

5 Assessment of Health Impacts

The following sections provide an assessment, characterization, and recommendations for each potential health impact.

5.1 Assessment of Air Quality on Health in Battlement Mesa

“What happens if the air is so bad that I have to close all my windows and shut off my swamp cooler?”
June 15 stakeholder meeting

Exposure to airborne contaminants from natural gas development and production is a major concern to Battlement Mesa residents. Gas development and production operations result in the release of many airborne contaminants. The potential for release of contaminants to air increases with well installation errors, blow outs, or well fires. Sources of contaminants during these operations include the natural gas resource itself, chemicals used in well development operations, such as hydraulic fracturing, wastes from well development activities such as produced water, and diesel exhaust from trucks and generators.

5.1.1 Air Quality and Health

Natural gas development and production operations and the diesel engines used to support them have the potential to release many hydrocarbons, carbonyls, and other contaminants into the air. People can be exposed to these contaminants as they breathe ambient air in and outside of their homes. Some of these contaminants, such as benzene, diesel exhaust, and PM_{2.5}, are human carcinogens. Others, such as carbonyls, alkanes, ground-level ozone, and 1,2,4-trimethylbenzene, can act as irritants of the eyes, skin, and respiratory tract or cause neurological effects²³⁻²⁴. In addition, hydrocarbons, carbonyls, and nitrogen oxides serve as precursors for ground level ozone formation. The health effects of many other potential contaminants are not known. Descriptions of health effects of the air contaminants of potential concern are presented in Section 4 of the Human Health Risk Assessment (Appendix D).

In addition to the effects that each of these substances can produce by itself, there is also the possibility of complex health reactions occurring as a result of the interaction of multiple substances. The current state of the science is limited in ability to assess exposures to these complex mixtures of air toxics, especially, synergistic and antagonistic interactions at low levels. Preliminary studies that indicate complex mixtures can act additively or synergistically to increase effects on human health. For example, studies of healthy adults indicate that continuous exposure to sulfur dioxide or nitrogen dioxide increases ozone absorption. Studies of asthmatics suggest that ozone enhances response to allergen challenge. Other studies have reported injury

to lungs with exposure to the combination of ozone and PM is larger than when exposed to either alone.²⁴⁻²⁵

5.1.2 Current Air Quality Conditions

There are several sources of air emissions that currently affect air quality in Battlement Mesa. The main sources are vehicle emissions and natural gas development and production, as described below.

With the exception of two natural gas wells, Battlement Mesa does not currently house any industrial activity. There are many gas wells outside the PUD boundaries that impact the ambient air quality within the PUD. There is a public utility station near the southeast PUD border with the potential for fugitive emissions of natural gas. Current residential traffic in the Battlement Mesa PUD, described in Antero's traffic analysis, also has impact on the current ambient air quality. Interstate-70 impacts the current ambient air quality. The Garfield County Emissions Inventory for 2007 indicates that highway vehicles were a primary contributor to carbon monoxide and nitrogen dioxide emissions and that highway vehicle emissions of carbon monoxide, nitrogen dioxide, sulfur dioxide, particulates, VOCs, and benzene have all decreased since 1996. The oil and gas industry was a primary contributor to sulfur dioxide, nitrogen oxide, carbon monoxide, VOC, and benzene emissions in 2007 and emissions due to oil and gas sources have all increased in the same time period²⁶.

High concentrations of ozone precursors (VOCs and nitrogen oxides) have been observed in areas with high natural gas production operations in Garfield County²⁶. CDPHE ranked Garfield County as 5th out of 64 Colorado counties in levels of these ozone precursors in 2009, while Garfield ranked only 14th in population²⁷. According to these reports, because VOC levels are already very high, ozone formation in Garfield County is likely to increase as nitrogen oxide increases. In 2008, the 8-hr average ozone concentrations measured at the Rifle monitoring station surpassed the 75 ppb NAAQS one time and 8-hour average ozone concentrations did surpass the minimum range of the proposed 60 -70 ppb NAAQS on five days in March and April 2009, with a maximum concentration of 64 ppb²⁸. Overall, ozone levels in Garfield County are increasing since measurements began in 2005. Natural gas industry practices of capturing and flaring emissions reduces VOC emissions, while increasing nitrogen oxide emissions. This may contribute to more ozone formation. It is unclear if ozone concentrations measured in Rifle are representative of ozone concentrations in Battlement Mesa because of differences in proximity to Interstate-70, elevation, industry, and meteorology.

EnCana Oil and Gas (USA) Incorporated (EnCana) began conducting ozone measurements in 2007 at their mountain station in Garfield County. The mountain station is located at 8407 feet above sea level in a remote area with very little natural gas development and production. While Encana's ozone data are from a rural area within Western Garfield County, it may not be a good estimate of ambient ozone levels in the Battlement Mesa PUD. Ground level ozone concentrations vary by elevation, with higher concentrations at higher elevations.

PM_{2.5} and PM₁₀ concentrations are measured at the Rifle monitoring station where several 24-hour PM_{2.5} concentrations surpassed 35µg/m³ in 2009, with the highest observed concentration at 41µg/m³²⁸. In 2008, PM₁₀ concentrations in Parachute surpassed the 150 µg/m³ 24 hour NAAQS standard, likely due to natural gas industry construction activities. The PM_{2.5} and PM₁₀ concentrations measured in Rifle and Parachute may not be representative of concentrations in Battlement Mesa because of differences in proximity to Interstate-70, elevation, industry, and meteorology.

5.1.3 What We Know and What We Do Not Know

There is sufficient information available to indicate that Antero's project in Battlement Mesa has the potential to impact air quality and the public health. However, many information gaps exist and it is not possible to predict what and how many health effects will occur as a result of Antero's project. There also is not enough information to determine whether or not current federal, state, and COGCC regulations and rules are sufficient to protect public health from air pollution resulting from natural gas development and production in high population density areas such as the Battlement Mesa PUD. To protect the health of Battlement Mesa residents, we recommend the implementation of air pollution prevention measures, some of which may be above and beyond those mandated in federal, state, and COGCC regulations and rules as an integral part of Antero's project. We also recommend the monitoring of air quality and the health of residents in Battlement Mesa to ensure public health is protected throughout Antero's 30-year project. What follows is a discussion of what we know and what we do not know and specific recommendations for preventing air pollution during Antero's project.

What We Know

We know that natural development and production impacts air quality in Garfield County. . Garfield County's 2007 emission inventory indicates that the oil and gas industry is the highest contributor to nitrogen dioxide, benzene, and sulfur dioxide emissions within Garfield County. For example, the oil and gas industry contributes five times more benzene to the inventory than any other emission source listed. The oil and gas industry also is a significant contributor to VOC, PM₁₀, and carbon monoxide emissions²⁶. Therefore, it is expected that Antero's project has the potential to impact air quality in the PUD.

Garfield County's 2009 Air Quality Monitoring Summary Report attributes natural gas production activities as the largest contributing source of light alkanes in Garfield County. The large amounts of these light alkanes increase the potential for ozone formation²⁸. Benzene, ethylbenzene, toluene, xylene, and trimethylbenzene measurements for 2009 in Garfield County were compared to regional measurements from 37 sites across the United States. Levels of benzene, toluene, xylenes, and 1,3,5-trimethylbenzene measured at the Parachute, Rulison, and Rifle sites in Garfield County were higher than levels measured at most of the other sites, including Grand Junction. These high measurements in Garfield County may indicate more

localized sources for these air contaminants, which have primarily gasoline and diesel combustion sources that include motor vehicles, oil and gas development activities (such as drill rigs and compressor engines) as well as oil and gas production equipment such as condensate tanks²⁸.

Antero has specified that they will use combustors to control VOC emissions from production tanks⁶ to achieve a 95% VOC control efficiency in compliance with COGCC rules⁵. Applying a 95% control efficiency to the potential VOCs emissions estimated for the Watson Ranch pad (Appendix E, Antero comment A34) results in 3.4 to 20 tons per year of VOC emissions from the production tanks on all 9 proposed well pads combined. Production tanks are only one of a number of potential sources of VOC emissions from natural gas operations. Some sources, such as flow back operations, are likely to cause a higher emission rate of VOCs, while others, such as glycol dehydrators, may have VOC emissions similar to the production tanks. Monitoring of production sites is needed to assess the long term emissions and how these emissions affect long term exposures to nearby residents. It is important to note that there is a tradeoff when using combustors versus not controlling condensate tanks at all. Combustion of fugitive VOC emissions generates carbon monoxide, carbon dioxide, and nitrogen oxides, whereas venting results in VOC emissions. Therefore, vapor recovery is preferred over venting or combustion for controlling fugitive VOC emissions

We know that well completion operations emit the higher levels of contaminants than drilling operations. The 2008 Garfield County Air Toxics Study which monitored four sites undergoing drilling activities and four sites undergoing well completion activities concluded that the well completion activities emit larger volumes of VOCs than drilling activities. The report indicated that the high concentrations of organic 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 indicates that local wind speeds, directions and surrounding topography are important factors in influencing levels of pollutants at any one sampling site. The report called for further research into how pollution concentrations are affected by these variables and concluded that research is needed to understand the local effects that such drilling and completion activities can have on the public at large²⁹. Furthermore, statistical comparisons of ambient air to well completion sample results for benzene and other contaminants demonstrate that short-term exposures to air pollutants during well completion activities have the potential to be significantly greater than overall ambient air exposures (Appendix D Table 2-12).

We know that the COGCC's 350 foot setback for high density areas was based on a 100 meter setback distance established by the Alberta Energy and Utilities Board to decrease the likelihood of death from exposure from an accidental release of hydrogen sulfide gas³⁰ (Stuart Ellsworth, Engineering Manager COGCC, January, 18, 2011). The 350 foot setback does not address short and long term health effects that may be associated with periodic or continuous exposure to other air pollutants, noise exposure, and accidents. At this time there are no known studies that document the safe distance between wells and homes, schools and other places where people congregate.

We know that there are several COGCC rules to address air emissions. Rule 324A requires operators to take precautions to prevent significant negative impacts to air; Rule 317 requires that any gas escaping during drilling must be directed a safe distance from the well and burned (flared); and Rule 805b requires that gas facilities and equipment shall be operated in such a manner that odors and dust do not constitute a nuisance or hazard to public welfare. Rule 805b also requires emission controls and permitting for production tanks with the potential to release 5 or more tons per year of VOCs (uncontrolled emissions) and located with ¼ mile of an occupied structure. However, recent odor complaints to COGCC and the Garfield County Oil and Gas Department from Battlement Mesa residents in July 2010 suggest that, in some situations, natural gas development and production may have some impact on localized air quality at residences within ½ mile of the well pad^{5,31}. The odor complaints occurred during flow back operations at Antero's Watson Ranch Pad located on the southeast border of the PUD, within approximately ½ a mile from several residences, and resulted in COGCC issuing a notice of alleged violation (also known as NOAV) to Antero on 7/14/2010. Grab samples taken in the 2005 to 2007 Garfield County Ambient Air Study, when residents noticed odors (thought to be from natural gas development and production) indicate that odor events could represent a health hazard. These samples contained levels of benzene, ethylbenzene, toluene, and xylenes that were greater than EPA regional screening levels for residential ambient air¹⁶. EPA Regional Screening Levels are health-based levels above which health effects may occur.

We know that many homes within the Battlement Mesa PUD are located within a ½ mile of one or more of the proposed wells pads, as shown on Figure 1. For example, homes in Stone Ridge Village and Monument Village are within ½ mile of pads A, B, and D, and homes in Willow Creek Village and Fairways Village are within ½ mile of pads D and M. Antero's project is expected to last up to 30 years and have approximately 200 wells on 9 well pads. The process of well development and completion is estimated to last from 2 to 5 years, depending on the price of natural gas and availability of subcontractors. Therefore due to proximity of the proposed well pads to residences it is likely that both periodic short-term and longer-term exposures to emissions will occur.

We know that diesel exhaust from heavy truck traffic, truck idling and generators has the potential to impact air quality within the PUD. Diesel exhaust includes PM, nitrogen oxide, carbonyls, alkanes and PAHs, all of which are known to have health impacts³². Estimates of yearly emissions can be found in Table 4 in the Part Two of the HIA. Levels of acetaldehyde and crotonaldehyde were higher in grab samples collected by Antero in August 2010 than in any of the ambient air samples collected in Garfield County since 2008 (Appendix D, Table 2-7). The Antero samples were collected along the truck access road to the south of the Watson Ranch pad during flow back and hydraulic fracturing activities. This information indicates a need for pollution controls on diesel engines. Since each of the proposed truck routes is near at least one of the Battlement Mesa housing areas, further information is needed to better characterize the level of exposure for residents to carbonyls emitted during natural gas development and production operations and efforts are needed to reduce exposure to truck traffic.

We know that several of the air pollutants associated with natural gas development and production can negatively affect human health. Benzene is a known human carcinogen, and ethylbenzene, acetaldehyde, formaldehyde, and crotonaldehyde are classified as possible human carcinogens by the U.S. EPA. Furthermore, toluene, xylene, and benzene may also cause other non-cancer health effects, such as birth defects. Many of these air pollutants cause short-term neurological effects, such as dizziness and headaches, and short and long term respiratory effects, such as nose and throat irritation and decreased lung function. Seniors, children and those with medical conditions are more susceptible to chemical exposures. Battlement Mesa is different from many other Colorado communities in that almost half of the community is either under 18 or over 65 years of age.

We know that there are many other sources of air pollution not being measured. We know that fugitive emissions from pipes, valves, pneumatic devices, wellheads and from maintenance operations have the potential to impact Battlement Mesa air quality and can do so over the life of the project, estimated to be at least 30 years. COGCC rules require that no bleed valves be used on pneumatic devices, where technically feasible and Antero has agreed to specific requirements for pipelines in the Surface Use Agreement. Further efforts may be needed to control all sources of emissions.

We know that road and construction dust from natural gas operations can impact air quality. The dust from the Antero project has the potential to impact the air quality in Battlement Mesa. As noted earlier, PM₁₀ concentrations measured in Parachute in 2009 surpassed the NAAQS standard, likely due to natural gas industry construction activities.

