

## **APPENDIX E: COMMENTS ON SEPTEMBER 2010 DRAFT HEALTH IMPACT ASSESSMENT**



BCC  
BATTLEMENT CONCERNED CITIZENS

The Battlement Mesa HIA  
c/o Roxana Witter  
Colorado School of Public Health  
13001 East 17th Place B119  
Aurora, CO 80045 [maperc@ucdenver.edu](mailto:maperc@ucdenver.edu)

November 15, 2010

Dear Dr. Witter:

Members of the Grand Valley Citizens Alliance and our sub-committee, Battlement Concerned Citizens, would like to respond primarily on the recommendations in the Health Impact Assessment report. We recognize that some of these ideas have been forwarded to the HIA team, but we would like to re-iterate their importance and suggest they be incorporated into the existing recommendations of the final HIA.

Thank you again for the hard work and research already invested in the report by members of your team.

(signed) *Leslie Robinson*  
GVCA Board Member

(signed) *Dave Devanney and Ron Galterio*  
BCC Co-Chairs

**4.1 Assessment of air quality on health in Battlement Mesa**  
**(pg. 19)**

Based on these findings, the following are some of the suggested ways to reduce the potential impact of air emissions.

- BCC1** 1. Require that a buffer of not less than one-thousand feet be instituted between any well operation and any human occupied dwelling regardless of mitigating circumstances.
- BCC2** 2. Prohibit open waste pits and require closed loop systems for all phases of operation.
- BCC3** 3. Prohibit open flaring-and release of air pollutants; and require recovery of all emissions.
- BCC4** 4. Require all new equipment to be installed on all well sites; install underground infrastructure of pipelines before drilling commences.

**BCC5** 5. Conduct baseline measurement of ambient air concentrations for air toxics within the Battlement Mesa PUD. Continue ambient air monitoring through out the development of Antero's natural gas project. Detection limits should be at or below EPA Regional Screening Levels and air quality standard.

**BCC6** 6. Require comprehensive and continuous air quality monitoring at all well sites and other strategic locations within the Battlement Mesa community. Conduct air sampling at COGCC setbacks (150 feet, 300 feet), Antero setback (500 feet) and set back requested by citizens (1000 feet) during well installation, completion, and production operations and at the proposed water storage facility.

**BCC7** 7. Require remote alarms systems and emergency notification to citizens for fluid or gas leaks, especially hydrogen sulfide.

**BCC8** 8. Require full disclosure of all chemicals, with their volumes, concentrations, and Material Safety Data Sheets (also known as MSDS), used in natural gas development process to government agencies and Battlement Mesa Residents.

**BCC9** 9. Provide for strong enforcement and establish substantial penalties for non-compliance.

**BCC10** 10. Provide for air quality testing to occur within a few hours following an event or complaint.

**BCC11** 11. Require complete dust suppression during all phases of construction and operation of pipelines, well sites, and other related operational facilities. Provide extra street-sweeping to remove mud and dirt accumulating from drilling traffic. Gravel or pave spur roads leading to well pads.

#### **4.2 Assessment of water and soil quality on health in Battlement Mesa (pg. 26)**

##### **Recommendations to Reduce Impacts to Public Health from Water and Soil Pollution (pg.33)**

Based on these findings, the following are some of the suggested ways to reduce the potential impact of water and soil pollution.

**BCC12** 1. The BMMD water plant needs to be staffed 24/7 to monitor the filtering and pumping operations of both incoming and out-going water and to respond to emergency shut down of river pumping system.

**BCC13** 2. Plant operators should have college or technical school certification or comparable experience specifically pertaining to water treatment.

**BCC14** 3. There is a lack of soil concentration data. Soil ingestion is certainly a pathway of concern for children (and pets) in many risk assessments. Baseline soil testing on and around proposed well pad sites should be made. Chemical concentration data in soil from existing operations should be obtained to study effects on health.

#### **4.3 Assessment of transportation and traffic on health in Battlement Mesa (pg. 33)**

##### **Recommendations to Reduce Impacts to Public Health from Traffic and Transportation (pg.39)**

Based on these findings, the following are some of the suggested ways to reduce the potential impact of traffic and transportation.

**BCC15** Truck traffic from adjacent well pads to Battlement's PUD is already affecting residents, especially on Stone Quarry Road. Citizens complain of 24/7 traffic noise, diesel truck idling during the day and night, causing pollution and smells; and irritating truck mufflers and jake-brakes sounds. Therefore, better drilling traffic avenues are needed away from residential areas.

**4.4 Assessment of noise, vibration, and light pollution on health in Battlement Mesa** (pg. 39)  
**Recommendations to reduce impacts to public health from noise, vibration, and light** (pg 43)

Based on these findings, the following are some of the suggested ways to reduce the potential impact of noise, vibration, and light pollution.

**BCC16** Conduct noise monitoring at COGCC setbacks (150 feet, 300 feet), Antero setback (500 feet), and set back requested by citizens(1000 feet) during well installation, completion, and production operations and at the proposed water storage facility.

**4.5 Assessment of impacts on community wellness** (pg. 44)  
**Recommendations to Reduce Impacts to Community Wellness** (pg.50)

Based on these findings, the following are some of the suggested ways to reduce the potential impact to Community Wellness.

**BCC17** 1. The report should separate "at risk" groups such as senior citizens and youth. By aggregating empirical data and qualitative observations across the entire Battlement Mesa population may minimize the adverse community wellness effects upon vulnerable groups.

**BCC18** 2. More research is needed about mental health effects in the Battlement elderly population in regard to their social and emotional reactions to natural gas drilling within their community. Their distress could be leading to depression, anxiety, and other ailments.

**4.6 Assessment of economic and employment impacts on health in Battlement Mesa** (pg. 50)  
**Recommendations to Reduce Impacts from Boom and Bust Cycles** (pg.54)

Based on these findings, the following are some of the suggested ways to reduce the potential negative aspects and maximize potential positive aspects from economic and employment impacts.

**BCC19** 1. Impact on real estate values should be less if the well pads and rigs are 1,000 feet or more away from the residential areas, schools, and businesses.

**BCC20** 2. By requiring best drilling practices, impact buffers, better sound, light, and traffic mitigation, this will create more local jobs.

**BCC21** 3. Emphasize local hiring for sub-contractor positions in the gas fields; employees should have health insurance coverage.

**BCC22** 4. Require Antero to post a surety bond in an amount equivalent to the total assessed valuation of all property within the Battlement Mesa PUD as determined by the County Assessor to compensate and protect residential and community property in the event of any catastrophic incidents.

**4.8 Assessment of accidents and malfunctions impacts on health** (pg. 59)

## Recommendations to Reduce Impacts from Accidents and Malfunctions (pg.63)

**Note:** We believe the magnitude of the accidents and malfunctions potential in the Antero Company plan to drill 200 gas wells in the Battlement Mesa PUD is seriously under-rated in the HIA. Given the potential for injury, death and property damage this activity poses in a residential area, we believe a health impact rate of -15 is more appropriate than the -10 cited in the draft report.

**BCC23**

The community takes little solace in the COGCC rules (600 series) concerning accident prevention and safety. The setback requirements for wells are woefully inadequate under any situation concerning dwellings or occupied structures. Antero has claimed that no well is closer than 515 feet from the nearest dwelling. However, we must remember that well pads are two to four acres or more in size, so development activities and the well pad will encroach much closer to residences than any stated distance from a well.

We point to a statistic from the Rifle Fire District, which separates out the number of incidents related to the oil-and-gas industry: there were 423 calls from January 1, 2004 – Dec. 9, 2009.

The following are some of the suggested ways to reduce the potential public health impact from accidents and malfunctions.

**BCC24**

1. Garfield County or COGCC should oversee **and inspect** all pipeline construction.

2. Review pipeline system for routes that avoid proximity to homes, schools or other areas used by residents to protect the public health and reduce injury. What is of great concern is the fact that

**BCC25**

Antero's pipeline plan involves several miles of feeder and mainline pipes which are within yards of many homes, go under 4-lane parkways and county roads, and have multiple crossings under the 230KV electric transmission line which runs through the Battlement PUD.

**BCC26**

3. There are great concerns about well pad locations at the base of steep -- and often tinder dry -- slopes, which would dramatically increase the risk that a well pad fire could escape the pad and sweep rapidly up the slope to homes before anyone can react effectively.

**Note 2:** We strongly disagree with the final statement in the fourth paragraph of "Conclusions" Part One, Page 68: With 200 wells being drilled in a high density location, we believe events are very likely to occur.

**BCC27**

Below are links to recent KREX-TV stories about problems with Antero projects that add to that assumption.

<http://www.krextv.com/news/around-the-region/Rancher-Exposes-Serious-Natural-Gas-Pipeline-Violations-106656008.html>

<http://www.krextv.com/news/around-the-region/Hazardous-Pipeline-Installed-With-Zero-Oversight-106735253.html>

<http://www.krextv.com/news/around-the-region/NC5-Investigates-Uninspected-Antero-Pipelines-Already-Leaking-106802293.html>

<http://www.krextv.com/news/around-the-region/Garfield-County-Says-No-To-Anteros-Drilling-Plans-107007319.html>

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Grand Valley Citizens Alliance

PO Box 656, Silt CO 81652

Leslie Robinson contact person:

970-618-0890

Battlement Concerned Citizens

Dave Devanney: 303-594-1066

or Ron Galterio at 970-285-0243

November 11, 2010

Dear Barbara Witter,

I live at 100 Limbupine Circle, Battlement Mesa, approximately  $\frac{1}{2}$  mile - as the crow flies - from the Antero (Watson site) gas well on 303 Rds.

On May 28, 2010, I began marking on my calendar whenever I noticed a definite 'petroleum' odor. I made 3 notations in June, 2010, & on July 1, 2010, I decided to keep a log book with specific information about dates, times, wind direction, odors, & how the odors affected me - i.e. - headaches & eye & throat irritations. By August 28<sup>th</sup>, I had 18 entries in my log book, & during this time I made numerous phone calls to the "Oil & Gas Complaints & Incidents Numbers".

Following the newspaper articles in the Grand Junction "Daily Sentinel" & the Glenwood Springs "Post Independent" on July 16, 2010, about Battlement Mesa residents' complaints about fumes & odors, Antero made changes in their drilling operation that greatly reduced the complaint calls. However, I have talked to Battlement Mesa residents who still have lingering health complaints, & I continue to have some throat congestion.

The recent HIA study has concluded that air quality could seriously deteriorate for this community of 4,500+ people during each well-pad "history", from construction to well-pad completion.

I believe that the revised COGCC rules still fall short of protecting people from these impacts.

Dave Nestlin has said that the state can impose specific drilling conditions to try to address

neighborhood concerns, + minimize some of the effects on those neighborhoods. Lets hope this can be done!

Regarding Antero's plans to drill within the Battlement Mesa PUD, in a June 16, 2010 article in the Post Independent, Dr. Rosanna Witter (who was contracted by Garfield County to conduct a health impact assessment (HIA) related to Antero plans to drill here) stated that, "Rather than measuring past impacts on health, the goal with this project is to try to measure future impacts".

I hope that Antero lives up to its claim to be a 'good corporate citizen & support responsible development in Garfield County'. It is encouraging that Antero & the Garfield County Commissioners may be listening to the B.C.C. (Battlement Concerned Citizens) + now, to the newly-formed RSPN (Rifle, Silt, Peach Valley, Newcastle) groups.

As the Antero Comprehensive Drilling Plan (CDP) to be submitted, "in the near future", going to include:

1. One thousand foot setback from any dwelling
2. Ten million dollar community safety bond
3. Voluntary adherence to Federal Clean Drinking Water Act
4. Voluntary adherence to Federal Clean Air Act
5. Voluntary adherence to Federal Pipeline Safety Regulations
6. Voluntary disclosure of hydraulic fluid components

This is what B.C.C. wants to insure safeguards for its citizens!

Very sincerely,

Bonnie Smeltzer - (83 yr. old <sup>life-time</sup> President of Garfield County)

C WYANT [lillian.wyant@q.com]

**CIT1**  
As a resident of Battlement Mesa, I am very appreciative of the time and effort that went into this study. Its findings and recommendations, however, give me even greater concern than I had before, and have only reinforced my opinion that drilling within the "Planned United Development of Battlement Mesa", or any other highly populated residential community, can pose serious health and safety problems. Since the residents of this "covenant" community must agree to adhere to strict standards prohibiting obnoxious odors, noise, lighting, and other undesirable activities that affect the environment and welfare of the community, no less should be asked of drilling companies. I sincerely hope all recommendations of this study will be adopted in order to protect the health, safety, and welfare of the residents of this community.

Lillian Wyant  
133 Willow Creek Trail  
Parachute, CO

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Cheri Brandon [cheribrandon@gmail.com]

To whom it may concern,

I have just realized I may be too late with these comments but I understand there has been an extension so I am going on that assumption and hope this will be included.

**CIT2**  
I recently moved from Battlement Mesa,( Sept. 4, 2010) . I am 66 years old. I loved my home there, my friends and my activities but with the expectation of Antero drilling amongst our wonderful community it became too much for me to bear. I have since rented out my home (homes are not selling Battlement) and I plan to buy here in the near future. I found myself getting more and more angry and depressed at the prospect of gas drilling so close to residences. I decided that at my age I don't have to take the stress and anxiety the entire tragedy produced. I have even had terrible dreams on the matter causing sleepless nights.

I moved to Battlement in 2004. In 2006 we slowly saw the rise of the industry surrounding our community. At that time I began to notice so much more dust in my home....on all the window sills, windows and my beautiful redwood back porch. I also noticed that when it rained on my windows the drops dried into mud spots. I soon discovered dust each day on the sills and when I tried to wash my window and porch I

found it just turned to yellow mud and was so difficult to remove.

As the years went by, I was lowered to scrubbing my porch by hand several times with a stiff brush with soap and water and yet the mud did not come up, most simply dried and remained on the wood.

I also began to get a persistant cough in 2009. At times my throat was dry and my cough was the same. Since moving to Glenwood and only in two and one-half months, the cough has stopped! I did not see a doctor about this,,,,I wish I had so you would have this in your doctor records.

My main comment, however, is not about the above mentioned items. I would like to comment on something your assessment mentioned as positive regarding the drilling in Battlement. You stated the industry would bring in money and business to the community. What you

don't realize is that right now Battlement is like a ghost town.

Parachute may look like it is booming, but Battlement has huge apartment buildings that have been closed due to lack of occupancy.

It has a grocery store that is failing due to lack of customers and businesses that have closed. Homes are not selling and people are not buying homes here. The folks who work in the industry do not buy homes, they rent because they are transient. They do not join or volunteer in the community, in other words, they are not invested in the community. You should check into this, ask Battlement Mesa INC about apartment rentals and business space filled. Ask them about the grocery stores status.

There is nothing positive about allowing gas drilling in Battlement Mesa.

Thank you for your consideration,  
Please feel free to contact me if you so wish,

Cheryl Brandon  
former resident of Battlement Mesa  
formerly at 72 Sagemont Circle

Glenwood resident

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DALE F AND BETSY A LEONARD [betsleon@msn.com]

I do not have scientific studies to back up my concerns, but I would like to speak none the less. I am concerned with the increased risk of fire. With industrial processes that use volatile chemicals and dry brush, there is an accident waiting to happen. I am concerned about the increased use of our roads to the pressures of truck traffic. This will impact both the condition of our infrastructure and will also inconvenience residents as they go about their business. I am concerned about the restorative work proposed. As of this date, restorative action has not occurred on any drill site along I-70 in our area; are we to believe this will change? I am concerned about the loss of aesthetics of our community once the drilling rigs are erected. Already our home values have suffered. I am concerned about the threats to the quality of our water, and the quality of the Colorado River. Despite all that industry says, chemicals will be injected into the earth; by nature there will be an effect. We do not know how severe. Some people are more sensitive than other people, I am concerned their health will be in jeopardy. I am concerned about the projected increased noise levels and wonder if light pollution will be a problem. I am concerned about a possible risk to air quality. Many of us moved to Battlement Mesa for the beauty and outdoor qualities. These all will be compromised.

I believe that natural gas drilling can be done in a responsible manner. This does not include drilling in the middle of a residential community. I thank you for the opportunity to express my opinions.

Sincerely,

Betsy A. Leonard

Betsy A. Leonard Environmental Education Specialist 71 River View Place Parachute, CO 81635-9641

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CITIZ

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To whom it may concern:

I am a resident of Monongalia County, West Virginia. As James Northrup states, the Marcellus shale gas industry is a case of 21st century technology meeting 20th century regulation. The state regulatory agency, the WVDEP, is completely unprepared for this industry, yet permits continue to be issued. The industry appears to be taking full advantage of the situation. Violations of current gas drilling regs are both rampant and sometimes flagrant, as in the case of Blake Run in Wetzel county, a headwater stream being used as a roadbed for Chesapeake truck traffic. (Visit the Wetzel Co. Citizens Action Group webpage to see more of what we are witnessing in West Virginia.) The Doddridge County episode of contamination of a stream that feeds the river being used for public water supply is another sad and scary tale.

Please refer to the analysis of violations in Pennsylvania conducted by the Pennsylvania Land trust Association. <http://conserveland.org/violationsrpt>  
Also the Riverkeeper Fractured Communities report is well worth review.  
<http://www.riverkeeper.org/wp-content/uploads/2010/09/Fractured-Communities-FINAL-September-2010.pdf>

I concur wholeheartedly with the conclusion of the Garfield County HIA report as drafted. While it is apparent that there are advantages to burning gas versus coal, there are costs both to environmental health, and per se human health, and the quality of local community life which must be factored into a national cost-benefit analysis. Some brakes need to be put on the gold rush until more is known about the comprehensive impacts of this industry.

Thank you for conducting this much-needed research and for encouraging more research into this issue. The old adage comes to mind...."If it sounds too good to be true....."

Deborah Fulton  
1030 Snake Hill Road  
Morgantown, WV 26508

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I feel that the HIA does not adequately address and has seriously underestimated the potential adverse impacts to the Battlement Mesa community that could result from any significant incident that may occur at the proposed "Water Storage and Treatment Facility" to be located in the southwest area of the Battlement Mesa PUD.

The major population areas of Battlement Mesa are both downhill and downwind of the proposed location for that facility; and any compromise of the integrity of the holding pond or its cover due to accident, human error, or natural disaster poses an unacceptable risk to the Battlement Mesa community.

I believe the HIA should contain a recommendation that the proposed water handling facility should not be permitted within the PUD or in any areas adjacent to the PUD that have the potential to impact the air, water, or soil of the PUD.

Ron Galterio  
12 Poppy Court  
Battlement Mesa, CO 81635

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RE: Public Comment – Battlement Mesa HIA

I believe that the Battlement Mesa HIA is a credible comprehensive study. However, I also feel that the time constraints that were imposed on the HIA did not allow for the in-depth research to occur that this important study deserves.

As was noted in the HIA, there are many gaps in the data that was available to the HIA team and a good deal of pertinent data simply did not exist. This resulted in uncertain outcomes in some areas of the study.

One issue that I believe did not receive adequate study and consideration is the cumulative impacts that the Antero Project could have on the Battlement Mesa community considering all the current and proposed oil and gas operations occurring in close proximity to the community.

I believe the HIA has raised many issues of concern that deserve further study and justify an extension of the HIA to adequately assess all of the potential impacts that the Antero Project may have on the Battlement Mesa community.

Therefore, I think there should be a recommendation from the HIA team to continue the HIA until all of the data necessary is available and considered to fully assess all of the potential impacts of this project.

Ron Galterio

12 Poppy Ct.

Battlement Mesa, CO 81635

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Our response to the Battlement Mesa Health Impact Assessment study:

I, my wife, and my son are residents of the Battlement Mesa community. We were attracted to this community more than ten years ago because it was advertised as a place for healthful retirement living in a beautiful Colorado setting. We lived in an apartment dwelling here for several years before we decided to purchase our current home.

When we bought this house we were aware that some natural gas drilling was occurring down the valley and we were concerned about the possibility of such activity happening here. We researched this possibility and were reassured by representatives of the Battlement Mesa Company that such would not occur here. Needless to say, we have been outraged to learn of plans to drill right here in the PUD not far from our home.

My occupational background is in community mental health. From 1968 to 1996 I was a Professor of Psychology at Bowling Green State University, Bowling Green, Ohio where we trained graduate students in clinical psychology. Our training program was heavily oriented toward community mental health. I also was a community mental health consultant to local businesses and public service agencies in northwest Ohio during this period.

I have read the pertinent sections of the HIA report that refer to "community wellness" as well as other sections that might be related to community well-being in the Battlement Mesa community. The report has sections specifically referring to community wellness: ES4.5 Summary of Community Wellness Assessment and "4.5 Assessment of Impacts on Community Wellness" and sections following. The sections on community wellness in this report take into account such factors as substance abuse, crime rates, suicide, and mental health as indicators of community wellness.

We present here some of our observations.

CIT7

**CIT8** Many obvious negative community social and mental health effects will result from the stressors studied in this HIA report. Air pollution, Water and soil contamination, heavy truck traffic, noise and light pollution, safety problems including the likelihood of accidents, fire, and explosions have got to take their toll on community wellness. How could anyone think otherwise? Some things are self-evident.

I perceive there to be several problems with this HIA Report.

**CIT9** First, these investigators minimize the scale of the Antero gas drilling operations. They refer to these operations as small in scale. As compared to what? Residents of this community might well disagree with this assessment. 200 wells within the residential areas of Battlement Mesa are no small matter to us. We perceive this Antero plan to be a large scale industrial intrusion into our peaceful residential community.

**CIT10** Also, unfortunately, in their conclusions, the report does not separate out the community wellness effects upon the more vulnerable groups, the elderly and the young.

**CIT11** By aggregating their empirical data and qualitative observations across the entire Battlement Mesa population these researchers appear to have minimized the adverse community wellness effects upon vulnerable groups.

**CIT12** In particular, I am disappointed that the researchers did not study mental health effects in the elderly population more thoroughly.

**CIT13** Persons over age 65 should be more carefully queried with regard to their social and emotional reactions to natural gas drilling within their community. Judging from my own personal reactions and those of my friends and acquaintances in the community, my educated guess is that there has been and continues to be reactive personal distress on the part of many of our retired Battlement Mesa citizens. These reactions include persisting moderate to clinical level depression, anxiety, and insomnia. Persisting depression, anxiety and insomnia have been shown in past research to be related to increased vulnerability to heart disease, degenerative disorders, and cancer.

**CIT14** Also, drilling operations obviously will affect the physical environment. Property values have fallen due to the current and future degradation of the Battlement Mesa environment. In spite of the gas industry proposed mitigations, Battlement Mesa is not as desirable an environment for retirees as was the case when most of us moved here. Our community wellness has been negatively affected by the intrusion into our community of gas drilling.

**CIT15** Battlement Mesa community desirability and liveability have decreased for retired persons in the last two years even ahead of the major drilling operations. Retired people here do not need a large scale study to tell them that this is so. The Battlement Mesa Activities Center programming for seniors has diminished enormously in the past two years because of the decreasing retiree population here. Many retired persons have left the community even at the expense of loss of property value. As far as community desirability and liveability for seniors is concerned, retirees have been and are now choosing to leave the Battlement Mesa community to go elsewhere for desirable retirement living.

**CIT16** These researchers have not acknowledged the large scale flight of retired persons from this community. I am astonished that this demographic shift has been virtually ignored by these

researchers. Data about resident demographic shifts could be obtained from real estate persons serving the community. There are probably other sources for such data.

In the recent past, Battlement Mesa was advertised as a wonderful place to retire. Many retirees were attracted here with the promise of healthful living in a beautiful environment. I wonder why this community is not now being advertised as such a place to retire? And why are there clearly very few retirees coming here to replace those retirees who have left?

This marked decrease in retired persons living here should not be ignored. This demographic shift should be clearly acknowledged in the HIA report. And, as part of this HIA study, exit interviews, or, at least, written comments should be gathered from retirees who have left our community to assess their reasons for leaving.

Respectfully submitted,

Robert, Elaine, Brett Warehime

50 Willow View Way  
Battlement Mesa, Colorado 81635

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Marc Gubkin [mgubkin@gmail.com]

The reference list in this HIA needs attention. To submit a reference such as

Burnett J. Health Issues Follow Natural Gas Drilling in Texas; In: Radio NP, ed. *Morning Edition*; 2009

**CITIA** shows that very little effort was made in preparing the reference list (there are many such examples in the list). I can only assume that the body of the report was prepared in equally sloppy fashion. Please fix the reference list so that others don't come to the same conclusion, or worse -- that the study itself is flawed.

I've reviewed and edited many scientific papers -- mostly in the chemical sciences -- over the past 30 years. I have seen how small errors can destroy scientific credibility. Don't let an obviously ill-prepared reference list screw up your study.

Marc Gubkin  
[mgubkin@gmail.com](mailto:mgubkin@gmail.com)

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Ladies and Gentlemen:

It is important that wells be placed no less than one mile from residences.

**CITIS** Your report states (part one, page 22): "The odor complaints occurred during flow back operations at Antero's Watson Ranch pad located on the southeast border of the PUD, within approximately 1/2 mile from several residences, and resulted in COGCC issuing a notice of alleged violation to Antero on 7/14/2010."

This incident produced fumes which stung resident's eyes, requiring them to close windows on a hot July night. Some residents smelled rotten eggs, which is an indication of sour gas. Sour gas (as opposed to sweet gas) produces hydrogen sulfide smells, and because of contaminants in the gas, costs the oil companies more to process.

Thomas Hall  
256 Battlement Creek Trail  
Battlement Mesa, Co 81635

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#### TRAFFIC AND NOISE IN BATTLEMENT MESA

I BELIEVE THAT MORE ATTENTION SHOULD BE GIVEN TO HOW TRUCK TRAFFIC AND EMPLOYEES VEHICLES SERVICING THE GAS DRILLING RIGS ARE NOW AFFECTING THE RESIDENTS THAT ARE ADJACENT TO THE PERIMETER ROADS SUCH AS STONE QUARRY ROAD.

AT THE PRESENT TIME THERE IS MODERATE TO HEAVY TRAFFIC ASSOCIATED WITH GAS DRILLING OUTSIDE THE BOUNDRIES OF BATTLEMENT MESA USING STONE QUARRY ROAD TO CR 300 ON A 24/7 BASIS.

THESE VEHICLES ARE GENERATING CONSIDERABLE AMOUNTS OF ENGINE EXHAUST POLLUTION AND MANY OF THE VEHICLES BOTH TRUCKS AND LIGHT TRUCKS OWNED BY THE EMPLOYEES ARE EQUIPPED WITH LOUD AND NOISY MUFFLERS .

**CIT19**

THE PROBLEMS ARE MAGNIFIED BECAUSE OF THE STEEPNESS OF STONE QUARRY TRAVELING EASTWARD REQUIRING THE VEHICLES TO BE OPERATED IN LOWER GEARS WHICH RESULTS IN MORE NOISE AND EXHAUST POLLUTION. SOME OF THE RESIDENTS RESIDING IN THE VILLAGES OF TAMARISK VILLAGE AND TAMARISK MEADOWS HAVE COMPLAINED ABOUT HEADACHES OND OTHER SYMPTOMS. WHEN THE VEHICLES ARE TRAVELING WESTWARD THE NOISE FROM THE USE OF JAKE BRAKES IS VERY NOTICEABLE AND DISTURBING.

MANY OF THE EMPLOYEES OF THE ENERGY COMPANIES RESIDE IN THE ABOVE VILLAGES AND THE RESIDENTS ARE SUBJECTED TO THIS POLLUTION AND NOISE AT ALL HOURS OF THE DAY AND NIGHT

RECENTLY THERE IS A LOUD GRINDING NOISE HEARD AND ODORS OF DIESEL EXHAUST FUMES STARTING ABOUT 1:00AM EVERY DAY FROM A DRILLING RIG LOCATED SOUTHEAST OUTSIDE OF BUT ADJACENT TO THE BOUNDRIES OF BATTLEMENT MESA. THIS HAS BEEN REPORTED TO THE APPLICABLE AUTHORITIES BY A RESIDENT OF TAMARISK MEADOWS

THIS SITUATION WILL ONLY GET WORSE WHEN DRILLING BY ANTERO IS STARTED WITHIN THE PUD.

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**CIT20**

Thank you for conducting the study. It is clear from your findings that this development will have a horrible impact on the health and safety of people in our community. That fact alone should be reason

enough to not allow this activity. Additionally, the negative impact this development will have on our natural environment is unacceptable.

I would like to voice my strong opposition to oil and gas drilling in our State, especially the unregulated "fracking" practices.

Sincerely,

Shannon Murphy  
702 W. Main St.  
New Castle, CO  
81647

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As a citizen of Garfield county, and a witness to the families and communities that have lost their livelihood due to the "Healthier alternative energy source" , it deeply concerns me that MORE natural gas drilling is even being considered in Garfield County. This is not only irresponsible for the air quality, but it is also devastating to the water sources in this area, as well as the welfare of the wildlife here. It's a **CITIZEN** BAD idea!!!! Have you ever heard of the HBO documentary called GAS LAND?? you need to watch it!!! KNOW THE FACTS about drilling, THE CHEMICALS USED and the lies and cover-up that is so common and NOT REPORTED ON!!!! Just because the names of the chemicals that are used in the fracturing of the bedrock aren't in the news, doesn't mean they aren't used!!!! THERE IS A REASON THAT WATER IS HAULED TO THE MAJORITY OF HOMES THAT ARE NEAR DRILLING SITES!!!!

PLEASE THINK ABOUT IT!!!!  
DONT RISK THE LIVELY HOOD OF MORE INNOCENT PEOPLE FOR MONEY!!!!

Sarah Bashaw

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Douglas J. Saxton  
81 Ridge View Place  
Battlement Mesa, Colorado 81635

November 11, 2010

Colorado School of Public Health.  
c/o Roxana Witter  
13001 East 17<sup>th</sup> Place B119  
Aurora, Colorado 80045

Re: Health Impact Assessment

To Whom it May Concern:

CIT22 I after having read the study, I feel compelled to offer these comments. The most troubling aspect of the situation is that it the study seems to assume that the Antero project will occur regardless of the study's findings or public opinion in Battlement Mesa, giving the impression that the legality of Antero's intent is the only thing that matters, even if the results are ruinous to public health.

CIT23 Assuming that nothing can stop the project from starting, can anything interrupt the project if any or all the risks anticipated turn out to match or exceed the worst case scenarios that are anticipated by the study? Would residents have to prove the danger by losing their good health or lives?

As I told the COGOC at their meeting recently, I'd like all the responsible parties to ask themselves whether they would make the same decisions about acceptable risk if they made their home in Battlement Mesa. Detachment has no place in decisions concerning public health.

The study itself cites most of the same risks that top the list of health concerns of Garfield County residents in another study- a county- wide assessment also funded by Garfield County, yet the HIA study does not refer to it. Your study has implications for every resident of the county living near a gas well and some who do not. Personally, I am most concerned with the potential for disaster caused by human error.

