

1 Introduction

The Colorado School of Public Health (CSPH) was commissioned by the Garfield County Board of County Commissioners (BOCC) to conduct a Health Impact Assessment (HIA) in order to address citizen concerns about health impacts of natural gas development and production in the Battlement Mesa Planned Unit Development (PUD). The HIA scope of work was informed by citizen concerns and was limited to Battlement Mesa. The HIA process included stakeholder participation and review. The two primary functions of the HIA are to:

- Identify ways in which Antero's proposed natural gas development project can affect the health of the Battlement Mesa residents.
- Develop a priority list of recommendations to minimize the potential health impacts of Antero's proposed project.

We worked with community members to identify the eight areas of concern: Air Pollution; Water and Soil Contamination; Traffic from Industry; Noise and Light Pollution; Community Wellness; Economic Impacts; Impacts on the Healthcare System; and Accidents and Malfunctions. Natural gas development in Battlement Mesa could, potentially, affect each of these eight areas of concern and human health. For example, trucks, drilling and hydraulic fracturing processes add sources of noise that would not exist were it not for natural gas development. Noise is also associated with various other health outcomes (e.g., stress, heart disease).

The principal findings of the HIA are that health of Battlement Mesa residents will most likely be affected by chemical exposures, accidents/emergencies resulting from industry operations, and stress-related community changes. To address these potential health impacts we provide more than 70 specific recommendations. These recommendations address the principal findings by focusing on pollution prevention; advancement of public safety; and development of a Community Advisory Board. Methodical assessments of each of the areas of concern use available data, tools and scientific literature to provide justification for the recommendations.

The HIA identified several information gaps. Because of these gaps, we were not able to provide precise predictions of health outcomes potentially associated with the natural gas project. The recommendations provided were developed to protect public health in light of these gaps. Recommendations to fill information gaps are also included.

The document is a revision of the original HIA which was released for public and stakeholder comment in September 2010. The HIA was revised and reorganized based on public and stakeholder comments and newly available information. Appendix E contains comments. We assigned a code (e.g. A1 or BCC1) to each comment. These codes then correspond to our specific response to comments contained in Appendix F. For example, a comment assigned a code of A1 in Appendix E has a specific response coded A1 in Appendix F.

Below is a summary of the natural gas project plans, community concerns and responses to these concerns to date. Also below is a summary of the Battlement Mesa Baseline Health Profile.

1.1 Antero's Plan to Drill within the Battlement Mesa PUD

Technological advances (e.g. hydraulic fracturing) have contributed to natural gas development in areas previously not considered for such activities. Whereas oil and gas development has historically taken place in locations that are geographically distant from human habitation (other than, perhaps, the housing for oil and gas workers themselves), it is increasingly common for drilling activities to occur in rural, suburban, and urban areas close to where people otherwise unaffiliated with the industry live, work and play³. Throughout the United States and in Garfield County, the residents in close proximity to drilling activities are raising concerns about the potential impacts drilling may have on air quality, water quality, public safety, and public health⁴. In its purpose statement accompanying their rules, the Colorado Oil and Gas Conservation Commission (COGCC) specifies counties, including Garfield, within Colorado's Piceance basin as facing particularly challenging public health issues because of the rapid growth of the industry into populated areas in this area⁵. The human health impact of natural gas development and production has not been thoroughly studied.

In the Spring of 2009, Antero announced plans develop natural gas within the Battlement Mesa PUD, utilizing mineral rights acquired from Exxon, The Battlement Mesa Company (BMC), and others⁶. Figure 1 shows the locations of the 9 well pads Antero intends to develop within the PUD as well as 3 other pads outside the PUD. There will be approximately 200 wells on the pads in the PUD. Antero also plans to develop a water storage and management system within the PUD, which will reduce truck traffic associated with the well development process. In addition, pipelines for natural gas and water movement will be installed.