What We Do Not Know

We do not know how and to what extent potential air pollutants from Antero's project will be transported within the Battlement Mesa PUD. While levels of air pollutants generally are expected to decrease with distance from a fixed source, actual emission distribution maybe more complex due to varying emission rates and topography and weather conditions. The distribution of air pollutants also will depend on the physical and chemical properties of individual pollutants. Some pollutants, such as ozone require very specific conditions for formation. At this time, there is insufficient measurement and modeling information to determine air pollutant movement from well pads and truck routes to people's homes.

We do not know how much of each air contaminant Battlement Mesa residents will be exposed to during Antero's project because there is little information on the concentrations of air contaminants in and around residences. The only information currently available is that from the 15 second outdoor grab samples collected by Garfield County residents when they noticed odors attributed to natural gas development and production activities. This information is limited in that (1) data was not collected to identify a specific source; and (2) the sample was a 15 second grab and therefore did not represent a 24-hour exposure and may have missed the peak level.

We also do not know how much of a particular contaminant to which an individual is exposed comes from natural gas operations and how much comes from other sources.

We do not know the toxicity of most of the chemicals measured in Garfield County air samples. Health-based toxicity guidelines are only available for about 20 percent of the contaminants that have been identified in ambient air samples collected in Garfield County. For most of the remaining air pollutants, adequate studies to determine health effects have not been done.

We do not know the level of many potential air pollutants in ambient air that may be associated with natural gas development and production, including polycyclic aromatic hydrocarbons (PAHs), heavy metals, radon and chemicals used in natural gas industry (e.g., hydraulic fracturing fluids, biocides) . These pollutants have not been measured in Garfield County relative to the natural gas industry.

We do not know if health effects will occur as a result of the interaction of the mixture of air pollutants present in Garfield County. The current state of the science is limited in ability to assess exposures and health effects of mixtures of air pollutants, especially interactions at relatively low levels.

We do not know how long people will reside in Battlement Mesa and how much time they spend in Battlement Mesa and at their homes. This type of information is used in determining how much an air contaminant a resident would be exposed to during Antero's 30 year project. Specific data on how long residents live in the area and how many days and hours they spend in their homes is not currently available. Because more retirees live in Battlement Mesa than in more typical suburban/rural areas, data from other areas and studies may not apply to Battlement Mesa. These time activity studies also may not account for individuals that work out of their homes.

We do not know what the levels of emissions will be after Antero implements all of their pollution control measures. Antero's general best management practices indicate Antero is committed to reducing air pollution. Documentation of the effectiveness of the pollution control measures is needed.

5.1.4 Human Health Risk Assessment

To develop a risk assessment, scientists need to identify three main things:

- Hazards: identities and toxic properties of the chemicals to which people are exposed.
- Exposure Levels and Routes: depend on the amount of exposure, length of exposure, and whether people are exposed through their lungs, digestive track or skin.
- Health Outcomes: the potential for health risks, including cancer risk, is the focus of risk assessments.

We used available relevant information to conduct a screening level Human Health Risk Assessment to evaluate the potential impacts to the public health from chemical exposures due to Antero's proposed project. A Human Health Risk Assessment cannot predict what and how many health outcomes will occur as a result of Antero's project. It only provides an estimate of the potential for health outcomes to occur given the information available and is a tool for ranking the relative seriousness of risks from different sources and pathways. It is important to emphasize that the estimates from the Human Health Risk Assessment may be either over or under estimated because of the uncertainties associated the risk assessment process. The Human Health Risk Assessment was conducted according to EPA guidance³³⁻³⁴ using data from Battlement Mesa and other locations in Garfield County. A baseline risk for Battlement Mesa was estimated, as well as risks to child, adult, and elderly receptors from Antero's project for five possible exposure scenarios. Appendix D contains the details of the Human Health Risk Assessment.

The Human Health Risk Assessment concluded the following:

- For Battlement Mesa residents living farther from the well pads (i.e. more than ½ mile), the long-term health risks is similar to the background risks estimated in the baseline risk assessment for Battlement Mesa (i.e. the risk without Antero's project).
- There is a significantly greater potential for exposure to chemicals in air during well completion activities than during production activities, especially for child, adult, and elderly residents living within ½ mile of the well pads.
- For Battlement Mesa residents living within ½ a mile of a well pad, the long-term health risks from chemical exposures are greater than the long-term health risks for residents living farther from the well pads and are in the range of concern. These health effects include an increased cancer risk, decreased lung function, anemia, and birth defects.
- For Battlement Mesa residents living within ½ mile of the well pads, the subchronic and short-term health risks to may be expected to occur. These health effects may include respiratory effects such as upper airway irritation and decreased lung function and neurological effects, such as headaches and dizziness.

The ½ mile distance is based on the distance at which Battlement Mesa residents reported odors and health effects to COGCC in July 2010.

Previous CDPHE human health risk assessments and the Saccomanno Study also concluded that residential long-term and short term exposure to air pollutants may result in an increased risk of cancer and non-cancer health effects.

5.1.5 Antero's Best Management Practices

The Human Health Risk Assessment was performed without consideration of Antero's best management practices because there has been no data collected with these best management practices in place. Implementation of Antero's best management practices for its Battlement

Mesa project should reduce air emissions during several activities and should reduce the risk of health effects from chemical exposures. Antero's best management practices that are most likely to reduce air emissions include:

- Auto-igniters on all production tank combustors should reduce long term emissions of VOCs. Combustion increases nitrous oxide emissions.
- Low emissions flow back process (currently under development) for all well pads in the PUD should reduce VOC and other chemical emissions associated with flow back activities.
- The centralized water storage facility and pipeline network will decrease truck trips and therefore decrease truck emissions.
- Well pad telemetry and remote monitoring will reduce maintenance trips to well pads and decrease vehicle emissions.
- Closed tank hatches on hydraulic fracturing and flow back tanks should reduce VOC emissions during well completion activities.
- Hydrocarbon absorption blankets on hydraulic fracturing and flow back tanks should reduce VOC emissions.
- Batch biocide treatment of hydraulic fracturing and flow back tanks after they have received some water should reduce biocide emissions.
- Replacement of diesel generators with electric generators should reduce diesel exhaust emission
- Tier 2/3 diesel engines should reduce diesel exhaust emissions. Tier 4 engines would further reduce diesel exhaust emissions.
- Low bleed valves and routine maintenance per the EPA Natural Gas Star Program should reduce fugitive VOC emissions.

While Antero's best management practices have the potential to reduce air emissions, in many cases, the effectiveness of the practices are unknown. We strongly encourage Antero to demonstrate the effectiveness of their best management practices. In addition, without specific permits or plans, it is unclear the extent of the best management practices will be used in Battlement Mesa. The objective of many of our recommendations assessment is to ensure Antero's best management practices are implemented in the PUD in order to reduce air emissions and protect public health. Antero's air monitoring study at the Watson Ranch pad has added valuable information for evaluating air emissions from natural gas development operations and further monitoring is recommended.

In addition to the best management practices, other Antero plans will reduce emissions in Battlement Mesa. Antero has stated that it will not have a centralized compressor stations in the PUD⁶. Compressor stations are sources of fugitive emissions and noise. Antero has committed to several dust control measures in the Surface Use Agreement⁶. With these control measures in place, project dust from construction activities, well pads, and access roads is not expected to significantly impact Battlement Mesa air quality. As noted earlier, Antero has committed to

installing a water storage and management system, which will reduce truck emissions, dust and noise in the PUD.

5.2 Characterization of the Air Quality on Health

The impact of air quality due to the Antero project in Battlement Mesa on the health of local residents can be characterized as follows:

Impact	Direction of health effects	Geographical Extent of exposure	Vulnerable populations	Duration of exposure	Frequency of exposure	Likelihood of health effects as a result of Project	Magnitude of health effects	Priority
Air Quality	Negative	Local to Community-wide	Yes	Long	Frequent	Likely	Low to High	High*

*For an explanation of the ranking system, see the chart at the beginning of Section 4.

When considering anticipated air contaminant exposures associated with the Antero development within the Battlement Mesa PUD, impacts to air quality will likely produce **negative health effects**. These health effects are most likely to occur in the **localized** areas near well development areas (defined as less than ½ mile) and in areas near truck haul routes. Much of the community will be within ½ mile of sources of air contamination. Declining ambient air quality will affect the entire community. Children, seniors and , residents underlying health problems are more **vulnerable** to the air pollutants. Air quality degradation may last for the duration of Antero’s 30-year project, from well pad preparation through well abandonment, and therefore could be long in duration. The highest levels of air contaminants are expected during the 5 year development period, but long term emissions from producing wells will also compromise air quality. The impacts to air quality are expected to be **frequent** and occur constantly and/or reoccur. If pollution prevention measures are not implemented it is **likely** that contaminant concentrations in residential air will be high enough to cause short-term and long-term disease, especially for residents living near wells. Health effects may include respiratory disease, neurological problems, birth defects, and cancer. Some health effects could be managed without medical attention, while some effects will necessitate medical attention some of these effects may not be reversible. Therefore the impacts are rated as **low to high**. For these reasons, air quality impacts are prioritized as **high**.

5.3 Assessment of Water and Soil Quality on Health in Battlement Mesa

“What will be the effect of chemicals on the water supply?”
June 15 stakeholder meeting

The impact of natural gas development and production on water and soil quality and the water supply is a major concern to Battlement Mesa residents. Surface run-off, and infiltration from

drilling cuttings and produced water stored in pits on well pads or off-site locations; well installation errors; and uncontrolled well development (kick backs, blow outs, and well fires) could result in emissions of contaminants to groundwater, subsurface soil, surface soil and surface water. Spills of hydraulic fracturing fluids, drilling muds, condensate, and diesel could result in contamination of surface soil. Run-off and infiltration then could result in subsequent contamination of surface waters and of groundwater and subsurface soil, respectively. Exhaust from diesel engines (through dry deposition of particulates) and wind erosion from drill cuttings could contaminate surface soils (through deposition of particulates). If the groundwater or subsurface soil is contaminated, VOCs could infiltrate and accumulate in the air of buildings. Sources of contaminants include the natural gas resource itself, chemicals used in well production activities, wastes from well production activities, and exhaust from machinery used in well production and maintenance.

5.3.1 Water and Soil Quality Impacts on Health

Natural gas development and production and the diesel engines used to support them have the potential to release metals, salts, hydrocarbons, carbonyls, and other contaminants to groundwater, surface water, and soil. People can be exposed to these contaminants through ingestion of water, incidental ingestion of soil and purposeful ingestion of soil (i.e. individuals with pica), dermal absorption from water, inhalation of soil particulates, inhalation of VOCs released from water during activities such as showering, and inhalation of VOCs in building air. Some of these contaminants, such as benzene³⁵, and several of the PAHs, are human carcinogens. Others, such as the carbonyls, alkanes, and 1,2,4-trimethylbenzene, can act as irritants of the eyes and skin or cause neurologic effects²³. Specific health effects of several potential contaminants are described in the in the Human Health Risk Assessment (Appendix D).

Significant contamination of water supplies with salts, such as those containing chloride, can make the water unsuitable for human consumption and stress water treatment facilities. The water requirements for natural gas development and production are large, with the potential to tax local water supplies, particularly in the event of a drought. However, many natural gas operators in Garfield County have installed water treatment systems with the purpose of treating and recycling produced water used in hydraulic fracturing, and it is Antero's intent to do so for its project in the Battlement Mesa PUD. With adequate treatment to eliminate harmful chemicals, it is possible that produced water can be recycled. This has the potential to significantly reduce the consumptive water use in natural gas development.

5.3.2 Water and Soil Quality and Natural Gas Operations

The Mamm Creek field, located approximately 20 miles to the east of Battlement Mesa in Garfield County, has experienced extensive natural gas development and production, with over 1100 gas wells installed between 2000 and 2007. The two phase hydrogeologic study conducted between 2006 and 2007 on the Mamm Creek field 21-22 provides data that is useful in estimating potential impacts from natural gas development and production on water quality in

Battlement Mesa. An increasing temporal trend of methane and chloride groundwater concentrations coincident with the increasing number of gas wells installed was observed in the hydrogeologic study^{21-22, 44}. The isotopic methane data indicate a thermogenic origin of methane, which may be attributed to the Williams Fork gas. The increasing chloride concentrations are attributed to Williams Fork production water.

In the Mamm Creek field hydrogeologic study, chloride concentrations did not exceed regulatory limits and there is no regulatory limit for methane. Benzene was only detected in groundwater and surface water samples collected in proximity to the West Divide Creek seep and the Amos well. Many of the benzene concentrations in these samples exceeded the 5 µg/L regulatory limit and the 0.41 µg/L EPA Regional Screening Level for tap water. At the West Divide Creek seep, a faulty cement job on the casing of the Schwartz well resulted in the migration of natural gas and BTEX over 2,000 feet southeast of the well and seepage into Divide Creek. At the Amos well, Williams Fork gas from poorly installed wells are believed to be responsible for the contamination.

Pavillion Wyoming, a community of approximately 166 residents located in Fremont County, also experienced intensive natural gas development and production, with 211 active gas wells, 30 plugged and abandoned wells, 20 “shut-in” wells, and 37 production pits in an 8 square mile area. In response to complaints from Pavillion residents of odors and off-tastes in domestic water, EPA conducted sampling of both domestic and monitoring wells in the area between 2009 and 2010. The sampling results indicate that domestic wells are contaminated with low levels of petroleum hydrocarbons and thermogenic methane and that the shallow groundwater is heavily contaminated with petroleum hydrocarbons and BTEX. Natural gas development and production are the most likely source of the petroleum hydrocarbons and BTEX. Several inorganic compounds, such as sodium, sulfate, and nitrate, also were detected which could have sources other than natural gas development and production. The hydrologic connection between the drinking water aquifer and shallow groundwater is not well characterized. In their health consultation based on EPA’s results, ATSDR found the quality of the drinking water in several of the domestic wells was not acceptable and concluded that exposure to some of the contaminants could result in health effects³⁶⁻³⁷. While the groundwater contamination that occurred in Pavillion is not directly comparable to Battlement Mesa because of differences in the natural gas resource and state regulations, it does indicate that natural gas development and production can adversely impact groundwater quality.