CIT24 . Well fires are very common. We live in an area where fire danger signs are posted most of the year. If the project is carried out, Antero should at the very least maintain a water tanker and pumper truck most of the year.

CIT25 . Antero's pipelines have been built in shoddy fashion with no inspection from any authority in nearby Silt. Punctures and leaks are considered by independent engineers to be inevitable. So much for the assurance of the safety of ground water. Your recommendations should include required inspections during the installation phase either by COGCC or a credible and independent third party.

. Gas lines are not impervious to human error either as witnessed by recent accidents near Denver and in California, yet the industry is trusted here to do its own policing.

CIT26 . Airborn pollutants are presented in the study to represent the greatest risk. Complaints made here about air quality are answered not in hours but in days and weeks, and then the main concern from those supposedly in a position to respond is a "data base". Since when does a data base relieve an immediate threat to public health?

CIT27  
CIT27 One mediating factor for risks is thought to be industry employment of so called best practices of the industry. Even if they could be forced into using those practices, how good are those best practices in the face of the threats to public health. If at best they could cut harmful emissions by 25% say, what risks do the remaining 75% pose?

Experts in public health who conduct the study should be telling us what consequences, after everything possible can be done to remediate, are then acceptable.

**CIT28** Is it right for any government whose ultimate responsibility is the health and welfare of its people, to say that the law will protect someone's right to do business as he sees fit no matter what happens to the public?

What agency would actively collect data and monitor health threats if, even before the project, those with apparent responsibility claim to be so understaffed that industry is on an honor system? It would seem that people have to die before there will be any perceived need for regulators to "catch up".

**CIT29** Lastly, I am concerned that the impact of "nuisance" will be understated by being called just that. I have heard residents near a single well talk of the constant 24/7 rumble of trucks near their home and stench of gas being burned off. Unless described in this way, you might well be talking about a dog allowed to roam a neighborhood instead of being on a leash.

**CIT30** I urge that your descriptions of risk be as explicit as possible and assume no more activity from regulators than is happening currently. Similarly, you should not assume that Antero will employ best practices any more than it does now. Their community relations record in Garfield County is abysmal. There is indeed A BIG DOG without a leash marking out his territory with little regard for the sanctity of health and home in Battlement Mesa.

Your findings as well as recommendations could protect our community as well as many other citizens in Garfield County from great hardship and peril. Please keep this in mind as you finalize your HIA study.

Sincerely,  
Douglas J. Saxton

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68 Meadow Creek Drive  
Parachute, CO 81635  
October 25, 2010

Dear Roxanna Witter and Crew:

Thank you for all your work on the HIA for Battlement Mesa. In light of several recent events, with the odors from the Watson Ranch well pad and the issues over drilling on Silt Mesa, it was good for the gas industry, especially Antero, to realize the impacts of drilling.

I'm not sure if some of my comments fit into the final HIA, but I'll give recommendations that I'm sure I'll present if and when Antero applies for their SUP.

Air quality will definitely be affected, as we have observed from the Watson Ranch problem—and that's quite a distance from the community! Also, on Oct. 2 my husband and I were out for a walk. As we rounded the east end of the Meadow Creek Drive loop, we got a strong chemical smell. The wind was blowing from the east. When I got home I called Community Counts. I first notified Antero, who later called back to say they had no well pads in that area. I tried

Encana, as was recommended, but it turned out to be from the finished well pad of Williams, below # 14 of the golf course, which is almost level with the river. Susan Alvilar got back to me on Monday and said that in production, every so often water accumulates and they have to take that out. The smells probably were from chemicals in the water, and they'll flare them next time.

Recommendations:

Under air

1. **CIT 31** Require that the underground pipes be put in place BEFORE any drilling begins on the connected well pad. In these pipelines underground- to be carried far away from the PUD- for fresh water, for spent water, for gas output, for electricity, etc., do it all at one time. Don't keep opening up the line for some additional pipe or other line This will reduce emissions from generators, truck exhaust and dust, and drilling operation chemicals.
2. **CIT 32** For post-drilling when the wells are on-line, make sure that the spent water with chemicals flows away in the above pipeline.
3. **CIT 33** Require that all wells capture byproducts, or emissions such as methane, and have an underground line to carry them away, too.
4. **CIT 34** Provide extra street sweeping as mud and dirt accumulate from drilling traffic, both from workers as well as drill equipment.
5. **CIT 35** Have 24-hour independent monitoring of air quality at the fire station site, as well at each well pad when drilling is taking place. Combine this with a method for informing people of unacceptable levels of harmful chemicals in the air.
6. **CIT 36** Notify each household in Battlement Mesa when, where and the duration of drilling/frac'ing will be taking place. Thus they can decide when and if they will open windows, use swamp coolers, or leave town.
7. **CIT 37** In light of the revelations about the pipeline at Silt that has been put in improperly and unsafely by a sub-contractor of Antero, require that an independent knowledgeable person be hired to monitor every step of the entire planned development of drilling in our PUD. (It would be a good idea to have had someone doing this already with wells drilled close to our PUD.)

Under Wellness

1. **CIT 38** If Antero does the infrastructure of pipes from the well pad near hole #6 /7 of the golf course, pad M, the existing hiking/bicycle trail will be dug up (not to mention part of the 7<sup>th</sup> green.) Require that an alternate trail be constructed PRIOR to dismantling the existing trail.

Under Boom and Bust

1. **CIT 39** Require that company workers and executives set up residence close to wells being drilled.

Under Accidents and Malfunctions

1. **CIT 40** Require at least a 1,000 ft. setback from structures to prevent a pad fire from quickly reaching uphill.
2. **CIT 41** Require that the vegetation be cut low around each well pad and up the hill from the pad, in such a way that a wildfire wouldn't result from a possible well pad fire.

Water (and Wellness)

**CIT 42** 1. Don't drill WITHIN the community—namely the 2 proposed well pads by the golf course, pads L and M. Even the BMSA attorneys found this to be egregious. These pads will be an eyesore, noisy, producing odors, and deter golfers from wanting to use the course. They'll be a constant reminder of the injustices many are feeling about this proposed drilling. Odors would permeate throughout the community as the winds change direction each day.

These are some additional recommendations to Antero that I wrote down after the BP oil spill.

**CIT 43** 1. No pointing the blame at another driller or operator, e.g. BP saying it's TransOcean and Halliburton. Remember that 11 people died due to arrogance of officials of BP, which shows a lack of integrity.

**CIT 44** 2. No cutting corners for speed and profit.

**CIT 44** 3. No hiding chemicals being used, or from test results of air or water quality.

**CIT 46** 4. Put the community first—both in the community and your workers.

**CIT 46** 5. If a problem occurs, be willing to stop the drilling, frac'ing, etc. and not pressure your workers to continue.

**CIT 46** 6. Put in WRITING all that you will or will not do, and sign the agreement. Don't say, "if possible," "when the opportunity occurs," "as we see fit," "best practices," etc, but **CIT 48** specifically spell it out, e.g. if an accident happens; if a fire occurs; if someone's health is impaired; if a house is damaged.

Sincerely,

Sandra Getter

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**Selected Comments of James P. Kornberg, MD, Sc.D.**

**November 10, 2010**

**Regarding:**

**Appendix D Human Health Risk Assessment (HHRA)**

**Battlement Mesa, Colorado Health Impact Assessment (HIA)**

**Q. Please state your name and business address.**

A. My name is James P. Kornberg and my address is P.O. Box 1210 Ridgway, Colorado 81432.

**Q. What is your occupation?**

A. I am a board-certified Occupational and Environmental Medicine (OEM) physician, and I have a doctorate in Environmental Health Sciences and Engineering, with specialization in air pollution and aerosol physics.

I have been a licensed physician in the state of Colorado for 31 years and have been licensed as a physician previously in Massachusetts and New York when I lived and practiced medicine in those states.

**Q. By whom are you employed?**

A. I am employed by COHBI Physicians, P.C., a Colorado professional corporation that I own and operate and through which I currently engage in OEM consulting as a licensed physician in this state.

I also engage in consulting in the field of Environmental Health Sciences and Engineering as a qualified expert based upon experience and my doctorate in this field.

**Q. What is your educational background, selected professional experience and nature of your current medical practice?**

A. For complete details, please see Kornberg HHRA Comments – Appendices 1 (education and experience) and 2 (abbreviated list of private and governmental entities for whom I have served as medical director and/or of advisor over the past 30 years).

**Q. What specific experience qualifies you to comment on the HHRA as it applies to the potential problems associated with Antero's proposed development in the Battlement Mesa PUD?**

A. For more complete details, please see Kornberg HHRA Comments – Appendix 3

**Q. What is the foundation for your comments?**

A. My comments are based collectively upon my education, professional experience and my medical and engineering knowledge of the peer-reviewed scientific and epidemiological literature related to potential problems associated with human and animal exposure to physical, chemical and biological hazards in the environment, including those substances that are mentioned in the HIA and HHRA.

I also rely upon my working knowledge of the scientific advisory and regulatory positions taken by various domestic and international governmental and advisory agencies, including the specification and derivation of permissible exposure limits for chemical substances and physical agents that are mentioned in the HHRA

**Q. What are your comments regarding the HHRA and its applicability to evaluating the health risks to citizens who will be exposed to Antero's gas well drilling activities within the Battlement Mesa PUD?**

CIT49 A.

COMMENT #1 – INADEQUATE EXPOSURE SCENARIO SELECTION

In their introduction, the authors indicate that they evaluated three exposure scenarios<sup>1</sup>:

(1) A long-term chronic [30 year] exposure scenario for all Battlement Mesa residents

(2) A long-term chronic exposure [30 year] scenario for Battlement Mesa residents living adjacent to a well pad.

(3) An acute exposure [7 day] scenario for Battlement Mesa child residents living adjacent to a well pad.

The authors also indicate their estimate that 19.6% of the Battlement Mesa/Parachute population is over the age of 65 (2000 Census) compared to 9.7% (over age 65) for the state of Colorado as a whole.<sup>2</sup>

Notwithstanding this important observation, they fail to include an exclusive, acute (7-day) exposure scenario for these seniors living in a residence adjacent to a well pad in their analysis.

It is well known in environmental health sciences and risk assessment that the very young and the very old are among the most susceptible members of society to adverse exposure events in air, water and soil. Older population members, in particular may have pre-existing morbidity (e.g. heart and lung disease) that can be aggravated by exposure to far lower levels of hazardous airborne substances than can be tolerated by healthy younger adults.

**The authors' failure to grant seniors living adjacent to a gas well drilling pad their own specific exposure assessment scenario is a major short-coming of this HHRA.**

**CITSA.**

**COMMENT #2 – ACKNOWLEDGED RELIANCE UPON INADEQUATE (INSENSITIVE) LABORATORY MEASURING METHODS THAT MAY LEAD TO OVERLOOKING THE PRESENCE OF HAZARDOUS CHEMICALS, INCLUDING CARCINOGENS**

Notwithstanding the authors' attempts to characterize and quantify the lifetime cancer and non-cancer risks to individuals exposed under the three stated exposure scenarios mentioned in Comment #1, the estimates of risk may be statistically underestimated and pragmatically invalidated by several factors<sup>3</sup>.

For example, the authors acknowledge but still fail to include the additional risks posed by chemical compounds that possess Regional Screening Levels (RSLs) that are less than

<sup>1</sup> HIA, Appendix D, HHRA, pages 1 (Introduction), 16 and 52 of 65

<sup>2</sup> Ibid 1, pages 2 and 3 of 65.

<sup>3</sup> I preface these remarks by stating that to their credit, the authors have acknowledged many of the limitations that I will mention. Some limitations, however, are so profound that they should have been considered "non-starters" for the authors and should have made them reconsider the futility of the proceeding with the HHRA in first place.

their respective Minimum Reporting Limits (MRLs). In other words, the laboratory methods of measuring these compounds are not sensitive enough to detect them at levels determined by the EPA to be potentially dangerous to human health.<sup>4</sup>

Chemicals that may be present at hazardous, yet undetectable levels include 15 volatile organic compounds (VOCs)<sup>5</sup>. Among them is TCE (trichloroethylene or trichloroethene), PCE (tetrachloroethylene, perchloroethylene [PERC] or perchloroethene) and vinyl chloride, all suspect or probable carcinogens, depending upon which governmental agency or respected authority is consulted.<sup>6</sup>

In Section 6.1.1<sup>7</sup> the authors acknowledge that the missed presence these chlorinated substances ***“at concentrations that could impact human health would contribute to an underestimation of the risks calculated in this HHRA;”*** but they then effectively indicate “not to worry,” because the failure to measure would contribute little to uncertainty because, ***“these chemicals are mostly chlorinated solvents which have not been associated with natural gas production operations.”***

The authors do not cite a reference for this conclusion. Missing any of these substances in the final calculations of overall risk would be a mistake. The presence, alone, of any fleet maintenance operations that require the use of degreasing agents would be enough to dampen any sense of security about these “poster” pollutants.

**CIT 5!**  
**A.**

### **COMMENT #3 – ACKNOWLEDGED MULTIPLE UNCERTAINTIES IN RISK ASSESSMENT**

To their credit, the authors acknowledge in Section 6 (Uncertainty in Risk Assessment) ***“...the risk estimated is this HHRA is most likely underestimated because of lack of data for the surface soil and water pathways, lack of toxicity data for most of the COPCs [contaminant of potential concern], lack of data for many potential COPCs, ozone and PM are not included in the quantitative risk assessment, and the chemicals reactions between the hundreds of chemicals in ambient air are not evaluated....”***<sup>8</sup>

Further, in Section 6.1.1, in discussing the Bell-Melton Ranch Monitoring Station Data, they mention under “Sample Frequency:”

***“Twenty-nine ambient air samples for VOCs were collected from the Bell-Melton monitoring station once per month for 29 months, followed by the collection of 128***

<sup>4</sup> Acknowledged by the authors on page 9 and 10 of 65, Appendix D.

<sup>5</sup> *ibid* 1, page 10 of 65.

<sup>6</sup> 2010 Guide to Occupational Exposure Values (ACGIH ISBN 978-1-607260-20-2) TCE and PCE – NIOSH Ca (potential occupational carcinogen); NTP (U.S. National Toxicology Program) R (reasonably anticipated to be a human carcinogen)

vinyl chloride – EPA – human carcinogen; NTP – Known to be a human carcinogen; -IARC (International Agency for Research on Cancer) 1 (Carcinogenic to humans)

<sup>7</sup> *ibid*, page 40 and 41 of 65.

<sup>8</sup> *ibid* 1, page 40 of 65.

*samples for SNMOCs [speciated non-methane organic compounds] and 60 samples for carbonyls over the next 27 months. There is a low to moderate uncertainty that this dataset reflects the 30-year exposure assumed in this HHRA as changes in meteorology and chemical emissions could lead to lower or higher concentrations in air from year to year. [underline mine]*

Throughout the remainder of Section 6.1 (Uncertainties in Chemical Data), the authors enumerate several other areas where chemical data uncertainty exists.<sup>9</sup>

In the Section 6.2 (Uncertainty in Exposure Assessment)<sup>10</sup> through Section 6.5 (Uncertainty in Risk Estimation Due to Chemical Mixtures)<sup>11</sup> they outline more uncertainties related to their efforts at risk assessment.

One key area of uncertainty, for example, relates to comments made in Section 6.3.3 (Potential COPCs [Contaminant of Potential Concern] Not Measured)

*“Table 6-1 lists 234 chemicals complied from Antero’s material safety data sheets (MSDS) for natural gas production operations that have not been measured in ambient air or surface water samples. These include chemicals in hydraulic fracturing fluids and drilling mud. The list includes carcinogenic PAHs [polynuclear aromatic hydrocarbons], metals, irritants, and odorous compounds, such as glutaraldehyde. Cancer risks and non-cancer hazards may be significantly underestimated without data for these chemicals.[underline mine]”*

Notwithstanding these remarks and their call for full disclosure<sup>12</sup> in the HIA, itself, nowhere did the authors emphasize that Antero’s MSDSs (Material Safety Data Sheets) probably do not reveal all possible hazardous substances<sup>13</sup> (measured or not) that this company may send into the environment.

It is not uncommon for a manufacturer or end-user to designate some components of the product as proprietary in order not to divulge the ingredients. Without the identification of all chemical agents that may be utilized, generated and captured during and after drilling operations and absent a rationally derived estimate of the presence of such substances over time, an accurate health risk assessment can not be conducted.

CIT52

A.

**COMMENT #4 – FAILURE TO CALL FOR ENVIRONMENTAL MODELING TO FILL THE GAPS IN UNCERTAINTY THAT IMPAIR AND LIMIT ESTIMATIONS OF HUMAN HEALTH RISKS**

<sup>9</sup> ibid 1, pages 40 to 43 of 65 (data related to well completion, residence odor, surface water run-off, ambient air background, and groundwater)

<sup>10</sup> ibid 1, pages 42 to 45 of 65 (failure to evaluate potentially complete exposure pathways, uncertainty in the 30 year prognostic value of data from the Bell-Melton Ranch monitoring station, use of well completion samples, use of EPA default exposure factor values, exposure end-point concentrations and exposures for children)

<sup>11</sup> ibid 1, pages 49 to 50 of 65

<sup>12</sup> HIA, part one, page 33.

<sup>13</sup> a subset of which may become biologically available to the exposed population if there is a probable complete exposure pathway present.

It is not clear why the authors did not insist upon the creation of a comprehensive, scientifically valid methodology for modeling Antero's five year ramp up and planned multi-year operations of its 200 natural gas wells<sup>14</sup>.

Section 6 of the HHRA is so full of uncertainties that there must be a call for current and prospective engineering, hydrogeological and meteorological exposure modeling to fill many of the gaps in knowledge that are prerequisite to a more accurate estimate of risk to the exposed population. The science to implement appropriate modeling exists; but accurate modeling will be impossible without full disclosure of information related to gas well development and chemical utilization.

**CT153**  
A.

**COMMENT #5 – PREDICTION OF SIGNIFICANT, PROBABLY UNDERESTIMATED CANCER RISKS**

Even given the analysis deficiencies and uncertainties described in Comments #2 and #3, the authors still predicted an estimated cancer risk of “83 cancers per one million people (8.3E-05) for Battlement Mesa residents living adjacent to a well pad...<sup>15</sup>.” The authors soften this number by stating that it is “well within EPA’s acceptable range of 1 to 100 cancers per million people,” while acknowledging that it exceeds “EPA’s goal of less than 1 in a million.”

Let’s put this number of 8.3E-05 into layman’s terms:

***This possibly underestimated lifetime risk of cancer for an average person living next to a well pad is 83 times the stated EPA goal for controlling the risk of environmentally induced cancer in the general population.***

***This number also means that any given individual will incur a personal increased unwanted and unrequested risk of developing cancer from the offending exposures that is 83 chances in one million greater than he or she would incur but for that exposure.***

Many medical experts and public health authorities have addressed the goal of reducing additional (unwanted and unrequested) cancer risk in the general population to one excess cancer in a population of one million people:

From a medical perspective, the following reference is from a standard authoritative textbook in the field of Environmental and Occupational Medicine (Sullivan and Krieger):<sup>16</sup>

<sup>14</sup> Ibid 1, page 4 of 65.

<sup>15</sup> Ibid 1, page 52 of 65.

<sup>16</sup> Dalefield, Rosalind R., Oehme, Frederick W. and Kreiger, Gary R., Chapter 6, "Principles of Risk Assessment," in Sullivan, John, B. and Krieger, Gary R., Clinical Environmental Health and Toxic Exposures, Second Edition, Lippincott, Williams and Wilkins, Philadelphia, 2001, p. 88 (ISBN 0-683-08027-X)

“The EPA is mandated to set a maximum contaminant level at which the risk of cancer is increased by only one in a million over a human lifetime of 70 years. This is over and above the background risk of 250,000 in a million.

This textbook is an established resource reference in the field of Environmental and Occupational Medicine. It is, for example, a reference textbook used in the MPH (Master of Public Health) program at the Medical College of Wisconsin.<sup>17</sup>

From a public health perspective, in one of its “Public Health Assessments”, the ATSDR (Agency for Toxic Substance and Disease Registry)<sup>18</sup> also defines its Cancer Risk Evaluation Guides (CREGs) as follows:

“CREGs are estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million ( $10^{-6}$ ) persons over their lifetime. ATSDR’s CREGs are calculated from US EPA’s cancer potency factors (CPFs)<sup>19</sup>

In addition, in one of its Health Consultations, the ATSDR, indicated:

“To determine whether the level of contaminants could pose a health threat, ATSDR screens the concentrations of contaminants against health based comparison values (CVs) and researches scientific literature which may document health effects caused by exposure to contaminants.... CREGs [Cancer Risk Evaluation Guidelines] are estimated contaminant concentrations expected to cause no more than one excess cancer in a million persons over a lifetime and are calculated from EPA’s cancer slope factors (SFs) using default values for exposure rates.”<sup>20</sup>

It is important to re-emphasize that the EPA “target risk” of “one excess cancer in a million persons over their lifetime” is identical to a personalized, increased individual risk of one in a million of developing cancer over one’s lifetime.

This conclusion is intuitively obvious, because if there arises one excess cancer among one million persons over a lifetime, then each person in the population incurs a one in a million chance of becoming that excess cancer case. The EPA’s CREGs, therefore, target both excess population cancer risk and excess individual cancer risk at the same time. If you are one of the exposed persons, it seems that you would be mostly concerned with

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<sup>17</sup> <http://www.mcw.edu/mphprogram/CurrentStudents/Textbooks.htm>

<sup>18</sup> Branch of the US Department of Health and Human Services

<sup>19</sup> ATSDR Public Health Assessment, Mallard Bay Landing Bulk Plant, Grand Cheniere, Cameron Parish, Louisiana, 7/23/02, prepared by the Louisiana Department of Health and Hospitals/Office of Public Health Under a Cooperative Agreement with the ATSDR.

<sup>20</sup> ATSDR Health Consultation, Washington County Air Quality (a/k/a Marietta Air Emissions), Marietta, Washington County, Ohio, March 2003

the potential consequences of your excess individual risk of developing cancer from an unwanted and unrequested exposure.

A. COMMENT #6 – SUMMARY COMMENTS

CIT 54

*In a nutshell, the authors have attempted to estimate human health risk without an adequate understanding of the nature (hazard speciation) and extent (concentration) of exposure over time.*

As a result of this lack of information, credible dose estimates<sup>21</sup> can not be calculated. The authors have relied upon a limited and potentially non representative data set related to a “short-list” of substances without inclusion of an undetermined number of potential hazards that could have a profound impact upon the authors’ risk estimates.

The authors can not perform an accurate risk assessment when they have no real idea, not only of the extent and duration of potential exposures, but also of the identification of many substances that may factor into their risk calculations for both cancer and non-cancer endpoints.

*This crack in the foundation of exposure and risk analysis renders the results of the HHRA tentative and overly optimistic at best and completely inadequate and extremely misleading at worst.*

A. COMMENT #7 - RECOMMENDATIONS

CIT 55

#7-1 – ADD A SENIOR (AGE > 65) RISK SCENARIO

*Any subsequent risk assessment should also include a special scenario to calculate the acute health risks to seniors over the age of 65 who could end up living next to a drill pad.*

#7-2 – BUILD AN ENVIRONMENTAL MODEL TO REDUCE UNCERTAINTY

CIT 56

*The HHRA needs to be retrofitted with the data gathered from a state of the art environmental engineering model.*

*The current and historical empirical data can be used as parameters against which the early predictions of the model can be compared and with which the model can be iterated and improved.*

In order for any such model to be valid, the commissioners and health department must call for complete and full disclosure from Antero and all other parties who may become responsible for adding biologically available contaminants to the air, water or soil in and around the Battlement Mesa PUD.

*Under all scenarios and circumstances full disclosure must be mandatory.*

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<sup>21</sup> dose = concentration times duration of exposure

**#7-3 – RUN THE MODEL WITH AND WITHOUT A PUBLIC HEALTH BUFFER ZONE**

CIT57

After the inclusion of the “senior exposure scenario,” I suggest that the new environmental model should be run first to estimate potential adverse environmental conditions when drilling is conducted within currently planned and permitted distances from Battlement Mesa residences, schools or businesses.

This model should then be re-run, to predict the environmental impact of gas-well drilling activities at several stipulated “buffer” distances (e.g. 0.5, 1.0 and 2.0 miles) from residents’ living and working areas.

**Risks from this analysis should be compared and should serve as one basis for potentially justifying an enforceable buffer zone between gas well drilling activities and the surrounding community at risk.**

**#7-4 – IMPOSE A MORATORIUM ON NEW GAS DRILLING ACTIVITIES PENDING THE DERIVATION OF MORE ACCURATE ESTIMATES OF HUMAN HEALTH RISKS**

CIT58

**Finally, given the preceding comments and observations, it is my opinion as a Colorado licensed, certified specialist in occupational and environmental medicine and as an environmental health scientist and engineer:**

- a). **The Garfield County Commissioners should impose a moratorium on any new gas well drilling activities, while the HIA and HHRA are being reworked to obtain more accurate estimates of human health risks.**
- b). **The length of any such moratorium should be prescribed by the Commissioners.**

In my experience, given the magnitude of the effort and the need to allow the authors of this HHRA to recalculate risk after mitigating many of the stated uncertainties, the minimum length of the moratorium should be at least six to nine months.

**#7-5 – SUPPLEMENTATION OF CURRENT COMMENTS AND OPINIONS**

CIT59

**My review of the HIA and HHRA is continuing and I request the opportunity to supplement this submittal with new comments and/or opinions for two weeks after the 11/15/10 deadline.**

Respectfully Submitted,

**James P. Kornberg, MD., Sc.D.**

James P. Kornberg, M.D., Sc.D.

Certified Specialist – Occupational and Environmental Medicine

Environmental Health Scientist and Engineer

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November 15, 2010

**CIT60**

Submitted by Joyce Wizer  
Masters in Educational Technology  
22 years teaching experience  
670 Village Drive, Rifle, CO 81650

Dear Dr. Witter,

Please consider these points as you finalize the HIA.

In part 1, on page 46 of the draft HIA, there is discussion of the possible impacts that drilling 200 wells in the Battlement Mesa PUD could have on education. No mention of high turn-over rates in class rooms was made; this is a significant omission.

Many of the jobs in the oil and gas industry are temporary; families of these workers make frequent moves as they follow work. This can have a significant impact on schools.

Over the course of my twenty years as a teacher, I kept track of how many of my students came and went each year. For most years, the turn-over rate was between 15% and 20 %. I thought that this was very high until the winter following Hurricane Katrina. That year my turn over rate was nearly 46%. Many of these families left the Gulf of Mexico looking for work in the oil and gas industry. They found work in gas fields of Garfield County, but they did not re-locate permanently to Colorado. Some of these students came and left several times before the school year was complete.

This turn over in students changed the climate of my class room. It is difficult to establish clear expectations and a culture of belonging when students know they will not be around for long. It is disconcerting to make a phone call home and reach the front desk of a hotel.

Impacts ripple out from the classroom to the school. Services for students can be delayed as the new school awaits paperwork from the previous school. This can diminish performance on state mandated tests, which can depress the school's AYP (Adequate Yearly Progress) upon which funding depends. Most of a school's money from the state is determined by the number of students present on "count days". The state awards a stipend for each student present on that day. If students arrive after that count day, the school's budget will have to be adjusted; the same amount of money now services more students.

If new students arrive in large numbers, class rooms are crowded. New teachers are hired, modulars are brought in, and in some cases, new schools are built. Please examine the new middle school in Battlement Mesa. It was built to accommodate increased enrollment, yet now they have sections closed off because the enrollment has dropped.

Notes from a conversation  
Desha Bierbaum, Principal at Wamsley Elementary School  
22 years of experience in education

Ms Bierbaum worked in Parachute at a time when they had a 45% turnover rate for their school. They registered 75 new students the first week of school, after carefully considering the balance and make-up of each class room prior to the beginning of the new year. The influx of new students lead to a rapid response to get them placed and much of the careful mapping was lost. This can lead to teacher burn-out and an unfair learning environment for all. New teachers had to be hired after the start of the school year, when most available teachers have already accepted positions elsewhere.

Wamsley Elementary has a current turnover rate of about 40%. In one class of 17 students, the teacher calculated that she had actually had 40 kids move into and / or out of her room. Administration and staff have found they must be proactive to make sure they have complete records for each student. The entire building is impacted because the students are usually trained to the school rules and expectations at the start of the year. With such high mobility they have found that they have to revisit this training monthly; precious academic time can be lost as a result.

Making AYP is an added stress to the school. Data from their reading program shows that students who failed to show growth were not at the school last year.

The community can see impacts as well. A sharp increase in rents accompanied increased numbers of jobs in the high-paying oil and gas industry. Teachers could not find affordable housing which lead to an increase in turnover in the teaching staff. Other members of the community find the increase in rent difficult to take in stride. Desha shared that many of her students live at the local campgrounds; one family with 5 kids was living in a tent on National Forest land. Lift-Up has already strained its resources as of November 1, 2010, and we have not yet started the holiday season.

Desha also expressed concern over increases in crime which can profoundly affect a community. What once felt like a safe place to raise children, no longer feels that way; the community feels disjointed and shattered as a result of a highly mobile work force.

Notes from a conversation with  
Deb Cain, Masters in counseling  
22 years experience in education

Ms Cain has observed impacts on students, classrooms, schools, districts, and communities as a result of high turn over rates.

Students can experience issues of abandonment when they move frequently. If this happens often, they can become hardened and unwilling to invest in forming new relationships. Many of these students move on one day's notice, so they experience huge changes over very little time. Since there is little consistency from state to state and from school to school, students can be disoriented and unsure of how they fit in. Because the parents work extremely long shifts, they are often not available to the student or the school. A large proportion of time for meetings with parents, teachers, and

administrators is devoted to helping students who are new to the school. This takes time away from other kids who have a stable foundation in the community.

It is often difficult to get records on students who move frequently. Knowledge of behavior issues can be critical to the success of a student, yet this information may not reach the new school in a timely manner.

The boom and bust cycle also creates poor allocation of community resources. A new school was built in Battlement Mesa to accommodate increased enrollment. Now that school sits 1/3 empty.

It is Ms Cain's observation that transient families lack of sense of community. There is no buy-in or pride for our school or our town.

CITBI

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COMMENTS ON THE HIA REPORT  
4.8 Accidents and Malfunctions Assessment

I would like to thank the Colorado School of Public Health for their comprehensive investigation into potential health impacts to the Battlement Mesa community resulting from Antero Company's plans to drill and extract natural gas from within our community. It is an unprecedented study, and it is extremely difficult to quantify the potential impact. Your efforts are commendable and much appreciated.

I believe the magnitude of the accidents and malfunctions potential in the Antero Company plan to drill 200 gas wells in the Battlement Mesa PUD is seriously underrated in the HIA. Given the potential for property damage, injury and even death this activity poses in a residential area, I believe a health impact rating of -15 is much more appropriate than the -10 cited in the report. I note that the assessment is based on historical data showing reportable and/or reported incidents to occur on about 6 percent of permitted wells. This basis presupposes that all reportable incidents were reported. Reflection on newspaper and TV reports of activities by the oil and gas industry would suggest this is a very optimistic assumption.