The contract that establishes the PUD requires the Garfield County BOCC to review any proposed land-use changes within the Battlement Mesa PUD through a *Special Use Permit* (also known as the SUP) process. The Garfield County BOCC has the authority to require modifications to the plans outlined in a given Special Use Permit application. Because its plans pertain to the Battlement Mesa PUD, Antero will submit a Special Use Permit to the BOCC before initiating drilling activities. In addition to county review, Antero will also submit plans through a state permitting process, conducted by the COGCC. Under a 2008 rule⁷, natural gas operators may submit Comprehensive Drilling Plans to COGCC⁵. If Antero submits a Comprehensive Drilling Plan to COGCC, COGCC will review the development project as a whole, which streamlines permitting for individual wells within Antero's project. There have been no permit applications submitted to Garfield County or COGCC as of the date of this HIA report. Antero has, however, entered into a legally-binding Surface Use Agreement with the BMC. This Surface Use Agreement outlines characteristics of the natural gas drilling plans for the Battlement Mesa PUD. While not as detailed as a Special Use Permit or Comprehensive Drilling Plan, the Surface Use Agreement between Antero and the BMC provides some information regarding Antero's plans for the Battlement Mesa project. Furthermore, Antero held 19 community meetings, which were open to the public, during 2009- 2011 where plans for

Antero's project were described. Power point presentations from these meetings are available online⁸⁻⁹. These sources of information plus information provided to us by Antero are used as a basis for this HIA. Appendix A includes a summary of the natural gas drilling process. Appendix B includes a review of energy development in the Piceance basin and the Surface Use Agreement between Antero and BMC. Appendix BB includes a site description of the Battlement Mesa Community.

1.2 Community Concerns

After Antero announced its intentions to drill within the Battlement Mesa PUD, community members living in Battlement Mesa expressed concern regarding potential environmental, health, and safety impacts. Citizen concerns have included but are not limited to:

- The proximity of drilling and gas production to homes, recreational areas, and schools
- "Vulnerable" populations with diminished immune capacity
- Exposure to airborne volatile organic compounds (VOCs), diesel emissions, particulate matter (PM), and other air contaminants
- Exposure to fluids used in the hydraulic fracturing process, hydrocarbons, and VOCs through soil or water exposure routes
- Potential increased risk of fires, explosions and/or motor vehicle crashes
- Changes in community "livability"

A grassroots advocacy organization, the Battlement Mesa Concerned Citizens (BCC) formed under a parent organization, the Grand Valley Citizens Alliance. In November 2009, the BCC submitted a citizen petition to the Garfield County BOCC requesting that BOCC require Antero to address health concerns before drilling for natural gas within the Battlement Mesa PUD.

While the human health impacts of natural gas development and production have not been specifically studied using state-of-the-art public health epidemiologic research methods, there has been substantial research related to exposures of potential concern in the natural gas industry. For instance, drilling for natural gas has the potential to increase occupational and community exposures to VOCs such as benzene, toluene, ethyl-benzene and xylene (BTEX). Heavy metals associated with drilling waste, particulate matter (PM) generated by transportation activities and diesel fuel combustion, and ozone precursors (ozone formation) are also known to be associated with natural gas development. Some constituents of hydraulic fracturing chemicals may pose health risks to workers or community members.

Sufficient exposures to these chemical compounds are associated with serious negative health outcomes such as lung disease in children and adults (i.e., asthma, chronic bronchitis, obstructive disease), cardiovascular disease, poor birth outcomes (premature birth, low birth weight, congenital malformations), various cancers, and other long and short-term health issues¹⁰⁻¹⁴.

Environmental contaminants to which people may be exposed include air emissions, ground and surface water pollution and soil contamination. In addition, physical hazards can include increased truck traffic and domestic explosions associated with gas seepage into domestic water supplies. Social hazards can include a variety of community disruptions associated with boom-and-bust cycles, itinerant workforces, and industrialization of residential areas¹⁵.

1.3 Initial Responses to Community Concerns

In response to community concerns, Antero has held several informational community meetings⁹ and has responded to community concerns by modifying some of its drilling plans, for example the removal of drilling pad C (replaced by the Parks and Rec pad). The Surface Use Agreement between Antero and BMC includes some measures which are intended to reduce the impact on the community's health and quality of life.