Review of water quality data in the USGS and COGCC databases indicate that groundwater and surface water contamination from natural gas development and production at levels with the potential to impact water quality and exceed regulatory levels results from incidents such as loss of well control during development, well installation errors, and spills from produced water pits, as described in the Accidents and Malfunctions Assessment. Available routine monitoring data in these databases indicate routine natural gas development and production (i.e. without incidents) may not be a significant source of water contamination, however, routine monitoring is limited and may not be representative of all instances of gas development and production. It is

noted, that samples are most often collected in response to a complaint or incident or as part of a remedial action. There is very little data for routine monitoring of impacts to water quality at gas wells or exploration and production (also known as E&P) waste pits, with the exception of required monitoring in the 3-mile perimeter of Project Rulison. This small amount of data limits the ability to make a true estimate of exposures from groundwater and surface water.

5.3.3 Current Conditions of Water and Soil Quality

The primary source of drinking and domestic water in Battlement Mesa is the Colorado River. The Battlement Mesa Water Treatment Plant draws water from two intakes located in the middle of the river for treatment. The available baseline groundwater and surface water data specific to Battlement Mesa is limited to the annual testing of the surface water intake and back-up groundwater wells at the Battlement Mesa Water treatment facility. These results indicate that there is no VOC, herbicide, or pesticide contamination of either drinking water supply. In addition, a domestic well at the Historic Battlement Mesa Schoolhouse was sampled on May 17, 2010 in response to an anonymous request from a landowner in the vicinity of Antero's Watson Ranch Well. The COGCC concluded the laboratory analysis did not indicate any impacts to this domestic water well from natural gas production operation³⁸.

Garfield County has conducted several hydrogeologic investigations over the past 5 years, including two completed studies and one on-going study of Mamm Creek, and the Piceance Phase IV Baseline Water Quality Study of the area north of the Colorado River up to the Grand Hogback between Rifle and New Castle completed in 2007. In addition, the COGCC conducted hydrogeologic studies associated with the Rulison blast site, southeast of Battlement Mesa in the 1990s. While the hydrological information from these studies do not apply directly to Battlement Mesa, water samples collected in these studies are useful for overall background assessment. The inorganic results, obtained from the 70 groundwater samples collected in the Piceance Phase IV Baseline Water Quality Study²⁰ are not applicable to Battlement Mesa, because the water chemistry between these two areas could be quite different. However, the BTEX and methyl-tert-butyl-ether (also known as MTBE) results could be somewhat representative of Battlement Mesa, because they are not naturally occurring at detectable levels in groundwater. No measureable concentrations of BTEX, methyl-tert-butyl ether, or methane were detected in any of the samples.

Antero collected groundwater samples from 18 domestic wells surrounding the Watson Ranch Pad in July 2009, prior to drilling (David Simon Antero personal communication January 27, 2011). The results from these samples are applicable to Battlement Mesa and appropriate for estimating baseline water quality in domestic wells. No measureable concentrations of BTEX, methyl-tert-butyl ether, methane, nitrite, sulfide, boron, cadmium, chromium, manganese, selenium, or silver were detected in any of these samples. Arsenic, barium, chloride, lead, nitrate, and fluoride levels were all below national drinking water standards. Only a few sulfate concentrations exceeded the 250 mg/L secondary national drinking water standard with concentrations ranging from 29 to 930 mg/L.

There is no baseline data for surface soil or subsurface soil within the PUD so current conditions are unknown.

The Colorado Department of Labor & Employment's Oil and Public Safety Division has permitted ten underground storage tanks within the PUD, summarized in the following table.

Permit Holder	Fuel	Tank Capacity (gallons)
Battlement Mesa Service	Gasoline	1,000
Battlement Mesa Service	Diesel	1,000
Battlement Mesa Golf Course	Gasoline	2,000
Battlement Mesa Golf Course	Diesel	1,000
Kum and Go, Stone Quarry Road	Gasoline	20,000
Kum and Go, Stone Quarry Road	Gasoline	12,000
Kum and Go, Stone Quarry Road	Diesel	12,000
Kum and Go, Tamarisk Trail	Gasoline	10,000
Kum and Go, Tamarisk Trail	Gasoline	10,000
Kum and Go, Tamarisk Trail	Gasoline	8,000

These underground storage tanks have the potential to leak and contaminant subsurface soil and groundwater with fuel contaminants, including benzene. The permit holder is required to perform weekly leak tests on the underground storage tanks and the Oil and Gas Public Safety Division performs an annual inspection of the underground storage tanks. Review of the Oil and Gas Public Safety Division files on August 18, 2010 indicated no leaks or contamination of soil or groundwater associated with these underground storage tanks.

There also are natural gas production operations occurring on the border of the PUD that could potentially impact the water and soil quality within the PUD, as well as the water supply. Other potential sources of contamination to groundwater and soil are the golf course and landscaping operations (e.g. application of fertilizers, herbicides and pesticides).

In the event that the Battlement Mesa Water Treatment Plant was shut down, drinking and domestic water for Battlement Mesa residents would be supplied from four groundwater wells along the south bank of the Colorado River. These wells are not directly supplied with water from the Colorado River and the source of water in these wells has not been established (Roger Bulla personal communication July 7, 2010). There could be a hydrologic connection between these wells and the aquifer on Battlement Mesa, allowing for a conduit of natural gas extraction activity contaminants to the secondary drinking water source, although this has not been verified.

5.3.4 Antero Drilling Plans in Battlement Mesa and Water and Soil Quality

In the two samples collected by Antero during completion activities at the Watson Ranch pad in 2010, levels of chemicals were very similar to pre-drilling levels with one exception (David Simon Antero personal communication January 27, 2011). In a sample from the domestic well nearest the well pad at the west perimeter, the manganese level of 0.085 mg/L exceeded the secondary national drinking water standard of 0.05 mg/L. Manganese levels were less than 0.01 mg/L in the sample collected from this well prior to drilling. Manganese is listed on several of Antero's material safety data sheets as a chemical used in pipeline excavation. This one sample result is not sufficient to indicate that Antero's drilling and well completion activities were the source of the elevated manganese and further sampling is necessary to confirm the result and the identify the source of the manganese.

Antero has contracted an evaluation of groundwater monitoring data from approximately 500 wells in and around its Gravel Trend leasehold position. However, the results of the evaluation were not available at the time of the HIA (Personal communication, Jerry Alberts, Antero February 15, 2011).

The Mamm Creek field hydrogeologic study results and USGS and COGCC databases indicate that natural gas processes could impact water quality in Battlement Mesa, although the likelihood is low. Increasing chloride concentrations could eventually affect the potable groundwater. As previously discussed, incidents resulting from well installation errors, loss of well control during well development, and spills could affect the potable groundwater and water quality to extent that causes exceedence of regulatory standards and triggers regulatory action. These types of incidents also could affect soil quality in Battlement Mesa. The assessment of Accidents and Malfunctions in Section 4.8 discusses the likelihood of such incidents.

While there is no permanent surface water body in the PUD, there are intermittent drainages and creeks that could discharge to the Colorado River. Monument Creek, one of the major drainages off of Battlement Mesa discharges to the river downstream of domestic water intakes. It still is possible that surface run-off could introduce contaminants from upstream well pads into the river. However, the Colorado River has a high volume of water and it is most likely that any contamination would be diluted to non-harmful concentrations. The annual surface water quality results have not indicated any detectable levels of contamination from natural gas development and production at the intakes. In addition, natural gas operators must inform the Battlement Mesa Water Treatment Plant of upstream spills or incidents affecting the river (COGCC rule 317B)⁵. In the event of such a spill or incident, the intakes to the treatment plant can be shut down. The treatment plant routinely stores a week's supply of water allowing time for remediation of spills. The Battlement Mesa Metropolitan District is subject to the protections of COGCC Rule 317B, which regulates natural gas operations in surface water supply areas.

Antero is proposing to employ pit-less drilling systems on the well pads within the PUD and to distribute and store production water at a centralized water storage facility, within the PUD.

COGCC rule 904 requires liners for pits at centralized water storage facilities and has a provision⁵, at the discretion of the director, for the installation of leak detection systems in sensitive areas such as the PUD. COGCC rule 908 requires that centralized water storage facilities be permitted⁵; the geologic and hydrogeologic characterization of site; control of public access; fire lanes; surface water diversion systems, waste characterization profiles; an operating plan; baseline groundwater sampling and analysis; groundwater and surface water monitoring (at the discretion of the COGCC director); and groundwater and soil sampling when a pit is closed and the site remediated. Adherence to these rules, including the discretionary leak detection and monitoring, will significantly reduce the potential for impacts to water and soil quality from produced water and other exploration and production waste stored in the centralized pit. However, leaking pipelines and spills from chemical and production water-hauling trucks could still create the potential to impact surface water quality. COGCC rules do not specifically address water pipeline leaks.

Any spills that occur on the pads could potentially impact water and soil quality by surface run-off and infiltration during precipitation events. This potential is evidenced in a sample of snow melt collected from a project Rulison well pad that contained levels of benzene greater than regulatory limits³⁹. COGCC rule 603 specifies that in high density areas, such as the PUD, berms (or other secondary containment devices) capable of containing 150 percent of the fluid in the largest tank within the berm be constructed around produced water and condensate tanks⁵. However, this rule does not provide for containment of spills that may occur outside the berm perimeter, such as during transfer of chemicals and materials to and from trucks and at well heads.

Wind erosion and surface run-off from drill cuttings stored on Antero's pads could impact surface water and surface soil quality. The COGCC rules do not specifically address drill cutting stored on well pads⁵.

At time of preparation of this HIA, it was not known if Antero is planning for deep injection of exploration and production wastewater within the PUD. COGCC rules require written permission from the COGCC director prior to construction of an injection well. The HIA would need to be updated to include potential impacts to public health, if injections wells are proposed.

The Battlement Mesa Metropolitan District has a capacity of 6 million gallons of water per day. Currently, 3-3 ½ million gallons per day are used, allowing for the accommodation of Antero's water needs during well development operations. If water capacity were to significantly decrease, the needs of Battlement Mesa would take precedence to Antero's needs.

It is unlikely that Antero's proposed project will have a significant impact on the primary domestic water supply for Battlement Mesa. The potential for a significant impact to the secondary water supply may exist. If the potable groundwater is impaired, Battlement Mesa may not have a back up source of domestic water. In addition, there is the potential for the Antero's project to impact the water quality of intermittent streams, creeks, and puddles, as well as soil

quality. Finally, it is possible that shallow aquifer contamination could cause VOC off gassing into Battlement Mesa homes, but since the hydrology of the area is not well understood, the likelihood of such an occurrence is not clear.

5.3.5 Characterization of the impact on Water and Soil Quality

The impact of water and soil quality due to the Antero project in Battlement Mesa on the health of local residents can be characterized as follows:

Impact	Direction of health effects	Geographical Extent of exposure	Vulnerable populations	Duration of exposure	Frequency of exposure	Likelihood of health effects as a result of Project	Magnitude of health effects	Priority
Water and Soil Quality	Negative	Community wide	Yes	Long	Infrequent	Unlikely	Low to High	Medium*

*For an explanation of the numerical ranking system used, see the chart at the beginning of Section 4.

When considering anticipated water and soil contaminant exposures associated with the Antero development within the Battlement Mesa PUD, water and soil quality may produce **negative health impacts** in the areas in close proximity to the development areas and community wide. If the domestic water supply were to be contaminated, the health effects would be **community wide**. Effects of wind erosion and surface run-off could be more localized, and could impact children more than adults. Children, older adults, and individuals with pre-existing disease may be more vulnerable to water and soil contaminants and are considered a **vulnerable population**. The duration of water quality degradation could be **long** and may last through the life of the Antero’s project, from well pad preparation through well abandonment. The impacts to water quality are expected to be **infrequent** and it is **unlikely** that contaminant concentrations in water and soil will be high enough to cause short-term and long-term disease because the current supply of domestic water is the Colorado River and the COGCC has extensive rules to protect this resource. If exposure were to occur, health impacts may include skin and eye irritation, neurological problems, and cancer. It is likely that medical attention would be necessary for some of these impacts and that some of these impacts will not be reversible. Therefore the health impacts, if exposure were to occur, are rated as **low to high** magnitude. For these reasons, water and soil impacts are prioritized as medium compared to other potential stressors.

5.4 Assessment of Transportation and Traffic on Health in Battlement Mesa

Will there be motor vehicle accidents and related injury and death?
February 3, 2010 stakeholder meeting

Increases in transportation and traffic can impact health and safety of a community by increasing the risk of motor vehicle accidents, release of hazardous pollutants, creation of road dust, and impediment of walking and biking routes. Development of natural gas wells can cause significant increases in a variety of traffic, especially large truck traffic. Increases in large truck traffic may place residents at greater risk for severe injury or death with the risk increasing with vehicle speed. Residents living in Battlement Mesa have expressed concerns that traffic associated with the Antero gas project will impact the health and safety of those living in the community. This assessment will address traffic impacts to the safety of Battlement Mesa citizens. Air quality, noise, and quality of life impacts due to increased traffic are addressed in other sections.

5.4.1 Traffic and Safety

Vehicular traffic is a known hazard to safety. Increases in traffic are associated with increased risk of motor vehicle injury and death, due to vehicle-vehicle, vehicle-pedestrian, and vehicle-bicycle accidents. Motor vehicle accidents can be associated with speeding, poor traffic management at intersections, and heavy vehicle movement. Numbers of injuries/fatalities are directly related to vehicle volume and severity of injury is directly related to vehicle speed⁴⁰⁻⁴¹. Large trucks of 10,000 or more pounds are much more likely to be involved in a fatal multi-vehicle crash than passenger vehicles⁴².