I have collected information on fire incidents and some other hazard events associated with natural gas extraction operations that occurred in the DeBeque, Grand Valley, Rifle, and Silt/New Castle fire districts' boundaries from January 2004 into early February 2010. The information collected was provided by these fire districts. Telephone interviews were conducted with the DeBeque and Silt/New Castle fire district chiefs because both declined face to face meetings. The information they provided was off-the-top-of-head, so may well be incomplete. I met with the chiefs of Grand Valley and Rifle fire districts. Their staffs provided written reports of incidents taken from their records.

Terminology was not always consistent among the districts. For simplicity my findings are summarized below by fire district and type of incidents divided into three primary categories: Fire & Explosions, Hazardous Materials Spills & Releases, and Vehicle Accidents. The incidents listed as vehicle accidents did not cause fires but hold serious potential to start fires or cause other injury so are included as risks.

Grand Valley District - January 1, 2004 to October 4, 2009

16 Fires & Explosions

- 27 Vehicle Accidents
- 9 Hazardous Materials Incidents

Rifle District - January 1, 2004 to December 9, 2009

- 423 Incidents involving the gas industry
- 53 Fires & Explosions
- 111 Hazardous Material Incidents
- 259 Other

A more detailed listing for 318 calls was provided the Rifle district for the period January 6, 2006 to February 7, 2010.

- 39 Fires & Explosions
- 28 Hazardous Materials Incidents
- 79 Vehicle Accidents
- 7 Unknown Odors
- 165 Other

DeBeque District - Past 4 or 5 years

- 2 Fires & Explosions
- 1 Hazardous Materials Incidents

Silt/New Castle District - Past 4 or 5 years

- 3 Fires & Explosions
- 1 Hazardous Materials Incidents

This is a total of 74 fires and explosions, 122 hazardous materials incidents, 106 vehicle accidents and over 500 incidents in which fire protection districts were called out in this region over the past 5 or 6 years. We haven't heard much about these incidents presumably because the gas companies naturally would like to keep them quiet, and they probably have occurred largely in more remote areas where most of the activity has taken place. But now the activity will be taking place within our community, and there is much cause for concern.

The community can take little solace in the fact that ... "COGCC addresses accident prevention (fire, explosion, hazardous materials release, pipeline maintenance) throughout the Rules Document"... and particularly 600 series rules concerning accident prevention and safety. These rules are inadequate for community safety. Furthermore COGCC does not have sufficient qualified inspectors or seemingly the will to enforce these rules. The setback requirements for wells are woefully inadequate under any situation concerning dwellings or occupied structures. Antero has claimed that no well is closer than 515 feet from the nearest dwelling. However we must remember that well pads are two to four acres or more in size so development activities and the well pad will encroach much closer than any stated distance from a well. With the directional drilling technology available today it is ludicrous to permit any well pad to be located within less than ¼ mile of a dwelling or occupied structure. COGCC needs to revisit these regulations in light of the current technology. The HIA should stress this need in the strongest terms.

The HIA cites a COGCC database recording 21 fires, loss of well control and explosions in Garfield County from January 1997 to August 2010. The information I obtained from the local fire districts

provided in earlier paragraphs indicates that such incidents are dramatically under-reported to the COGCC.

I strongly disagree with the final statement in the fourth paragraph of "Conclusions' Part One, Page 68 ... "Should water contamination and industrial accidents/malfunctions occur they could also cause important health impacts to Battlement Mesa residents, but these events are not likely to occur." I believe I have shown these events are very likely to occur and will place many residents and much property in serious jeopardy.

Harvesting our natural gas resources is an inherently dangerous and risky operation despite best management practices and a multitude of safety precautions. The fact many of the well pads are located on or at the base of steep tinder dry slopes in Battlement Mesa dramatically increases the risk that a well pad fire will escape the pad and sweep rapidly up the slope to the homes before anyone can react effectively. It should be noted that the Battlement Mesa area is known for its high and frequent winds. Much of the time they are upslope winds. Many in the community recall the fire that burned several homes in Monument Creek Village in the late 1990s. That fire was started by children playing with matches at the base of the slope below the village.

Natural gas development is an activity that should not be permitted within a community or in close proximity to dwellings. In Battlement Mesa such activity will place many homes and lives in jeopardy.

Thank you for the opportunity to present my comments.

Sincerely,

Richard Buchan  
19 Willow Creek Court  
Parachute, CO 81635

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See attached support from Dr. Stephen King of comments from Dr. Kornberg.

Thanks,  
Dave Devanney

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Date: Mon, 15 Nov 2010 17:44:14 -0600  
From: [toxicking@aol.com](mailto:toxicking@aol.com)  
Subject: RE: HHRA Battlement Mesa  
To: [cohbipc@hotmail.com](mailto:cohbipc@hotmail.com)  
CC: [toxicking@aol.com](mailto:toxicking@aol.com)

**CIT62** Dear Dr. Kornberg:

I have reviewed the "Human Health Assessment for Battlement Mesa Health Impact Assessment," and I have several comments that I would like to make. However, due to time constraints, I am not able to so at this time.

Based on my review of the Assessment, I agree with your opinions in your document.

I will be happy to offer my comments in the future if given the opportunity.

Stephen King, Ph.D., M.P.H.  
Environmental Toxicologist & Epidemiologist

Attached is my CV.

**Stephen King, Ph.D., M.Div., M.P.H.**  
**Toxicologist, Epidemiologist, and Biomedical Ethicist**  
**P.O. Box 11210**  
**Spring, Texas 77391**

## **EDUCATION**

The University of Texas School of Public Health at Houston, Texas, Ph.D., Environmental Sciences (Concentration in Toxicology); Minor in Epidemiology; and Minor in Management, Administration, and Planning (Concentration in Biomedical Ethics), 2006: Dissertation Research Title: "Maternal Ingestion of Radon-222 in Drinking Water and the Absorbed Radiation Dose to the Embryo"

The University of Texas M.D. Anderson Cancer Center, Houston, Texas, Fellow - Department of Symptom Research, January 2003 through December 31, 2003

The University of Texas M.D. Anderson Cancer Center, Houston, Texas, Fellow - Division of Anesthesiology & Critical Care, Section of Pain & Symptom Management, January 1999 through December 31, 1999

Reappointment as a Fellow, January 2000 to December 31, 2000

Reappointment as a Fellow, January 2001 to December 31, 2001

Reappointment as a Fellow, January 2002 to December 31, 2002

The University of Texas M.D. Anderson Cancer Center, Houston, Texas, Fellow - Department of Neuro-Oncology, Section of Pain & Symptom Management, January 1997 through December 31, 1997

Reappointment as a Fellow, January 1998 to December 31, 1998

Memorial-Hermann Hospital, Texas Medical Center, Houston, Texas, Clinical Ethics Rounds in Palliative Care, 1996

The University of Texas M.D. Anderson Cancer Center, Houston, Texas, Fellow - Clinical Ethics, January 1995 to September 1995

The University of Texas School of Public Health at Houston, Texas, M.P.H., Occupational Health (Concentration in Toxicology), 1995; Thesis Research Title: "Maternal Exposure to Toxic Compounds and the Relationship to the Subsequent Development of Neuroblastoma in Children"

Houston Graduate School of Theology, Houston, Texas, M.Div., Theology and Biblical Studies, 1988; Thesis Research Title: "The Sanctuary Movement: A Conflict of Law and Obedience"

Sam Houston State University, Institute of Contemporary Corrections and the Behavioral Sciences, Huntsville, Texas, Graduate Certificate in Law Enforcement and Police Science (30 Semester Hours), May 1972

Sam Houston State University, Huntsville, Texas, Graduate Work, 30 Semester Hours toward M.A., Law Enforcement and Criminal Justice, 1969-1971; Proposed Thesis Research Title: "Compulsion of Non-Testimonial Physical Evidence in Relation to the Fifth Amendment Protection Against Self Incrimination"

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**The Battlement Mesa HIA**  
**c/o Roxana Witter**  
**Colorado School of Public Health**  
[maperc@ucdenver.edu](mailto:maperc@ucdenver.edu)

Dear Dr. Witter:

I am Larry Soderberg, 614 Ponderosa Cr., Parachute, Co 81635, 970-285-6010, [larka9@comcast.net](mailto:larka9@comcast.net) and I ask that my report be considered into the final draft of the HIA:

Antero's so-called 'water handling facility' at location F in the southwest corner of the Battlement Mesa PUD is actually a hazardous waste site which will hold hazardous and toxic residue from the drilling rigs nearby. It is similar but much smaller than the larger and properly designed Hazardous Waste Facility several miles away in western Mesa County which is sequestered from all housing development. Antero's placement of this dangerous residue within 100 yards of existing homes in our PUD is unacceptable.

Larry Soderberg

To Whom It May Concern,

**E1** I agree with, and support the need to collect more data in order to remove much of the uncertainty and subjectivity present in this assessment. I see the main problems with the report as listed below:

- E2** • The Water & Soil Quality Assessment portion of the report indicates a potential for community-wide, long term water quality degradation due to spill incidents and/or runoff. This supposition is contrary to existing water quality data included in the report as well as "unlikely" at the admission of the author.
- E3** • The Human Health Risk Assessment failed to make a case for an excess risk of cancer to the public due to exposure to the 19 chemicals studied. The characterization of baseline cancer risk was limited to 1,4-dichlorobenzene and benzene which was inappropriately compared to the effects of many more chemicals that were not included in the baseline measurement (notably ethylbenzene). This lack of initial data resulted in the "appearance" of additional chemicals contributing to the risk of cancer that may have already been present, but were not measured as part of the baseline.
- E4** • An increase in traffic is normally associated with any business development - whether a manufacturing facility or a natural gas field. The "health" effects associated with this portion of the assessment are not specific to the oil & gas industry and are, primarily, of a public safety nature rather than one of community health.

**E5** The U.S. is replete with communities affected by natural gas and oil development. It is unknown to me why the authors did not utilize mortality and morbidity data from communities having similar demographics for comparison. This type of data could add some substance to the predictions made throughout this report, particularly in the assessments of community wellness, economic and employment and health infrastructure. Because many the impacts identified in this report are speculative, I believe that it is irresponsible to make 57 recommendations except those that involve collecting additional information such that the stakeholders may make more informed decisions.

Regards,

Timothy Hicks, MSPH, CSP, CIH  
Industrial Hygienist, U.S. Division  
Encana Oil & Gas (USA), Inc

Reappointment as a Fellow, January 2002 to December 31, 2002

The University of Texas M.D. Anderson Cancer Center, Houston, Texas, Fellow - Department of Neuro-Oncology, Section of Pain & Symptom Management, January 1997 through December 31, 1997  
Reappointment as a Fellow, January 1998 to December 31, 1998

Memorial-Hermann Hospital, Texas Medical Center, Houston, Texas, Clinical Ethics Rounds in Palliative Care, 1996

The University of Texas M.D. Anderson Cancer Center, Houston, Texas, Fellow - Clinical Ethics, January 1995 to September 1995

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Houston Graduate School of Theology, Houston, Texas, M.Div., Theology and Biblical Studies, 1988; Thesis Research Title: "The Sanctuary Movement: A Conflict of Law and Obedience"

Sam Houston State University, Institute of Contemporary Corrections and the Behavioral Sciences, Huntsville, Texas, Graduate Certificate in Law Enforcement and Police Science (30 Semester Hours), May 1972

Sam Houston State University, Huntsville, Texas, Graduate Work, 30 Semester Hours toward M.A., Law Enforcement and Criminal Justice, 1969-1971; Proposed Thesis Research Title: "Compulsion of Non-Testimonial Physical Evidence in Relation to the Fifth Amendment Protection Against Self Incrimination"

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**The Battlement Mesa HIA**  
**c/o Roxana Witter**  
**Colorado School of Public Health**  
[maperc@ucdenver.edu](mailto:maperc@ucdenver.edu)

Dear Dr. Witter:

**CIT63**

I am Larry Soderberg, 614 Ponderosa Cr., Parachute, Co 81635, 970-285-6010, [larka9@comcast.net](mailto:larka9@comcast.net) and I ask that my report be considered into the final draft of the HIA:

Antero's so-called 'water handling facility' at location F in the southwest corner of the Battlement Mesa PUD is actually a hazardous waste site which will hold hazardous and toxic residue from the drilling rigs nearby. It is similar but much smaller than the larger and properly designed Hazardous Waste Facility several miles away in western Mesa County which is sequestered from all housing development. Antero's placement of this dangerous residue within 100 yards of existing homes in our PUD is unacceptable.

Larry Soderberg

Public input to the Battlement Mesa Health Impact Assessment

November 9, 2010

Thank you for looking at the health impacts of oil and gas drilling in our residential area. My husband and I are relatively new residents of the Battlement Mesa area. We moved here to work and to build a retirement home that we hoped would serve us well for many years to come.

This community was promoted as an ideal place to raise a family and to retire and many families and retirees have relocated here specifically for the beauty and healthy outdoor recreations. We had no idea that it would even be possible for oil or gas drilling to take place in the vicinity of our homes, schools and other public places such as our churches, local medical facilities, grocery store and the golf course.

CIT64

We have many in this community who are very young and many of us are elderly or immune compromised. We are already impacted by dust, noise and odors from drilling taking place nearby. Please help us to protect ourselves and those who depend on us to protect them, our children and grandchildren.

It appears that the same company that attracted these families to buy the property and build homes was planning all along to profit from selling the drilling rights to companies that could destroy the very reasons we moved here. They could ultimately destroy our air quality, water quality, destroy the quiet peaceful community that has built up in the area and destroy our property values and be allowed to walk away unscathed and much wealthier.

This is a travesty and a total disregard for human health and the protection of private property that we all hold so dear in this Country. I want to be perfectly clear, we are not against drilling, we are against drilling in residential communities.

Please think of the families who live in this area, their children and grandchildren and help us to protect the health, welfare and safety in our residential area.

Respectfully,

Jennifer Richardson  
Battlement Mesa Resident

September 22, 2010

Cheri Brandon

~~████████████████████~~  
Glenwood Springs, CO  
81601

Dear Battlement Mesa Concerned Citizens,

I am writing this letter upon receiving your request to relate my reasons for relocating to Glenwood Springs.

As you know many of our Battlement Mesa citizens were shocked to hear of the impending Antero drilling within our PUD. I attended the first public meeting conducted by Antero and the others conducted later. We all have since learned that negotiations had been going on for years between Exxon-Mobil, Battlement Mesa Inc. and Antero. Despite these negotiations, home buyers were never informed of such a potential occurrence.

CIT65

I was shocked and saddened to learn of Antero's intentions. We residents, and I myself included, had resigned to live here despite already being exposed to the dust, road damage, heavy traffic and social and population changes to our Retirement Community. I felt insulted and cheated that this heavy industrial company, with all the possible dangerous implications, with such audacity, was being allowed to enter our densely populated small community thus putting us in harms way.

Most of us had bought or built homes here under that selling statement of a retirement community. This was the intent of the Battlement Mesa Company until the gas industry began to flourish in the area. Suddenly it was now a community to "live, work and play" with rental prices shooting up leaving so many seniors on fixed incomes forced to move away making way for the "wealthier gas worker renters". Businesses faced major rent increases and many had to close or move away. Battlement Mesa Inc. was out for the big buck.

I began to feel angry and the impending events weighed on my mind a lot. I joined the BCC in hopes that there may be a way to stop Antero. I had many a sleepless night mulling over the effects of drilling to the integrity of my community. I still cannot believe our county commissioners and the COGCC will allow this to happen to us. I have finally decided that, at my age, I do not need the stress, anger, anxiety, feelings of helplessness and possible health problems that come with this whole tragedy.

I feel, that with directional drilling and all the other land available for such, the gas industry has other options than drilling in my back yard. I also know we little people cannot fight the giants such as Exxon-Mobil, stakeholders and, of course, our state mineral laws.

I have opted to leave the home I love, the many friends I love and the activities I enjoy in Battlement Mesa to find some peace of mind, hopefully, clean air and safe water in an area where I hope to hell the gas industry will not tread.

Sincerely,

Cheri Brandon



September 22, 2010

Dear Sirs,

C2166  
I lived in Battlement Mesa from 1996 to 2004 and I moved to Grand Junction to get away from the localized gas drilling. I was elected to the Battlement Mesa Homeowners Association and sat on that Board for the entire time I lived there. I was Vice President of GVCA and I was on the Board of Western Colorado Congress as well as on the Western Organization of Resource Council (WORC) which is based in Billings, Montana. I was the Gas and Oil representative for Western Colorado on the WORC Board. Therefore, I am very familiar with the items in the HIA report.

We who lived in the gas patch know about spills, odors, explosions, traffic etc. I know personally about the rig (near Rifle) which fell over and caught fire next to a home. The owners (not the drillers) called the Rifle fire department who responded to the fire. When they arrived, the drillers had a chain across the entrance and refused to lower it for the fire truck. The Fire Chief said, "We're coming through." They did and they put the fire out. That is not the only time we've had fires. Some of them were documented and others were not.

According to the *Denver Post* as reported by the COGCC, there have been 263 spills in Garfield between January 2008 and June 2010. During that time, Antero submitted 5 % gas permits in Garfield and reported 15 spills. Five of the 15 spills required remedial action and in one, a notice of violation was filed due to the failure to report the spill to the COGCC.

Antero received three other violation notices since January 2008; they were received in June 2009, January 4, 2010 and July 14, 2010. As the report states using Antero's spill rate, it is estimated Battlement Mesa can be expected to have at least 12 spills requiring remediation with the potential to impact soil, ground water or surface water and public health.

Because accidents and malfunctions occur on a regular basis in gas development and production, I ask, what emergency plans are in place that address catastrophic malfunction? So far, Battlement Mesa citizens have seen NO EMERGENCY PLANS from Antero. Are they to suffer a Gulf Oil rig explosion with the tremendous fire potential in Battlement Mesa? I lived through a fire on the dry hill sides below Battlement Mesa which burned down numerous houses below my house. When the pipes are installed, will Battlement Mesa have to wait nervously for a San Bruno explosion?

Even if gas and oil companies followed to the letter every requirement of COGCC, there would still be potential for fire, explosions, spills and accidents. Antero has had violations and they haven't even started drilling the 200 wells planned. What can be done to stop these horrific accidents?

Peggy Rawlins  
519 Liberty Cap Ct  
Grand Junction, CO 81507  
970-263-4741



Antero Resources  
1625 17th Street  
Denver, Colorado 80202  
Office 303.357.7310  
Fax 303.357.7315

November 15, 2010

The Battlement Mesa Draft Health Impact Assessment  
c/o Roxana Witter  
Colorado School of Public Health  
13001 East 17th Place B119  
Aurora, CO 80045

Dear Ms. Witter:

Antero Resources ("Antero") hereby submits its comments to the Draft HIA for Battlement Mesa.

Antero has welcomed the opportunity to work with the Colorado School of Public Health in formulating a better understanding of the potential health impacts associated with oil and gas development. Antero will continue to utilize this opportunity to share with your organization the mitigation strategies and best management practices that Antero employs to address public health concerns raised by the Draft Battlement Mesa Health Impact Assessment ("DHIA").

Antero provides specific remarks on individual parts of the Draft HIA. Antero also incorporates by reference within our comments the submittal of the Colorado Oil & Gas Association (West Slope) as it effectively addresses the overarching issues. Antero believes their comments concerning statistical methods, assumptions, and their suggestions listed in their *General and Specific Comments on Human Health Risk Assessment for Battlement Mesa Health Impact Assessment* deserve your full consideration as you prepare your Final Health Impact Assessment.

Many of our comments reference aspects of our existing or proposed best management practices. Antero continues to believe that these best practices significantly mitigate or alleviate potential impacts arising from the proposed Battlement Mesa development program. Antero also reinforces the statement made at many points in the DHIA that our operations constitute a very small portion of impacts associated with gas and oil development in Garfield County. In contrast to 2008 activity levels our proposed two rig program constitutes less than 2% of overall activity and impacts, though because of proximity, our activity may have higher proportionate impacts in some categories.

Finally, Antero would like to thank the HIA Team for allowing more time for the comment period and consequently a more thorough review of the DHIA.

Best regards,

Gerard G. Alberts

Attachments:

- Exhibit 1 – Antero Mitigation Strategies and Best Management Practices
- Exhibit 2 – COGCC Response to Gasland
- Exhibit 3 - Watson Ranch E&P Tanks VOC Emissions Model Output
- Exhibit 4 – COGCC Odor NOAV Settlement and 8/10/2010 Response to Alleged Violation

Antero Comment	HIA Subject Line Item	Paragraph	Sentence	HIA Page #	RA Page #
<b>General Comments</b>					
<b>Executive Summary</b>					
Change Urban to 'Unit'; Battlement Mesa Planned [Unit] Development	ES1 Introduction	1	2	I	I
Add 'a'; Battlement Mesa is [a] community...		3	1	I	I
Change "five" to 5; the median age was 5 years...		3	1	II	II
		4	1	II	II
Change first sentence to read: The Antero project is anticipated to include approximately 200 natural gas wells on 9 pads, a centralized water storage facility in compliance with Colorado Regulation 7 RACT standards with roughly 8.4 miles of collocated buried water and gas pipeline.					
Change first sentence to read: In November 2009, Battlement Mesa Concerned Citizens formally requested THAT THE BOCC and THE GCPH address health concerns before Antero development activities begin.		6	1	II	II
Change Major Land Use Impact Review to Special Use Permit (SUP)		6	3	II	II
		6	Last	II	II
Antero's Mitigation Strategies and Best Management Practices (BMPs) are presented in Exhibit 1 of this comment letter. This information will be submitted with the Garfield County Special Use Permit application.	ES2 The HIA Process			III	III
Antero has, however, attached examples of the mitigation strategies and BMPs that will be implemented to address the potential impacts identified in the HIA study. These are included as Exhibit 1.		4	2	III	III
	ES4 Assessment of Health Impacts			V	V
	ES4.1 Summary of Air Quality Assessment			VI	VI
		2	4	VI	VI
Please refer to Antero's Air Quality and Odor Control BMPs in Exhibit 1.	ES4.2 Summary of Water and Soil Quality Assessment			VI	VI
Please refer to Antero's Groundwater and Surface Water Resources BMPs in Exhibit 1.		1	Last	VI	VI
	ES4.3 Summary of Traffic Assessment			VII	VII
	ES4.4 Summary of Noise, Vibration, and Light Assessment			VII	VII
For a given pad, they will only be selected periods of time, not the entire five year period.		1	5	VII	VII
Delete "children may be more vulnerable..." sentence. This is incorrect. The truck traffic will go on designated heavy haul routes which do not go by these noted schools.		1	6	VII	VII

A1

A2

A3

A4

A5

A6

A7

A8

A9

A10

A11

A12

A13

Antero Comment	HIA Subject Line Item	Paragraph	Sentence	HIA Page #	RA Page #
<p><b>A13</b> Delete: normal production phases in the years subsequent to well development. Change sentence to: On the other hand, after the development phase (drilling, fracking), major elevations in noise levels are not expected to occur during the estimated productive well life of approximately 20 years.</p>		1	10	VIII	
<p><b>A14</b> Please take into consideration Antero's Noise Mitigation BMPs in Exhibit 1.</p>		1	14	VIII	
<p><b>A15</b> Add sentence: "All drilling and completion operations and associated noise within the boundaries of the PUD will be in accordance with State and County noise regulations."</p>		1	15	VIII	
<p><b>A16</b> Antero's opinion is that the subjective numerical assignments are difficult to interpret and are presented in a vacuum as essentially professional judgment calls</p>		1	Last	VIII	
<p><b>A17</b> Please refer to Antero's Noise Abatement BMPs.</p>			Recommendations	VIII	
	<b>ES4.5 Summary of Community Wellness Assessment</b>			VIII	
	<b>ES4.6 Summary of Economic and Employment Assessment</b>			IX	
	<b>ES4.7 Summary of Health Infrastructure Assessment</b>			IX	
	<b>ES4.8 Summary of Accidents and Malfunctions Assessment</b>			X	
<p>Please refer to Antero's Safety BMPs (Exhibit 1).</p>	<b>ES5 Recommendations</b>		Recommendations	X	
			Bullet Point 1	XI	
<p>See Antero's Mitigation Strategies and BMPs (Exhibit 1).</p>	<b>ES6 Next Steps and Conclusions</b>			XII	
	<b>Part One: Health Impact Assessment</b>			1	
	<b>Preface</b>			1	
<p><b>A18</b> Many of Antero's efforts to minimize negative effects of the program are detailed in the Mitigation Strategies and BMPs (Exhibit 1).</p>		2	Last	1	
<p><b>A19</b> The RA did not subtract background air concentrations from the O&amp;G area sample results – these background concentrations were "qualitatively" assessed and most of the cancer risk drivers and many non-cancer risk drivers were either not analyzed or excluded in the background data set.</p>		4	1	2	
<p><b>A20</b> This could read: If there are needs for additional exposure mitigation beyond current regulations and what Antero has presented in it's Mitigation Strategies and BMPs (Exhibit 1).</p>		4	Last	1	
	<b>Regarding Ozone and Human Health</b>			2	
		1	Last	2	
<p><b>A21</b> Under regulation number 7 and regulation number 3, as promulgated by the Colorado Department of Public Health and Environment, oil and gas activities are required to operate with emission controls.</p>	<b>Regarding Climate Change and Human Health</b>			2	
	<b>1 Introduction</b>			3	
	<b>1.1 The Battlement Mesa Community</b>			3	
	<b>1.1.1 Parachute</b>			4	

Antero Comment	HIA Subject Line Item	Paragraph	Sentence	HIA Page #	RA Page #
	1.1.2 Demography			4	
	1.1.3 Economy			5	
Antero disagrees with the comment "Federal and State economic incentives to develop natural gas resources" as it pertains to the Battlement Mesa PUD. A footnote is requested for this statement.	1.2 Antero's Plan to Drill Within the Battlement Mesa PUD	1	1	6	6
Replace 'country' with United States		1	3	6	6
Replace 'purchase surface rights and mineral rights from the BMC as well as its intent to develop' to: "Develop"		2	1	6	6
Add: "utilizing its mineral rights acquired from Exxon, Battlement Mesa Companies, and others." to end of first sentence.		2	1	6	6
Remove 'and' (BOCC to review AND any proposed land-use) and change Major Land Use Impact: Review to 'Special Use Permit' (SUP) throughout paragraph.		2	2	6	6
Change BMC to read: 'legally-binding Surface Use Agreement with the Battlement Mesa Companies (BMC)		2	9	6	6
Add over 30 total meetings. Antero held 18 community meetings where the public was specifically invited.		2	12	6	6
Delete 'to': CSPH team are used TO as a basis for this HIA	1.3 Community Concerns	2	14	7	7
		3	3	7	7
Please provide evidence for heavy metals released in drilling activities claim.	1.4 Initial Responses to Community Concerns	1	1	8	8
		1	1	8	8
Compromises include the removal of the most highly contentious pad, the "C" pad, and associated pipeline through the Stone Ridge neighborhood. This pad was substituted with the Parks and Rec. pad. We also removed roughly ½ mile of pipeline from inside the PUD because people in the Mesa Ridge Townhomes were concerned about the pipeline running too close to their homes. As part of the C pad removal and Parks and Rec. agreement, Battlement Mesa Partners, the Battlement Mesa Services Association (BMSA), the Parks and Rec. Department, and Antero created an agreement to build a community park, near the new middle school. We have, for now, removed the Lyons pad from the plan because we do not currently have an SUA with Lyons. There are a total of 9 pads, 1 water facility, not the previous 10 pads, and 1 water facility.		2	Bullet Point 3	8	8
	2 HIA Methods			9	
	2.1 Screening			9	
		1	2	9	9
	2.2 Scoping			9	
	2.3 Assessment			9	
Please refer to David Neslin's 'Gasland' memorandum (attached as Exhibit 2)				9	

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Antero Comment	HIA Subject Line Item	Paragraph	Sentence	HIA Page #	RA Page #
A36 Many of Antero's efforts to minimize negative effects of the program are detailed in the Mitigation Strategies and BMPs (Exhibit 1).	2.4 Recommendations	3	2	10	
		1	3	10	
A37 An example of the rapid adoption of a new technology to reduce air quality impacts and odors is Antero's use of the "sealed flowback tank" This is referenced in Exhibit 1.	2.5 Reporting 2.6 Implementation 2.7 Evaluation	1	Varied	11	
		1	Varied	11	
		1	Varied	11	
		1	Varied	11	
A38 Approximately 88% of Antero's pads in the Gravel Trend and Battlement Mesa development areas utilize buried pipelines to move water to/from, water storage facilities to support well drilling, completions and injection activities. Additionally resulting in truck traffic reduction.	3 Summary of Battlement Mesa Baseline Health Profile 3.1 Vulnerable populations 3.2 Physical determinants of health 3.3 Social determinants of health 3.4 Limitations 4 Assessment of Health Impacts	1	2	17	
		1	2	17	
		1	2	17	
		1	2	17	
		1	2	17	
A40 Many of Antero's efforts to minimize negative effects of the program are detailed in the Mitigation Strategies and BMPs.	4.1 Assessment of Air Quality on Health in Battlement Mesa 4.1.1 Air Quality and Health	Example	3	18	
		Entire Report		19	
				19	
A42 EPA regional screening levels based on 24hr/day exposure for 350 days/yr for 30 years. This timeframe doesn't apply to drilling, fracing, or the expected 20-year duration of the well.	4.1.2 Current Air Quality Conditions	2	2	20	
		2	2	20	
A43 If Garfield County emissions inventory indicates that highway vehicles were a primary contributor, then the first sentence should be more definitive.	4.1.3 Antero Drilling Plans in Battlement Mesa and Air Quality	6	4	21	
				21	
A44 Only 1 detect of 1,4 Dichlorobenzene out of 29 samples: not enough information to determine cancer risk.				21	