Even before it commissioned the HIA, Garfield County had undertaken many steps in response to community concerns regarding natural gas development and production in the county. Garfield County Public Health Department (GCPH), the county health department, initiated and managed the Saccommano Report and currently manages on-going ambient air monitoring stations at several locations in Garfield County. The Garfield County Oil and Gas Department (GCOG) initiated and managed an intensive study of water quality and hydrology of the Mamm Creek Gas Field. GCPH also has participated in numerous Colorado Department of Public Health and Environment (CDPHE), COGCC, and United States Environmental Protection Agency (EPA) air and water studies documenting:

- Air toxics (e.g. benzene) in ambient air, at levels higher than levels measured in a neighboring county with no gas development¹⁶
- Evidence of ground-level ozone formation, which once surpassed the EPA 8 hour standard of 75 parts per billion (ppb) in 2008¹⁷
- Ground water containing thermogenic methane in natural gas development and production areas¹⁸⁻²⁰
- Trends in health impacts consistent with potential exposures (via a county-wide health assessment)²¹
- Citizen concerns over oil and gas impacts to health (via county-wide surveys)²²

In November 2011 the BOCC instructed GCPH to address the BCC's concerns raised in its citizen petition. GCPH approached the CSPH with a request to collaborate on a HIA. Subsequently, the BOCC agreed to contract with the CSPH to conduct this HIA. Through funding from the Pew Health Impact Project, a Canadian HIA consultation firm with experience in resource development projects, Habitat Health Impact Consulting has provided technical assistance to the CSPH for this HIA.

1.4 Battlement Mesa Health Profile

As part of the HIA, we completed the Battlement Mesa Health Profile. We used available data to evaluate the baseline health of the residents of the Battlement Mesa Community. These data were analyzed using the 2000 U.S. Census information to calculate rates. Several measures of health are best determined by using zip code to define a community. We use the zip codes 81635 and 81636, which are used by the residents of Battlement Mesa, Parachute and surrounding areas. Because these zip codes are shared, Parachute is included along with Battlement Mesa in the descriptions of physical health determinants and some social health determinants. Some of the social health determinant measurements were not available at a zip code level, and so we provide descriptions of these at a county level. While the assessments of stressors focus on the impacts to those living within the Battlement Mesa PUD, others living nearby may experience some effects as well. The entire Battlement Mesa Baseline Health Profile is available in Appendix C.

1.4.1 Measures of Physical Health

To assess the baseline physical health of the Battlement Mesa/Parachute area, we obtained inpatient hospital diagnoses, cancer, birth, and death analyzed information from the CDPHE for the years 1998-2008. The analysis included health diagnoses, birth outcomes, and causes of death with a known association between disease and the exposures of concern, as well as those for which community members voiced concerns of elevated occurrence of disease. Major categories of disease and death included depression and those involving the nervous system, ear/nose/throat, vascular system and pulmonary system. Major categories of cancer included: Hodgkin lymphoma and non-Hodgkin lymphoma, multiple myeloma, leukemia, melanoma, breast cancer, prostate cancer, bladder cancer, colorectal cancer, and cancer of the adrenal gland. Birth outcomes included low birth weight and preterm delivery. Health for Battlement Mesa/Parachute residents was compared to the health of Colorado residents.

Overall, the citizens of Battlement Mesa appear to be generally healthier than other citizens of Colorado. They experienced fewer hospitalizations and fewer deaths. Battlement Mesa women experienced the same rates of cancer and of negative birth outcomes as other women in Colorado. In Battlement Mesa men, we observed a slightly higher than expected rate of prostate cancer, which we felt is an observation likely due to variability of small numbers or statistical chance (when multiple independent tests are compared, there is a statistical probability that 5 % of the tests will be abnormal by chance alone). No other differences were noted between men in Battlement Mesa when compared with other Colorado men.

There are no systematic databases describing out-patient or emergency room visits. Data regarding mental health was not available.

1.4.2 Measures of Community Health

To evaluate the baseline community health in Battlement Mesa/Parachute, we obtained available information regarding sexually transmitted infections, crime, substance abuse, and education. Where information concerning Battlement Mesa was not available, we looked at Garfield County data. Systematic collection of measures of community health, cohesion and well-being in Battlement Mesa being are not being conducted.

Overall, the incidence of sexually transmitted infections in Garfield County rose during the years 2005- 2008, peaking between 2007 and 2008. Between the years 1992-2005, for adults, violent crime arrests doubled; property arrests fluctuated throughout the period, and increased slightly; and drug violations increased almost ten-fold. In the same time period, for juveniles, violent crime arrests increased; property arrests fluctuated but did not change significantly; and drug violations increased almost ten-fold. Substance abuse and mental health information extracted from the GCPH's 2006 assessment on community needs indicates depression, anxiety and stress along with tobacco smoking and alcohol abuse appear to be the top indicators of the burden of mental health and substance abuse, respectively, in Garfield County.

Figure 1: Locations of Proposed Well Pads within the Battlement Mesa Planned Unit Development