5.4.2 Current Traffic Conditions

Currently, large truck traffic within the PUD is mainly from delivery trucks supplying the local businesses, including gas stations and convenience and grocery stores, and natural gas operators servicing well pads outside the PUD. There are established county approved haul routes along the perimeter of the PUD, while most roads within the perimeter are limited to small vehicles. There are two entries into Battlement Mesa. The main entrance is just south of Exit 75 off of Interstate-70. A traffic analysis conducted by Schmueser/Gordon/Meyer, Inc. (SGM) for Antero in September 2009³² found that this entrance had the highest traffic count in Battlement Mesa with 8,662 vehicle trips per day (vt/d). The second entry into Battlement Mesa is from Exit 75 via US 6 west to County Road (CR) 300 (CR 300/Stone Quarry Road) on the southwest side of Battlement Mesa. Traffic counts at the US 6/CR 300 intersection were 2,300 vt/d, but were only 648 vt/d on CR 300 where it enters the PUD west of the recreational vehicle (RV) park. Other counts indicate that on West Battlement Mesa Parkway there were 5,340 vt/d and on CR 307 (River Bluff Road) there were 371 vt/d. Since there is no current industrial activity and very few retail stores, it is assumed that the large majority of these vehicle trips were passenger cars and light trucks, although this is not specifically stated in the traffic report. The report also projects an increase of 2.3% vehicle trips annually unrelated to the Antero drilling plan, based on average annual growth of Garfield County.

Motor vehicle accidents in Garfield County are handled by the county sheriff’s office, local municipal law enforcement and the Colorado State Patrol. When looking at accidents handled by the state patrol, Garfield County had the 9th highest number of motor vehicle accidents in the state in 2008, with 1,091 accidents total (14 fatal crashes, 116 that resulted in injury and 961 that resulted in property damage)⁴³. Data from the county sheriff’s office and data specific to Battlement Mesa are not currently available.

Top 10 Colorado Counties 2008 Fatal, Injury, and Property Damage Crashes by County as Covered by the Colorado State Petrol (not all Colorado Crashes)				
http://csp.state.co.us/TS_CrashStat.html				
County	Fatal	Injury	Property Damage	Grand Total
Jefferson	19	395	2,530	2,944
El Paso	20	278	1,953	2,251
Adams	13	233	1,773	2,019
Mesa	7	211	1,188	1,406
Larimer	14	275	1,080	1,369
Weld	28	258	1,065	1,351
Eagle	6	132	1,073	1,211
Douglas	10	145	1,032	1,187
Garfield	14	116	961	1,091
Boulder	14	182	860	1,056
Grand Total	290	3,895	23,028	27,213

Children attending school in Battlement Mesa arrive and leave via passenger car, school bus, walking, or bicycle. Underwood Elementary (grades 1-3), St. John Elementary (grades 4-5) and Grand Valley Middle School (grades 6-8) are in Battlement Mesa. The Early Childhood Center (PreK-Kindergarten) and Grand Valley High School are in Parachute. Some students are not offered bus service if they live within a “Walk” zone. Specifically, students attending Underwood Elementary and living in Saddleback Village, Tamarisk Village, Tamarack Meadows are not offered bus service; children attending St. John Elementary and living in Willow Ridge, Willow Park, Valley View, Monument Creek Village, Canyon View, and Stone Ridge are not offered bus service; and children attending Grand Valley Middle School and living in Mesa Ridge, Eagle’s Point, Willow Ridge, Willow Park, and Valley View are not offered bus service. (Battlement Mesa early childhood students and high school students are all offered bus service and ride together.) School hours in Battlement Mesa schools are 8:40 am -3:40 pm at Underwood (early release at 2:10pm); 8:25am- 3:25pm at St. John (early release at 1:55pm); and 7:50am-7:15pm at Grand Valley Middle School (1:45pm early release). A map detailing Antero’s planned haul routes and school bus stops will be included in the final report.

5.4.3 Antero Drilling Plans in Battlement Mesa and Traffic

Traffic associated with natural gas development is related to earth moving construction of well pads; movement of materials and waste to and from the well site; installation of pipelines; long term production; maintenance operations; final reclamation of the site after production is completed; and travel of workers to/from work. The most traffic intensive phases involve pad construction, drilling and well completion and pipeline construction.

Antero has described a three phase development plan for the Battlement Mesa project as described in presentations at the public meetings. Phase 1 will develop the Stierberger Pad, Pad E, Pad G, and the water storage facility (Pad F) on the south side of the PUD. Phase 2 will develop the Parks and Rec Pad, Pad A, Pad B, and Pad D on the north side of the PUD. The Parks and Rec pad replaces the Pad C originally planned. Phase 3 will develop the L and M pads on the northeast side of the PUD. Each phase will involve access road, pad and pipeline construction needed to develop the wells and tie them to the water movement system and the gas gathering lines at the eastern edge of the PUD.

The traffic analysis conducted by SGM used estimates from previous Antero development sites in the Mamm Creek area to project average and maximum trips per day, for the Battlement Mesa project. Trips per day range from 2 (production phase) to 280 or more (intensive construction phase). Drilling completion, light construction, and pipeline installation range from on average 16-31 vt/d and a maximum of 30-46 vt/d. The duration of the pad construction ranges from 10-30 days and the other phase durations *per well* are drilling (18 days); completion (30 days); pipe installation (60 days/ mile); duration of each phase per pad was not calculated but efficiencies associated with drilling multiple wells sequentially on a pad will reduce the time of each phase on a pad. Production is projected to last 20 years. Reclamation after production is expected to have 7-10 vt/d for 11 days per pad.

Although initial presentations to the public describe well development phases to last 3-4 years, more recent estimates in the traffic analysis indicate that well development is expected to occur for at least five years, maybe longer, depending on economic and regulatory conditions. Antero has indicated that it will consider on public input regarding the duration of the well development phase of the the project. Well development phases will overlap on different well pads so that while pad construction is occurring on one pad, drilling is accomplished on another and completion may be occurring on another pad. Therefore, traffic will be overlapping as well, with trucks associated with construction, drilling, pipeline and completion using the haul routes simultaneously. Trips per day for each of these phases are added to estimate the number of trips per day expected during the first five years when well development is occurring. The number of trips per day is estimated to be 90-120 vt/d when light construction is occurring. When more intense well pad construction is occurring (during the Phase 2 well pad construction) traffic is projected to be 340 vt/d for approximately 120 days. Well drilling will occur 24 hours a day and the vehicle trips will be spread throughout the day and night. Antero has stated they will limit

truck hauling to hours outside of school zone hours. The majority of these trips are expected to be heavy trucks.

Antero plans to use county haul routes for traffic. During all phases entrance and exit from Battlement Mesa will be via the US 6/ CR 300 route (Stone Quarry Road), on the southwest side of the PUD. Phase 1 also will utilize CR 303, CR 308 and CR 302. Phase 2 will utilize CR 303, CR 308, East Battlement Mesa Parkway, South Battlement Mesa Parkway, and CR 307 (River Bluff Road). Phase 3 will utilize CR 303, CR 308, East Battlement Mesa Parkway, North Battlement Mesa Parkway, and West Battlement Mesa Parkway. The county restricts hauling on CR302, CR 307, South Battlement Mesa Parkway, and West Battlement Mesa Parkway. It is assumed that Antero will be required to obtain special permits to use these roads.

School buses for all the schools use and cross Antero haul routes. Although all children in the PUD may be impacted by crossing the haul routes while going to and from school, middle school age children may be the most impacted since the middle school is near two haul routes and children this age are more likely than younger children to be walking or bicycling on their own. According to the traffic analysis plan, Antero has decided to avoid any heavy truck hauling during school zone hours. Children going to/from school outside of school zone hours may be crossing haul routes while truck traffic is occurring.

Antero has planned mitigations to decrease impacts of traffic on the Battlement Mesa Community, as evidenced in its best management practices (Appendix E). Of significance, Antero has committed to building a water management system comprised of water distribution pipes going from the well pads to the water storage site on the south side of the PUD. This water management system is intended to decrease movement of water by trucks and it is estimated that there will be fewer trips during the development phases because of this system. Antero estimates that there will be 50,000 fewer trips (Appendix E).

In addition to heavy truck traffic, there will be workers coming into Battlement Mesa and traveling within Battlement Mesa in passenger cars and light trucks. It is estimated that there will be an average of 120-150 workers in Battlement Mesa during the five year development period. Antero intends to house some workers in Battlement Mesa to decrease worker movement into and out of the PUD. Workers exceeding speed limits can put other vehicles and pedestrians at risk for injury and fatality. . Antero management emphasizes safe driving but a formal safe driving program does not exist.

It is expected that the increase in heavy truck volume from negligible to tens or hundreds per day within the PUD may compromise road integrity and needs for increased road maintenance is anticipated. County funds will be needed to maintain haul routes as well as installation of road and pedestrian safety mitigations if needed.

5.4.4 Characterization of Traffic Impacts on Safety

The following table summarizes the characterization of impacts from traffic.

Impact	Direction of health effects	Geographic extent of exposure	Vulnerable populations	Duration of exposure	Frequency of exposure	Likelihood of health effects as a result of Project	Magnitude of health effects	Priority
Traffic and Transportation	Negative	Community-wide	Yes	Long	Frequent	Possible	Low to high	High*

*For an explanation of the ranking system used, see the chart at the beginning of Section 4.

When considering public health to residents of Battlement Mesa, the increased traffic within the PUD is likely to create **negative** health effects due to increased safety risks. Because the haul routes include the entire circle of the Battlement Mesa Parkway as well as other roads within and on the perimeter of the PUD, the impact of the traffic is likely to be **community-wide**. There will be certain parts of the community that will be greater impacts for the duration of Antero’s project (those homes next to CR300/Stone Quarry Road) while others will be impacted by very high volume traffic during the construction of the Phase 3 pads (those along River Bluff Road). Because children often walk and ride bicycles and are not as safety conscious, they are more **vulnerable** than most adults to the impacts of traffic within the PUD. Antero has committed to limit heavy truck traffic during school zone hours which will decrease risk to children traveling to and from school at those times. Children staying after school for sports and other activities may be at risk for traffic incidents related to truck traffic outside of those hours. Furthermore, truck traffic is likely to continue on weekends and holidays and children may be crossing haul routes at those times. The duration of exposure to increased traffic will be **long**, spanning the entire duration of the development of all three phases, at least five years. The traffic will be frequent, in some cases (River Bluff Road), up to 280 trucks may be passing some days for several months. Along Stone Quarry road, there will be 45 to 113 trucks passing a day for approximately five years. Increased traffic is known to be associated with increased risk of traffic accidents and it is **possible** that there will be traffic related accident as a result of the Antero project. The magnitude will depend upon how well the traffic is controlled, how well mitigation efforts are adhered to, and to unrelated or perhaps chance factors. Traffic can cause minor to severe/fatal injuries and as such, the magnitude of the impacts will be **low to high**. For these reasons, traffic impacts are prioritized as high compared to other potential stressors.

5.5 Assessment of Noise, Vibration, and Light Pollution on Health in Battlement Mesa

“I am concerned that noise and vibration will affect my sleep. Will these be addressed?”
June 15 stakeholder meeting

Increased noise, vibration, and light are common concerns for citizens near construction and industrial sites. At natural gas sites noise and vibration can occur in the construction phase, drilling and completion phases, and due to truck traffic. Light pollution can occur due to 24 hour lighting during development and production operations. Because of these sources, noise, vibration, and light concerns have been expressed by Battlement Mesa residents at stakeholder meetings.

COGCC Rule 802⁴⁴, based upon the State of Colorado Noise Ordinance⁴⁵, states that pad construction operations are considered industrial sites and site noise may not exceed 80 decibels (dB) in the day and 75 dB at night at 350 feet from the well. In residential zones, during normal production operations noise at 350 feet from the well must not exceed 55 dB in the day and 50 dB at night. The rule does not address noise levels at a home either during well development or production phases. The noise rule does not address well development noise levels for residents in areas where development activities are expected to occur for extended periods of time, such as is being proposed in Battlement Mesa. In such cases, the COGCC rule may not be protective of health. COGCC Rule 803⁴⁶ states “site lighting shall be directed downward and internally so as to avoid glare on public roads and building units within seven (700) hundred feet.” COGCC does not have a rule limiting ground vibration, but according to the US Department of Transportation ground vibration is generally not felt below 65 VdB and annoyance can be experienced at 70 VdB⁴⁷.

According to EPA research, construction equipment can produce noise ranging from 80-89 dB at a distance of 50 feet and 60-69 dB at 500 feet⁴⁸. Heavy construction equipment can cause vibration of 85 VdBA 50 feet from the source⁴⁷.

Because there is a potential for noise, light and vibration to exceed COGCC rules and background levels, a review of potential noise, vibration and light impacts is warranted.

5.5.1 Noise, Vibration, Light pollution and Health

Both acute loud noise and chronic lower level noise have been associated with a variety of negative health effects. Hearing loss and impairment are known to occur as a result of exposure to acute, high decibel noise (greater than 85 dB). The odds of hearing loss increase as the decibel level increases. A dose relationship between noise level and hearing loss exists⁴⁹.

Studies looking at the relationship between noise and cardiovascular disease, hypertension, psychological symptoms, and respiratory impairment are numerous. Reviews and meta-analysis of these studies conclude that noise has the potential to impact these health outcomes⁵⁰⁻⁵³.

Cardiovascular risk factors have been shown to be impacted by noise levels in the range of 51-70 dB in persons with several years of exposure⁵⁴.

Noise annoyance can lead to stress related impacts on health such as feelings of displeasure, interference with thoughts, feelings, and activities and disturbed sleep and can have impacts on mood, performance, fatigue, and cognition⁵⁵. Studies indicate that noise levels which produce these impacts can vary: annoyance can occur at 55dB; school performance can be impacted at 70 dB; and sleep can be impacted by as little as 35-60 dB. Ground vibration and low frequency noise may cause health impacts similar to those associated with noise annoyance. Establishment of causal relationships between noise/ vibration and health impacts is complicated by the fact that noise annoyance in particular can vary with pitch, frequency, and duration. In addition, individual adaptation to noise can vary and complicates subjective reporting as well as expected outcomes.

Nevertheless, the studies suggest that some persons may experience impacts at noise levels that meet the permissible COGCC and State of Colorado regulations.

Preliminary research suggests that light at night may affect health by disrupting normal circadian rhythms⁵⁶⁻⁵⁷. The International Agency for Research on Cancer has listed shift work a Class 2A (probable) carcinogen based on epidemiologic links to breast cancer. Mechanisms for the health effects of light at night are actively being studied and include altered melatonin and other hormone release⁵⁸.