Antero Comment	HIA Subject Line Item	Paragraph	Sentence	HIA Page #	RA Page #
<p>The Watson Ranch Pad site specific production tank emissions are based on the October 8, 2010 Extended Analysis for the Watson Ranch Pad and the most recent production data (as included in Exhibit 3) are as follows:                      Producing Gas Wells: 11 wells are on sales and one well was drilled but not completed. Annual VOC Emissions: 4,158 tons/year (uncontrolled) or 0.2 tons/yr (controlled). Total HAP Emissions: 0.20 tons/yr. Production Basis: 4,608 bbl/yr (Highest month 384 times 12 months) (During the period of January-October condensate production was 1638 bbl used highest month to determine total production projected forward) Calculated site specific emission factor – 1.81 lbs/bbl (uncontrolled) Emissions based on State Factor Using state emission factors 4,608 bbl/yr (10lbs/bbl) = 46,080 lbs or 23 tons/year. Current Permit: Watson Ranch was permitted for 13.4 tons/yr uncontrolled and 0.7 tons/yr controlled. (Based on state emission factor of 10 lbs/bbl) Watson Ranch has a Cinnarron Burner.</p>		2	2	21	21
<p>Please identify the "other" sources that you believe have an emissions profile similar to production tanks.</p>	Reference 9 is incorrect for COGCC complaint reports	3	2	22	22
<p>The 7/14/2010 NOAV was settled via a no further action decision, as per the attached as per Exhibit 4. Additionally, the company's Air Quality and Odor Control BMPs are provided.</p> <p>Information below is based on Antero field observations during the well completion air monitoring event – Nathan Rogers and Jerry Alberts with Antero and Paul Reaser with Garfield County.</p> <ul style="list-style-type: none"> <li>• Frac/Flowback monitoring conducted on the Antero Norcross A Pad during the summer of 2008.</li> <li>• Center of the Norcross A Pad is 150 feet from perimeter of pad.</li> <li>• Southeast corner of the pad was about 212 feet from pad center.</li> <li>• Open top flowback tanks (VOC Emissions Source) were about 30 feet from the southeast corner of the pad.</li> <li>• Garfield County air monitoring station was essentially on the property line downwind (east of the flowback tanks) or about 30 feet from the VOC emissions source i.e. flowback tanks, and the monitoring station was about 212 feet from pad center.</li> <li>• All airborne concentrations will be relative to the distance from the well pad. As such, the Antero setback distance for all of its well pads is 500 feet and at the Watson Ranch pad the distance to the nearest dwelling unit is 747.</li> </ul>	4.1.4 Characterization of the Air Quality on Health	8	1	23	24

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Antero Comment	HIA Subject Line Item	Paragraph	Sentence	HIA Page #	RA Page #
<p>The HIA indicates "It is likely that contaminant concentrations in residential ambient air may be high enough to cause short-term and long-term disease." It seems somewhat ambiguous to say "likely" and "may be" in the same sentence.</p>	<p>4.1.5 Findings and Recommendations from Air Quality Assessment</p>	2	24	25	
<p>The 7/14/2010 NOAV was settled via a no further action decision, as per the attached COGCC documentation (Exhibit 4). Additionally, the company's Air Quality and Odor Control BMPs are provided.</p>		1	4	25	
<p>The 7/14/2010 NOAV was settled via a no further action decision, as per the attached COGCC documentation (Exhibit 4). Additionally, the company's Air Quality and Odor Control BMPs are provided.</p>		1	Last	25	
<p>However, the risk is within EPA's acceptable range.</p>		1	4	25	
<p>Antero suggests that the HIA mention the resolution of this NOAV as attached in Exhibit 4.</p>		1	Last	25	
<p>However, estimated that the risk is within EPA's acceptable range.</p>		2	Last	25	
<p>What is the scope of the suggested quality assurance project plan (QAPP)? Under what statute or authority would this be implemented?</p>		2	Bullet Point 1	25	
<p>What is the suggested corrective action for when odor events occur?</p>		2	Bullet Point 3	25	
<p>Electrical Infrastructure is not adequate to support electrically powered generators in place of diesel powered. Only can support a single drilling rig. Where feasible and economically practicable.</p>		2	Bullet Point 5	25	
<p>This technology for O&amp;G pits is not proven yet; therefore, should not require a technology based item, rather, should only require compliance with CDPHE regulations number 7 and RACT.</p>		2	Bullet Point 11	26	
<p>Please refer to Antero's Air Quality and Odor Control BMPs (attached).</p>		2	Bullet Point 2	25	
<p>It is not necessary to require this as the company has provided this data to the County and to the HIA staff. Antero continues to be committed to making its air quality monitoring data available to the public in a timely manner.</p>		2	Bullet Point 2	25	
<p>The corrective action should be based on whether compliance with the CDPHE Reg 2 Odor Rule has been demonstrated and on whether the odor reducing BMPs per COGCC rule 805(b) have been implemented as noted by the Form 2A COAS.</p>		2	Bullet Point 3	25	

Antero Comment	HIA Subject Line Item	Paragraph	Sentence	HIA Page #	RA Page #
<p>A CDPHE General Permit is required for well pads with VOC emissions above certain thresholds. Antero has General Permits for all of its well pads with VOC emissions greater than these thresholds. In addition, Antero operates with combustors at all of its well pads even though they are not always required under Colorado Reg 3/7. In addition, Antero operates with automatic igniters for all of its well pad combustors in the Battlement Mesa leasehold position.</p>	4.2 Assessment of Water and Soil Quality on Health in Battlement Mesa			26	
	4.2.1 Water and Soil Quality Impacts on Health			26	
	Please provide the documentation for "hundreds" of contaminants.	1	1	26	
	4.2.2 Current Conditions of Water and Soil Quality			27	
	Antero will sample where practicable the water wells within one half mile radius of each well pad and per surface owner request before drilling and after well completion activities. This data is subsequently sent to each water well owner.	1	Last	27	
	4.2.3 Antero Drilling Plans in Battlement Mesa and Water and Soil Quality			28	
	Please refer to Antero's Groundwater and Surface Water Resources BMPs (Exhibit 1).	3	Last	29	
	Delete language referring to possibilities, anything is possible.	5	2	30	
	What does "uncontrolled well development" mean?	5	3	30	
	What is the likelihood of incidents occurring?	5	3	30	
COGCC rules do address drill cuttings under 907.d.(3)	7	Last	31		
	4.2.4 Characterization of the impact on Water and Soil Quality			31	
	4.2.5 Findings and Recommendations from Water and Soil Quality Assessment			32	
	Recommendations	Bullet Point 3		33	
No. Let COGCC distribute. Every company is different. Can change day to day.	Recommendations	Bullet Point 4		33	
Please refer to Antero's SPCC BMPs (Exhibit 1).	4.3 Assessment of Transportation and Traffic on Health in Battlement Mesa			33	
Why single out workers? Anyone driving at high speeds increase risks.	4.3.1 Traffic and Safety			33	
	4.3.2 Current Traffic Conditions			34	
	4.3.3 Antero Drilling Plans in Battlement Mesa and Traffic			34	
What about the existing operators in area?		1	1	34	
				35	

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Antero Comment	HIA Subject Line Item	Paragraph	Sentence	HIA Page #	RA Page #
Well development period is dependent on the public's input too. Antero will consider the public's wishes regarding duration of the project. Some may want a short period of intensive activity while others may want an extended period but less intensive.		4	1	36	
Primarily drilling which will have significantly less associated traffic than construction and completions. Drilling is the only activity planned for 24 hours per day.		4	7	36	
Children MAY BE crossing haul routes.		6	Last	37	
Insert 50,000 fewer routes.		7	Last	37	
Please refer to Antero's Traffic BMPs (Exhibit 1).		8	Last	37	
This a broad statement that may or may not be the case. This could be said of virtually any county program. [Divert County funds]		9	Last	37	
	<b>4.3.4 Characterization of Traffic Impacts on Safety</b>			37	
This may be a bit high...probably not several hundred but certainly several tens per day, on average. Antero is developing a construction schedule to reduce the traffic load on River Bluff Road.		1	9	38	
	<b>4.3.5 Findings and Recommendations from Traffic and Transportation Assessment</b>			38	
				38	
				38	
Who does the penalty system apply to? Entire County? Project? Antero?				39	
	<b>4.4 Assessment of Noise, Vibration, and Light Pollution on Health in Battlement Mesa</b>			39	
Delete Stakeholder comment "I am concerned..." repetitive.		1	1	39	
COGCC regulations include operations involving pipelines or gas facility installation or maintenance, the use of a drilling rig, completion rig, workover rig, or stimulation is subject to the maximum permissible noise levels for industrial zones... not just pad construction.		2	1	40	
The 55 dB day and 50 dB night applies to the production phase.				40	
Antero has conducted noise monitoring at Watson pad and we showed that we are in compliance with COGCC Rules and Regs.		4	1	40	
	<b>4.4.1 Noise, Vibration, Light pollution and Health</b>			40	
				40	
The OSHA standard allows 90 dBA for 8 hours which is protective of human hearing loss		1	1	40	
	<b>4.4.2 Current Noise, Vibration, and Light Conditions</b>			41	
About 1/5 of Battlement Mesa residents are within 1 mile of I-70.		1	1	41	
	<b>4.4.3 Antero Drilling Plans in Battlement Mesa and Noise/Vibration/Light</b>			41	
Please refer to Antero's Noise Mitigation BMPs (Exhibit 1).		1	3	41	
Noise measurements and studies show Antero operations are in compliance with this standard.		1	4	41	
Please refer to Antero's Noise Mitigation BMPs (Exhibit 1).		3	4	42	
SUP[Special Use Permit] vs. Major Land Use Impact Review		3	6	42	

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Antero Comment	HIA Subject Line Item	Paragraph	Sentence	HIA Page #	RA Page #
Antero measurements and studies have shown the contrary	4.4.4 Characterization of Noise, Vibration and Light Impacts	3	Last	42	42
Rough estimates indicate that schools are approximately 1,000 feet or more from truck routes and may not experience significant noise impacts. Haul routes will not go by these schools.		2	8	43	43
	4.4.5 Findings and Recommendations from Noise, Vibration, and Light Assessment			43	43
Antero has measured noise levels at proposed set-backs in the Battlement Mesa area. These findings are available. They were presented to the BMSA in 2009.		2	1	43	43
Rough estimates indicate that schools are approximately 1,000 feet or more from truck routes and may not experience significant noise impacts. Haul routes will not go by these schools.		Recommendations	Bullet Point 6	44	44
Such requirements will be included as part of contractor MSA provisions. These are not dedicated trucks.		Recommendations	Bullet Point 2	43	43
What protocol is being requested to alert residents of anticipated noise?		Recommendations	Bullet Point 3	43	43
	4.5 Assessment of Impacts on Community Wellness			44	44
	4.5.1 Current Community Wellness Conditions			44	44
	4.5.2 Antero Drilling Plans in Battlement Mesa and Community Wellness			45	45
	4.5.3 Characterization of Community Wellness Impacts			49	49
	4.5.4 Findings and Recommendations Related to Community Wellness			50	50
	4.6 Assessment of Economic and Employment Impacts on Health in Battlement Mesa			50	50
		1	3	51	51
Antero's plan is to operate 2 drilling rigs over a 5 year period in the Battlement Mesa PUD. Is this really considered a "boom" scenario? If so, by what measure? The Piceance Basin currently has 37 rigs operating today and has recently had up to 130. "Sudden economic growth" that a "boom" of 2 rigs would surely not be limited to the Battlement Mesa area since most of the services are based throughout the Western Slope and those impacts would be spread therein.	4.6.1 Economy, employment, and health			51	51
Oil and gas activity in Garfield County is currently depressed. Antero's proposed project will be a step in the right direction to restoring the economic well being of the area.	4.6.2 Current Economic and Employment Conditions	3	2	51	51
	4.6.3 Antero Drilling Plans in Battlement Mesa and Economics and Employment			52	52

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	Antero Comment	HIA Subject Line Item	Paragraph	Sentence	HIA Page #	RA Page #
<b>A100</b>	The addition of 2 rigs hardly constitutes a boom. Worker population influx will not be significant since the availability of qualified workers is high due to the downturn in the oil and gas industry. Some workers may have exited the area seeking employment in other parts of the country while some may have remained and found employment outside of the oil and gas industry. Re-employment of those workers is expected.		1	Last	52	
<b>A101</b>	As noted above, re-employment of resident workers will dominate over influx. It will not create a boom economy at all.		2	5	53	
<b>A102</b>			3	Last	53	
<b>A103</b>	In 2008 there were approximately 120 rigs in Grand Valley (Garfield County) the proposal for 2 rigs is approximately 1.6% of historical rig count.					
<b>A104</b>		<b>4.6.4 Characterization of the Economy and Employment Impacts on Health</b>				
<b>A105</b>	Direction of Health effects: is positive		Table	Table	53	
<b>A106</b>	Likelihood of health effects as a result of project: likely		Table	Table	53	
<b>A107</b>	Magnitude of health effects: this rating system only recognizes negative health effects; positive health effects can result from this project but are not described in the rating system		Table	Table	53	
<b>A108</b>	Repeat positive health impacts/		1	1	53	
<b>A109</b>	Repeat positive rank		1	Last	54	
<b>A110</b>		<b>4.6.5 Findings and Recommendations from Economic and Employment Assessment</b>				
<b>A111</b>	As stated in this report, Antero's project is too small to initiate a boom and bust cycle; therefore this recommendation is not appropriate for this study.		Recommendations	3	54	
<b>A112</b>	Colorado Mountain College currently provides this training.		Recommendations	5	54	
	Not appropriate since the project is not expected to create a significant sudden industry downturn upon development completion.		Recommendations	6	54	
	Currently lobbied by new health clinic located in Battlement Mesa for medical services for staff and contractors.	<b>4.7 Assessment of Impacts to Health Infrastructure in Battlement Mesa</b>			55	
		<b>4.7.1 Private and Public Health Services and Health</b>			55	
		<b>4.7.2 Current Health Infrastructure Conditions</b>			56	
		<b>4.7.3 Antero Drilling Plans in Battlement Mesa and Healthcare Infrastructure</b>			57	
		<b>4.7.4 Characterization of Healthcare Infrastructure Impacts</b>			57	
		<b>4.7.5 Findings and Recommendations Related to Health Care Infrastructure</b>			58	
		<b>4.8 Assessment of Accidents and Malfunctions Impacts on Health</b>			59	

Antero Comment	HIA Subject Line Item	Paragraph	Sentence	HIA Page #	RA Page #
	4.8.1 Accidents, Malfunctions and Health	Last	5-end	60	
A113 These statements are sensational in nature and are not representative of the potentials associated with Antero's project.	4.8.2 Current Conditions for Accidents and Malfunctions	1	Last	61	
A114 The alleged failure of an administrative process is not relevant to likelihood or the potential impact of a spill.		2	1	61	
A115 An odor complaint does not necessarily indicate an "Accident or Malfunction" which seems to be the reason for inclusion here.		2	Last	61	
A116 This NOAV has no bearing on "Accidents and Malfunctions".		Varied	Varied	61	
A117 2010 - Antero experienced no Lost Time Injuries (LTI's) in Colorado.	4.8.3 Antero Drilling Plans in Battlement Mesa and Accidents and Malfunctions	3	Last	62	
A118 Antero has detailed maps which show these distances and will make them available for review.	4.8.4 Characterization of the Impact from Accidents and Malfunctions			62	
A119 Antero has an Emergency Response Plan specific to the Piceance basin and is in the process of amending the plan to specifically address the Battlement Mesa area.	4.8.5 Findings and Recommendations from Assessment of Accidents and Malfunctions	2	Last	63	
A120 Antero has addressed or is in the process of addressing all stated Recommendations.	4.9 Summary of Assessments on Health in Battlement Mesa	1	2	64	
A121 Please refer to Antero's Traffic BMPs (Exhibit 1).	5 Next Steps	Air	General	65	
A122 Refer to Air Quality BMPs (Exhibit 1). Antero has gone above and beyond industry standards with regards to mitigation measures.	6 Conclusions			68	
	7 References			71	
	Part Two: Supporting Documentation				
	TABLES				
	APPENDICES				
	APPENDIX A: SUMMARY OF THE NATURAL GAS DRILLING PROCESS				
	APPENDIX B: NATURAL GAS DEVELOPMENT IN THE PICEANCE BASIN				
	B1 Geology				
	B2 Energy Development in the Piceance Basin: Past	B2	9	B3	
A123 Exxon retained mineral rights when it sold the PUD's surface rights to BMC.	B3 Energy Development in the Piceance Basin: Present				
	B4 Antero's Plan in Battlement Mesa				

Antero Comment	HIA Subject Line Item	Paragraph	Sentence	HIA Page #	RA Page #
<p><b>A124</b> Bmps include a fracing restriction during daylight hours only.</p>	<p>Hours of Ops 1 B6</p>	<p>6.1</p>	<p>First</p>	<p>40</p>	<p>5</p>
<p><b>APPENDIX C: BATTLEMENT MESA BASELINE HEALTH PROFILE</b></p>					
<p><b>APPENDIX D: HUMAN HEALTH RISK ASSESSMENT</b></p>					
<p><b>A125</b> Uncertainty section title should be in bold for ease of finding the section.</p>	<p>1.2.2</p>	<p>Second</p>	<p>5</p>	<p>40</p>	<p>5</p>
<p><b>A126</b> Although the RA concluded "The estimated cancer risks and the non-cancer hazards across the rural background areas were significantly lower than those across the oil and gas development and urban areas" it appeared that these background risks were determined in the absence of data for many of the risk drivers. Shouldn't the RA text reflect these differences?</p>	<p>1.2.2</p>	<p>Second</p>	<p>5</p>	<p>5</p>	<p>5</p>
<p><b>A127</b> The RA concluded "The cancer risk estimates for benzene across the oil and gas development areas were significantly higher than those across the urban and rural background areas;" however, it appeared that the risks for these areas were determined in the absence of data for significant risk drivers. Shouldn't the RA text reflect these differences?</p>	<p>General Comment</p>	<p>6</p>	<p>Varied</p>	<p>Varied</p>	<p>Varied</p>
<p><b>A128</b> While it appeared that the background data were not subtracted from the data used in the risk calculations, we could not verify this; however, if not subtracted, we believe this uncertainty and potential bias should have been more prominent in the RA discussion and conclusions. Also, the RA should clearly discuss what, if any, background or other alternative source corrections were made to the EPCs used in the risk assessment.</p>	<p>General Comment</p>	<p>6</p>	<p>Varied</p>	<p>Varied</p>	<p>Varied</p>
<p><b>A129</b> Uncertainty in the toxicology and risks for several relevant compounds was explained in the uncertainty section but should be included in the conclusions section for more clarity related to the actual risks. Both crotonaldehyde and 1,4-dichlorobenzene are significant contributors but are highly uncertain human carcinogens, and ethyl benzene, while a less important contributor is not even considered a human carcinogen. However, the uncertainty in the risks associated with these highly uncertain or non-human carcinogens are not addressed where most readers will be informed of their uncertainty or the impact of their inclusion in the calculated risks.</p>	<p>General Comment</p>	<p>6</p>	<p>Varied</p>	<p>Varied</p>	<p>Varied</p>
<p><b>A136</b> Discussion regarding eliminating the uncertainties in the risks associated with crotonaldehyde, 1,4-dichlorobenzene and ethyl benzene should be included as in all relevant uncertainty sections and in the conclusions since they play major roles in the cancer risk.</p>	<p>General Comment</p>	<p>6</p>	<p>Varied</p>	<p>Varied</p>	<p>Varied</p>

Antero Comment	HIA Subject Line Item	Paragraph	Sentence	HIA Page #	RA Page #
<p>Surface soil risks were addressed by noting that "While, the risk assessment process is generally skewed towards overestimating rather than underestimating risk, the risk estimated is this HHRA is most likely underestimated because of lack of data for the surface soil and water pathways." However, for surface soils there was no demonstrated complete pathway in the RA beyond the immediate vicinity of the well pads, and any potentially significant inhalation exposure from surface soil-borne CPOCs appears unlikely. As such, we believe the uncertainty of this potential risk contribution is high and should be addressed in the uncertainty section and, to be fair, in any section where surface soil risks are discussed.</p>	6	First		40	
<p>The RA noted "Several potentially complete pathways were not evaluated in this HHRA because data was not available or potential for exposure is low. Excluding these pathways would not be expected to significantly affect the results of this HHRA and may lead to a low underestimation of the risk." However, it was not clear what "low underestimation" means, or how something not expected to significantly affect the results can result in a "low underestimation."</p>	6.2.1	Second		43	
<p>PAHs are identified as potential CPOCs and the RA indicates that "Cancer risks may be significantly underestimated without PAH data for both ambient air and surface soil." However, since PAHs are typically considered non-volatile or semi-volatile, and exposures would most likely require dust-borne transmission of settled emissions and migration of surface soils proximal to the well pad, it was not clear that there would be a complete air or surface soil off-site pathway for PAHs. To conclude there is a complete pathway requires both data to demonstrate source emissions and a detectable concentration at off-site receptor locations. Since the RA indicates a "lack of data" for these compounds, it appears that any risks associated with potential off-site PAH exposure may be overstated in the RA.</p>	6.3.3	First		48	

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Antero Comment	HIA Subject Line Item	Paragraph	Sentence	HIA Page #	RA Page #
<p>The RA provides a 2010 CDPHE HHRA conclusion in the first bullet stating "The estimated cumulative lifetime cancer risks for the crotonaldehyde, benzene, formaldehyde, ethyl benzene, 1,3-butadiene, and acetaldehyde are at or slightly above the high-end of EPA's acceptable cancer risk range of 1 to 100 excess cancers in a million (1E-06 to 1E-04) across all monitoring sites." This quote, however, appears to imply that the individual compounds have this risk range when, with the exception of crotonaldehyde, these individual compounds had only slightly in excess of a 10-5 risk. Also, without considering crotonaldehyde, the summed risks of all other compounds was well below 10-4 at all four of the sites assessed (Bell, Brock, Parachute and Rifle). We believe this quote from the 2010 CDPHE HHRA may be misleading and could be interpreted to overstate the actual risks at these sites.</p>	1.2.4	Second		7	
<p>While the 2010 CDPHE HHRA included a discussion of the high level of uncertainty associated with the primary risk driver (crotonaldehyde) in their first bullet conclusion, this RA failed to include this highly relevant information in their quote from the HHRA. This RA also failed to include the caveats included in the second bullet (the finding of a low increased risk of non-cancer health effects), and excluded the third conclusion (of four), which stated "Based on the available 24-hour air monitoring data, the estimated acute noncancer hazards for benzene are well below an acceptable value of one indicating a low increased potential for acute health effects of benzene (e.g., immune system effects)." We believe including part of the conclusions without including the caveats, or leaving out the third conclusion altogether, may result in an incomplete and/or biased interpretation of the 2010 CDPHE HHRA findings.</p>	1.2.4	Second		7	
<p>"Prospective" should read "perspective."</p>	2.4	Third		12	
<p>RA states that "EPA has determined 1,4-dichlorobenzene is likely to be a human carcinogen based on limited animal studies (Class C)." However, this misstates EPA's definition of "Class C" (aka Group C) carcinogens such as 1,4-dichlorobenzene which as classified as "possibly" carcinogenic to humans.</p>	4.2.6	First		28	
<p>The RA's position that summing individual compound risks "likely" underestimates total risks is not supported by actual data. The generally accepted risk assessment approach utilized by US EPA assumes additivity, and synergism should not be assumed without a reasonably scientific basis for this assumption. Also, potential antagonistic actions should not be downplayed, as appeared to be the case in the RA.</p>	6.5	Third		50	

A134

A135

A135

A136

A137

**A137**

It was not clear how, in the second bullet, the RA concluded from a qualitative assessment of CPOCs without toxicity values that the risks "may be significant underestimates." Neither the basis of the qualitative assessment nor the consideration that these CPOCs may not be related to gas production were discussed in the RA. The final statement in the last bullet provides a fairer assessment of these potential risks

7.2

Third

52

**A140**

None of the raw data from which the tables in the RA were generated were provided for our review. Without the raw data we cannot determine whether appropriate methods were used to collate data and perform statistical analysis. For example, the RA statistics appear to rely heavily on Kaplan-Meier non-parametric methods. However, if the data were parametric and skewed, the 95% UCLs used in the RA calculations may be biased high.

Varied

Varied

Varied

**A141**

Table 2-7 was missing from the RA. Without this table we cannot tell what compounds were analyzed for and/or detected in the "background" samples. Also, without the raw background data we cannot determine whether many of the relevant compounds that drive the calculated risks were analyzed but not reported, or were otherwise not considered in the RA (e.g. the aromatics).

2.4

First

12

**A142**

The use of compounds with a greater than five percent detection frequency does not appear to be in concert with the guidance provided by US EPA 2010 document referenced heavily for the basis of statistical determinations. On page 120 of the ProUCL Version 4.00.05 Technical Guide, EPA/600/R-07/041 it reads "The maximum censoring level considered in the present simulation study is 70%. For data sets having a larger % of nondetects (e.g., 80%, 90%, or 99% nondetects), statistical estimates may not be reliable. Decisions about the use of an appropriate method should be made by the risk assessors and regulatory personnel on a site-specific basis." In the RA, several contributors (e.g., 1,3-butadiene, 1,4-dichlorobenzene, 2-hexanone, and methylene chloride) were detected only once and/or at a frequency of less than ten percent. Also, while the five percent frequency was applied to air monitoring data, it was not applied to the background dataset (per Section 2.4), and no basis for adopting the five percent frequency for one dataset versus another was provided in the RA.

2.5

First

12

Antero Comment	HIA Subject Line Item	Paragraph	Sentence	HIA Page #	RA Page #
<p><b>A143</b> The difference between the risks for individuals living near, versus not near a well pad are "different" based on a simple comparison. However, the RA should point out that these minor risk differences are not statistically different to any degree of certainty when the uncertainty and variability of the calculated risks are considered.</p>	<p>5.3.2</p>	<p>Third</p>		<p>37</p>	
<p><b>A144</b> It was not clear in the RA that the odor samples were somehow correlated to the well completion activities, and it also was not clear why the uncertainty addresses the different stages of well completion. However, since the sampling was driven by noticeable odors, it would appear that if there is a potential bias associated with these samples it would be a high bias (i.e., greater odor means higher chemical concentrations).</p>	<p>6.1.3</p>	<p>Second</p>		<p>41</p>	
<p><b>A145</b> In the bullet discussing population density, it is unclear how population density would increase ambient chemical concentrations associated with emissions, or how increased population density would result in an underestimation of the risks.</p>	<p>6.2.2</p>	<p>First</p>		<p>44</p>	
<p><b>A146</b> The HIA lacks medical/toxicology uncertainty discussion regarding the mathematically calculated inhalation health risks. While uncertainties are discussed in the RA to some extent, we believe it would be appropriate to include a discussion of these uncertainties in the HIA for perspective.</p>	<p>Varied</p>	<p>NA</p>		<p>Varied</p>	
<p><b>A147</b> The HIA lacks medical/toxicology uncertainty discussion regarding the mathematically calculated inhalation health risks. While uncertainties are discussed in the RA to some extent, we believe it would be appropriate to include a discussion of these uncertainties in the HIA for perspective.</p>	<p>Varied</p>	<p>NA</p>		<p>Varied</p>	
<p><b>A148</b> EPA's Regional Screening Level (RSL) Summary Table May 2010 provides "screening levels" for the mathematics used in the RA process while the EPA User's Guide (Section 3.4 Potential Problems) warns about going forward in the decision making process without verifying with a toxicologist or regional risk assessor. We expect this is the next step in the RA process and believe it would prudent to include this concept in the conclusion or data gaps sections of the RA.</p>	<p>Varied</p>	<p>NA</p>		<p>Varied</p>	

**A144**

Antero Comment	HIA Subject Line Item	Paragraph	Sentence	HIA Page #	RA Page #
<p>No specific reference – While many toxicological concepts are beyond the scope of the typical RA and may not be necessary for the intended audience to understand the RA, a few broad concepts associated with the CPOCs identified in the RA may be worth discussing.</p> <p>For example:</p> <p>Acetaldehyde is the primary metabolite of ethanol metabolism in the liver and the primary toxin associated with excess ethanol ingestion. However, acetaldehyde is classified by the FDA as a GRAS (Generally Recognized As Safe) food additive for a number of products. This paradox – a chemical being a possible or more certain carcinogen, while also being a normal metabolite or an essential element, may be helpful to understanding relative toxicity of CPOCs,</p>	<p>Varied</p>	<p>NA</p>	<p>NA</p>	<p>Varied</p>	<p>Varied</p>

**A150**

The uncertainty of applying data from animal studies designed to develop protective carcinogenic risk factors and noncarcinogenic reference doses may be helpful to the RA readers. Chronic animal toxicology experiments are conducted with doses that will allow for the determination of both LOAELs and NOAELs (i.e., doses expected to generate effects in some of the animals). In many cases, these studies, if extrapolated to the human model, would result in unrealistic or impossible human intakes.

