs) mandated by the Clean Air Act (EPA 2010).

NGD activities are divided into two phases, well development and production. Well development involves pad preparation, well drilling, and well completion. Data indicate that well completion is the period of highest emissions (CDPHE 2009a, Howarth 2011). The well completion process has three primary stages: 1) completion transitions (well plugs are installed as an activity is completed or delayed and then removed before the next activity begins); 2) hydraulic fracturing (the injection of water and chemicals into the drilled well to release the natural gas); and 3) flowback (the return of fracking water, liquid hydrocarbons known as well condensate and natural gas to the surface). Production involves the collection and distribution of “salable” gas once the development process is complete.

Garfield County, CO is one area experiencing the rapid expansion of NGD. Natural gas production in Garfield County increased eightfold from 70 billion cubic feet (BCF) in 2000 to 550 BCF in 2008 (COGCC 2011). The Colorado Oil and Gas Conservation Commission (COGCC) has noted that people are increasingly raising public health concerns as rapid NGD growth exposes more people to the industry (COGCC 2009).

A2. Garfield County Ambient Air Studies

As evidenced by ambient air studies in Garfield County, NGD activities emit several hazardous air pollutants (HAPs), including benzene, toluene, ethylbenzene, and xylenes (BTEX). Toluene and xylene concentrations measured in grab air samples averaged 105 and 138 $\mu\text{g}/\text{m}^3$, with maximum concentrations reaching 540 and 1500 $\mu\text{g}/\text{m}^3$, respectively. Benzene concentrations averaged 32 $\mu\text{g}/\text{m}^3$, reaching a maximum of 180 $\mu\text{g}/\text{m}^3$ (CDPHE 2007). BTEX measurements from Garfield County’s 2009 ambient air study were compared to regional measurements from 37 sites across the US. Levels of benzene, toluene, and xylenes at three out of four sites in Garfield County were higher than levels measured at most of the other sites (GCPH 2010). One of these sites is located in Parachute, CO, with over 40% of the population being of Hispanic origin (2010 US Census), as discussed in Part D of our proposal. The Colorado Department of Public Health and Environment’s (CDPHE) 2007 emissions inventory for Garfield County indicates that the oil and gas industry is the primary contributor to benzene (CDPHE 2009b).

The 2008 Garfield County Air Toxics Study, which monitored four sites each undergoing drilling activities and well completion activities, concluded that the well completion activities emit larger volumes of volatile organic compounds (VOCs), including several HAPs, than drilling activities. The report indicated that the high concentrations of VOCs could be of great concern, as many of the well pads are located close to populated areas in Garfield County. In addition, the report indicated local wind speeds, directions and surrounding topography were important factors in influencing levels of pollutants at any one sampling site (CDPHE 2009a).

Ozone levels in Garfield County appear to have some relationship to pollutant emissions from NGD activities. CDPHE’s 2007 emission inventory for Garfield County indicates that the NGD industry is the primary contributor to NO_x emissions as well as the primary non-biogenic contributor of VOC, as noted above (CDPHE 2009b). Garfield County’s 2009 Air Quality Monitoring Summary Report attributes NGD activities as the largest contributing source of ozone precursors, such as light alkanes (GCPH 2010).

In 2008, the 8-hr average ozone concentrations measured at Garfield County's monitoring station in Rifle, CO surpassed the 75 ppb National Ambient Air Quality Standard (NAAQS) on one day and the proposed 60 -70 ppb NAAQS on five days in March and April 2009 (GCPH 2010).

A3. Garfield County Health Studies

CDPHE and the Colorado School of Public Health (CSPH) scientists conducted a series of screening level human health risk assessments (HHRAs) using ambient air data collected in the studies described above. Collectively, these risk assessments have identified several HAPs, including BTEX, hexane, 1,3-butadiene, crotonaldehyde, acetaldehyde, and formaldehyde, as chemicals of potential concern in ambient air within Garfield County's NGD area. These HHRAs found cancer risks to typically fall within the 1 and 100 in a million range and chronic non-cancer hazard indices to be less than one (CDPHE 2007, CDPHE 2010, CSPH 2011). However, the HHRAs indicated that acute and sub-chronic risks may be a concern and reported acute and sub-chronic hazard indices exceeding one.

Based on the preponderance of evidence from the ambient air data collected by GCPH and CDPHE from 2005 to 2010, the CPSH Health Impact Assessment (HIA) concluded that the health of residents in a Garfield Community town, Battlement Mesa, "will most likely be affected" by exposures to HAPs emitted from NGD activities (CPSH 2011). Battlement Mesa has a larger percentage of residents aged 65 and older than the US population, as discussed in Part D of our proposal. The Agency for Toxic Substances and Disease Registry's (ATSDR) 2008 Health Consultation for Garfield County also concluded that that inhalation of ambient air in the monitored areas of Garfield County is associated with a low increased risk of developing cancer, chronic non-cancer health effects, and acute non-cancer health effects (ATSDR 2010).

A4. Information Gaps

While there are data on HAPs in Garfield County's ambient air, there is little data suitable for profiling the NGD sources (i.e., well pads) or for modeling dispersion of HAPs from NGD sources. These two data types are needed to determine risk of health impacts for residents living in close proximity to NGD activities. The screening level HHRAs, HIA, and ATSDR Health Assessment for Garfield County all identified lack of data on emissions during specific stages of well development activities and lack of emission factors from NGD as key gaps in addressing better understanding of health effects from HAP exposures. The 2008 Air Toxics Study concluded that additional research is needed to understand the local effects that drilling and completion activities can have on the public at large.

The health risks from emission sources during many NGD activities are not fully addressed by existing state or federal air rules. The applicable COGCC rules specify distances ("set backs") between wells and residences. However, these set backs are primarily based on concerns about safety (e.g., accidents, explosions) during NGD and it is not known if the set back distances protect public health from HAPs exposure. In its purpose statement accompanying their rules, the COGCC specified the need for further information on which to base regulator rules for set back distances (COGCC 2009).

A5. Specific Aims and Objectives

The CDPHE, in partnership with our community partners, GCPH and CSPH, is submitting this proposal as a **community-scale monitoring project** to better assess the degree and extent of HAPs emitted from NGD during well completions and their impact on human health. This study aims to build on data from previous and on-going ambient air monitoring studies in Garfield County and collect new data to address gaps identified in previous studies. This proposal addresses all five community-scale monitoring goals specified in the RFP: (1) delineate local scale pollutant concentration gradients in proximity to natural gas well completions; (2) characterize near-source pollutant concentrations from natural gas well completions; (3) provide data to investigate the relationship between HAPs and health impacts; (4) provide a baseline for which to compare the effect of pollution reduction measures and long-term monitoring; and (5) evaluate the effectiveness of air quality models in describing dispersion of HAPs from natural gas wells.

As described in Part F of this proposal, this project directly supports Goal 1, Objective 1.1 of EPA's Strategic Plan: Clean Air and Global Climate Change, Healthier Outdoor Air. This project will supplement the National Air Toxics Assessment (NATA) with valuable information on the contribution

of NGD to air toxics emissions from outdoor sources and for characterizing potential public health risks due to inhalation of air toxics on both a national and regional scale. This information will aid EPA in characterizing NGD well pads as emission sources of air pollutants. Outcomes from this project will serve as a model for other areas in the country experiencing extensive NGD (e.g., Barnett Shale in TX, Jonah Field in WY, and Marcellus Shale in PA).