5.5.2 Current Noise, Vibration, and Light Conditions

Residences in Battlement Mesa are located approximately one half mile or more from Interstate-70 and most homes are not likely to have noise impacts from this source. There is not any baseline/ background noise monitoring data available for Battlement Mesa. In 2002, La Plata County, Colorado conducted noise sampling in rural, residential, traffic corridors and light industrial areas⁵⁹. Twenty-four hour residential subdivision noise ranged from 37-53 dB, with an average of 42-45 dB. Traffic corridors ranged from 55-65 dB, with an average of 57 on a state highway and 45 on a collector road. Although it is not possible to know if the La Plata information is representative of all of Battlement Mesa, it is reasonable to expect that noise for most of the homes in Battlement Mesa is similar to that measured in the residential subdivision in La Plata. Likewise, night time light is likely to be similar to other residential areas, consisting of municipal street and outdoor home lighting. Baseline lighting measures for Battlement Mesa do not exist.

Some residences in Battlement Mesa, however, may already be proximate to natural gas production sites located outside the PUD and maybe experiencing or have experienced noise and light trespass elevated above background in relation to this development. There does not appear to be any significant sources of vibration within the PUD.

5.5.3 Antero Drilling Plans in Battlement Mesa and Noise/Vibration/Light

Interpretation of Antero Noise Monitoring and Noise Modeling:

Antero provided the CSPH with documentation of noise monitoring conducted at the Watson Pad on 8/29/2010 through 9/2/2010. Antero also provided CSPH with reports of noise models for a drilling scenario at the Watson Pad and a fracturing scenario for the D-pad. CSPH interpretation of these reports is as follows:

- 1) Noise monitoring conducted during drilling operations on the Watson Pad on 8/29/2010-9/2/2010 indicate that noise at 625 feet (residence is 925 feet) to the northwest and 540 feet (residence is 655 feet) to the south east, was measured below industrial noise limits of 75 and 80 dBA (night and day time, respectively). While these measurements do not constitute a violation, the measured noise was above levels that may cause health impacts. In addition, the results of this report indicate that noise levels can vary as much as 25 dBA.
- 2) A second report documents noise monitoring conducted on 8/30/2010 through 8/31/2010 before and after the rig floor blankets, draw works brake shroud were installed. The results of the study indicate these mitigations can decrease noise levels.
- 3) Noise mitigation effectiveness may be in part determined by local topography and meteorology.
- 4) There was no measurement of background/ baseline noise levels in Battlement Mesa or on the Watson Pad when the noise monitoring was conducted.
- 5) A third report provides results from use of a model to predicted noise levels during a drilling scenario at Watson Ranch. Comparison between the model's predicted noise levels and the *average* of the measured noise levels suggest the model may be within 10 dBA of the measured noise. This suggests that modeling may be a reasonable tool for planning mitigation efforts. However, because noise levels can vary by as much as 25 dBA, it is still necessary to monitor noise so that mitigation efforts can be documented and improved upon should noise levels exceed COGCC rules or exceed levels that may impact health.
- 6) A fourth report provides results from use of a model to predict noise levels during a fracturing scenario at the D pad within the PUD. The model indicates that noise levels would be above the levels that may impact health, although they meet permissible COGCC rules. Two proposed mitigations ("Option A" and "Option B") could reduce noise to levels that are still within range of health impacts but are improved over unmitigated scenarios. Again, it is necessary to monitor noise during these activities to ensure that noise achieves levels that are less likely to impact health, even if then noise levels meet COGCC rules. Additional mitigation efforts may be necessary to protect health.

Antero data indicate that noise associated with could range from approximately 40-70 dBA at 350 feet during drilling activities and models suggest that *unmitigated* noise during fracturing could be over 85 dBA at 350 feet. According to the models, mitigation is expected to reduce noise from these activities to the 50- 63 dBA range. In community meetings, Antero has described possible noise abatement strategies, including hay bale walls, blankets, brake shrouds and berms. According to meetings documents and the Surface Use Agreement, Antero is not planning centralized compression (a significant noise source). Well head compression if utilized will be housed with noise suppression equipment. It is unclear how well these strategies will reduce noise below levels that impact health. Simple attainment of the COGCC permissible limits may not be sufficient to protect from health impacts due to noise from the extended well development period.

It is important to note that other noise sources will include large truck traffic; road and well pad construction machinery; diesel engines used during drilling; hydraulic fracturing and completion stages; drill rig brakes, pipeline construction activities and possibly other activities. Antero has stated it is possible that they will use electric engines for some drilling operations within the PUD but that diesel engines will be used for all completion activities. Noise is expected to range from intermittent (traffic and drill rig brakes) to continuous (diesel engine use during drilling and hydraulic fracturing) for several weeks to months. Drilling noise will occur around the clock. Fracturing is conducted during daylight hours, however other completion operations may contribute to nighttime noise.

Although specific distances from truck haul routes to schools is not available, rough estimates indicate that schools are roughly 1,000 feet or more from truck routes and may not experience significant noise impacts, although this should be verified with school staff. Residents living less than 500 feet from truck routes, such as along CR 300 (Saddleback Village) or West Battlement Mesa Parkway (Willow Creek Village), are close enough to experience noise that could be between 65 and 85 dB when trucks are passing, at times 9- 12 times per hour or more. These areas could experience some associated intermittent vibration as well.

Because drilling operations occur round the clock, the well pad is lighted and may contribute to light intrusion at nearby residences throughout the drilling operations for each pad. In addition, security lighting may be in place for the duration of the well pad life. Antero has also proposed light abatement strategies, including sodium vapor lights, light shields, and rig placement modifications. Antero modeling indicates that these measures will adequately reduce light intrusion to residents. It will be important for Antero to respond with further mitigation if residents report impacts from noise or light.

5.5.4 Characterization of Noise, Vibration and Light Impacts

The impact of noise due to the Antero project in Battlement Mesa on the health of local residents can be characterized as follows:

Impact	Direction of health effects	Geographical Extent of exposure	Vulnerable Populations	Duration of exposure	Frequency of exposure	Likelihood of health effects as a result of Project	Magnitude of health effects	Rank
Noise, Vibration, Light	Negative	Local	Yes	Long	Frequent	Possible	Low-Medium	Medium

When considering anticipated noise, vibration, and light exposures associated with the Antero development within the Battlement Mesa PUD, noise, vibration and light may produce **negative** health effects. Of the three, noise is likely to have the most impact on health. While all or most parts of the community may be proximate to noise sources at different times, it is not likely that the entire community will be affected by noise during the development of an individual pad or by truck traffic. There are some residents close to haul routes that may experience elevated noise due to truck traffic for five years or more. Noise impacts will therefore be **local** to areas in close proximity to the development areas and areas close to truck traffic routes. The elderly may be more **vulnerable** to noise annoyance and may experience more health impacts due to noise due to underlying cardiac disease and/or other stress conditions. The elevated noise is expected to be associated with construction and development phases and with truck traffic on haul routes. The pad development phases will last several months, while nearby truck traffic may last several years for some residents, and so, duration of exposure is expected to be **long** depending on location. Significant noise levels are not expected during normal production phases in the years subsequent to well development. Should reworking of wells be conducted, noise levels are expected to increase, again for several months, during the reworking phase. When noise occurs is expected to occur **frequently** as it will be constant and/or frequently reoccurring. It is unlikely that residential noise will be loud enough to cause noise induced hearing loss or long enough in duration to impact cardiovascular disease. In general, health impacts are likely to result from annoyance due to noise above background and may cause sleep disturbance, displeasure, fatigue, etc. It is not likely that medical attention will be necessary for most people, although some may seek medical assistance. Therefore the health effects are rated as **low- medium magnitude**. It is possible that in some individuals, noise levels will produce significant annoyance and may produce larger health effects.

5.6 Assessment of Impacts on Community Wellness

Will the development have impacts on education? What will be the mental health impacts? Will there be more or less services in the community?

February 3, 2010 stakeholder meeting

Residents of Battlement Mesa are concerned that the Antero project may affect the well-being of their social and community environment. Current epidemiologic literature cites a myriad of challenges in understanding the specific effects of the community and social environment on individual physical and psychological health. Largely, this is due to the difficulty in analyzing the separate and complex processes through which community and individual factors work together to influence health⁶⁰⁻⁶¹. Never the less, it is widely accepted that societal factors contribute to the health status of individuals through either the promotion or hindering of healthy choices and behaviors, and it is the collective health of individuals which contribute to the broader sense of community well-being among residents⁶²⁻⁶³.

While there is no single determinant or definition of a healthy community, we assessed current quantitative community wellness conditions through societal-based factors which were expressed as concerns by Battlement Mesa citizens. School enrollment, crime rates, prevalence of substance abuse, prevalence of sexually transmitted infection, and social service availability were assessed as surrogate measures of community health. Other measures of quality of life, such as the availability of and participation in recreational activities and the depth and breadth of active social networks that lead to the experience of community were also considered. Many resident statements made during stakeholder meetings and comments to the draft HIA serve as examples of ways that the experience of community can influence an individual's experience of well-being.

5.6.1 Community Wellness and Health

Many factors contribute to community wellness and health as follows:

Community Experience: Well-planned combinations of built and natural environments promote social interaction and pride in community living, which are in turn determinants of mental health and well-being⁶². Strong social support and community networks have generally positive effects on physical and mental health of individuals⁶⁴. Changes to a community can result in positive, negative or mixed impacts to the health of a community⁶⁴⁻⁸⁰. There is limited data available to directly assess the functioning level of social capital and cohesion in any community. Monitoring access and use of public health and social services may serve as measurement of some of the outcomes related to community health. As population of an area changes or grows, it is expected that the infrastructure of services rendered to that community may need to adapt to meet increasing or changing demands

Education: Inherent with changes in population come changes to school enrollment; increased population may lead to an increase in the class size, and possibly an increase in the ratio of students-to-teachers. Larger class sizes can also put a strain on the physical aspects of

educational facilities. Influx of a semi-permanent or long-term work force coupled with a booming local economy can increase local school enrollments beyond capacity and expected annual growth rates. High turnover of students can also disrupt classrooms and lead to compromised learning environments. In Colorado, if students are present when school counts occur, increased school enrollment may lead to increased funds, which can improve educational services and options. However if students arrive after the count date, the school does not receive extra funding for new students.

Mental Health and Suicide: Treatment for mental health conditions and suicidal tendencies is conducted predominantly in the outpatient setting. As such, hospital discharge data for these and related conditions generally do not reflect the true burden of these issues in any given community. Additionally, due to their highly sensitive nature, outpatient data for these issues at the local community level is not publicly available. Studies of the community impacts of industries such as natural gas do not offer clear evidence for direct impacts to mental health, other than to suggest that changes in other measures may add or subtract from the levels stress, worry, and satisfaction experienced by individuals in the community^{73, 78}.

Sexually Transmitted Infection: In any population, sexually transmitted infections (STI) are an important public health prevention priority⁷⁵. In addition to a variety of fertility problems caused by STI, syphilis and HIV/AIDS cause substantial health problems in all those infected. In addition to long-term health effects of acquired sexually transmitted infections, there are the daily consequences of pain, discomfort, and often embarrassment. Loss of worker productivity is also a concern with sexually transmitted infection, due to time required away from work to access testing, and received results and treatment, a process which may involve two days off work depending on travel distance to the nearest confidential testing/treatment center⁷⁶⁻⁷⁷.

5.6.2 Natural Gas Industry and Community Wellness

Boomtowns Changes: There are a small number of case studies available relating community impacts to boomtown effects of the natural gas industry. Some of the available studies provide evidence that exposure to natural gas development and production can have negative psychosocial health implications^{71, 78-80}, while a few others find positive effects⁷⁰. Additionally, there are a few studies that find no association at all between natural gas development and production and social and psychological health^{15, 70}.

Social problems of mental health, criminal activity, divorce, suicide and alcoholism are said to occur at disproportionate rates in boomtown natural gas economies^{71, 78-80}. This literature also describes disruptions in social cohesion due to population influx and opposition that arises between the “new comers” (both temporary and permanent new residents) and the “old timers”^{71, 78-80}. Both groups are likely to be vulnerable to combination of positive and negative community impacts.

Crime: Several research studies have correlated increased crime rates with communities involved in natural gas development and production, including crimes such as domestic violence, rape, prostitution, assault, child abuse, and homicide⁶⁶⁻⁶⁹. Because jobs in natural gas development and production often involve a transient workforce, residents in affected communities often attribute increasing crime rates to the industry workers. On the other hand, there has also been some literature reporting lower crime rates after the commencement of natural gas development and production⁶⁵ and some research arguing that there is no association at all between natural gas development and production and social and psychological health outcomes^{15, 70}.

Substance abuse: Several studies have reported an increased burden of substance abuse behaviors in communities involved in natural gas development and production, with primary emphasis being that substance abuse is prevalent among workers in the oil natural gas development and production^{65, 69, 72}. In some cases, increased illegal substance activity has been associated with seasonal increases in natural gas development and production⁷³.

Mental health: Studies of the community impacts of boomtown industries do not offer clear evidence for direct impacts to mental health, other than to suggest that changes in other measures may add or subtract from the levels stress, worry, and satisfaction experienced by individuals in the community^{73, 78}.

Sexually Transmitted Infection: Increases in the community burden of sexually transmitted infection have been identified as a health effect of extraction industries in many low- and middle-income countries⁷⁶⁻⁷⁷. Although literature regarding STI and the extraction industries in North America does not exist, this is an area which should be monitored. Key factors perceived to increase the spread of sexually transmitted infection within the extraction-industries include the transient nature of the in-migrant worker population who are away from social controls of their home community, the long and difficult work days possibly fostering desire for drug and alcohol binges during time off, and high salaries and disposable income in a young work-force⁷⁶⁻⁷⁷. These factors contribute to the difficulties experienced in providing sexually transmitted infection prevention and treatment for an itinerant natural gas development and production workforce. In addition to the inherent stigmas often associated with sexually transmitted infection testing/treatment, workers cite lack of access to sexually transmitted infection services due to geographic isolation from sexually transmitted infection services, lack of available walk-in testing and sexually transmitted infection clinic hours overlapping with their own working hours⁷⁶⁻⁷⁷.