Antero Comment	HIA Subject Line Item	Paragraph	Sentence	HIA Page #	RA Page #
<p>Three general sources of CPOCs appear to be included in the RA's risk characterization for gas development: 1) natural background concentrations (i.e., CPOCs present in areas not influenced by the community or the gas development activities); 2) community-derived ambient CPOCs (i.e., CPOC concentrations that result from human activities not related to gas production); and, 3) gas development-derived CPOCs (i.e., CPOC concentrations that result solely from gas production activities). The RA used the Silt-Cox and Silt-Daley ambient data, apparently to represent community-derived contributions, and calculated "baseline" risks based on these data for comparison to the risks associated with gas development activities. However, no thorough discussion is provided in the RA regarding these individual contributions to the overall risks calculated for gas production. In addition, it was not clear that the community-derived baseline risks for the rural Silt-Cox and Silt-Daley sites are actually representative of the Battlement Mesa baseline risk. It appears that the Battlement Mesa baseline risks could be significantly higher than the Silt area baseline risks; however, this uncertainty was not discussed in the RA.</p>	<p>Varied</p>	<p>Varied</p>	<p>Varied</p>	<p>Varied</p>	<p>Varied</p>
<p>The acute risks were based on the CPOC concentrations detected during sampling in response to odors and the exposure pathways used in the exposure and risk assessments included both surface water and ambient air CPOCs. The surface water pathway apparently assumed that well pad-derived surface water puddles would occur on the adjacent properties, and that the CPOC concentrations in surface water would be the same on the adjacent properties as at the well pad. Neither of these assumptions was discussed in the uncertainty section although they appear to be highly unlikely scenarios. No basis for assuming well pad-derived surface water runoff will reach, and puddle on, adjacent properties was provided. Similarly, no basis was provided for assuming that volatile CPOC concentrations would not be significantly lower on adjacent properties even if the surface water did migrate offsite. Also, it was not clear at what distance from the well pad the air samples used for calculating the acute risks were collected, but no discussion was provided regarding the uncertainty associated with the distance of the receptor from the CPOC source.</p>	<p>3.5.3, 6.1.3, 6.1.4</p>	<p>Varied</p>	<p>varied</p>	<p>22, 41, 42</p>	<p></p>

AISI

AISI

**A153**

Antero Comment	HIA Subject Line Item	Paragraph	Sentence	HIA Page #	RA Page #
<p>Well completion samples appeared to be collected at distance of 130 to 430 feet, measured from the well pad center. The uncertainty in CPOC concentrations related to these distances versus the expected setbacks and other potential well completion differences (source conditions and practices, engineering and emission controls, meteorological conditions, etc.) should be more adequately addressed in the section describing the uncertainty of these data.</p>	<p>3.5.2, 6.1.2, 6.2.3</p>			<p>20, 21, 41, 44</p>	

**A154**

<p>The RA assumed a 10 month exposure to EPGs associated with well completion; however, this timeframe significantly exceeds the expected duration of well completion planned by Antero.</p>	<p>3.5.2, 6.1.2, 6.2.3</p>				<p>21, 41, 44</p>
<p>A typical Antero well completion involves either a batch of four (4) wells or eight (8) wells.</p>					
<p>Under the four (4) well completion scenario, the frac/flowback period is four (4) weeks. Therefore, for a 20-well pad undergoing frac/flowback in batches of four (4), the well frac/ flowback timeline is approximately five months.</p>					
<p>Under the eight (8) well completion scenario, the frac/flowback period is six (6) weeks. Therefore, for a 20-well pad undergoing frac/flowback in batches of eight (8), the well frac/flowback timeline is approximately four months.</p>					

## **Exhibit 1**

### **Antero Mitigation Strategies and Best Management Practices**

Antero Resources' Mitigation  
Strategies and Best  
Management Practices

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Battlement Mesa Area

	PAGE #	BWIP	PAGE #	BWIP	PAGE #	BWIP	PAGE #	BWIP	PAGE #	BWIP	PAGE #	BWIP	PAGE #	BWIP
cess Roads	2	Casing Program designed to protect water resources	3	Perimeter sound walls on well pads during construction	3	500 foot setback from dwelling units	4	Emergency Response Plan-Incident Command System	4	Annual SPCC Training	4	Annual SPCC Training		
or liquid dust s used on roads	2	Bradenhead Pressure Monitoring during frac	3	Perimeter landscaping on select well pad locations	3	Clustered Development	4	Annual Review & Evaluation of Emergency Response Plan	4	Quarterly SPCC inspections	4	Quarterly SPCC inspections		
industry effort to d roads	2	Water used for well completions recycled when practicable	3	Noise deadening blankets for drilling rig components	3	New pads will not exceed 3 acres of disturbance	4	Local Emergency Response Trailer w/emergency provisions	4	Spill Reporting & Cleanup Process	5	Spill Reporting & Cleanup Process		
r pipelines long-term t	2	Closed loop drilling systems; No pits constructed	3	Drilling using electricity instead of diesel engines, as feasible	4	Pad Density- No more than 1 pad per 120 acres	4	OSHA Accident Notification procedure	4	Pad perimeter berms which provide secondary & tertiary containment	5	Pad perimeter berms which provide secondary & tertiary containment		
icle speeds during	2	Production tank area bermed and lined with plastic	3	Dawn to dusk completion operations	4	Buried gas & water pipelines adjacent to roads when possible	4	Security Fencing	4	Downgradient pad perimeter berming for frac/flowback tanks	5	Downgradient pad perimeter berming for frac/flowback tanks		
ng to reduce and mud	2	Pad Perimeter berms	3	Hospital-grade mufflers on high noise machinery	4	Above ground facilities located to minimize visual effects	4	Signage at locations with emergency numbers	4	Lined frac/flowback tank area or portable spill berms	5	Lined frac/flowback tank area or portable spill berms		
		Voluntary water well testing program	3	Consideration of electric line power for drilling ops	4			Enclosed & Secured surface production equipment		SOP's for handling & transfer of frac/flowback & produced fluids	5	SOP's for handling & transfer of frac/flowback & produced fluids		
		Wetland/drainage survey and mapping prior to site disturbance	3	Pre-trip inspections of truck exhausts & limiting the use of jake brakes	4			Lock-out systems		High level overflow alarms on production tanks	5	High level overflow alarms on production tanks		
		110 percent secondary containment for locations w/in 500' of surface water	3	Sound proofed generator skids and mud pumps	4			24-hr security cameras		Covered drip buckets for condensate & produced water tanks & loadout lines	5	Covered drip buckets for condensate & produced water tanks & loadout lines		
		Frac/Flowback tank area lined and/or portable spill berms used for containment	3	Improved portable flare design (TCI's high cobustion rate, low noise, low visibility)	4					Pipeline Inspections including Cathodic Protection Inspection		Pipeline Inspections including Cathodic Protection Inspection		
				Use of top drive and disk brakes on the drilling rigs	4					Quarterly Chemical Piggng on gas pipelines		Quarterly Chemical Piggng on gas pipelines		
				Stationary engines located & oriented to direct noise away from nearby homes	4					Weekly piggng to keep line dry/clean from any stagnant liquid		Weekly piggng to keep line dry/clean from any stagnant liquid		
				Wellhead compression housed with high level of noise suppression equipment	4					Pressure- pipelines operated at well below MAOP		Pressure- pipelines operated at well below MAOP		
				Rig oriented to direct light away from nearby residents	4					Pipelines locatable by a tracer line or location device		Pipelines locatable by a tracer line or location device		
				Install lighting shield devices on the more conspicuous lights	4					Facilities operated with a WQCD stormwater construction permit		Facilities operated with a WQCD stormwater construction permit		
				Lighting directed inward & downward unless a safety issue	4					Stormwater Management Plan implemented at sites		Stormwater Management Plan implemented at sites		
				Low density sodium lighting	4					Straw wattles & erosion		Straw wattles & erosion		

# Antero Resources' Mitigation Strategies and Best Management Practices: Battlement Mesa Area

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## Air Quality and Odor Control

- All production tank venting emissions are routed to a VOC combustor
  - Purpose is to control VOC emissions from condensate flashing and working and breathing losses
- VOC combustors operate with auto-igniters
  - Purpose is to keep VOC combustors lit
- Low Emissions Flowback Process
  - Exhibit 1.a. attached hereto, illustrates Antero's reduced emissions flowback process
  - Purpose is to eliminate odor/VOC releases to atmosphere during flowback
  - Initial flowback stream is routed from wellhead to a four-phase separator (green completion skid) and then to a sealed flowback tank
  - Most non-salable gas is captured by 4-phase test separator and sent to temporary flare
  - Residual non-salable gas will be captured by sealed flowback tank and sent to temporary flare/combustor
  - Salable gas is captured by 4-phase test separator and sent to sales line
  - For exploration wells (no gas pipeline in area), salable gas is flared during testing period
  - Flowback water is contained in closed-top frac tanks
  - Oil captured during separation process is routed to production tank
    - Vapors routed to onsite combustor
  - Temporary flowback flare and/or combustor operate with an automatic igniter
- Odor monitoring conducted during well completions using a Nasal Ranger to monitor compliance with detectable odor limits in Colorado Regulation 2
- Portable meteorological weather station operates during well drilling and completion operations
  - Includes data logger to archive wind speed/direction, temp an humidity
  - Information to be shared with COGCC and CDPHE during odor investigations
- Water Storage Pond will be designed to comply with Reasonably Available Control Technology (RACT) under Colorado Regulation 7
- Buried water pipeline used to move water between water storage facility and well pads for drilling and completion operations
  - On average - this plan will eliminate 460 water truck loads per well (92,000 to 120,000 truck loads for a 200 well development plan)
  - Eliminates the associated dust, noise, and air pollution associated with truck traffic
  - Road damage and traffic impact is reduced
- Well Pad Telemetry/Remote Monitoring
  - Reduces well pad truck/pumper visits
  - Low profile antenna equipment

- Frac/Flowback Storage Tank Hatches
  - Tank hatches are closed and latched until the tanks are being prepared to receive flowback water
  - Hatches closed but unlatched when receiving flowback fluids
  - Operate with HC absorbing blanket when full
- Frac Storage Tanks – Batch treatment with biocides occurs after tanks fill with water during nighttime flowback
- Biocide used for fresh water well completions replaced with product that does not contain glutaraldehyde (MECT-WS-1)
- Diesel Powered Drilling Rig Generators
  - Electric grid power substituted for diesel generators where possible and economically feasible
  - Drill rig engines are regulated as non-road engines under the Standards of Performance for Stationary Compression Ignition Internal Combustion Engines (40CFR 60, 85)
  - Diesel engines powering the drilling rigs are certified to at least the Tier 2/3 standards
  - Ensure that engine fuel meets regulated sulfur content requirements.
- Separators and Wellheads – Fugitive VOC emissions from valves and flanges
  - Controls = Low bleed valves and routine maintenance of connection integrity as per EPA Natural Gas Star Program
- Air Monitoring Study – Collecting VOC data at the Watson Ranch Pad during drilling, well completion, production plus background in coordination with Colorado School of Public Health
  - Air monitoring data collected at 300 foot and 500 foot setbacks in each cardinal direction and towards closest dwelling unit
  - Monitoring included grab samples collected during potential odor events
  - Well completion monitoring event completed August 2010. Study to be completed calendar year 2010 and results presented to CDPHE, COGCC, Garfield County and Colorado School of Public Health first quarter 2011
  - Supplemental well completion monitoring to be conducted at Watson Ranch Pad on December 20, 2010 in conjunction with Colorado School of Public Health HIA Study

## **Fugitive Dust**

- Pad locations and access roads graded to reduce dust impacts
- Soiltac and/or liquid dust suppressants are used to mitigate fugitive dust emissions on access roads and well pads
- Investigating joint industry effort (Battlement Mesa) to pave selected roads (e.g. CR 302 and 308)
- Long-term development provides for buried water lines to minimize fugitive dust emissions from truck traffic
- Limiting vehicle speeds during pad site access
- Road sweeping to reduce fugitive dust and mud tracking onto roadways

## Groundwater and Surface Water Resources

- Drilling and Completions
  - Conductor set to isolate shallow fresh water aquifers
  - Surface casing set to on average 2,200 feet and cemented to surface
    - Does not see high frac pressures
    - Protects all freshwater sources during subsequent drilling and fracing operations
  - Production casing set from total depth to surface, to on average 6,500-7,000,
    - HC bearing intervals cemented and confirmed with a cement bond log
    - Designed to withstand high frac pressures
  - Bradenhead pressure monitoring during frac
    - Confirms casing integrity
    - Confirms cement integrity throughout frac
    - Per COGCC Rule 341
- Closed loop (pitless) drilling systems; no reserve, drill cuttings or frac/flowback pits will be constructed
- Water used for well completions will be recycled as practicable
- Frac/Flowback tank area lined and/or tanks equipped with portable spill berm containment structures
- Production tank containment area bermed and lined with plastic
- Pad perimeter berms to contain unintended fluid releases to location
- Voluntary Water Well Testing Program
  - Pre - all water wells/springs within ½ mile radius of the surface-hole location for each well on a pad
  - Post – within one year a follow-up test on the pretest wells/springs or when all wells drilled and completed on a well pad
  - Where practical water quality testing as requested by landowner for water wells, springs, potable water and agriculture water
  - Comply with provisions of water well testing in surface use agreements
- Wetland/drainage survey and mapping conducted prior to site disturbance
- Containment for locations within 500 feet of surface water is 110 percent secondary containment for any volume of fluids contained at a well site during drilling and completion operations

## Noise and Light

- Noise Abatement
  - Perimeter sound walls on well pad locations during construction
  - Permanent landscaping on select well pad locations for visual and noise mitigation
  - Noise deadening blankets for drilling rig components such as draw works, rig floor and generators

- Drilling using electricity instead of diesel engines, as feasible
- Dawn to dusk operations for completion operations—no noise at night for fracing
- Hospital-grade mufflers on high noise output machinery
- Pre-trip inspections of truck exhausts
- Limiting the use of jake brakes on trucks
- Low Noise Exhaust Mufflers on Drilling Rig generators
- Sound proofed Generator skids
- Sound proofed Mud Pumps
- Improved portable flare design - TCI's high combustion rate, low noise, low visibility flare will be utilized
- Disk brakes used on the drilling rigs instead of the noisier drum brake
- Use of top drive to reduce pipe handling noise on drilling rig
- Stationary engines and their exhausts located and oriented to direct noise away from the homes closest to well pad locations
- Any wellhead compression housed with high level of noise suppression equipment
- Lighting Abatement
  - Rig oriented to direct light away from nearby residents
  - Install lighting shield devices on all of the more conspicuous lights
  - Lighting will be directed inward and downward except as deemed necessary by Antero to illuminate other areas for safety reasons
  - Low density sodium lighting
  - Rig shrouded on 3 sides

### **Planning Infrastructure and Development Activities which Minimize Impact**

- Antero setbacks of 500 feet from dwelling units – COGCC setbacks are 150-200 feet
- Clustered development
- New pad construction not to exceed 3 acres
- Pad density not to exceed 1 pad per 120 acres
- Bury all gas and water pipelines adjacent to roads whenever possible
- Water used for well completions will be recycled as practicable
- Above-ground facilities located to minimize visual effects (e.g. production tanks will be low profile tanks and painted to mitigate visual impacts)

### **Safety**

- Emergency Response Plan
  - Incident Command System- a standardized, on-scene, all-hazard incident management concept is utilized, which allows its users to adopt an integrated organizational structure to match the complexities and demands of single or multiple incidents without being hindered by jurisdictional boundaries.
  - Annual review/evaluation of ERP – Plan review, training undertaken, emergency exercises conducted and to consider any updated or revisions to

the plan based on legislative changes, industry trends, experience and best practice.

- An Emergency Response Plan specifically designed for Battlement Mesa will be developed and incorporated into the Piceance Basis ERP. This plan will address hazards specific to the Battlement Mesa area.
- Emergency Response Provisions
  - An Emergency Response Trailer is equipped and will be located in the Battlement Mesa area. It is equipped with a variety of tools, equipment and supplies for spills and releases primarily and can be used as a mobile Command Post.
- OSHA Accident Notification
  - Verbal and/or written notification made to OSHA within 8 hours of the following: a fatality, the immediate hospitalization of three or more employees due to an injury or exposure, or the hospitalization of three or more employees within a one month period after an injury or exposure has occurred.
- Well Site and Facility Security
  - Well Site Fencing
  - Signage placed at all well locations with emergency number and location information
  - Enclosed and secured surface production equipment
  - Lock-out systems
  - 24-hour security cameras with remote viewing and file storage capabilities

### **Spill Prevention, Control and Countermeasure (SPCC Program)**

- Annual SPCC Training
- SPCC inspections conducted quarterly
- Spill reporting and cleanup procedures
- Pad perimeter berms are implemented at each drilling pad
  - Purpose is to provide tertiary spill containment for production tanks and separators
  - Provides secondary spill containment for all material activities on site not just oil storage.
  - Provides a barrier between pad activities and surrounding areas
- Frac/Flowback tank area will be located in an area with down gradient pad perimeter berming
- Frac/Flowback tank area lined to mitigate seepage losses from the unintended spillage of well completion fluids, or frac/flowback tanks will be placed in portable spill berms
- Standard Operating Procedures (SOPs) for handling and transfer of frac/flowback and produced fluids
- High level overflow alarms installed on production tanks
- Covered drip buckets for condensate and produced water tanks and loadout lines

- Purpose is to minimize spillage and drips that occur during normal loading activities
- Designed to catch residual liquids that remain in lines after the tank valves and truck valves have been closed
- Covers minimize VOC emissions and exposure to storm water
- Pipeline – Water and Natural Gas
  - Compliance with COGCC Rule 1101 for Flowlines
  - Pipelines are designed and installed in accordance with ASME B31.8 (national code for pressure piping systems)
  - Installations are inspected by third parties with non-destructive means
  - Water and Gas line installations are hydro-tested by third parties in accordance with ASME B31.8 prior to placing the line into service
  - Cathodic Protection Inspection- gas pipeline network is tested to monitor possibility of corrosion. The test is done following NACE Standard RP0169-92. Antero's gas pipeline network includes about 77 such test points.
  - Chemical pigging conducted every quarter on gas pipelines to eliminate chance of internal corrosion
  - Weekly pigging carried out to keep the line dry/clean from any stagnant liquid in the system
  - Pressure- the pipeline is operated at well below its MAOP to ensure its integrity in the worst case scenario
  - Locatable by a tracer line or location device placed adjacent to or in the trench of all buried nonmetallic pipelines to facilitate the location of such pipelines
  - Emergency Response & Safety Plan includes such incidents like pipeline leakage/rupture

## **Stormwater Management**

- Facilities operated with a Water Quality Control Division (WQCD) stormwater construction permit
- Stormwater BMPs in accordance with the Stormwater Management Plan will be implemented in a manner that minimizes erosion, transport of sediment offsite, and site degradation
- Inspections will be conducted every two weeks/monthly and in accordance with WQCD General Permit to confirm that applicable BMPs are in place, maintained and functioning properly
- Straw wattles and erosion blankets implemented to prevent sediment from leaving the site
- Site Preparation conducted to establish stable slopes, water courses and drainage features to minimize erosion and sedimentation

## **Traffic**

- Transportation of water by pipeline versus hauling by water truck
- Work scheduling to reduce peak traffic loading

- Designated haul routes within PUD which avoid school zones
- Safe Driving Program
  - Such programs will be an Antero requirement of its contractors
- Heavy equipment movement scheduling to avoid school bus operation hours
- Designated truck route entry points which avoids “front door” to Battlement Mesa area
- Additional signage to direct and control Antero truck traffic
- Truck chain-up policy during inclement weather
- Additional Pre-trip vehicle inspections
- Truck Convoy policy
- Additional flagmen and crossing guards
- Roadway improvements to eliminate sharp turns, blind corners and driveways
- Roadway improvements to alleviate potential traffic congested points
- Water pipeline infrastructure installed concurrently with the gas pipeline infrastructure where possible to reduce truck traffic

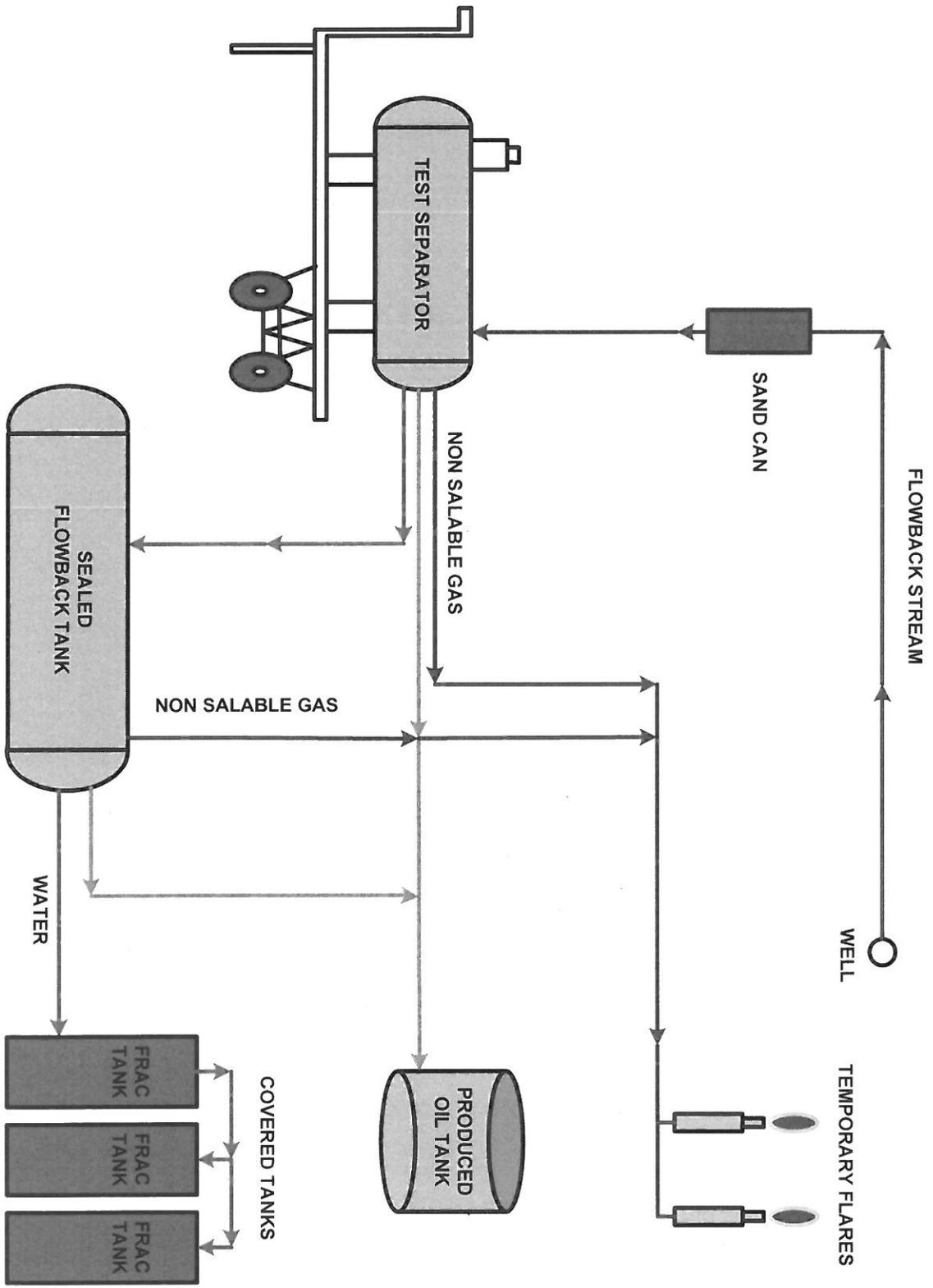


Exhibit 1.a.  
 Reduced Emissions Flowback Process

**Exhibit 2**

**COGCC Response to Gasland**



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The documentary *Gasland* has attracted wide attention. Among other things, it alleges that the hydraulic fracturing of oil and gas wells has contaminated nearby water wells with methane in a number of states including Colorado. Because an informed public debate on hydraulic fracturing depends on accurate information, the Colorado Oil and Gas Conservation Commission (COGCC) would like to correct several errors in the film's portrayal of the Colorado incidents.

### Background

Methane is a natural hydrocarbon gas that is flammable and explosive in certain concentrations. It is produced either by bacteria or by geologic processes involving heat and pressure. Biogenic methane is created by the decomposition of organic material through fermentation, as is commonly seen in wetlands, or by the chemical reduction of carbon dioxide. It is found in some shallow, water-bearing geologic formations, into which water wells are sometimes completed. Thermogenic methane is created by the thermal decomposition of buried organic material. It is found in rocks buried deeper within the earth and is produced by drilling an oil and gas well and hydraulically fracturing the rocks that contain the gas. In Colorado, thermogenic methane is generally associated with oil and gas development, while biogenic methane is not.

The analytical methods used to differentiate between the two types of methane are well-known, scientifically accepted, and summarized in a well-known presentation by Dennis Coleman and papers by I.R. Kaplan and Dennis Coleman. These works, in turn, cite nearly 75 other references related to the topics of methane generation, "fingerprinting," forensic investigations, and stable isotope geochemistry.

Based upon our review of hundreds of Colorado gas samples over many years, the COGCC is able to differentiate between biogenic and thermogenic methane using both stable isotope analysis of the methane and compositional analysis of the gas. In the Denver-Julesburg and Piceance Basins, the COGCC has consistently found that biogenic gas contains only methane and a very small amount of ethane, while thermogenic gas contains not just methane and ethane but also heavier hydrocarbons such as propane, butane, pentane, and hexanes. As explained below, *Gasland* incorrectly attributes several cases of water well contamination in Colorado to oil and gas development when our investigations determined that the wells in question contained biogenic methane that is not attributable to such development.

### The Weld County Wells

*Gasland* features three Weld County landowners, Mike Markham, Renee McClure, and Aimee Ellsworth, whose water wells were allegedly contaminated by oil and gas development. The COGCC investigated complaints from all three landowners in 2008 and 2009, and we issued written reports summarizing our findings on each. We concluded that Aimee Ellsworth's well contained a mixture of biogenic and thermogenic methane that was in part attributable to oil and gas development, and Mrs. Ellsworth and an operator reached a settlement in that case.

DEPARTMENT OF NATURAL RESOURCES: Mike King, Executive Director

COGCC COMMISSION: Richard Alward – Thomas L. Compton – DeAnn Craig – Mark Cultright – Michael Dowling – Joshua B. Epel – Trési Houpt – Mike King – Martha Rudolph  
COGCC STAFF: David Neslin, Director – Margaret Ash, Field Inspection Manager – Debbie Baldwin, Environmental Manager – Stuart Ellsworth, Engineering Manager – Carol Harmon, Hearings Manager

However, using the same investigative techniques, we concluded that Mike Markham's and Renee McClure's wells contained biogenic gas that was not related to oil and gas activity. Unfortunately, *Gasland* does not mention our McClure finding and dismisses our Markham finding out of hand.

The Markham and McClure water wells are both located in the Denver-Julesburg Basin in Weld County. They and other water wells in this area draw water from the Laramie-Fox Hills Aquifer, which is composed of interbedded sandstones, shales, and coals. Indeed, the water well completion report for Mr. Markham's well shows that it penetrated at least four different coal beds. The occurrence of methane in the coals of the Laramie Formation has been well documented in numerous publications by the Colorado Geological Survey, the United States Geological Survey, and the Rocky Mountain Association of Geologists dating back more than 30 years. For example, a 1976 publication by the Colorado Division of Water Resources states that the aquifer contains "troublesome amounts of . . . methane." A 1983 publication by the United States Geological Survey similarly states that "[m]ethane-rich gas commonly occurs in ground water in the Denver Basin, southern Weld County, Colorado." And a 2001 report by the Colorado Geological Survey discusses the methane potential of this formation and cites approximately 30 publications on this subject.

Laboratory analysis confirmed that the Markham and McClure wells contained biogenic methane typical of gas that is naturally found in the coals of the Laramie-Fox Hills Aquifer. This determination was based on a stable isotope analysis, which effectively "finger-printed" the gas as biogenic, as well as a gas composition analysis, which indicated that heavier hydrocarbons associated with thermogenic gas were absent. In addition, water samples from the wells were analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX), which are constituents of the hydrocarbons produced by oil and gas wells in the area. The absence of any BTEX compounds in these water samples provided additional evidence that oil and gas activity did not contaminate the Markham and McClure wells.

The COGCC has also reviewed the records for all oil and gas wells located within one-half mile of the Markham and McClure wells, which is more than double the typical hydraulic fracture length in Colorado. This review indicated that: all oil and gas wells near the Markham well were drilled and hydraulically fractured in 1991, except for two wells that were fractured in 2005 and 2006, respectively; and all oil and gas wells near the McClure well were drilled and hydraulically fractured in 2002, except for one well that was hydraulically fractured in 2005. The records do not reflect any pressure failures or other problems associated with these wells that would indicate a loss of fracture fluid or gas from the well bore into the surrounding geologic formations.

In support of its thesis that the Markham and McClure water wells were contaminated by oil and gas development, the *Gasland* website makes several arguments that merit a brief response. First, the website quotes Professor Anthony Ingraffea of Cornell University for the proposition that drilling and hydraulic fracturing could cause biogenic methane to migrate into aquifers under certain circumstances. However, Professor Ingraffea's statement does not suggest that these circumstances apply to the Markham and McClure wells, nor does it address the extensive scientific literature establishing that biogenic methane is naturally present in the aquifer in question. Second, the website quotes Weston Wilson, an Environmental Protection Agency employee, speculating that oil and gas operators in Weld County are withdrawing large amounts of groundwater and that these withdrawals are releasing biogenic methane. However, oil and gas companies in Weld County obtain most of their water from municipalities, which obtain such water from surface water sources such as the Colorado-Big Thompson and Windy

Gap projects. Finally, the website asserts that the water in the Markham and McClure wells deteriorated after drilling and hydraulic fracturing occurred nearby. However, COGCC records indicate little or no temporal relationship between the Markham and McClure complaints and nearby drilling and hydraulic fracturing activities, which occurred several years earlier and in most cases many years earlier.

### **The West Divide Creek Seeps**

*Gasland* also addresses complaints about oil and gas activity in the West Divide Creek area of the Piceance Basin in Garfield County, though it again confuses issues related to biogenic gas with those related to thermogenic gas. The film focuses on two seeps that are in close geographic proximity but derive from different origins. One of the seeps occurs in a wetland on property owned by Lisa Bracken, who appears in the film; it contains biogenic methane. The other seep, which the COGCC terms the West Divide Creek gas seep, is about 1,500 feet to the south on property owned by a neighbor; it contains thermogenic methane caused by EnCana's failure to properly cement a natural gas well.

*Gasland* adopts the claim that the West Divide Creek gas seep was caused by hydraulic fracturing. After investigating the matter thoroughly in 2004, COGCC staff concluded the seep was caused by gas migrating up a gas well borehole that had not been properly cemented and in which the upper portion of the gas bearing Williams Fork Formation had not been isolated. On August 16, 2004, following a public hearing, the COGCC commissioners approved an enforcement order ([Order 1V-276](#)) that incorporated the staff's causation conclusions and assessed a substantial fine against the operator.

In investigating the West Divide gas seep, the COGCC determined that it contains thermogenic methane. The gas composition and stable isotope signature of the gas closely matched that of the gas being produced from the Williams Fork Formation. The gas from both the West Divide Creek seep and the Williams Fork Formation is composed primarily of methane, but it also contains ethane, propane, butane, pentane, and hexanes. In addition, BTEX compounds were detected in ground and surface water in the vicinity of the West Divide Creek seep, which indicates that the gas is related to oil and gas activities and not of biogenic origin.

In contrast, the laboratory results for the gas samples collected from the seep on Ms. Bracken's property have demonstrated that the gas is biogenic. The COGCC has collected nine gas samples on six different occasions during 2004, 2007, 2009, and 2010. With respect to each sample, the gas composition was found to be 100 percent methane, no heavier hydrocarbon compound was detected, and the stable isotope ratio indicated that the gas is biogenic. The COGCC has also collected six water samples on four different occasions during 2004, 2007, and 2009 and ten soil samples on multiple occasions during 2008 and 2009 from Ms. Bracken's property. BTEX compounds and/or other hydrocarbons associated with oil and gas operations were not detected in any of these samples. Based on these results, the COGCC has concluded that the gas seep on Ms. Bracken's property resulted from the fermentation of organic matter by methanogenic bacteria. This is not uncommon in wetland areas, such as those that exist along West Divide Creek.

### **Other Information**

Oil and gas development is an industrial activity, and property owners sometimes complain that it has contaminated their water well. The COGCC investigates all such complaints and reports the results individually to the complainant and collectively to the Colorado Water Quality Control

Division. In some cases, the COGCC has found that the well contains thermogenic methane linked to oil and gas development. In most cases, however, the COGCC has found that contamination is not present or that the methane comes from biogenic sources and is not attributable to oil and gas production. The following excerpt from a report summarizing the COGCC's investigation following the contamination of the Ellsworth water well is illustrative:

In response to concerns regarding the presence of methane gas in water wells completed in the Laramie/Fox Hills Aquifer, COGCC, Noble Energy, and Anadarko/Kerr McGee sampled a total of 28 water wells between March 25, 2009 and April 7, 2009 across an approximately 170 square mile area. Sample results show that these wells contained either no methane gas or biogenic (biological generated) methane gas. None of these wells, other than the Ellsworth water well, contained thermogenic methane gas. The sample results along with letters discussing the results were sent by COGCC staff to the 28 well owners [who had requested testing].

Nevertheless, it remains important to establish prudent regulations to ensure that other resources, such as groundwater, are protected. Producing oil and gas formations in much of Colorado, including the Denver-Julesburg and Piceance Basins, lie at depths of up to 8,000 feet below the ground surface, while the aquifers that sustain domestic water wells are generally less than 1,000 feet below the ground surface. COGCC regulations establish casing and cementing standards to ensure that gas being produced from 8,000 feet down does not leak into the shallower aquifers. These regulations require wells to be cased with steel pipe and the casing to be surrounded by cement to create a hydraulic seal within the annular space between the wall of the well bore and the steel pipe. In addition, a number of recent amendments to the COGCC regulations address concerns raised about hydraulic fracturing:

- Rule 205 requires operators to inventory chemicals, including fracturing fluids, and to provide this information upon request to the COGCC and certain health care professionals;
- Rule 317 requires cement bond logs to confirm that aquifers are protected;
- Rule 317B imposes mandatory setbacks and enhanced environmental precautions on oil and gas development occurring near public drinking water sources;
- Rule 341 requires well pressures to be monitored during hydraulic fracturing;
- Rule 608 mandates additional pressure testing and water well sampling for coalbed methane wells; and
- Rules 903 , 904 , and 906 impose enhanced requirements for pit permitting, lining, monitoring, and secondary containment to ensure that pit fluids, including hydraulic fracturing flowback, do not leak.

Finally, it should be understood that the COGCC Director, Dave Neslin, offered to speak with *Gasland's* producer, Josh Fox, on camera during the filming of the movie. Because the issues are technical and complex and arouse concerns in many people, Director Neslin asked that he be allowed to review any material from the interview that would be included in the final film. Unfortunately, Mr. Fox declined. Such a discussion might have prevented the inaccuracies noted above.

## **Exhibit 3**

### **Watson Ranch E&P Tanks Model Output**

\*\*\*\*\*

\* Project Setup Information \*

\*\*\*\*\*

Project File : D:\JYM\Antero\Site Specific Emission Factors\Antero Watson Ranch.ept  
 Flowsheet Selection : Oil Tank with Separator  
 Calculation Method : AP42  
 Control Efficiency : 95.0%  
 Known Separator Stream : Low Pressure Oil  
 Entering Air Composition : No  
  
 Filed Name : Antero Resources  
 Well Name : Watson Ranch Pad  
 Well ID : October 9, 2010 Analysis  
 Date : 2010.11.04

\*\*\*\*\*

\* Data Input \*

\*\*\*\*\*

Separator Pressure : 200.00[psig]  
 Separator Temperature : 88.00[F]  
 Ambient Pressure : 14.70[psia]  
 Ambient Temperature : 70.00[F]  
 C10+ SG : 0.7730  
 C10+ MW : 148.84

-- Low Pressure Oil -----

No.	Component	mol %
1	H2S	0.0000
2	O2	0.0000
3	CO2	0.3311
4	N2	0.0246
5	C1	4.2651
6	C2	1.3612
7	C3	1.2465
8	i-C4	0.5707
9	n-C4	0.8684
10	i-C5	0.9192
11	n-C5	0.9516
12	C6	6.6283
13	C7	17.6842
14	C8	15.0889
15	C9	15.4373
16	C10+	17.4008
17	Benzene	0.7985
18	Toluene	5.0367
19	E-Benzene	0.8223
20	Xylenes	7.5938
21	n-C6	2.5640
22	224Trimethylp	0.4068

-- Sales Oil -----

Production Rate : 12.8 [bbl/day]  
 Days of Annual Operation : 365 [days/year]  
 API Gravity : 51.9  
 Reid Vapor Pressure : 1.60[psia]  
 Bulk Temperature : 70.00[F]

-- Tank and Shell Data -----

Diameter : 15.50[ft]  
 Shell Height : 9.00[ft]  
 Cone Roof Slope : 0.06  
 Average Liquid Height : 6.00[ft]  
 Vent Pressure Range : 0.06[psi]  
 Solar Absorbance : 0.54

```

-- Meteorological Data -----
City           : Grand Junction, CO
Ambient Pressure : 14.70[psia]
Ambient Temperature : 70.00[F]
Min Ambient Temperature : 39.60[F]
Max Ambient Temperature : 65.70[F]
Total Solar Insolation : 1659.00[Btu/ft^2*day]
    
```

\*\*\*\*\*  
 \* Calculation Results \*  
 \*\*\*\*\*

```

-- Emission Summary -----
Item           Uncontrolled   Uncontrolled   Controlled   Controlled
              [ton/yr]      [lb/hr]       [ton/yr]    [lb/hr]
Total HAPs    0.330          0.075         0.017       0.004
Total HC      9.754         2.227         0.488       0.111
VOCs, C2+    5.936         1.355         0.297       0.068
VOCs, C3+    4.158         0.949         0.208       0.047
    
```

```

Uncontrolled Recovery Info.
Vapor          793.8500 x1E-3 [MSCFD]
HC Vapor       756.0100 x1E-3 [MSCFD]
GOR            62.02      [SCF/bbl]
    
```

```

-- Emission Composition -----
No Component   Uncontrolled   Uncontrolled   Controlled   Controlled
              [ton/yr]      [lb/hr]       [ton/yr]    [lb/hr]
1  H2S         0.000         0.000         0.000       0.000
2  O2          0.000         0.000         0.000       0.000
3  CO2         0.738         0.168         0.738       0.168
4  N2          0.041         0.009         0.041       0.009
5  C1          3.817         0.871         0.191       0.044
6  C2          1.778         0.406         0.089       0.020
7  C3          1.316         0.300         0.066       0.015
8  i-C4        0.389         0.089         0.019       0.004
9  n-C4        0.430         0.098         0.022       0.005
10 i-C5        0.234         0.053         0.012       0.003
11 n-C5        0.179         0.041         0.009       0.002
12 C6          0.514         0.117         0.026       0.006
13 C7          0.524         0.120         0.026       0.006
14 C8          0.160         0.037         0.008       0.002
15 C9          0.062         0.014         0.003       0.001
16 C10+        0.018         0.004         0.001       0.000
17 Benzene     0.039         0.009         0.002       0.000
18 Toluene     0.080         0.018         0.004       0.001
19 E-Benzene   0.005         0.001         0.000       0.000
20 Xylenes     0.039         0.009         0.002       0.000
21 n-C6        0.158         0.036         0.008       0.002
22 224Trimethylp 0.011       0.003         0.001       0.000
Total         10.532        2.405         0.527       0.120
    
```

```

-- Stream Data -----
No. Component   MW      LP Oil   Flash Oil  Sale Oil  Flash Gas  W&S Gas  Total Emissions
              mol %   mol %   mol %   mol %   mol %   mol %   mol %
1  H2S         34.80   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
2  O2          32.00   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
3  CO2         44.01   0.3311   0.0683   0.0150   4.3723   4.7617   4.3860
4  N2          28.01   0.0246   0.0006   0.0000   0.3941   0.0005   0.3803
5  C1          16.04   4.2651   0.3473   0.0000   64.5118  0.0003   62.2467
6  C2          30.07   1.3612   0.4855   0.2413   14.8275  33.1527  15.4710
7  C3          44.10   1.2465   0.8617   0.7174   7.1644   25.4456  7.8063
8  i-C4        58.12   0.5707   0.5047   0.4738   1.5849   6.2956   1.7503
9  n-C4        58.12   0.8684   0.8112   0.7790   1.7480   7.1080   1.9362
10 i-C5        72.15   0.9192   0.9293   0.9207   0.7633   3.2085   0.8492
11 n-C5        72.15   0.9516   0.9756   0.9716   0.5831   2.4707   0.6494
    
```

12	C6	86.16	6.6283	6.9660	7.0022	1.4350	6.1688	1.6012
13	C7	100.20	17.6842	18.7519	18.9116	1.2647	5.4953	1.4132
14	C8	114.23	15.0889	16.0482	16.2029	0.3365	1.4754	0.3765
15	C9	128.28	15.4373	16.4335	16.5975	0.1172	0.5183	0.1313
16	C10+	148.84	17.4008	18.5306	18.7180	0.0277	0.1237	0.0311
17	Benzene	78.11	0.7985	0.8429	0.8486	0.1163	0.5027	0.1298
18	Toluene	92.13	5.0367	5.3511	5.4005	0.2025	0.8851	0.2264
19	E-Benzene	106.17	0.8223	0.8751	0.8837	0.0107	0.0472	0.0120
20	Xylenes	106.17	7.5938	8.0820	8.1620	0.0858	0.3786	0.0961
21	n-C6	86.18	2.5640	2.7027	2.7198	0.4309	1.8593	0.4810
22	224Trimethylp	114.24	0.4068	0.4317	0.4355	0.0235	0.1020	0.0262
	MW		105.24	110.35	110.95	26.68	51.52	27.55
	Stream Mole Ratio		1.0000	0.9389	0.9367	0.0611	0.0022	0.0633
	Heating Value	[BTU/SCF]				1461.15	2774.29	1507.26
	Gas Gravity	[Gas/Air]				0.92	1.78	0.95
	Bubble Pt. @ 100F	[psia]	153.81	18.47	5.35			
	RVP @ 100F	[psia]	224.34	49.44	28.81			
	Spec. Gravity @ 100F		0.696	0.703	0.704			

**Exhibit 4**

**COGCC Odor NOAV & Antero Response to NOAV**



\*\*\* NOTICE OF ALLEGED VIOLATION \*\*\*

OGCC Operator Number: 10079 Name of Operator: ANTERO RESOURCES PICEANCE CORPORATION Address: 1625 17TH ST STE 300 ATTN: City: DENVER State: CO Zip: 80202 Company Representative: JON BLACK

Date Notice Issued: 07/16/2010

Well Name: BAT Well Number: 13B-17-07-95 Facility Number: 415687 Location (QtrQtr, Sec, Twp, Rng, Meridian): SESW 17 7S 95W 6 County: GARFIELD API Number: 05 045 19108 00 Lease Number:

COGCC Representative: KELLERBY SHAUN Phone Number: 970 285-7235

THE FOLLOWING ALLEGED VIOLATION WAS FOUND BY THE COGCC REPRESENTATIVE FOR THE SITE LISTED Date of Alleged Violation: 07/14/2010 Approximate Time of Violation: Description of Alleged Violation: On 7/14/10 Cogcc staff conducted an inspection of API 05-045-19108 in response to a complaint of a hydrocarbon odor. Before entering the pad site a strong odor was noticed on Gardner Lane. On Pad site odor was noticed with flow back activity, contractor stated that 7 wells were actively in flow back at the time of inspection. Flow back tanks were open top tanks, and tanks with hatch's that were open during the flow back process. A gas monitor indicated that a small amount of methane was present in the flow back tanks being used at the time of inspection.

Act, Order, Regulation, Permit Conditions Cited: 805.a.

Abatement or Corrective Action Required to be Performed by Operator: Operator will monitor completion operations for odor, and adjust operations, as needed, to eliminate all nuisance odors. Abatement or Corrective Action to be Completed by (date): 07/16/2010 \* Proper and timely abatement does not necessarily preclude the assessment of penalties and an Order Finding Violation.

TO BE COMPLETED BY OPERATOR - When alleged violation is corrected, sign this notice and return to above address: Company Representative Name: GERARD G. ALBERTS Title: MANAGER ENV Reg. Signature: [Signature] Date: 11-2-2010 Company Comments:

\*\*\* THIS NOTICE CONSTITUTES A SEPARATE NOTICE OF ALLEGED VIOLATION FOR EACH VIOLATION LISTED \*\*\*

WARNING Abatement and reporting time frames for Notices of Alleged Violation begin upon receipt of the notice or five days after the date it is mailed, whichever is earlier. Each violation must be abated within the prescribed time upon receipt of this Notice, expected to the Colorado Oil and Gas Conservation Commission at the address shown above, and postmarked no later than the next business day after the prescribed time for abatement. Should abatement or corrective action fail to occur, the Director may make application to the Commission for an order finding violation. Proper and timely abatement does not necessarily preclude the assessment of penalties and an Order Finding Violation.

PENALTY PROPOSED BY THE DIRECTOR PER RULE 623 The Director may propose a penalty as listed in the table below, not to exceed a maximum of \$1,000.00 per day per violation. Such proposed penalty amount will be limited to \$10,000.00 per violation if the violation does not result in significant waste of oil and gas resources, damage to correlative rights, or a significant adverse impact on public health, safety, or welfare. Such proposed penalty amount may be increased if aggravating factors indicate the violation: was intentional or reckless; had, or threatened to have, a significant negative impact on public health, safety, or welfare; resulted in significant waste of oil and gas resources; had a significant negative impact on correlative rights of other parties; resulted in, or threatened to result in, significant loss or damage to public or private property; involved recalcitrance or recidivism upon the part of the violator; involved intentional false reporting or record keeping; resulted in economic benefit to the violator. Such proposed penalty amount may be decreased if mitigating factors indicate the violator: self-reported; promptly, effectively and prudently suspended to the violation; cooperated with the Commission or other agencies with respect to the violation; had any economic benefit reduced or eliminated due to the cost of correcting the violation; has demonstrated a history of compliance with Commission rules, regulations and orders. The Commission has final authority over the penalty amount assessed. The Commission or other agencies with respect to the violation; could not reasonably control, or be responsible for, the cause of the violation; made a good faith effort to comply with applicable requirements prior to the Commission learning of the violation; had any economic benefit reduced or eliminated due to the cost of correcting the violation; has demonstrated a history of compliance with Commission rules, regulations, and orders. The Commission has final authority over the penalty amount assessed. BASE FINE \$500.00 PER DAY PER VIOLATION RULES 210, 307, 311, 312, 313, 314A, 315, 405, 601, 604. BASE FINE \$1,000.00 PER DAY PER VIOLATION: RULES 205, 206, 207, 208, 209, 301, 302, 303, 305, 306, 308, 309, 310, 313A, 318A, 318B, 317, 317A, 317B, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 341, 401, 402, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 1002, 1003, 1004, 1101, 1102, 1103, 1201, 1202, 1203, 1204, 1205.

In accordance with Rule 623.2(4), fines for violations for which no base fine is listed shall be determined by the Commission at its discretion.

Signature of COGCC Representative: [Signature] Date: 07/16/2010 Time: Resolution Approved by: Date:

**From:** Jerry Alberts  
**Sent:** Tuesday, August 10, 2010 12:39 PM  
**To:** 'Ash, Margaret'; 'david.neslin@state.co.us'  
**Subject:** Response to Watson Ranch NOAV  
**Attachments:** xMSDS-Citric\_acid-9923494.pdf; AreaRAE\_datasheet.pdf; MECT-WS-1 MSDS.PDF; MECT-WS-1 PDB.DOC

Margaret and Dave,

This email is provided as Antero's response to the COGCC July 16, 2010 NOAV issued by your staff on July 14, 2010 for API 05-045-19108. The odor reduction BMP list(s) are included as part of this response and they also serve to address your request as per our July 22 meeting.

Please contact me at your convenience with any questions regarding these issues and the information presented herein.

Best regards, - - Jerry

### **Response to July 16, 2010 Notice of Alleged Violation (NOAV)**

Operator Number: 10079  
 Well Name: BAT, Well Number: 13B-17-07-95  
 Facility Number: 415587  
 API Number: 05 045 19108 00  
 COGCC Representative: Shaun Kellerby

### **Date of Alleged Violation:**

July 14, 2010

### **Description of Alleged Violation:**

On 7/14/10 COGCC staff conducted an inspection of API 05-045-19108 in response to a complaint of a hydrocarbon odor. Before entering the pad site a strong odor was noticed on Gardner Lane. On pad site odor was noticed with flow back activity, contractor stated that seven (7) wells were actively in flow back at the time of the inspection. Flow back tanks were open top tanks, and tanks with hatch's that were open during the flow back process. A gas monitor indicated that a small amount of methane was present in the flow back tanks being used at the time of the inspection.

### **Act, Order, Regulation, Permit Condition Cited:**

805.a. General. Oil and 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.

### **Abatement or Corrective Action Required to be Performed by Operator:**

Operator will monitor completion operations for odor, and adjust operations as needed, to eliminate odor.

### **Abatement or Corrective Action to be Completed by:**

July 16, 2010

### **Antero NOAV Response:**

Antero regrets that unpleasant odors were detected by some residents and Mr. Kellerby of the COGCC staff, during the early and late evening periods of several days in mid-July, downwind of the Watson Ranch site. After looking into these odor issues, Antero believes that they likely arose from a specific biocide applied to flowback water during a discrete part of Antero's completion process and were detected because of the wind direction during that period of time. Antero notes that the unpleasant odors would be described as "organic" in nature – more like a septic system odor rather than some type of non-natural chemical odor. Antero strives to utilize the best practical treatment, maintenance or control technologies and operational practices to minimize odors.

To address odors arising from evening flowback operations during the completion process, as described in more detail in our response below, Antero has already: installed a portable meteorological station onsite to better understand wind and weather patterns in the local Watson Ranch site vicinity, installed tarps on the open top flowback tanks, performed daily checks on its auto-igniter equipment, undertook operational modifications (adding the biocide to full, rather than near empty flowback tanks), and completed the initial testing of an alternative biocide(s) for treating the flowback water. As our response details, Antero will continue to implement these odor reduction actions and otherwise further adjust its operations as needed to minimize odors. Although no data suggests that the odors constituted any public health hazard to nearby residents, Antero will continue to take steps to ensure that nearby or downwind residents do not detect unpleasant odors as a result of Antero's operations.

### **Odor Reduction Strategies Implemented Prior the Commencement of Fracture Stimulation Operations**

1. Combustor VOC Controls – Vapors from production tanks are routed to a combustor equipped with an automatic igniter. Vapors are controlled in accordance to CDPHE General Permit standards.
2. Salable and Non-salable Flowback Gases - Collected and either routed to a portable flare or to the sales pipeline.
  - a. Initial flowback is routed to a flash separator (closed system) and then to an open top flowback tank. The flash separator acts to reduce odors by allowing the non-salable gas in the flowback to be collected and routed to the portable flare.
  - b. Initial flowback is eventually routed to a four-phase separator (green completion skid) as the volume of flowback water returned from the well decreases.
  - c. Non-salable gas from the four-phase separator is routed to the above portable flare for a short period of time until the 4-phase separator pressure increases such that it allows the gas to be routed to the sales pipeline.
  - d. Flowback water is continuously routed to the flash separator to reduce odors and then to the open top flowback tank until the well is placed on production.
  - e. The open top flowback tanks were subsequently equipped with tarps to reduce odors on July 16, 2010.
  - f. Temporary flare operates with an automatic igniter.
3. Frac Storage Tank Hatches – Were inspected on July 14, 2010 and the hatches on tanks that held flowback water were confirmed as closed. The Antero Standard Operating Procedure (SOP) states that all frac storage tank hatches are closed until the tanks are being prepared to receive flowback water. At that time the hatches are open until they are deemed full and then subsequently closed.
4. Air Monitoring Study – Collected VOC data for a 24-hour period on July 15/16, 2010 and again towards the end of August during frac/flowback operations at the Watson Ranch Pad. Monitoring included grab samples collected during potential odor events. Targeted compounds including but not limited to glutaraldehyde. Data will be available in September/October and shared with the COGCC, CDPHE and the Colorado School of Public Health.

### **Odor Reduction Adjustments Completed in Response to July 16, 2010 NOAV**

1. Open top flowback tanks were retrofitted with tarps to reduce odors.
2. Portable meteorological weather station installed on July 15 – Includes data logger to archive wind speed/direction, temp and humidity. Information to be shared with COGCC and CDPHE during future odor investigations.
3. Frac Storage Tanks – Were emptied pending resumption of fracking schedule to reduce potential odors following last batch of July fracture stimulations. A total of 39 frac/flowback tanks were emptied and

this effort commenced on July 16 and took about 6 days to complete.

4. Adjustments to 4-Phase Separators – Purpose is to reduce gas in water that is dumped to the flash separator and then to the open top flowback tank.
5. Frac Storage Tanks Treatment with Citric Acid - Immediately introduced to the frac storage tanks (41) as a countermeasure to reduce odors. About 5 gallons of citric acid were used to treat about 300 bbls of water in the frac storage tanks. The MSDS for this product is attached.
6. Auto Igniters – Daily site visits by pumpers to monitor performance.
7. CDPHE Tim Taylor conducted odor monitoring at the Watson Ranch Pad on July 27, 2010
  - Findings demonstrate compliance with Reg 2 Odor Standard
  - Odor monitoring collected according to CDPHE Reg 2 Methodology
  - Used Nasal Ranger and appropriate dilutions, (2:1, 4:1, 7:1 and 15:1)
  - Results compared to odor standards application to “residential” areas

### **Odor Reduction Strategies to Supplement Existing Odor Reduction BMPs for the Watson Ranch August/September 2010 Fracture Stimulation Operations**

1. Pilot project to evaluate the operational feasibility of alternative Biocides whose chemical properties suggest an odor reduction benefit. The pilot project will be implemented during the Aug/Sept fracture stimulations scheduled for the Watson Ranch Pad. The MSDSs for the two biocides that are likely to be evaluated are attached for your review.
2. Engage with Roxana Witter of the Colorado School of Public Health to evaluate the toxicology and odor reduction benefits of the alternative biocides under consideration in pilot study.
3. Standard Operating Procedure for biocide treatment of frac storage tanks was revised.
  - a. Biocide typically added in the evening to each empty frac storage tank and during the night the storage tanks are filled with flowback water from the well.
  - b. Revised SOP is to batch treat with the biocide after the flowback tanks are deemed full.
4. Endorsed RAE Photo Ionization Detector. Used to detect hydrocarbons releases and potential HC odors from open top flowback tanks. Brochure is attached.

### **Supplemental Odor Reduction Adjustments Under Consideration for Future Fracture Stimulation Operations**

1. Strategies for additional collection and treatment of vapors from open top flowback tanks are under investigation. For example, routing the flowback tank overhead to a charcoal scrubber.
2. Odor Mitigation via Bio Remediation Technologies. Treating frac storage tanks to further reduce potential hydrocarbon odors. Pilot study is ongoing. AquaSol and Trident3 are products under consideration.

Gerard G. Alberts  
Manager, Environmental & Regulatory

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**BATTLEMENT MESA SERVICE ASSOCIATION**

Post Office Box 6006  
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October 29, 2010

Ms. Roxana Witter, MD, MSPH  
Colorado School of Public Health  
University of Colorado Denver  
13001 East 17<sup>th</sup> Place  
Aurora, CO 80045

Dear Ms. Witter,

The Battlement Mesa Service Association Board of Directors supports the recommendations of the Health Impact Assessment for Battlement Mesa conducted by the Colorado School of Public Health. One of the most important priorities of our Board is looking after the health, safety and welfare of our community. Your study and its efforts to help minimize impacts of the oil and gas industry in our area will be a valuable tool for multiple agencies in their review of future oil and gas related projects.

The Board also recognizes that this particular assessment was created specifically to address the proposed Antero drilling plan within the boundaries of the Battlement Mesa PUD. However, the Board is aware that there are significant oil and gas developments by other operators directly adjacent to, inside of, and in the areas surrounding the Battlement Mesa PUD. The BMSA Board of Directors hopes that this study will be incorporated into future considerations regarding oil and gas development in the entire Battlement Mesa/Parachute area.

Thank you for the opportunity to comment on this study.

Sincerely,

Keith Lammey, President  
Battlement Mesa Service Association

# STATE OF COLORADO

Bill Ritter, Jr., Governor  
Martha E. Rudolph, Executive Director

Dedicated to protecting and improving the health and environment of the people of Colorado

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Colorado Department  
of Public Health  
and Environment

November 15, 2010

Mr. Jim Rada  
Environmental Health Manager  
Garfield County Public Health  
195 W 14th Street  
Rifle, CO 81650

Dear Mr. Jim:

The Colorado Department of Public Health and Environment (CDPHE) is pleased to offer the following comments on the draft *"Health Impact Assessment for Battlement Mesa, Garfield County, Colorado"* (HIA). The comments provided below form the basis for CDPHE's general conclusion that while the draft HIA provides reasonable broad conclusions and recommendations, enhancements to certain sections should be made before such a document is used to inform decisions involving oil and gas development and its impacts on public health.

CDPHE also questions whether an HIA represents an appropriate tool for informing a permit decision involving a single permit applicant; or whether it is ultimately best used to inform potential changes to air quality, water quality and waste disposal regulations designed to protect public health. At this juncture, it would appear that careful consideration of the highest and best use of this tool should be made.

Our specific comments follow and have been provided by technical experts from several CDPHE Divisions. Please note that CDPHE's Water Quality Control Division may have a few additional comments within the next few days, in which case we will submit them under separate cover. We would be happy to meet to discuss any of the contents of this letter at your convenience.

## General Observations

- CD1** • There is no mention of potential public health risks from other activities within the region. For example, health risks can occur from indoor air pollution due to furniture/carpet off-gassing and household chemical usage. Benzene exposure during gas fueling can also be a large personal impact. We recommend that this HIA address this topic.
- CD2** • There is no comparison of risk within the HIA's area of focus and other geographical areas. We believe this information would offer a useful perspective. While this HIA shows that there may be some elevated risks, other areas (including any larger urban area) may have risks that are higher.

**CD3** • There is no mention of meteorology and how it can affect exposure to pollutants. Topography, particularly in Garfield County, can also play a significant factor.

**CD4** • There appear to be inconsistencies involving the use of decimal places and how much weight they really carry. There are sections throughout the document, for instance section 3.1, where percentages will be reported with either decimal places or without decimal places. In many cases, presenting percentages to 1 or 2 decimals is not valid given the potential uncertainties.

**CD5** • There appear to be inconsistencies with compound names, particularly with acetaldehyde that is called acetylaldehyede in some sections of the HIA.

**CD6** • There are grammatical and punctuation errors in the draft document, which have not been identified this review.

**Section ES2, page ES-III, 1<sup>st</sup> paragraph:**

**CD7** • The first sentence of this section states "An HIA involves several defined steps: screening, scoping, assessment, recommendations and implementation, reporting, and monitoring."

**CD8** • The term "evaluation" is used rather than "monitoring" in Sections 2 and 2.7; also, it is more common to use "evaluation" in HIAs, herefore, it is recommended that the term "evaluation" be used in place of "monitoring". Additionally, it is recommended that the report sections use the same terms (e.g., use term "Implementation" rather than "Next Steps" for Section 5).

**Section ES4.1 - Summary of Air Quality Assessment:**

**CD9** • We recommend that the stated conclusion, "air quality is most likely to be acutely impacted" also clearly states that more data are needed to better estimate the potential for these acute health effects. It should be noted that the potential for acute health risk appears to be low, based on the limited currently available information. For example, the acute hazard estimates were derived by using the limited information regarding air monitoring and chemical toxicity.

**Section ES6, pages ES-XII to XIII:**

**CD10** • The report indicates "...the results of this HIA ...will likely have application beyond the study area..." Similar statements are made in Section 6 in the last paragraph of page 69, continuing onto page 70. The report does not indicate the way in which HIA results could be applied to other areas of Colorado or other parts of the county. Because the report, including the ranking system, is based on Battlement Mesa specific data including geography, populations (e.g., ages, health status), duration and extent of the oil and gas project being considered, economic activity, and the existing health infrastructure, it is not clear how HIA results could be applied to other areas. It is recommended that either this comment be removed from the report or additional information be provided regarding how and which sections of the HIA may be applied to other areas.

**Part 1 Health Impact Assessment**

**CD11** • "Regarding Ozone and Human Health", page 2: There is likely a significant portion of ozone that is transported in, or is created from pollutants that are transported in, from areas outside of the county. This goes far beyond just the sum of ozone precursors produced in the County.

## Introduction

- **Section 1.4, page 8:** Ozone exceeded the "level of" the 8 hour standard once in 2008. This is not a violation of the standard. Also, it is unknown how much of this ground-level ozone is from precursors emitted in Garfield County.

## HIA Methods

- **Section 2.5 -Reporting:** It is stated that CDPHE provided review of the human health risk assessment. In fact, CDPHE was unable to review the human health risk assessment due to time constraints. Please revise this statement accordingly.

## Section 4 - Assessment of Health Impacts

- **Section 4, page 18:** The text for the example/hypothetical health impact is incorrect. The statement "No particular pollution is more vulnerable..." should read "No particular population is more vulnerable..."
- **Section 4.1.1, page 19:** In the first paragraph, PM<sub>2.5</sub> is listed as a human carcinogen. This is incorrect. PM<sub>2.5</sub>, by itself, is not a carcinogen. Rather it is possible that PM<sub>2.5</sub> may contain carcinogenic material, depending on the PM<sub>2.5</sub> sources.
- **Section 4.1.1, page 19:** The second paragraph discusses additive/synergistic effects. Can decreases in health effects occur due to substance interactions? If so, it should be noted as well.
- **Section 4.1.2, page 20:** The 4th paragraph refers to the Silt-Daley and Silt-Cox monitoring sites. It would be helpful if an explanation of where these sites are located in relation to Battlement Mesa were provided. This paragraph also indicates that the Silt-Daley and Silt-Cox monitoring sites are located in rural sites without natural gas development and production. This section goes on to provide monitoring data from these sites and associated cancer risks. The report does not provide information regarding the potential source(s) of air pollution at these monitoring sites, and therefore, it is not clear if the air quality would be expected to be similar at Battlement Mesa. The only similarity between the sites and Battlement Mesa provided in the report is that they are rural sites without natural gas development and production.
- **Section 4.1.2, page 20:** In the fifth paragraph, the text says that "Chemical speciation indicated that the main source of carbon in the samples is most likely from a combination of oil and gas production and building heating." This is an incorrect interpretation. The speciation report developed by CDPHE states that the main source of carbon can possibly be attributed to combustion of lighter weight fossil fuels. No specific sources are discussed.
- **Section 4.1.2, page 21:** In the last paragraph, EnCana's mountain station is discussed. What about EnCana's canyon station, which also has ozone data? While it is in a gas development area, it would provide a useful comparison.
- **Section 4.1.3, pages 21-24: Antero Drilling Plan in Battlement Mesa and Air Quality**
  - General

CD21

- It appears that the risk assessment is performed by combining different data sets (15-second grab samples; 2005-2007; 2008; 2009; and 2010). CDPHE suggests separation of the data sets for estimating risk. This approach would facilitate evaluation of trends with time. Most importantly, it is necessary to discuss trends in acute hazard estimates from 2005 to 2010. For example, the acute hazard estimate for benzene is 6.0, based on the 15-second grab sampling (2005-2007), and the acute hazard estimates from 2005 to 2009 based on the maximum 24-hour air concentration is 0.5 at the Bell site. It should be noted that the highest acute hazard of 2.0 based on the 2005-2007 data was found at the Brock site (CDPHE, 2007 risk assessment).

CD22

- It is important to emphasize in this section that the estimated hazard index of 40 for acute non-cancer hazard is associated with a large uncertainty because of: (1) the use of chronic toxicity values for the majority of chemicals; and (2) the use of 15-second grab air samples. Overall, it seems inappropriate to use chronic toxicity values to estimate acute hazards.

CD23

It would be helpful to explain how the air concentration was calculated to estimate chronic exposures to residents living adjacent to a well pad.