5.6.3 Garfield County and Battlement Mesa during the Garfield County 2003-08 Boom

The 2008 Saccomanno Study reported several social and community concerns, including increase in spouse and child abuse, child neglect and stressed family relationships; increase in

alcohol abuse and drug abuse (especially methamphetamine); high suicide rates; increase in sexually transmitted infection (related to increase in temporary workers); access to health care and mental health services, availability of housing, cultural clash between longtime residents and industry workers; and traffic and public safety²¹. Concerns of the Battlement Mesa residents are similar to those reported in the Saccomanno report and reflect the county's earlier experience with the natural gas industry during the 2003-08 boom. Primary data on several baseline community health characteristics were collected and described below. These baseline characteristics are described in detail in Appendix C, including data on school enrollment, criminal activity, mental health and substance abuse, and sexually transmitted infections. The years 2005-2008 appear to be a period of increase for several of the measures observed.

Education: During 2005-08, school enrollment in Garfield County's District 16 increased by 37.4%. There was a change in the racial/ethnic distribution of students enrolled during this time, demonstrated by the decrease in the proportion of Caucasian/non-Hispanic students accompanied by a rise in the percentage of Hispanic children. Comments received from local education professionals indicate that classroom turnover of children of transient workers led to classroom disruption and diminished educational experience for all children. While the Antero project by itself will not likely cause a severe increase in the number of students, it is possible that the project could attract transient workers with families to Battlement Mesa and which may lead to some classroom turnover and subsequent educational disruption.

Crime: Crime data is not available for Battlement Mesa, so data from near-by Parachute Colorado is reviewed. Criminal activity was elevated during 2005-08, with a calculated average of over 300 arrests per year during that time, an increase of 50% over previous years. Crime rates decreased to previous levels of approximately 200 per year in 2009. It is unclear if the increase number of crimes simply reflects an increased population or is linked to the nature of the population of transient workforce. In any case, it is important to consider additional policing needs when there is a rise in criminal activity.

Sexually Transmitted Disease: Chlamydia and gonorrhea counts in Garfield County steadily increased during the 2005-2008 time period. In Battlement Mesa the largest number of cases occurred in 2007 and 2008. For the purposes of community health monitoring, it is important to review these data prospectively to evaluate future changes and trends.

Mental Health: Longitudinal data on mental health, substance abuse and suicide were not available for similar analysis. Results from a 2006 public health survey conducted by the Garfield GCPH found that upwards of 17% of residents were burdened by at least one of these conditions. Further, in many cases, when respondents reported experiencing mental health problems (defined as experiencing depression or stress), they also reported difficulties coping with substance abuse issues and engaging in physical activity⁸¹. A 2006 study of hospital discharge data for Garfield County regional hospitals found that 275 persons had been hospitalized for alcohol/substance abuse or suicidal behavior during the period 2003-05. Of

those 275, 47 (17.1%) had an alcohol/drug abuse diagnosis and 228 (82.9%) had a diagnosis of suicidal behavior⁸². Data from before or after this time period was not identified.

Substance Abuse: A 2006 survey of EnCana subcontractors working in Colorado, conducted by White River Counseling, reported that 66.3% of subcontractors were concerned about methamphetamine use among their employees, and 68.9% were concerned about heavy drinking. Concern was rated primarily with respect to productivity and workplace safety, however questions about community impact were also assessed. Notably, the respondents who reported higher levels of concern about the potential impact of employee substance abuse affecting the local community also had stronger feelings about being proactive to prevent alcohol and drug abuse⁷⁴. While not a conclusive study, this indicates that workers may be receptive to substance abuse prevention and intervention efforts presented as part of a community health initiative. For these reasons, it is important to monitor whether drug and alcohol use among community residents shifts with the introduction of gas drilling.

5.6.4 Current Battlement Mesa Community Amenities and Services

Community Experience: Battlement Mesa is a residential community with very little current commercial activity and no industrial activity within the PUD. The focus of the community has been on providing high quality residential experience. The community has been on the periphery of natural gas development during the county's 2003-08 boom and is currently experiencing natural gas development in several areas just outside the PUD boundaries. This past and current experience with the natural gas industry has influenced many citizens' perceptions of how the industry will impact the experience of living in Battlement Mesa.

Lifestyle/ Outdoor Amenities: Bike trails, golf course, community center, open space, visual vistas,

Public Health Services: To meet area community health needs, Garfield County operates a comprehensive Public Health Department (the GCPH) with locations in Rifle and Glenwood Springs⁸³. Battlement Mesa residents are eligible for all services provided by the GCPH. Some services relevant to the community health measures discussed include:

- General health education and screenings
- Communicable disease surveillance
- STD/HIV screening
- Crisis support hotlines for domestic violence, suicide and mental health
- Tobacco prevention
- Emergency service and assistance
- Adult education programs
- Human services, including employment, food and housing assistance programs

- Services of a designated environmental health department, including the C.A.R.E.S. project for responding to community concern about environmental health issues

5.6.5 Current and Possible Anticipated Impacts to Community Wellness from the Antero Project

Positive Community Impacts: It is possible that the increased workforce could help support new business within the community, such as a restaurant or coffee shop, which could enhance the community experience. Other positive economic impacts are included in the Economic Assessment.

Additional students would bring new funds to the schools, which could improve the educational experience for all Battlement Mesa children. Students would need to be present on “count day” (usually in early October) for the school to receive additional funds. Rapid turnover of students may decrease the positive impact of additional funds.

Antero has pledged one million dollars to the community, however, it is not known how these funds will be used but it is possible that this money could be used to enhance the community in some way.

Negative Impacts to Quality of Life: Citizen statements and comments indicate that some residents view the impending natural gas development as a change that already alters their experience of the Battlement Mesa community for the worse. According to several residents’ comments, Battlement Mesa represents an active choice of lifestyle and the industrial nature of the Antero project invalidates this choice. Furthermore, just the anticipation of near future development has altered the experience of community. Many resident comments and statements suggest that the shift of community focus from residential to industrial decreases the importance and influence of the residential life within the Battlement Mesa. Residents express concern that a rise of industrial influence, at the expense of residential influence, will lead to reduced quality of life experience. Uncertainties regarding many aspects of the development also serve to influence the experience of community for some residents. Some citizens report that the anticipation of natural gas development has led to anxiety and depressive symptoms. One former resident stated that the anticipation of the project led to loss of quality of life and the subsequent associated symptoms were a primary reason for leaving Battlement Mesa. Residents also report that uncertainty regarding the project contributes to anxiety and other symptoms.

Diminished access to outdoor recreational space, limited by industrial traffic and well development, is possible. In addition, the quality of outdoor recreational pursuits such as walking, biking, and golfing may be diminished by increased traffic, noise, air pollution, and other industrial activities. Such activities may also serve as constant reminders of the changed community focus. For example, the presence of many trucks can change the quality of a walk or bike ride, in addition to being a safety hazard and releasing pollutants into the air. If industrial traffic causes residents to feel the need to leave Battlement Mesa for a peaceful walk rather than

go out their door, then the quality of life has been impacted. Such unquantifiable, yet valued aspects of community appear to be at risk for some Battlement Mesa residents.

Negative Impacts to Social Capital/Social Cohesion: Perhaps the biggest contributor to the social cohesion of Battlement Mesa is its status as a “planned community”, where business, schools, and facilities and access for recreation are cohesively integrated with residential living⁹. As such, effects on the social cohesion of Battlement Mesa residents may be determined and intertwined with physical effects to the community itself, such as damaged or neglected roads, neighboring homes and businesses, public lands and parks. The Antero project seems to have already led to changes to social capital and cohesion. Whether further disruption to social cohesion takes place will depend on the extent to which the Antero project disrupts planned nature of the Battlement Mesa community, particularly during the 5 years of well development. It is possible that traffic, noise, truck emissions, well site emissions may disrupt the interaction of community and environment, providing a means for decreased social cohesion.

Boomtown Effects: The projected workforce of 120-150 is not expected to produce boomtown effects in Battlement Mesa. However, some impacts may occur on a smaller scale, therefore, consideration should be given to potential impacts of this relatively small workforce on this community.

Education: At this time it is not known how many students may be associated with the Antero workforce in Battlement Mesa, however, it is not likely that this workforce will increase school enrollment beyond capacity. However, children of transient workers may enter the school system in Battlement Mesa and frequent turnover may disrupt classrooms. In addition, it is possible that students entering school throughout the school year could burden school resources. If additional students are present at the time of “count”, the school would receive additional funds for these students. If, however, students enter the school after the “count” day, no additional resources are allocated from the state for those additional students.

Crime: Crime rates in Parachute during the last natural gas boom suggest that if the population of Battlement Mesa increases as a result of the Antero workforce, additional law enforcement may need to be considered.

5.6.6 Characterization of Community Wellness Impacts

As described above, community wellness is characterized by qualitative factors such as quality of life, social cohesion and the general experience of community, as well as quantitative factors such as school enrollment, rates of sexually transmitted infection, incidence of criminal activity, burden of substance abuse. For the purposes of this project, the impact due to the Antero project in Battlement Mesa on the community wellness of local residents was calculated in terms of both positive and negative impacts as follows:

Positive Health Effects

Impact	Direction of health effects	Geographical Extent of exposure	Populations that Benefit	Duration of exposure	Frequency of exposure	Likelihood of health effects as a result of Project	Magnitude of health effects	Priority
Community Wellness	Positive	Community wide	Yes	Long	Frequent	Possible	Low	Low*

*For an explanation of the ranking system used, see the chart at the beginning of Section 4.

The Antero project could support positive community change by supporting businesses that enhances community cohesion, such as a coffee shop or restaurant. The community would be enhanced by increased school funds, if additional students are present on school count days. In addition, the one million dollar contribution to the community could be used in such a way as to enhance the experience of community for Battlement Mesa residents. Positive community impacts would be expected to be **community-wide**, affecting residents throughout the Battlement Mesa PUD. Improved school funding would positively impact **youth** in particular. Positive community effects associated with the Antero project would be expected to last during the five year development phase and therefore be considered **long** in duration. Positive community effects are likely to **frequent** if they occur. However, whether there will be a positive health impact to the community is uncertain, particularly because it is unknown how much the workforce will support existing or future local business or whether children will be enrolled in the schools on count day. It is also unknown how the one million dollar contribution to the community will be used. Therefore, it is estimated that positive health impacts is **possible**. The magnitude of positive health effects are expected to be **low**.

Negative Health effects

Impact	Direction of health effects	Geographical Extent of exposure	Vulnerable populations	Duration of exposure	Frequency of exposure	Likelihood of health effects as a result of Project	Magnitude of health effects	Priority
Community Wellness	Negative	Community wide	Yes	Long	Frequent	Possible	Low to High	Medium-High*

*For an explanation of the ranking system used, see the chart at the beginning of Section 4.

Negative health effects that may be experienced include changes to social cohesion and declining quality of outdoor experience associated with the shift of residential to industrial community. In addition, stresses associated with perceived or real increased threat of crime, heavier industrial traffic, visible impacts to natural environment and recreation areas, rapid influx and possibly turnover of newcomers to the community, exposure to STI and substance abuse, and stress on schools. Much of the anticipated concern is rooted in the previous experience of the community with the 2003-08 natural gas boom. Many of these stressors may be felt by citizens throughout the Battlement Mesa PUD and therefore impacts would be **community wide**. Elderly and children may be more **vulnerable** potential negative to the community. The elderly may be more susceptible to crimes of theft or burglary, and may be most affected by changes in social cohesion and community experience. Children would be most affected by changes in school enrollment and classroom stability. They may also be affected by changes in outdoor areas used for play, which may overlap with areas prone to more industrial activity or along roadsides used more frequently for hauling drilling materials. We expect the community impacts to continue for the duration of Antero’s project (five years), and therefore be **long**. Even though the Antero project is relatively small, its location within the community will have more impact on community than development located outside the community boundaries. Therefore, it is expected that exposure to negative effects will be **frequent**. The likelihood that health impacts will occur as a result of negative effects to the community is **probable**. The overall magnitude of health effects is **expected to be low to medium** for most residents, however, some residents may experience **high** magnitude effects. We have prioritized community stress as medium but recognize that the impacts to the community depend in a large part on the mitigation of other stressors. If mitigation of air, traffic and noise are not sufficient then the sense of community will be negatively impacted, associated stress will increase, and steps to protect the community should take a high priority.

5.7 Assessment of Economic and Employment Impacts on Health in Battlement Mesa

Will a boom and bust cycle occur? We are now in a bust and the food banks drying up. What will happen to the property values?
February 3, 2010 stakeholder meeting

Economic conditions of a region can have important impacts on the health of the population. Employment status can impact individual health and well-being and economic uncertainty can impact health by increasing stress. Economic development of poor and rural areas is often credited with bringing resources that support health; however natural gas development in Garfield County and other parts of the West have had mixed economic impacts in the past. On the positive side, the natural gas industry brings jobs to a region and the increased economic activity supports other commercial and industrial businesses. On the other hand, the value of private property where natural gas development occurs has been shown to decline. In addition there are anecdotal reports of residents moving out of areas of natural gas development. Residents of Battlement Mesa have expressed concerns that sudden economic growth within their community may negatively impact the community by causing housing and goods inflation, and impacting services. Others in the community are concerned that gas industry development will decrease the appeal of the community and cause a decrease in home values, leading to physical and emotional stress and impacting community unity. A review of economic and employment impacts of the Antero gas project in Battlement Mesa is warranted.

5.7.1 Ways Economic Activity can Influence Health

Income and employment influence many central determinants of health and wellbeing, including quality of housing, education, diet, lifestyle, and access to health services. In developed countries, employment is directly related to positive health outcomes⁸⁴. In the United States, stress related to job loss, unemployment, and job instability is strongly correlated with self-report of poor health⁸⁵. Also in the United States, health insurance access is directly related to employment for those under the age of 65. Loss of insurance can lead to decreased health care access and poorer health. Increased economic activity of a region can increase jobs and tax revenues which can support public services, thereby enhancing community wellness. On the other hand, if the economic activity leads to a decrease in land values, resulting psychological stress may impact health. Boom and bust cycles of an industry can also lead to community stress and cause disruption of public services, which may impact health. Prolonged stress can impact overall physical and mental health, including impacts to cardiovascular disease, immune system effects, depression, and anxiety⁸⁶.