CD24

- **Page 21, 2<sup>nd</sup> paragraph:** The report states "There is the potential for the production tank on each well pad to emit 37 tons per year VOCs (including methane), based on Antero's estimate of 0.36 tpy benzene and the composition of the condensate at the Watson Ranch Well...." It is not clear why methane is being included as a VOC emission because methane is not considered a VOC under EPA's Clean Air Act regulatory requirements. Additionally, calculating VOC emissions using State emission factors from a tank that emits 0.36 tpy benzene results in 75 tpy VOC (excluding methane). It is recommended that the VOC calculation be included as a footnote.

CD25

- **Page 21, 2<sup>nd</sup> paragraph:** This section indicates that the Antero project will include 10 well pads. Section ES1, page II, 2<sup>nd</sup> paragraph indicates that the project will include 9 well pads. The correct number of well pads should be determined and reported consistently throughout the document.

CD26

- **Page 21, 2<sup>nd</sup> paragraph:** The report indicates that combustors will be used to control VOC emissions from tanks to comply with Colorado Oil and Gas Conservation Commission (COGCC) rule 805b. Actually, the COGCC rule only requires that tanks emitting at least 5 tpy VOC be controlled if they are located within ¼ mile of affected buildings. However, Air Quality Control Commission (AQCC) Regulation No. 7, Section XVII.C.1 requires controls for condensate tanks that emit at least 20 tpy VOC. Based on the VOC emissions contained in the report, condensate tanks would be required to be controlled.

CD27

- **Page 21, 2<sup>nd</sup> paragraph:** The report states "It is important to note that while combustors may decrease VOC emissions, they have the potential to increase carbon monoxide, carbon dioxide, and nitrogen oxides emissions." It would be clearer if this sentence were revised to indicate that there is a tradeoff when using combustors versus not controlling condensate tanks at all. If a combustor is used, VOC emissions will decrease although carbon monoxide, carbon dioxide, and nitrogen oxides emissions will be generated. If a vapor recovery unit were used instead of a combustor, VOC emissions would be decreased and fewer carbon monoxide, carbon dioxide, and nitrogen oxides emissions would be generated.

- CD28** ○ **Page 23, 3<sup>rd</sup> paragraph:** The report states "COGCC rules require that no bleed valves be used on pneumatic devices, where technically feasible." Actually, the COGCC rule also allows that low bleed valves may be used. Essentially, the rule does not allow high bleed valves to be used.
- CD29** ○ **Page 23:** Scenario 3 lists acute exposure for children while scenarios 1 and 2 are for chronic exposure for all residents. Why only children in scenario 3? Adults may also be susceptible for acute exposure.
- CD30** ○ **Page 23-24:** The statement "adjacent to a well pad" is used a number of times. What is the definition of "adjacent"? Is it 100' or 1000'? Since dispersion can occur rapidly, this needs to be defined in some form.
- CD31** ○ **Page 23-24:** The summary of conclusions doesn't seem to offer a relative sense of whether the identified potential risks are elevated, when compared with non-gas development areas or urban areas. It is well documented that potential risks for cancer are often well over  $10^{-4}$  in urban areas and Hazard Index are much higher as well. In addition, indoor air is often much worse than ambient air due to out-gassing of carpet/furniture and household chemical usage. A comparison to these potential risks would be useful in the summary.

**4.1.4- Characterization of the Air Quality on Health**

- CD32** • **Page 25:** The statement that "It is likely that medical...." may be better termed "It is possible that...", unless you can further substantiate your reasoning.
- CD33** • As mentioned above, it seems more appropriate to characterize air quality health impacts based on the results of human health risk assessment by taking into consideration health risk estimates; and the level of uncertainty.
- CD34** • **Page 24, 1<sup>st</sup> paragraph:** Although ranking system described in Section 4 on pages 17-18 seem clear, the application of the ranking system is not as clear. For example, the magnitude of health effects for air quality is listed as "Moderate to High." As described on page 18, medium severity indicates "Causes health effects that necessitate treatment or medical management and are reversible" (rank = 2) and high severity indicates "Causes health effects that are chronic, irreversible, or fatal" (rank = 3). However, low severity indicates "Causes health effects that can be quickly and easily managed or do not require treatment" (rank = 1). The Division believes it is likely that air pollution may also result in low severity health effects. The report averaged the ranking of 2 and 3, resulting in a value of 2.5. It is not clear why the low severity rank of 1 was not included in the average, or even why ranks are being averaged rather than simply using the highest or most severe rank.

**4.1.5- Findings and Recommendations from Air Quality Assessment**

- CD35** • **What we know:** It is important to add that risk estimates are statistical projections of hypothetical risk intended as screening tools for risk management decision-making. The potential for adverse health impacts (acute and chronic) appears to be low based on the currently available information.
- CD36** • **What we do not know:** In this section, it would be helpful if the text also explains that the true magnitude of health risks is not known due to the availability of limited information for exposure and chemical toxicity. It is not known if adverse health impacts will occur because health risk assessment cannot determine if biological effects will actually occur.

**CD37** • **Page 25, 1<sup>st</sup> paragraph:** The report states "These studies also show that the largest volume of emissions to air occur during well development." Actually, it is the emission rates that may be higher during well development. It is not correct to say that the emission volume is greater during well development. Also, it is suggested that the studies being referred to in the 2<sup>nd</sup> sentence of this paragraph be noted with a footnote listing references for the studies being cited.

**CD38** • **Page 25, #3 of Recommendations:** This recommendation states: "Require corrective action when odor events occur, including notification of the GCPH and residents to reduce impacts." This recommendation is not clear. For example, notification is not a corrective action. Also, it is suggested that examples of corrective action be included in this recommendation.

**CD39** • **Page 25, #4 of Recommendations:** This recommendation states: "Require adherence to COGCC 805b green completion practices, with no variances, and EPA natural gas STAR program to reduce VOC emissions to the lowest level technically possible." Note that the COGCC rule does require that green completions if technically or economically infeasible, in which a variance is not required. The Gas STAR program is broad and in some cases, contains various ways emissions can be reduced from a single type of emission source. It may not be feasible to adhere to all methods at once. Also, it may not be economically infeasible to reduce VOC emissions to the lowest level technically possible. It is suggested that this recommendation be revised to take these factors into account.

**CD40** • **Page 25, #5 of Recommendations:** This recommendation states: "Require use of electrically powered generators in place of diesel powered generators for well drilling and fracking operations to reduce VOC, PAH, and PM emissions." Using electrically powered generators may not be feasible, depending on the availability of electricity. It is suggested that this recommendation be revised to take this factor into account.

**CD41** • **Page 25, #6 of Recommendations:** This recommendation states: "Require a valid emissions permit from the CDPHE for each well pad, per COGCC rule 805b to establish inspection and monitoring requirements." Actually, the COGCC rule only requires that tanks be permitted if they emit at least 5 tpy VOC and if they are located within 1/4 mile of affected buildings. However, AQCC Regulation No. 3, Part B, Section II.D.3 requires controls for condensate tanks that emit at least 5 tpy VOC. If the tank does not fall under either of these requirements, a permit would not be issued by the Division. It is suggested that this recommendation be revised to take this factor into account.

**CD42** • **Page 26, #11 of Recommendations:** This recommendation states: "Require pits at the water storage facility to be covered to reduce VOC emissions." It is suggested that this recommendation be revised to indicate that water storage pits should be operated such that no oil sheen is present on the water surface and/or that tanks shall be utilized instead of pits, where feasible.

**PART 2, Table 1. Identified Stakeholders.**

**CD43** • The CDPHE does not have the authority to determine whether a gas well can be drilled. The COGCC has this authority. CDPHE does, however, have broad authority to regulate air pollution sources so as to protect air quality, pursuant to the state and federal air quality statutes. Please refer to our regulations for further perspective.

## APPENDIX- D: HUMAN HEALTH RISK ASSESSMENT

### • General Observations:

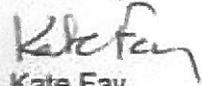
- CD44** ○ Acronyms: This section appears to need re-formatting to be visually easier to view.
- CD45** ○ Overarching for the whole appendix is the statement "adjacent to a well pad" that is used a number of times. What is the definition of "adjacent"? Is it 100' or 1000'? Since pollutant dispersion can occur rapidly, this needs to be defined.
- CD46** ○ Overarching for the whole Appendix is Scenario 3, which lists acute exposure for children while scenarios 1 and 2 are for chronic exposure for all residents. Why only children in scenario 3? Adults may also be susceptible to acute exposure.
- CD47** • **1.2- Previous Risk Assessments:** It may be useful to include two ATSDR health Consultation reports in this section.
- CD48** • **Section 1.2.1, p. 4:** The 2002 study was primarily performed by EPA and its contractors. Funding was entirely from EPA. The EPA contractors conducted all the field sampling and analysis. CDPHE assisted with site selection and data compilation/report writing.
  - **Section 1.2.1, p. 4:** "Samples were collected... at wells and residences located in the Parachute Valley" is not quite accurate. A better wording would be "Samples were collected... around wells and in both gas and non-gas development areas in the Grand Valley." There was only one residence that had sampling.
  - **Section 2.1.1, p. 8:** In the second sentence, it states "... 18 samples collected from the rural..." To be consistent and accurate, it should be stated "... 18 samples collected at the rural background...", as in Section 1.2.2.
  - **Section 2.3.2, p. 11-12:** Combining different sets of data and years for Bell-Melton may not be appropriate for a chronic exposure. During 2005-2007, there was a lot of gas development/drilling activity nearby. In later years, it is predominantly gas production activity in the immediate area. Emissions from these different activities will skew sampling results. In addition, the VOC list ("air toxics" list) contains a significant number of halogenated compounds that are not present in the NMOC list, which is composed of hydrocarbons. Thus, there is not a consistent set of compounds across the years.
  - **Section 2.6, p. 15:** This is the first instance of acetaldehyde inconsistently being called "acetylaldehyde".
- CD53** • **Section 3.4.3- Incomplete Pathways:** It would be more appropriate to classify exposure to subsurface soil (> 2 feet) as "insignificant" pathways instead of "incomplete" pathways.
  - **Section 3.5.2, p. 20-21:** The definition of "adjacent" is very critical in this section. According to Antero's diagrams, no residences are within 500' of proposed pads. If this is the case, then using well completion monitoring data taken at distances of 130' to 430' may not be appropriate without some dispersion scaling.
  - **Section 3.5.3, p. 22-23:** In the first paragraph, if "The acute risk calculated for the ambient air pathway is applicable to both the child and adult resident living adjacent to a well pad", then why not

provide an acute risk calculation for adults as well as for a child? Children (under 10) only comprise 15% of the population.

- CD56** • **Section 3.5.3-Child Resident Acute Exposure Assumptions and Intake Equations:** For estimating surface water acute exposure over 7 days, an averaging time of 365 days is used. The acute risks are significantly underestimated by applying an averaging time of 365 days. It is important to use an averaging time of 7 days or 15 days.
- CD57** • **Section 5.2.1- Ambient Air Baseline Risk:** The Silt Daley and Silt Cox are described as rural sites without natural gas production operations. These sites should be characterized as rural oil and gas development sites.
- CD58** • **Section 5.2.1, p. 34:** The second paragraph discusses the cancer risk for the rural background sites. It is probably worth noting that even at a background location, the risk is greater than the EPA ideal of  $10^{-6}$ , though within their acceptable range.
- CD59** • **Section 6.1.3, p. 41:** The grab samples from 2005-2007 during odor events were approximately 15 seconds in length. This should be mentioned, and would provide support for the high uncertainty in relating them to 24-hour samples.
- CD60** • **Section 6.2.2, p. 43-44:** The gas activities in the Bell-Melton site area have changed from development to production over the time period. This provides an uncertainty in the representativeness as long-term exposure.
- CD61** • **Section 6.2.5, p. 45:** In the first full paragraph, it is recommended that the reference "...at an Antero well pad" be removed. Who owned the well really had no specific bearing on the study.
- CD62** • **Section 6.4, p. 48-49:** To be accurate in the naming, "Air Quality Standards (AQS)" should be changed to "National Ambient Air Quality Standards (NAAQS)" in all places in this section.
- CD63** • **Section 6.4, Ozone, p.48:** In the third paragraph under ozone, it states, "However, 8-hour concentrations did exceed the proposed 60 ppb AQS..." This is an invalid statement. The proposed range for the new ozone NAAQS is 60 to 70 ppb. Thus, levels have exceeded the lower end of the proposed range, and the maximum of 64 ppb was near the middle of the proposed range. Based on this, the following sentence "For the days on which the proposed 8-hour AQS is exceeded...." Should be eliminated as being inaccurate.
- CD64** • **Section 6.4, Particulate Matter, p. 49:** In the third paragraph under particulate matter, it states, "However, several 24-hour PM2.5 concentrations..." should be modified to "However, several 24-hour PM2.5 concentrations at the Parachute monitoring station..." It also states in the following sentence, "The highest observed concentration was 41 ug/m3" Was this during inversion events in the winter, or other? Some additional information as to what might have been the cause would be nice.
- CD65** • **Section 7.2, p. 52-53:** As mentioned previously, having a comparison to risks in other areas is important to keep these increased risks in perspective. Urban areas typically have much higher risks, and indoor risks can be much higher.

Again, thank you for the opportunity to comment on this draft HIA and look forward to assisting you as you proceed. Please feel free to call me with any questions or if you would like to arrange a meeting with our review team that prepared these comments.

Sincerely,



Kate Fay  
Energy Manager

Cc: Dave Neslin, COGCC  
Lisa Miller, CDPHE  
Raj Goyal, CDPHE  
Gordon Pierce, CDPHE  
Mark McMillan, CDPHE



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November 15, 2010

The Battlement Mesa Draft Health Impact Assessment  
c/o Roxana Witter  
Colorado School of Public Health  
13001 East 17th Place B119  
Aurora, CO 80045

RE: Delivered Electronically

Dear Ms. Witter:

The West Slope Colorado Oil & Gas Association ("WSCOGA") WSCOGA offers the following comments related to the draft Battlement Mesa Health Impact Assessment ("DHIA").

Advancing scientific understanding of environmental and social challenges surrounding natural gas development is critical. During the last decade, advancement in technology and implementation of best practices has reduced impacts resulting from natural gas operations in Garfield County. Continued technological advancement and the use of scientific process-like those associated with the health impact assessment ("HIA") -will perpetuate this positive trend. Moreover, informing regulatory structures using science will help increase responsible domestic natural gas production in Western Colorado for the long term. To this end, WSCOGA applauds the spirit in which the *Colorado School of Public Health* ("CSPH") seeks to address citizen concerns related to natural gas development activities in the Battlement Mesa PUD. WSCOGA's comments are intended to provide constructive criticism of the DHIA data, methodology and its potential application. WSCOGA believes refinement of the DHIA will result in a final HIA that more accurately estimates potential impacts resulting from proposed natural gas development.

WSCOGA's purpose is to foster and promote the beneficial, efficient, responsible, and environmentally sound development, production and use of Colorado oil and natural gas. WSCOGA recognizes local communities are concerned natural gas development may adversely impact the health and wellness of PUD residents. In fact, member company employees and contractors also live within Battlement Mesa and its surrounding communities. WSCOGA member companies respect concerns expressed by residents of the Battlement Mesa community and are committed to responsible natural gas development that protects company employees, contractors, the public and environment.

A critical review of the DHIA, including the human health risk assessment, identified possible problematic assumptions and or omissions within the DHIA. The result of such assumptions may include the DHIA being unrepresentative of current conditions, unrealistic, and or unsubstantiated:

- W1 1. The DHIA assumes data gathered from other studies in Garfield County is representative of conditions that will result from natural gas development proposed within the Battlement Mesa PUD and that all airborne contaminants detected are derived solely from natural gas development with no other active or ambient sources contributing to their presence.
- W2 2. The DHIA assumes data collected from other studies for the purposes of conducting the DHIA is scientifically valid, peer reviewed and functional as a foundation for the DHIA.
- W3 3. The DHIA assumes factors used to establish exposure scenarios for the human health risk assessment are representative of conservative, yet realistic exposure scenarios for residents in Battlement Mesa.
- W4 4. The DHIA does not clearly provide context for the potential health impacts to Battlement Mesa residents contributed by Antero Resources' proposed natural gas development. The HIA should provide a comparison that assesses the existing potential health impacts assuming the Antero Resources proposed natural gas development does not occur in the PUD.
- W5 5. The draft HIA does not fully consider and incorporate the current myriad of federal, state and local regulatory permits, regulations and requirements that apply to natural gas development that serve to protect public health and the environment by preventing or mitigating the potential impacts projected in the DHIA.
- W6 6. The DHIA does not contextualize the best management practices proposed by Antero Resources that afford further protections of public health and the environment.

WSCOGA requests the CSPH critically assess the validity of these assumptions and or significance of these omissions when drafting the final HIA.

W7 In addition to the items highlighted above, WSCOGA is concerned the DHIA inadvertently extends beyond the stated scope and purpose of the HIA. Interpretation of the scope is derived from a number of sources including a contract between the Garfield County Board of Commissioners and the University of Colorado School of Public Health; public statements made by the HIA team; the Battlement Mesa Concerned Citizens' letter as highlighted in *HIA Attachment 1*; and, the purpose statement within the DHIA Executive Summary:

*The purpose of this HIA is to provide the BOCC with specific health information and recommendations relevant to Antero Resources Corporation (Antero) plans for natural gas development and production in the residential community of the Battlement Mesa Planned Urban Development (PUD), Garfield County, Colorado. Part 3 HIA – Executive Summary, Page 1)*

The HIA's narrow scope, as identified in the purpose statement, seeks to identify health information and recommendations specific to the development plan of Antero Resources only within the Battlement Mesa PUD. Assuming the project team crafted the DHIA using this limited scope, language in the DHIA makes references and recommendations that may extend beyond the scope:

*Because there are natural gas plays in other parts of the United States undergoing similar development as that occurring in the Piceance Basin, this HIA and future studies are likely to be broadly applicable. Communities in Texas and Wyoming have reported health and social impacts associated with natural gas development and production, while communities in Pennsylvania, New York and other places are trying to anticipate and forestall impacts before drilling occurs. Use of this or other HIAs as a tool to summarize potential impacts can help communities prioritize mitigations and local resources. (12. Part 1 HIA – Conclusions, Page 3)*

Geologic conditions, physical environments, regulatory requirements and development methods and processes for natural gas development not only vary within areas of a specific basin, but may vastly differ between basins and regions throughout the country. In Item 19, HIA Attachment #1, the BCC refers to the PUD as a “unique community” in a “unique situation.” This characterization by the BCC further reinforces the need for a narrow scope. Moreover, the BCC letter makes no explicit request for the scope of analysis to include a nexus with broader political discussions and national energy policy debates. Therefore, while true that elements of the HIA may be broadly useful to proposed natural gas development in other basins and regions in the future, such prospective statements go beyond the scope of the project and increase the potential for politicizing the HIA process and findings. For example: the Garfield County Board of commissioners already infer in a petition of intervention to the COGCC that the DHIA may be referenced in testimony to the COGCC in a matter unrelated to the Battlement Mesa PUD. (GarCO Petition, November 10, 2010 submitted to COGCC via Cassandra Coleman)

WSCOGA believes the HIA team may want to consider redrafting such references that occur throughout the document. Another example includes:

*Because development of domestic natural gas resource is part of the national policy to increase domestic energy production and reduce greenhouse gas emissions, **a high level discussion of the health implications of this policy needs to take place.** While municipal, county and state governments have begun to respond to citizen concerns, a*

**national discussion of the benefits and risks associated with this policy is due. (12. Part 1 HIA – Conclusions, Page 3)**

Tremendous national debates related to drilling, completion and production technology and processes are ongoing. The outcome of these debates has potential to change energy and regulatory policies and affect the very nature of domestic energy production in America. Inference to these broad discussions detracts from the narrow scope of the Battlement Mesa HIA. Whether or not "*national discussion of the benefits and risks associated with [these] policies*" is needed, is a fair question –but not one for the Battlement Mesa HIA.

W8 Also related to tone and context, WSCOGA observed in the document a lack of explicit recognition that existing federal, state and local regulations already establish specific permitting processes intended to allow for public review and comment of proposed development(s). These regulations also impose specific requirements on natural gas producers to diminish (or even alleviate) many of the potential impacts described in the DHIA. Little context is offered qualifying that the identified impacts are already largely accounted for in existing regulatory structures. This acknowledgment should be more explicit. For example, on page 33, para 1, part one: COGCC Rule 603 is described related to secondary containment. This paragraph states the "rule does not provide for containment of spills..." however, containment of such spills is required by other existing regulations such as the Colorado Department of Health and Environment's storm water control and the Environmental Protection Agency's Spill Prevention Control and Countermeasures (SPCC) programs. The example serves to illustrate a recurring theme throughout the document whereby existing regulatory mitigations already address the documents' stated potential impacts. Furthermore, there is also little or no contextual recognition of mitigating practices implemented in Garfield County to date. Nowhere is this omission more pronounced than in road and traffic impacts resulting from natural gas development. Natural gas operators have continually assisted Garfield County in addressing such impacts through funding of physical improvements and applying best practices to avoid and mitigate potential traffic impacts.

W9 WSCOGA would also like to address potential consistency/continuity issues between HIA supporting documents and the text of the DHIA. For example, Appendix D, *Human Health Risk Assessment*: this section contains significant discussion related to uncertainty associated with data used for the assessment (e.g., the use of air monitoring data from the Bell Molten location as indicative of air quality impacts that might occur from natural gas development in Battlement Mesa); however these uncertainties would qualify the "conclusions" of the HIA and need to be more clearly stated in the HIA itself –not just the supporting documents.

W10 Finally, and stylistically, WSCOGA proposes that a thorough technical edit of the text occur to limit the use of qualifiers such as 'extensive', "extensively", "significant" etc. to only those situations where those qualifiers are appropriate and truly justified.

Beyond the comments highlighted above, please accept the attached supporting documents labeled, "WSCOGA Specific and General DHIA Comments"; and, WSCOGA Risk Assessment Comments as additional input on the Draft, Battlement Mesa Health Impact Assessment.

Member companies of the West Slope Colorado Oil & Gas Association appreciate the time, energy and efforts invested by GarCo staff and the larger HIA team. The final HIA will no doubt assist the natural gas sector in advancing a greater awareness and understanding of potential impacts related to future natural gas operations in the Battlement Mesa PUD.

Thank you for allowing additional time for WSCOGA to review and assess the Battlement Mesa Draft Health Impact Assessment.

Best Wishes,

A handwritten signature in black ink, appearing to read "David Ludlam". The signature is written in a cursive, flowing style.

David Ludlam  
Executive Director  
West Slope Colorado Oil & Gas Association

**Specific Comments on Draft Health Impact Assessment  
Provided by the West Slope Colorado Oil & Gas Association**

Executive Summary, ES4, 3<sup>rd</sup> ¶ - *“These assessments take into account Antero’s proposed control plans and mitigation strategies to the extent they are known (from public presentations, Surface Use Agreement, and other information provided by Antero).”*

W11

It is not evident the DHIA considered existing regulations that require permitting and compliance with specific regulatory and or statutory requirements. In addition, it is not evident the assessments considered the numerous best management practices proposed by Antero for its proposed development plan. Should the DHIA not cross reference with existing regulatory requirement to help inform the risk assessment matrix?

Executive Summary, ES4.1 – *“The Antero natural gas development plan is likely to change air quality and produce undesirable health impacts in residents living in close proximity throughout the community.”*

W12

This statement is highly contentious and scientifically unsubstantiated based on the results of DHIA, which concluded the potential exposure to airborne contaminants was within EPA’s acceptable risk range. If the DHIA adhered to EPA guidance, used realistic exposure assumptions, and considered existing regulations and proposed best management practices, the health risks estimated in the DHIA would be reduced.

Executive Summary, ES4.2, 1<sup>st</sup> ¶ - *“Since the hydrology of the area is not well understood, the likelihood that these wells could be compromised by drilling in the PUD is unclear, but their location suggests that they could be compromised by natural gas development and production activities.”*

W13

Further evaluation of hydrogeology of Battlement Mesa supply wells should be conducted to better understand whether hydraulic connection exists between the subsurface below Battlement Mesa and the formation which the supply wells are completed. The statement quoted above assumes there is a hydraulic communication. The supply wells serve as a secondary or backup supply of domestic water that is subject to treatment prior to distribution to the Battlement Mesa community. A general description of the Battlement Mesa geology and hydrogeology (including the occurrence and use of groundwater) is provided in the Presco 2006 Gas Well Drilling Monitoring Report available on the COGCC e-library. [located here.](#)

W14

Executive Summary, ES4.2 – Although the DHIA states water quality impacts in Battlement Mesa are unlikely to occur as a result of Antero’s development plan, should water and or soil contamination exposure occur, these changes would produce undesirable health impacts. This statement is unsubstantiated and assumes an exposure pathway for drinking water ingestion and inhalation of volatile contaminants dissolved in water would remain intact for a considerable period. In the event of a spill that reached the Colorado River, where the intake for the primary supply of domestic water exists for Battlement Mesa, the spill would be greatly diluted by the volume and subsequent flow in the Colorado River. Furthermore, the DHIA does not recognize other potential sources of contamination that could enter the Colorado River upstream of Battlement Mesa including substances released from accidents associated with tankers being transported via Interstate 70 or the railroad. In the event that a very significant spill infiltrated to groundwater and reached the water supply wells, which serve as a secondary or backup source of domestic water, the HIA assumes that any contamination would go undetected and untreated for the prolonged period of exposure. In the event one of these water supply sources were to be contaminated, treatment alternatives are available which would remove the contaminants from the extracted water prior to any exposure to Battlement Mesa residents. The municipal water supply district is required to test the water provided to Battlement Mesa citizens to demonstrate it meets drinking water standards. The assumption that residents will be subject to a prolonged period of exposure of contaminated groundwater in the event that contamination impacts a water supply is unlikely.

W15

Executive Summary, ES4.3 – The DHIA does not appear to recognize extensive interaction between operators and the Garfield County road and bridge department in managing a variety of traffic and road maintenance related issues. Significant time and resources are expended to safely plan and implement the transport of drilling rigs, other equipment and materials to minimize disruption to residents and ensure safety of vehicles (including school buses) and pedestrians using county roadways. Furthermore, all operators have driver safety programs that educate and

enforce safe driving among employees and contractors as driving is recognized as a significant potential safety hazard associated with conducting natural gas drilling and production.

W16

Executive Summary, ES4.4 – The DHIA does not consider existing COGCC regulations that address noise and mitigation alternatives available to mitigate noise levels. The DHIA assumes sources of noise are unregulated and unmitigated.

W17

Executive Summary, ES4.5 – Ongoing high unemployment in Garfield County as a result of a marked decrease in drilling activity and the national recession are not recognized in the DHIA as being a significant stressor. The nationwide recession has likely created a more significant impact to Battlement Mesa residents compared to the impacts associated with a vibrant natural gas industry in Garfield County.

W18

Executive Summary, ES4.8 – The DHIA recognizes the assessment of potential impacts resulting from accidents and malfunctions is difficult to predict. Most operators utilize automated controls and telemetry systems that communicate alarm conditions intended to avoid accidental releases. Also, many of the reportable incidents related to spills include those accidents or malfunctions where containment berms control the extent of any spill and limit the severity of potential impacts. In addition, frequent inspections of operating facilities by employees and contractors also aids in detecting potential problems and mitigating accidents or malfunctions to a minor impact.

W19

Executive Summary, ES5 – WSCOGA agrees with recommendations of the DHIA in promoting pollution prevention and protection of public safety and the environment. However, WSCOGA does not believe Antero's proposed development plan is representative of causing a significant boomtown effect and associated adverse impacts. To the contrary, Antero's proposed development plan will provide significant support to the local economy, which may be welcomed under current economic conditions.

W20

Next Steps, ES6 – The DHIA recognizes numerous data gaps were identified that limited the evaluation of potential health impacts. WSCOGA recommends that its comments on the DHIA be addressed and incorporated into the final HIA before scoping any additional data collection including providing a comparative analysis of risk associated with a zero development scenario assuming no further development occurs in the Battlement Mesa PUD. WSCOGA also believes any further study focus on collecting data that is sufficient to confirm or modify many of the assumptions made in the DHIA. Although WSCOGA believes a final HIA may be beneficial in validating that existing policies, permitting processes, regulations and best management practices are protective of public health and the environment, an HIA is not necessarily required for every proposed development in proximity to residential areas if similar policies, permitting processes, regulations and best management practices are in place to provide a sufficient level of protection.

W21

Part One, Section 2.7, page 11 – The DHIA states the CSPH will monitor Antero's project permitting process at both the state and county level. The usefulness of the HIA will be partially determined by whether potential health impacts and mitigation strategies were considered when the permitting process occurs. COGCC rules allow for consultation between the local government designee and the CDPHE for various public health and environmental concerns related to proposed natural gas development. Recent amendments to the COGCC rules were intended to consider these potential impacts and to allow the inclusion of conditions to a Form 2A permit issued for new surface disturbance. WSCOGA suggests the CSPH evaluate whether the new permitting process, including consultations between state and local agencies, the landowner and the public, is adequate in considering these potential impacts along with existing regulations and best management practices utilized by operators.

W22

Part One, Page 15, 2<sup>nd</sup> and 3<sup>rd</sup> ¶'s – Statistics presented for sexually transmitted diseases and crime in these paragraphs, and in subsequent sections of the DHIA, imply workers from the natural gas sector are solely responsible for noted increases; however, such increases are likely realized in any region undergoing significant increases in population for whatever reason. Would normalizing the statistics presented here versus the corresponding increase in population be more appropriate?

W23

Part One, Page 19, Section 4.1 and 1<sup>st</sup> ¶ of Section 4.1.1 – Recognition of elements and contaminants seen in daily exposure by Battlement Mesa residents is non-existent in the DHIA. Should references to "hundreds of airborne contaminants" be put into context with other numerous ambient airborne contaminants and particulates?