5.7.2 Past Natural Gas Economic Impacts in Garfield County

Employment: The 2007 Socio-Economic Impact study, commissioned by Garfield County and conducted by BBC Research provides a breakdown of economic activity in the county during the 2003-2008 natural gas boom. In 2005, industry contributions to total county employment included regional services, tourism, external household funding (retiree and non/wage income)

gas development, government services, net out-commuting (to jobs in neighboring counties) manufacturing and agriculture. External monies brought to the county by retiree/non-wage income ranked 3rd highest in total jobs supported, while the natural gas industry ranked 4th highest in total jobs in the county⁸⁷. The subsequent global economic slowdown and national decline in natural gas prices in 2009 led to a rapid decline of jobs and economic activity associated with the industry.

Property Values: Housing prices may be adversely affected by proximate natural gas development activities. The Garfield County Land Values and Solutions Study, conducted in 2006 by BBC research determined that property values decreased when a natural gas well was developed on the property. The value of the property was lowest during the drilling phase and began to recover during the completion phases. While the value continued to rise as time since drilling increased, the value of a property did not achieve the same level of appreciation as similar properties without a well. The report also states that increased property value as a whole may occur as a result of increased demand due to natural gas industry worker influx, but the increase is diminished in instances when the property has a well on it. The authors used interview information to determine that possible causes of decreased value include uncertainty and risk adverse behavior on the part of buyers, realtors, and lending institutions⁸⁸.

Boom/Bust: Natural gas development has created boom/bust economies in Wyoming, Colorado and other regions of the West over the last decade, with mixed economic impacts to local residents and workers. A case study conducted in Wyoming indicates that many high paying industry jobs require particular skill sets and these jobs are often filled by itinerant industry workers. There were local residents that directly benefited from increased economic activity. On the other hand, some local residents experienced negative economic impacts associated with inflation, increased property taxes and decreased services^{71, 80}. Some local businesses benefit from an increase in commerce, but other businesses were not able to expand to meet demand. Increased commerce may bring “big box” stores and other new businesses, which put strain on longtime local business, and some ended up closing. Some local residents not earning high industry wages were not be able to keep up with rising cost of living, housing prices, and property taxes. While those working for the industry and related service industries may have less stress and better health related to the economic activity, a local, inflationary economy can cause psychological stress to local workers and residents⁷⁹. Because the gas well development phase is very labor intensive, boom economics associated with worker population influx predictably cycles to bust economics when the development phase for the area is over and development moves on to other regions.

Economic changes associated with natural gas development may improve health for some due to individual improvement in job status. Others may be at risk of increased stress associated with declining property value. In addition, changes could bring job insecurity to some residents, thereby increasing stress.

5.7.3 Antero Drilling Plans in Battlement Mesa

Employment: The number of workers involved in well development can vary widely according to pad site topography and geology, number of wells per pad, characteristics of the gas, etc. Most workers are employees of companies subcontracted to perform very specific development jobs and remain on a given pad only as long as needed, sometimes only days, weeks or a few months. Antero plans to use two rigs to develop approximately 200 wells in the PUD over the course of approximately five years. Antero estimates that this kind of serial operation will keep approximately 120-150 workers working within the PUD. Once all the wells in the PUD are developed, the workforce needed to maintain the wells over the 20 years of production is relatively small.

Industry workers will realize direct economic benefits of high wage industry jobs. Tax revenues from the Antero project will be realized at a county level. The presence of 120-150 workers in the PUD will provide indirect economic benefits to some local businesses. However, there are very few businesses in the PUD, therefore this trickle down effect is not likely to have a substantial positive impact on most of the Battlement Mesa citizens. Local residents not employed by the industry or supporting businesses may not benefit from economic growth but may be at risk for negative impacts of decreased housing values, goods price inflation, and potentially compromised services.

Property Values: The impact of job growth to the economy of Battlement Mesa is likely to include some demand for local housing. Some workers may live in Battlement Mesa, thereby creating demand for housing, although it is not clear if this will be primarily in the rental or sales market., Some workers will live outside of the Battlement Mesa community.

The 2006 Garfield County Land Values and Solutions Study focused on rural properties with a well on the property. The natural gas development project in Battlement Mesa is different in that there will be 200 wells within the PUD, but none on any individual residential property. In Battlement Mesa, the development period, which was noted to have the most profound impact on land values, will be at least 5 years. This development period will be longer than development period for wells in the study. It is likely that Battlement Mesa citizens will see decreased property values as a result of well development within the PUD and the impacts could affect most of the properties in Battlement Mesa. Furthermore, the impact may be substantial given the prolonged development period. While the recent economic downturn has also universally impacted property values, properties close to natural gas development are likely to be additionally impacted by the development as well as the economy. Once the development is over and the sites are undergoing only production activities , land values may recover, although the Land Values Study suggests that values may not ever become equivalent to properties not impacted by natural gas.

Boom/Bust: It is not likely that the two rig operation will create a boom or bust economy in Battlement Mesa.

5.7.4 Characterization of the Economy, Employment and Property Values Impacts on Health

Positive Health Impacts

The positive health impacts on the economy, employment and housing values due to the Antero project in Battlement Mesa on the health of local residents can be characterized as follows:

Impact	Direction of health effects	Geographic extent of exposure	Populations that benefit	Duration of exposure	Frequency of exposure	Likelihood of health effects as a result of project	Magnitude of health effects	Priority
Economy, employment and property value	Positive	Community wide	Few	Long	Infrequent	Unlikely	Low	Low*

*For an explanation of the ranking system used, see the chart at the beginning of Section 4.

Positive health impacts could be expected in relation to less stress associated with employment for workers living in Battlement Mesa, as well as increased economic activity for those operating some businesses within the PUD. The positive impact of employment and economic activity may be felt **community wide** should businesses and services increase as a result of the workers presence. Children and families of those employed by Antero and the subcontractors and local businesses are likely to **benefit** by decreased stress associated with economic security and possibly by increased access to health care if health insurance is offered with their job, but these are likely to be few relative to the entire Battlement Mesa Community. The duration of the economic benefits is likely to occur during the 5 year development period, therefore be **long** in duration. The economic benefits of this small operation are likely to be distributed throughout the county, therefore the frequency of economic benefits in Battlement Mesa are likely to be **infrequent**. However, because the economic gains to the Battlement Mesa residents will be small, the likelihood of positive health impacts resulting from the small economic gains in Battlement Mesa is **unlikely**. The magnitude of the health impacts are expected to be **low**.

Negative Health Impacts

The negative health impacts on the economy, employment and housing values due to the Antero project in Battlement Mesa on the health of local residents can be characterized as follows:

Impact	Direction of health effects	Geographic extent of exposure	Vulnerable populations	Duration of exposure	Frequency of exposure	Likelihood of health effects as a result of project	Magnitude of health effects	Priority
Economy, employment	Negative	Community wide	Yes	Long	constant	Likely	Low to high	Low*

and property value								
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*For an explanation of the ranking system used, see the chart at the beginning of Section 4.

Economic impacts, and subsequent stress and related health effects are likely to be negative for those not directly employed by the industry. The adverse economic effects of decreasing property values are likely to increase stress for many residents of Battlement Mesa. Negative economic impacts, including decreased property values, may be experienced **community-wide**. Those on fixed incomes may be more **vulnerable** to the loss of property value. The decline of property value is likely to be **long** lasting: at least as long as the development period, which is expected to be at least 5 years. It is unknown how long property values may be impacted after the end of the development period. The frequency of having stress and related symptoms as a result of declining property value may be **constant**. It is **possible** that the severe stress could worsen underlying disease. The magnitude of health impacts would be related to the degree of stress felt by the individual and may be **low to high**.

5.8 Assessment of Impacts to Health Infrastructure in Battlement Mesa

“What will be the impacts to health care in Battlement Mesa?
February 3 stakeholder meeting”

Health infrastructure can include private and public medical services, hospitals, and emergency transport services. Availability, access and quality of local clinical and public health services can be limited in small communities, due to small populations, low rates of insured patients, and limited public resources. New industry can lead to positive and /or negative impacts on the health care infrastructure. Industrialization of a rural community can increase the insured population and local revenues, which may provide resources for expansion of local clinical and public health care services. On the other hand, without substantial investment in health infrastructure, population and employment changes may increase both clinical and public health care utilization, stretching already limited resources. The citizens in the rural community of Battlement Mesa have expressed concerns that development of natural gas resources in their community may negatively impact available medical resources. Because the Battlement Mesa health infrastructure may be exposed to utilization changes, a review of potential health impacts is needed.

5.8.1 Private and Public Health Services and Health

Availability, access and quality of medical health services can have direct impacts on individual physical health. Research demonstrates that residents of rural communities often have decreased clinical health care services available to them, negatively impacting health ⁸⁹⁻⁹². Limited

availability can be due to a combination of small population and low health insurance coverage, both of which limit the financial viability of both clinical and public services. As a result, residents of rural communities may need to travel long distances for care.

Increased economic activity in a community may bring more patients and insurance coverage which can support increased and diversified clinical medical services. On the other hand, a rapid increase in population, particularly uninsured population, can increase utilization of services beyond capacity and may strain the finances of small medical facilities and decrease incentive to increase services⁷⁸.

Public health programs provide services to the general community and can fill some gaps for the un-insured⁹³⁻⁹⁴. Vaccination programs, health screenings, and communicable disease clinics provide limited clinical health care to uninsured populations. Public health programs that focus on food safety programs and health education programs benefit the community at large. When the local population increases, particularly an uninsured population, local public health services may experience increased utilization while capacity may lag or never catch up. Cyclical economic conditions may also cause intermittent strain on public health programs while making it difficult to adjust capacity to need. On the other hand, local revenues may be able to increase public health services, should tax and royalty structures and community priorities permit it. In some cases, severance taxes from extractive industries are sent to state agencies, with little benefit to the localities where the industrial activity is occurring⁷⁸.

5.8.2 Current Health Infrastructure Conditions

Currently, primary clinical health services in Battlement Mesa include a primary care clinic administered by the Grand River Hospital District, staffed five days a week by family medicine providers and visiting specialists. The clinic also provides physical therapy services three days a week. There is also separate chiropractic, orthopedic, and dental services in Battlement Mesa. There are four hospitals within 60 minutes of Battlement Mesa. The closest hospital is Grand River Medical Center in Rifle, 20 minutes away. This is a 12-bed hospital with an emergency room, surgical, acute care facilities, and outpatient clinics. Grand River Medical Center is a Level 4 trauma center; it does not provide have obstetric (baby delivery) services. Valley View Hospital in Glenwood Springs, 46 miles away, has 80 beds, a 24 hour emergency department, and obstetric services. Community Hospital in Grand Junction, 48 mile away, has 78 beds and does not provide obstetric services. St. Mary's Hospital in Grand Junction, 49 miles away, is a Level 2 trauma center and has obstetric services. The closest Level 1 trauma center is 4 hours away in Denver. Patients needing such services may be airlifted. Emergency response and transport is provided by the Grand Valley Fire Protection District. There is an occupational health clinic operated by Grand River Hospital District in Battlement Mesa that sees work related injuries five days a week.

There is a 40 room assisted living facility in Battlement Mesa. The closest skilled nursing facility is in Rifle and there are other nursing facilities in the county. Meals on Wheels is offered in Battlement Mesa and a senior center in Parachute offers lunch daily.

Public Health services for Battlement Mesa citizens are offered by GCPH. Services include vaccination clinics, communicable disease surveillance, health education programs, safety programs, health screening for Medicaid patients, and programs for underinsured children and low income families. The Environmental Health Program serves the public by evaluation and education regarding environmental health risks related to air and water quality, sewage treatment, mosquito control, and environmental sustainability. The GCPH offices are located in Rifle and Glenwood Springs.

Insurance coverage rates for Battlement Mesa residents are not available. According to the Colorado Household survey conducted in 2008-9 by the Colorado Department of Health Care Policy and Financing⁹⁵, 14% of Colorado residents were uninsured and in the five county region that included Garfield County, 21% of the population was uninsured (the highest in the state). In Colorado, 15% of employed adults were uninsured. Insurance status for natural gas industry workers is unavailable.

5.8.3 Antero Drilling Plans in Battlement Mesa and Healthcare Infrastructure

The development of natural gas wells requires several labor intensive phases, which can last several years for large natural gas projects. Most health infrastructure impacts relate to the expanded workforce during the well development phase. Antero estimates an average of 120-150 workers will be working in Battlement Mesa.

Workers associated with natural gas development and production projects can increase utilization of emergency services due to increased work related and transportation related accidents associated with the injury⁷⁸. Insured natural gas workers utilizing the health care system could provide positive support to the system as long as the utilization does not exceed capacity. Should utilization exceed capacity, then the availability of services may be negatively impacted. Uninsured workers strain the health care system. Public health programs may see an increase of utilization as a result of an increase the insured and uninsured population. On the other hand, public health programs may benefit from increased local revenues, as long as utilization does not exceed capacity. Should this happen without increased supporting revenue dedicated to public health, then services may be compromised. The cyclical nature of the natural gas development and production, which is dependent upon market influences, technological advances and regulatory forces, can make both clinical and public health infrastructure planning difficult and lead to a mismatch between needs and services.

Some workers and their families are expected to utilize clinical and public health services in Battlement Mesa and other local services. According to Antero representatives, Antero workers are offered health insurance; however, information regarding health insurance coverage for

subcontracted workers (the majority) is not available. Some clinical services may see an increase in utilization, including emergency, urgent care and trauma services and services related to pediatric care for young families. Depending on the insurance status of the workers, these services may or may not be directly supported by the industry. Utilization of health services by insured gas workers will support the health system. Clinical and emergency providers may be negatively impacted by uncompensated care, and public health services may see an increase in local needs without increased funding. Revenues to Garfield County could be used to support public health services, depending upon prioritization of needs.

5.8.4 Characterization of Healthcare Infrastructure Impacts

Positive Effects on Healthcare Infrastructure

The positive health impacts on healthcare infrastructure due to the Antero project in Battlement Mesa on the health of local residents can be characterized as follows

Impact	Direction of health effects	Geographic Extent of exposure	Benefited populations	Duration of exposure	Frequency of exposure	Likelihood of health effects as a result of Project	Magnitude of health effects	Priority
Health Infrastructure	Positive	Community-wide	Yes	Long	Infrequent	Unlikely	Low	Low

*For an explanation of the ranking system used, see the chart at the beginning of Section 4.

Positive impacts to the health care system are anticipated to be small given Antero’s project involves 120 to 150 workers, spread into a community of approximately 5,000 in Battlement Mesa and 55,000 in Garfield County. Positive health impacts could be expected in relation to increased utilization of health care services by insured patients. Any insured workers or family members utilizing health care services in Battlement Mesa provide clinic support, necessary for continuing clinical operations. However, the extent of such support may not be sufficient to lead to increased availability, quality, or diversity of services. Local tax revenues from the Antero project will contribute to the overall county fund which may be used to support public health services, but are not likely to be large enough to directly impact public health services in Battlement Mesa. Should health services be supported in Battlement Mesa, the improvements would be beneficial for the **entire community**. Those that utilize health care services most frequently such as the elderly, young children and disabled may derive the most **benefit** of expanded services. Should health service impacts occur, they are likely to be noted during the development period lasting approximately **5 years**. Given the relatively small number of workers and families associated with the Antero project the frequency of positive effects on the health care system in Battlement Mesa are likely to be **sporadic**, occurring when an insured worker or family member utilizes the health care system. Not all workers/families are expected to utilize Battlement Mesa health services it is **unlikely** that Battlement Mesa citizens will

experience positive impacts as a result of positive changes to the health care infrastructure related to the Antero project. The magnitude of positive health effects due to health infrastructure impacts are expected to be **low**. For these reasons, the health care infrastructure is prioritized as low compared to other potential stressors.

Negative Effects on Healthcare Infrastructure

The negative health impacts on healthcare infrastructure due to the Antero project in Battlement Mesa on the health of local residents can be characterized as follows

Impact	Direction of health effects	Geographic Extent of exposure	Vulnerable populations	Duration of exposure	Frequency of exposure	Likelihood of health effects as a result of Project	Magnitude of health effects	Priority
Health Infrastructure	Negative	Community-wide	Yes	Long	Infrequent	Unlikely	Low	Low*

*For an explanation of the ranking system used, see the chart at the beginning of Section 4.

Negative impacts to the health care system are anticipated to be small given Antero’s project involves 120 to 150 workers, spread into a community of approximately 5,000 in Battlement Mesa and 55,000 in Garfield County. Negative impacts to local health infrastructure could occur if uninsured workers utilize local health services without the ability to pay for the services, however, the extent of such a strain may be small enough that it is unlikely to lead to decreased availability and quality of services. Impacts of uninsured workers are likely to be noted by providers, but it is unclear that this would reach a level that would negatively impact either clinical or public health services. Should health services be affected in Battlement Mesa, the effects would involve the **entire community**, although those that utilize health care services most frequently such as the elderly, young children and disabled may be more **vulnerable** to negative impacts such as decreased availability. Should health service impacts occur, they are likely to occur during the **5 years** of well development. Given the relatively small number of workers and families associated with the Antero project the frequency of negative effects on the health care system in Battlement Mesa are likely to be **sporadic**, occurring when an uninsured worker or family member utilizes the health care system. It is possible that large financial strain to local providers, particularly emergency care providers, could occur should expensive emergent care become necessary for an uninsured worker, but this is anticipated to be an infrequent event. It is **unlikely** that Battlement Mesa citizens will experience negative health impacts as a result of changes to the health care infrastructure related to the Antero project. The overall magnitude of health effects due to health infrastructure impacts are expected to be **low**. For these reasons, the health care infrastructure is prioritized as low compared to other potential stressors.

5.9 Assessment of Accidents and Malfunctions Impacts on Health

Is there a plan to prevent pipeline leaks and explosions?
February 3, 2010 stakeholders meeting

Accidents and malfunctions can occur as a result of a variety of causes, including equipment failure, human error, and environmental hazards. Identification of potential sources of accidents and malfunctions can lead to effective prevention efforts, while recognition of potential health, community, and environmental effects can direct response strategies which can decrease impacts should an incident occur. COGCC addresses accident prevention (fire, explosion, hazardous materials release, pipeline maintenance) throughout the Rules Document⁵. The 600 series rules address safety regulations. For example, setbacks for pad locations are 150 feet in low population density areas, 350 feet in high population areas and 1000 feet for other facilities such as schools, hospitals, etc. Rule 906 specifies reporting, prevention and clean up requirements for spills and releases. Pipeline regulations are found in Rules 1101-1103, however, there is not a designated setback for pipelines in the COGCC rules.

According to the Denver Post, there were over 1,000 spills statewide and over 230 in Garfield County reported to the COGCC between January 2008 and June 2010⁹⁶. There were 21 fires, loss of well control (including gas kicks), and explosions in Garfield County that were reported to the COGCC from January 1997 to August 2010 (COGCC database). The Battlement Mesa citizens have expressed concerns regarding the potential for accidents and spills and the potential for related health and safety impacts. Because incidents of this nature happen with low, but predictable, regularity, an assessment of potential health impacts is warranted.

5.9.1 Accidents, Malfunctions and Health

Accidents and malfunctions can occur as a result of well installation errors, material failure, construction and operations accidents, equipment accidents and failures, third party activities, and environmental episodes. Incidents can manifest as fires, explosions, hazardous material losses, and/or spills. Fires and explosions may result from well blowouts, gas kicks, pipeline leak or rupture, ignition of flammable materials during storage, transportation or transfer. Hazardous materials spills/loss may be due to transportation accidents or equipment failure, during material transfer, leaking valves, fittings, etc in storage equipment, well blowouts, and improper disposal of hazardous materials. Environmental conditions such as wildfires, tornados, lightning, blizzards, and extreme heat and cold may cause or exacerbate incidents.

These incidents may result in release of contaminants into surface water, ground water, soil, and air. Releases associated with significant accidents and malfunctions are likely to be acute, high level emissions. Releases of produced water into soil and water sources contain salts, metals, VOC/BTEX, drilling fluids, and hydraulic fracturing chemicals. Spills of drilling and hydraulic fracturing materials could include a variety of chemicals such as diesel fuel and other hydrocarbons, VOCs, acids, glutaraldehyde, and other proprietary chemicals. Releases of natural

gas into water or air contain VOCs. Combustion products of hydrocarbons released during fires contain PAHs, including naphthalene, sulfur oxides, nitrogen oxides, PM and other chemicals.

Examples of potential health effects of chemicals given sufficient exposure:

Chemical	Acute health effect
VOC	Irritant, neurological
Benzene	Neurological, anemia
Naphthalene	Anemia
Combustion Products	Respiratory, cardiovascular, irritants
Hydrochloric acid	Irritant
Glutaraldehyde	Irritant, allergic reactions

In addition to chemical exposures, accidents and malfunctions can expose nearby persons to injury or death. Although outcomes are potentially severe, these exposures are generally short-term, infrequent, and only those in close vicinity at the time of the accident are at risk. Employees on the well pad during a fire or explosion are at most risk for injury. Although the likelihood of an explosion involving a pipeline is small, persons in the community may be at risk for serious injury or death should such an incident occur. For example, an explosion occurred in a rural area of Johnson County Texas on July 7, 2010 when crews installing a communications pole hit a 36-inch gas transmission line. Newspaper reports indicated that one worker was killed, and seven injured. The fire was reported to be 400-600 feet in circumference and intense heat was felt 900 feet away. The gas line valves were shut off 1.5 hours after the explosion, and the fire stopped. A more recent explosion of a 30 inch gas distribution line in San Bruno, California on September 9, 2010, destroyed 150 homes and killed four people. The cause of this explosion is still unknown. Other accounts of explosions related to natural gas development, production, and distribution can be found in newspaper accounts throughout the country.

5.9.2 Current Conditions for Accidents and Malfunctions

According to the Denver Post, 236 spills in Garfield County were reported to the COGCC between January 1, 2008 and June 15 2010, involving 66,386 barrels of fluids (primarily drilling liquids and produced water)⁹⁶. During that time, Antero submitted approximately 5 percent of the gas permits in Garfield County, reported 15 spills to the COGCC (6 percent of the spills). Antero's contribution of 1707 barrels of fluids to the total barrels spilled in Garfield is small (2.6 percent). Five of Antero's 15 spills have required remedial action and one resulted in a notice of alleged violation (also known as NOAV) because of failure to report the spill to COGCC per the oil and gas rules. The number of spills reported to COGCC may not capture the total number of spills that have occurred because COGCC only requires reporting of spills involving five or more barrels. It is not known how many spills of less than five barrels have occurred in Garfield County. However, it is reasonable to assume that there have been some spills involving less than five barrels that have not been reported to COGCC.

Antero has received four other Notice of Alleged Violations since January 1, 2008. The latest on July 27, 2010 was in response to the release of an unknown quantity of water and hydrocarbons to a seep on the Eastern wall of Grant Brothers Gravel pit as a result of a faulty pipe joint weld on a pipeline. Another Notice of Alleged Violation on July 14, 2010, was in response to several odor complaints filed during flow back operations on the Watson Ranch well pad. Another Notice of Alleged Violation issued on January 04, 2010, resulted from lack of secondary containment of condensate from hydraulic fracturing tanks and observation of condensate lying on the ground around hydraulic fracturing tanks and separation units. COGCC issued a fourth Notice of Alleged Violation because Antero spudded a well prior to permit approval in June 2009³¹.

Local newspapers and COGCC databases have recorded numerous incidents of well fires, blowouts, tanker spills, condensate tank emissions and pit discharges in Garfield County. These incidents have resulted in contamination of surface and ground water with BTEX, and other chemicals. Residents have reported a variety of health effects, including acute and long term neurological complaints, upper respiratory issues, headaches and fatigue, and nausea. There have been no reported fatal injuries related to accidents or malfunctions in Garfield County reported to COGCC. As noted in comment CIT61 on the September 2010 Draft HIA, there may well be more of these types of incidents than are reflected in the local media and the COGCC database.

5.9.3 Antero Drilling Plans in Battlement Mesa and Accidents and Malfunctions

Applying Antero's spill rate of 15 spills per 252 permit applications (6 percent) and rate of 5 remediations per 15 spills to the 200 wells proposed for Battlement Mesa it is estimated that approximately 12 spills of 5 barrels or more may be expected in Battlement Mesa over the life of the project. It can be expected that at least four of these spills may have some impact to soil, groundwater, or surface water requiring remediation and have the potential to impact public health.

As discussed in the Water and Soil Quality Assessment, Battlement Mesa residents use a municipal water system that draws water from the Colorado River. Secondary water supplies include four shallow ground water wells which were used prior to the establishment of the water treatment plant. These wells are monitored once a year for quality.

The Surface Use Agreement between Antero and The BMC specifies a temporary 50 foot easement for pipeline construction and a permanent 25 foot easement for gas gathering lines. Antero also plans to build a wastewater pipeline system along the same easements. The Surface Use Agreement states that the gas gathering lines will be 48 inches below the surface. The gas gathering lines in Battlement Mesa will be 12 inches in diameter. According to maps provided at community meetings, the pipelines primarily follow haul routes, however, there is one pipeline that will cross an open space in a residential area between Valley View Village and Fairways Village and another that crosses open space to the north of Stone Ridge Village. In addition, the

proposed pipelines for the Parks and Recreation pad, A pad, and B pad appear to be very close to some homes in Stone Ridge Village and Tamarisk Meadows. It is unclear from available maps exactly how far this pipeline, or any other pipeline on the map, is from residences, schools and other buildings.

Although the COGCC rules allow for 350 foot well pad setbacks in densely populated areas, the Antero well pads in Battlement Mesa are all at least 500 feet from the nearest residence. Antero has proposed measures in addition to those required in the COGCC oil and gas rules to prevent well blow outs. These measures include use of blow preventers rated to 5000 psi and surface casings set to an average of 2,200 feet. However, preventative measures do not rule out the possibility of a catastrophic event arising from a pipeline explosion, well fire, or major spill in the Battlement Mesa PUD as a result of Antero’s project. There also is the possibility for catastrophic events as a result of vandalism and sabotage of Antero’s project. In the comments on the original version of the HIA, the Battlement Mesa Concerned Citizens raised the concern of well pad locations at the base of steep slopes with dry vegetation that could increase the risk of a well pad fire spreading rapidly up slope towards homes.

5.9.4 Characterization of the Impact from Accidents and Malfunctions

Impact	Direction of health effects	Geographical Extent of exposure	Vulnerable populations	Duration of exposure	Frequency of exposure	Likelihood of health effects	Magnitude of health effects	Priority
Accidents and malfunctions	Negative	Local or Community wide	Yes	Short	Infrequent	Possible	Low to high	High*

*For an explanation of the ranking system used, see the chart at the beginning of Section 4.

When considering the possible health impacts due to an accident or malfunction of Antero gas operations in Battlement Mesa, the health effects are likely to be **negative**. Depending upon the size and nature of the incident, health and safety impacts may be felt only in close proximity (**local**) or throughout the PUD (**community-wide**). Again, depending upon the nature of the incident, certain populations may be more **vulnerable** to health impacts. For instance, elderly or frail and those living in the assisted living facility, may have difficulty evacuating an area quickly. Children in school may also be slower to evacuate. Those with underlying medical conditions such as pulmonary or cardiovascular disease, may have negative health effects from fires or air emissions at levels that are may not have significant impact to others. Accidents and malfunctions are likely to be **short in duration** and **infrequent**. Given the 6% rate of incidents in the industry and within Antero’s other operations in Garfield County, incidents are likely to occur and it is **possible** that health impacts will occur. The health effects will be **low to high** in magnitude, potentially ranging from minor irritation to severe injury or death. For these reasons, accidents and malfunctions are prioritized as high compared to other potential stressors mainly because of the possibility for severe injuries and death in the event of a catastrophic event.