- W24** Part One, Page 19, Section 4.1.1, 2<sup>nd</sup> ¶ - The possibility of complex health reactions occurring as a result of the interaction of multiple disturbances is referenced as having possible additive or synergistic effects that increases the potential for health impacts. Although there may be data that supports this effect for some compounded exposures, the science supporting this is not well understood. Furthermore, not all individuals react to similar exposures and many other genetic, age and lifestyle factors complicate the ability to understand and predict dose-response relationships. Although the DHIA recognizes potential health risks related to contaminants associated with natural gas operations are not well understood, due to little or no scientific information, the same is true for exposure of residents to chemicals found in many household materials and products. The DHIA needs to clearly state that not all potential health impacts estimated in the DHIA can be directly associated with exposure to contaminants associated with natural gas development.
- W25** Part One, Page 20, 4<sup>th</sup> ¶ of Section 4.1.2 – Due to differences in physical location, proximity to other sources of air contaminants (e.g., interstate highways, railroad), and type of development (residential vs. rural agricultural), is it valid to utilize data from the Silt-Daley and Silt-Cox monitoring sites to be reflective of baseline conditions in Battlement Mesa?
- W26** Part One, Page 21, 2<sup>nd</sup> ¶ of Section 4.1.3 – This paragraph asserts VOC emissions may degrade air quality. Should the final HIA note such emissions are already controlled by COGCC Rule 805b and by rules promulgated by CDPHE? Without such qualifications lay readers may assume impacts are not already addressed.
- W27** Part One, Pages 23 and 24, bulleted list describing health and cancer risks – How does the risk estimated for Battlement Mesa compare to the risk present in other parts of Colorado?
- W28** Part One, Page 25, 5<sup>th</sup> recommendation in Section 4.1.5 – It is not feasible to power fracing operations with electrically powered generators and other equipment. Perhaps the final DHIA narrative should describe why this mitigation recommendation is not technically feasible via interviews with local utility providers.
- W29** Part One, Page 28, 3<sup>rd</sup> ¶ - Is there a reference for the conclusions made in this paragraph regarding the relationship of the four groundwater wells to presumed up-gradient aquifers? From the description provided in this paragraph it seems reasonable these wells could be completed in alluvium associated with the Colorado River.
- W30** Part One, Page 29, 1<sup>st</sup> sentence (continuation from Page 28) – One of the references cited here (reference 41) to justify conclusions regarding impact to groundwater from natural gas development activities is contentious and may contain debatable conclusions. Extensive testimony was provided to the COGCC to refute the conclusions of this reference. Should such testimony be reviewed for the final HIA?
- W31** Part One, Page 29, last ¶ - The last sentence of this paragraph states there are little data for routine monitoring of impacts to water quality at gas wells, however, most operators in Garfield County have routinely collected pre- and post-drilling and completion samples from domestic wells in the vicinity of their operations. These results are provided to the COGCC and USGS. Were the results of those samples reviewed for this HIA?
- W32** Part One, Pages 31 and 32, Section 4.2.4 – The high negative ranking given to the potential impact to water and soil quality appears inconsistent with the preceding discussion of the risk. Should not the narrative related to the preceding discussion directly inform the ranking?
- W33** Part One, Page 33, 5<sup>th</sup> recommendation in Section 4.2.5 – Should context occur in the final HIA noting that berming of well pad perimeters, construction of diversion ditches and other measures required to prevent pollution of water and soil are already required by Federal and State regulations?
- W34** Part One, Page 33, 9<sup>th</sup> recommendation in Section 4.2.5 – The inlet protection system discussed here is very expensive and does not appear to be justified by the conclusions of this DHIA.
- W35** Part One, Page 33, 1<sup>st</sup> ¶ of Section 4.3 – Is there an assumption natural gas workers will drive at high speeds more frequently than the larger population?

**W36** Part One, Page 37, 4<sup>th</sup> ¶ - Recognition of the natural gas industry's significant contribution to the rebuilding and maintenance of roads throughout Garfield County and the providing of funds for extra police patrols and other measures to address road safety issues should be noted here, again for lay-reader's context.

**W37** Part One, Page 41 1<sup>st</sup> ¶ of Section 4.4.2 – The use of noise data from La Plata County as indicative of conditions in Battlement Mesa may not be valid. Moreover, is it possible Battlement Mesa near the north end of the PUD are indeed impacted by noise from Interstate 70 and the railroad more so than oil and gas production activities? Similarly, the conclusion in “What we know” on Page 43, that background noise levels in Battlement Mesa are low, is subjective and may not be entirely accurate.

**W38** Part One, Page 45, Section 4.5.1 – This section implies the incidence of STD's, criminal activity, mental health issues, etc. is due to natural gas development. As earlier suggestions noted, would it be more meaningful to compare the incidence rate of these issues in Garfield County to those that occur in other areas undergoing similar rates of population growth?

**W39** Part One, Page 46, 4<sup>th</sup> ¶ (“Education”) – Schools in Battlement Mesa/Parachute and surrounding areas experienced a significant amount of growth in student population and development of new and expanded facilities during the recent high levels of natural gas development. As a result, is it reasonable to assume the physical limitations of the schools in the area will be exceeded due to the proposed natural gas development in Battlement Mesa?

**W40** Part One, Page 47 1<sup>st</sup> ¶ (continued from Page 46) – It is unclear how the references cited in reference numbers 72-74 have relevance to natural gas development.

**W41** Part One, Page 48 2<sup>nd</sup> ¶ - It is unclear about how the rate of STD's that are experienced in low-and middle-income countries is applicable to this HIA.

**W42** Part One, Page 48 3<sup>rd</sup> ¶ - It is unclear how negative effects to surrounding “wilderness and public lands” caused by natural gas development is within the scope of the project analyzed by this HIA.

**W43** Part One, Section 4.5.3 – The 1<sup>st</sup> ¶ on Page 50 states that a negative rank of -11.5 is assigned to community wellness impacts. This ranking is inconsistent with the preceding discussion.

**W44** Part One, Section 4.6 – Throughout this section there is no recognition of the significant economic contribution the natural gas industry has made to Garfield County over the last decade. As a result of the tax revenue from this industry, Garfield County has had the ability to construct many new facilities, expand services, and establish fund balances that likely exceed those maintained by any county in Colorado. Although the industry activity and the economy in general, and associated tax revenues, have declined in recent years, the significant contribution from the industry in the past has put Garfield County in a position where the county was able to maintain services during this economic downturn.

**W45** Part One, Section 4.6 – It appears important references related to the economy of Garfield County were not reviewed for the development of this section. These references include the Garfield County Socio-Economic Study, prepared by BBC Research & Consulting; and the Oil and Gas Economic Impact Analysis 2007, prepared by the Colorado Energy Research Institute. It is recommended the CSPH review these and other relevant references and revise this section accordingly.

**W46** Part One, Section 4.6.3 – This section emphasizes the perceived negative impact or downplays the positive impact to businesses in the Battlement Mesa/Parachute areas that might result from additional natural gas development. Did the researchers consider interviewing local businesses (e.g., hotels, restaurants, gas stations, etc.) to ground truth whether those businesses believe this project will only result in small benefits to their business?

**W47** Part One, Section 4.6.4 – This section states the proposed project is unlikely to result in health impacts and the magnitude of those impacts will be low, however, the ranking assigned to this category of impacts was high. This inconsistency needs to be evaluated.

**W48** Part One, Section 4.6.5 – Many of the recommendations provided in this section may be outside the HIA scope. Does the CSPH maintain the necessary expertise in make these recommendations? Were personnel from Garfield County or other authorities with expertise on taxing, economic and finance consulted?

**W49** Part One, Section 4.7 - There is no recognition of natural gas sector contributions to regional health infrastructure in Western Colorado. The availability, access and quality of medical health services in the County and the region increased significantly over the past decade -largely due to the direct and indirect economic and philanthropic contributions of the natural gas business. Did the CSPH interview administrators with Grand River Hospital District in Rifle; St. Mary's and Community hospitals in Grand Junction, CO; or Hospice and Palliative Care of Western Colorado? These entities have increased capacity to more than accommodate current economic/social conditions and future projected need in the region. The conclusions reached in this section are inadequate: For example, the Saint Mary's flight for life program was created to support the energy industry. The program has received millions in support from natural gas operators in 2009-2010. Were health care institutions interviewed specifically to assess whether sufficient capacity exists to meet the projected health care needs resulting from Antero's proposed development?

**W50** Part One, Page 59 last ¶ - Was the scope of the spills cited in this paragraph investigated to determine the nature and extent of each incident? It is likely many of the spills reported to the COGCC were contained within secondary containment with little or no impact to soils, surface and or ground water.

**W51** Part One, Page 60 last ¶ (continues to Page 61) – The inclusion of the pipeline explosion incidents cited in this paragraph seem to have little relevance to the proposed development – no incidents of this type have occurred in Garfield County and may only create unnecessary concern among area residents.

**W52** Part One, Section 4.8.4 – The negative ranking assigned to the impact from accidents and malfunctions relies heavily on the number of spills reported to the COGCC. As noted above, many of these spills occurred within secondary containment structures; therefore, a more thorough analysis of these spill reports needs to be performed before an accurate ranking can be assigned.

**W53** Appendix A – This section should include various permitting and regulatory requirements associated with each step of the process described in this appendix. Without context, the lay reader does not gain any appreciation of the compliance requirements and safeguards built into these processes. For example, readers should understand specific requirements for verifying that surface casing and other casing strings have been properly cemented to protect shallow groundwater.

**W54** Appendix B – It is recommended this appendix be thoroughly reviewed by a professional geologist that is familiar with geology of the Piceance Basin.

**W55** Appendix B, Section B2 – This section contains a number of inaccuracies regarding current residential conditions in Battlement Mesa. It appears much of the information provided in this section is dated.

**General and Specific Comments on**  
**Human Health Risk Assessment for Battlement Mesa Health Impact Assessment**

**Prepared for The West Slope Colorado Oil & Gas Association**

**By**

**Technical and Management Systems and Service Inc.**

**November 15, 2010**

**General and Specific Comments on  
Human Health Risk Assessment for Battlement Mesa Health Impact Assessment**

**Prepared for The West Slope Colorado Oil & Gas Association**

**By**

**Technical and Management Systems and Service Inc.**

**November 15, 2010**

## 1. General Comments

### W56 1.1. General Comment 1

The potential impacts of oil and gas production in Garfield County, Colorado have been evaluated using EPA risk assessment techniques numerous times over the past 8 years. All of the risk assessments, including the Battlement Mesa Human Health Risk Assessment (BM-HHRA), have used conservative “health protective” screening techniques that tend to overestimate the potential health risks. All of the studies are consistent in supporting the conclusion that human health risks in Garfield County, including those related to oil and gas production, are generally within EPA’s acceptable ranges. Table 1 summarizes the risk assessment findings for these studies.

**Table 1 - Summary of Previous Community Level Risk Assessment Addressing Oil and Gas Impacts**

Study - Report	Main Human Health Findings
2002 Community-Based Short-Term Ambient Air Screening Study in Garfield County for Oil and Gas Related Activities (CDPHE 2002) (CDPHE 2002)	Highest computed community cancer risk = $2E-5^a$ <b>(within EPA’s acceptable range)</b> .  HI’s all below 1.0 <b>(within EPA’s acceptable range)</b> .
2005-2007 Garfield County Air Toxics Inhalation: Screening Level Human Health Risk Assessment (CDPHE 2007)	Highest computed community cancer risk = $7E-5^b$ <b>(within EPA’s acceptable range)</b> .  HI’s all below 1.0 <b>(within EPA’s acceptable range)</b> .
2008 Community Health Risk Analysis of Oil and Gas Industry Impacts in Garfield County, Colorado (Coons and Walker, 2008)	Highest modeled community cancer risk = $1E-5^{b,c}$ <b>(within EPA’s acceptable range)</b> .  <b><u>The Community Health Effects Portion Found</u></b> <i>Garfield County incidence rates for colorectal cancer, lung cancer, melanoma, bladder cancer, leukemia’s, and thyroid cancer in both males and females, and for breast and cervical cancer in females, <b>did not differ significantly</b> from the state rates for the period 1992 through 2005<sup>d</sup>.</i>
2010 Garfield County Air Toxics Inhalation: Screening Level Human Health Risk Assessment Inhalation of Volatile Organic Compounds Measured In 2008 Air Quality Monitoring Study, CDPHE June 2010.	Highest computed community cancer risk = $7E-5^b$ <b>(within EPA’s acceptable range)</b> .  HI’s all below 1.0 <b>(within EPA’s acceptable range)</b> .
2010 Human Health Risk Assessment for Battlement Mesa Health Impact Assessment (CSPH September 2010)	Highest computed community cancer risk = $7E-5$ <b>(within EPA’s acceptable range)</b> .  HI’s all below 1.0. <b>(within EPA’s acceptable range)</b> .
<p><sup>a</sup> Adjusted to use current benzene inhalation toxicity constant from EPA 2010 consistent with Battlement Mesa Human Health Risk Assessment (BM-HHRA)</p> <p><sup>b</sup> Adjusted from 70 year exposure to 30 year risk to be compatible with the BM-HHRA.</p> <p><sup>c</sup> Modeled at 500 meters from source assuming no backflow recovery. 500 meter is reflective of Antero’s proposed plan.</p> <p><sup>d</sup> The authors note that the study represents a snapshot in time and some diseases such as cancer can have latency periods that may not reflected in the cross-sectional view. Notwithstanding; however, the fact that the long-established public health cross-sectional survey approach did not detect an increase in Garfield County cancer incidence is an important risk assessment finding that deserves significant consideration. The BM-HHRA did not acknowledge the Community Health Effects segment of the 2008 Report.</p>	

These studies give essentially the same finding on a community level. Namely, that added cancer risks computed using the EPA's cancer risk toxicity model and highly conservative exposure assumptions fall within the EPA's acceptable range of 1E-6 to 1E-4. Similarly, the risks for non-carcinogenic effects also fall within the EPA's acceptable range.

Most of the risk assessments implicate exposure to benzene via an air inhalation pathway as a major contributor to the computed cancer risk. According to Coons and Walker, 2008, there is a causal link between exposure to benzene and the occurrence of leukemia (a type of cancer). They also point out that incidence rates for all male leukemia's in Garfield County were lower than those in the comparison counties and the state during 2003 - 2005 (the only period for which county specific data were available). Female leukemia incidence rates for Garfield County were essentially the same as for the state, as a whole, slightly lower than for Montrose County, and higher than those for Mesa and Delta Counties.

This information can be placed in perspective by considering the background cancer incidence rate in Colorado. According to the Colorado Department of Public Health and Environment (CDPHE) the 2007 cancer incidence rates, when adjusted for a 70-year lifespan are:

- 36% (0.36 or 3.6 E -1) for males, and
- 27% (0.27 or 2.7 E -1) for females.

The computed lifetime added cancer risks shown in Table 1 center around 5E-5 to 7E-5 which is 0.005% to 0.007% ( $0.00005 * 100 = 0.005\%$ )<sup>1</sup>. When the added cancer risks displayed in Table 1 are added to the CDPHE 2007 background cancer incidence rates, the increase in absolute cancer risk are derived as follows (using 1E-5 as an example):

- 0.36 goes to 0.36005 for males (a 0.01 % increase), and
- 0.27 goes to 0.27005 for females (a 0.02 % increase).

Though subject to discussion, these increased in absolute cancer rates and increases are not compelling.

Using the Battlement Mesa/Parachute 2000 population of 5,041 persons cited in the BM-HHRA, this risk indicates.

- $5,041 * 5E-5 = 0.3$  cancer case

That is, across the Battlement Mesa/Parachute population about 1/3 of an additional case of cancer would be expected from a 5E-5 added cancer risk. In comparison, the background cancer incidence rate would generate 1,588 cases in a 70-year period.

It is expected that measured Garfield County air quality parameters, and computed risk, will decline in response to the reduction in emissions from ongoing implementation of recent and future Colorado Oil and Gas Commission (COGC) and Colorado Department of Public Health and Environment (CDPHE) air quality rules that require emission controls for various oil and gas production related sources. Antero's proposed development plan in the Battlement Mesa Planned Urban Development (PUD) will be subject to these current regulations. In addition, Antero's has proposed best management practices for their development plan that go beyond existing air emission control regulations to further reduce potential emissions from their oil and gas production activities.

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<sup>1</sup> Note the cancer risk estimates that come from EPA's Risk Assessment Guidance for Superfund Process (e.g., the RAGS Process) are actually individual incidence rates indexed to the exposure scenario. That is, a 1E-5 risk is the lifetime added cancer risk (LACR) that an individual would receive from the exposure as described by the scenario. A 1E-5 individual LACR is sometimes reported as a 1 in 100,000 ( $1 / 100,000 = 1E-5$ ) added risk. An individual's additional risk or "probability" of cancer as a result of the exposure scenario is 1 in 100,000. Equivalently, if 100,000 individuals are in the exposure scenario, there would be 1 added (attributable) case of cancer ( $1 E-5 * 100,000 = 1$ ). Adding the LACR to the background cancer incidence rate shows the "absolute" or total individual cancer risk.

## **WS7** 1.2. General Comment 2

The BM-HHRA was conducted generally in accordance with US EPA Risk Assessment Guidance for Superfund (RAGS), although some significant deviations are discussed below. This BM-HHRA approach is generally consistent with the previous risk assessments summarized in Table 1. A model in the RAGS process is a concept known as the Reasonable Maximum Exposure (RME) (EPA 1989) which is:

*The reasonable maximum exposure is defined as the highest exposure that is reasonably expected to occur at a site. ... Estimates of the reasonable maximum exposure necessarily involve the use of professional judgment. ... The intent of the RME is to estimate a conservative exposure case (i.e., well above the average case) that is still within the range of possible exposures. This is generally regarded as "a combination of some lower exposure values [50th percentile] and some upper values [90-95th percentile].*

The BM-HHRA did not use the RME concept; rather, it utilized all upper values and as a result has substantially overestimated exposure and therefore potential health risks (the previous risk assessments identified in Table 1 did not use the RME concept either).

This effect, overstatement of risks by allowing conservative assumptions to be used in the RAGS process, is not unusual and is commonly called the "cascade of prudence". The cascade of prudence occurs when conservative assumptions are cascaded atop conservative assumptions. This often results in computed risks falling out in the 99<sup>th</sup> percentile of the actual distribution of simulated risks (Hamilton and Viscusi, 1999).

Through the use of ultra conservative exposure assumptions and data handling techniques, the results of the BM-HHRA clearly exhibit the cascade of prudence effect. As an example, examination of the BM-HHRA All Battlement Mesa Residents Chronic Risk Scenario using probabilistic techniques reveals that the authors computed benzene risk (5.4E-6) actually exceeds the maximum (greater than the 100<sup>th</sup> percentile) of the distribution of simulated risks. This "worst possible case" approach may be appropriate for conducting a screening analysis of potential health risks, but should not be used solely to formulate regulatory policy or requirements intended to allow or disallow oil and gas development or impose additional requirements for such development, especially when existing regulations and proposed BMPs to control air emissions were not considered in the risk assessment.

## **WS8** 1.3. General Comment 3

Recognizing that the BM-HHRA needed to rely on other studies to characterize air quality associated with oil and gas development outside of the Battlement Mesa PUD, several overarching concerns are expressed regarding data usage, handling and statistical methods that affect the entire BM-HHRA results. They are summarized here and detailed further in these comments.

- The BM-HHRA uses data compiled from several studies over the period 2005 to 2010. The inherent quality and useability of the data is not assessed and there is apparently no record of integrated planning, quality assurance, or validation. This lack of data control and validation does not satisfy EPA RAGS guidance and represents a significant deficiency affecting the reliability of the BM-HHRA.
- Much of the summary statistical information compiled in various tables could not be duplicated and there are discrepancies. There are several serious technical and conceptual flaws including gathering and combining data from different studies and computing summary statistics from correlated data as though they are independent data.
- The Chemicals of Potential Concern (COPC) identification reflects the rote regulatory process. No common sense, process knowledge, or understanding of analytical chemistry is applied. Numerous constituents are "screened in" and retained throughout the risk assessment that are not related to oil and gas production and are likely laboratory artifacts (e.g., methylene chloride). Due to an apparent lack of understanding of the oil and gas production industry, all contaminants

detected in previous studies are assumed to be derived directly from oil and gas production activity. Furthermore, the approach taken in the BM-HHRA in identifying COPCs does not appear to conform to EPA RAGS guidance.

Overall, it appears that the data was taken from the various databases at face value and populated into the spreadsheets without much concern as to its analytical precision accuracy, or its representativeness of actual conditions. In some cases, it appears that the database was sifted to identify maximum concentrations without regard to spatial or temporal considerations. The lack of data control and validation may introduce significant error into the BM-HHRA findings.

#### 1.4. General Comment 4

Based on a review of the BM-HHRA and supporting documents, the following conclusions can be made regarding the three exposure scenarios considered.

##### **WS9** 1.4.1. All Residents Chronic Exposures - Scenario

This scenario parallels the previous screening assessment (Table 1). The findings: "Highest computed community cancer risk =  $7E-5$  (within EPA's acceptable range) and HI's all below 1.0. (within EPA's acceptable range) are consistent and predictable. As indicated, the assessment is highly conservative and expresses the cascade of prudence.

An analysis of the benzene portion using probabilistic techniques suggests that the scenario overstates risks by a factor estimated to be about two orders of magnitude (factor of 100). This is illustrated in Figure A where the results of a probabilistic examination of the benzene risk are profiled along with the BM-HHRA benzene risk estimate. As indicated:

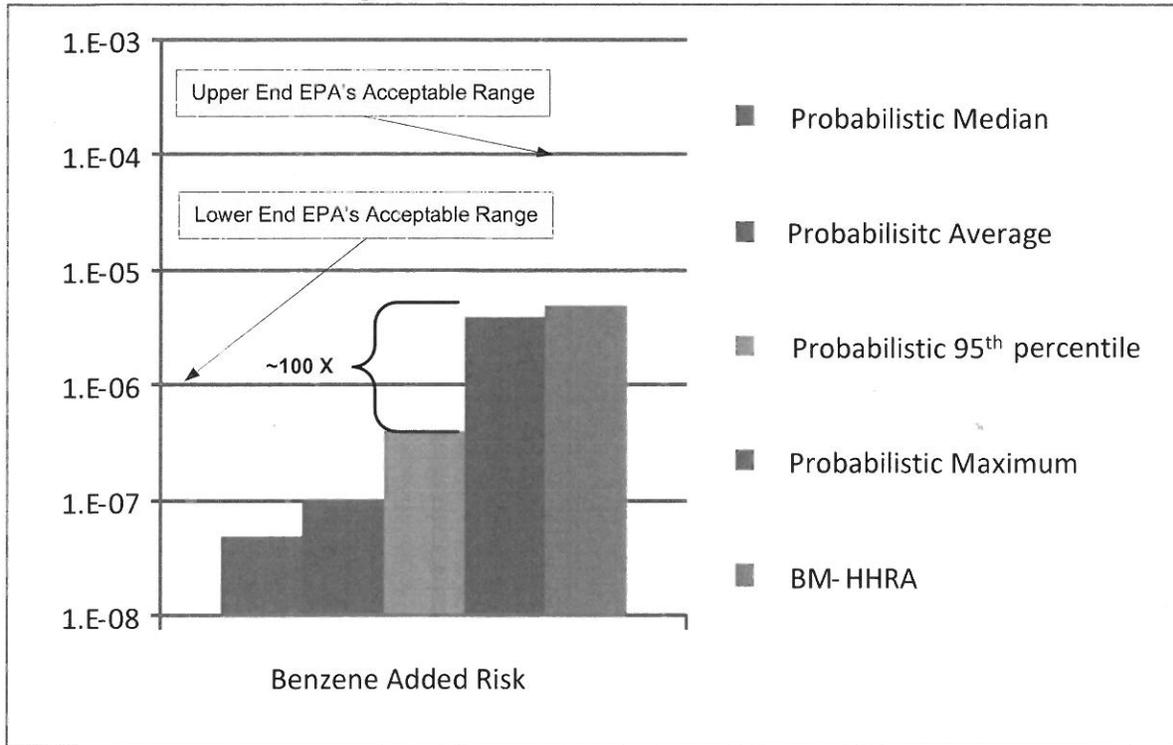
- All benzene risk estimates are below the upper end of EPA's Acceptable Risk Range ( $1E-4$ ).
- The BM-HHRA risk estimate actually exceeds the maximum probabilistic estimate.
- There is an approximate 100-fold difference between the BM-HHRA estimate and the probabilistic 95<sup>th</sup> percentile estimate.
  - The probabilistic 95<sup>th</sup> percentile estimate is actually below the Lower End of EPA's Acceptable Risk Range ( $1E-6$ ).
- The probabilistic median and mean risk estimates are both at or below  $1E-7$ .

Benzene was selected for this examination because there is reliable data on its occurrence and toxicity, and because it is frequently regarded as an indicator of oil and gas production (although there are numerous other sources). Based on this analysis, it is apparent that:

1. Benzene risk in the All Residents Chronic Exposures Scenario are well within EPA's Acceptable Risk Range, and
2. The BM-HHRA significantly overstates the benzene risks.

It is very likely that all other BM-HHRA estimated risks exhibit this same high level of conservatism and may overstate the 95<sup>th</sup> percentile estimate by a wide margin – perhaps by a factor of 100.

**Figure A – Profile of Benzene Risk Estimates.**



Used as a screening tool with a wide err on the side of safety component, as illustrated above, the scenario still concludes that cancer and non-cancer risk are within the EPA's acceptable range.

### **W60 1.4.2. Residents Living Adjacent to Well Pads - Scenario**

This scenario parallels the previous screening assessments (Table 1), but seeks to incorporate the effects of receptors living in close proximity to actual oil and gas operations. The findings: "Highest computed community cancer risk = 8E-5 (within EPA's acceptable range) and HI's of 2.0 (slightly above EPA's acceptable range) again are fairly consistent with previous studies and are predictable. The assessment contains numerous cascading errors on the side of safety and likely overstates conditions by a factor of 100 as illustrated above. Additionally, the assessment exhibits several method inaccuracies including:

- In order to develop a short-term exposure point concentration (EPC) to compute the effect of a 10-month exposure (installation and development period), the "maximum" concentrations were apparently mined and sorted from the 2005 to 2010 data, regardless of their physical existence in space and time. This, mixture of maximums, which have no apparent traceable spatial or temporal perspective cannot be considered representative. A fixed time (10-month) exposure in a fixed location (adjacent to an oil and gas production facility)<sup>2</sup> would not be represented by such a combination of worst-case EPCs.
- The 10-month exposure period, by mistake, uses chronic toxicity information to evaluate what is essentially a subchronic exposure nested within a chronic exposure scenario. The EPA clarifies that a subchronic exposure consists of more than 30 days up to 10% of the human life span (10

<sup>2</sup> A more representative scenario could have been developed by reviewing the individual well pad monitoring information and selecting several specific time and location episodes (e.g., a low, medium, and high) for presentation along with spatially appropriate "remainder of the 30 year scenario data".

months ~ 1% of a 70 year lifespan). This mistake results in an inflated 10-month contribution to the scenario.

- The non-cancer risk (Hazard Index = 2.0) is mishandled and over reported. According to standard EPA RAGS Guidance (EPA 1989), in summing the Hazard Quotients (HQ) to arrive at a Hazard Index (HI), if the sum (the HI) exceeds 1.0, the risk assessment is to break out the HI by affect and target organ. This was not done so the HI of 2.0 reported in Table 5-3 represents an amalgamation of effects that are incorrectly treated as additive.

Notwithstanding these errors which overstate the results, this scenario when used as a screening tool with a wide err on the side of safety component the scenario still concludes that cancers are within the EPA's acceptable range. Moreover, given the mishandling to methods and techniques, it can probably be shown that the non-cancer risks (i.e., the HQ) are also within the EPA's acceptable range of health risk.

### ***WBI* 1.4.3. Acute Risk Characterization for Child Resident Living Adjacent to a Well Pad Scenario 7-Day Duration.**

This is a new scenario within the body of RAGS screening level risk assessment reported for Garfield County. The characterization is seriously flawed in at least four important aspects (as well as the general issues discussed previously). The entire scenario, as presented, is not suitable for risk management decision processes owing to factors including improbable exposure assumptions to outright methodological error in the handling of toxicity information. These are summarized below:

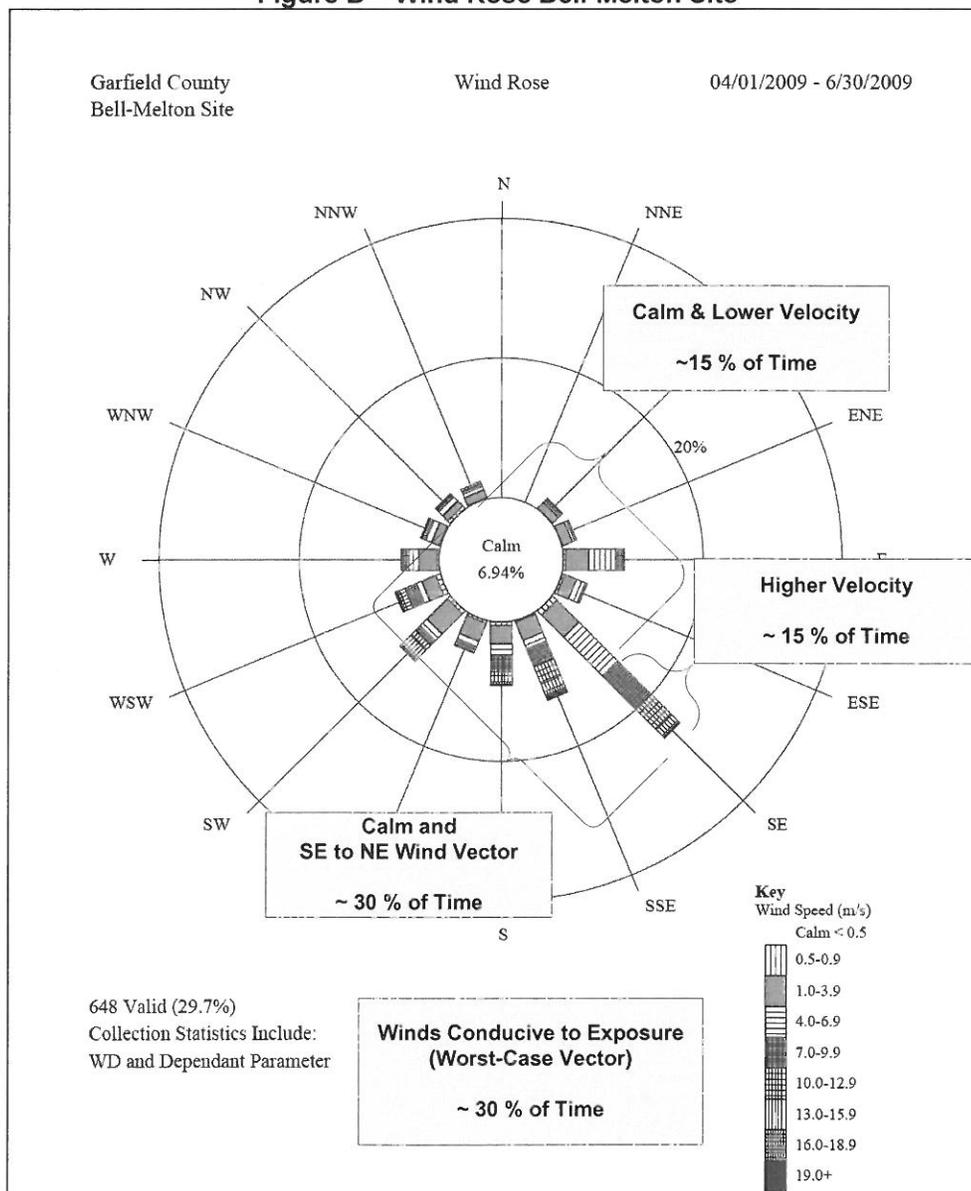
- The exposure assumptions are unrealistic and do not reflect plausible conditions as dictated by the physical conditions known to exist. Figure B is a wind-rose for the Bell-Melton area (ARS 2009). As indicated, the pattern of calm to light breeze wind conditions in a single direction (emulating a continuous source to receptor relationship), which would be conducive to a significant "lingering exposure" occur only about 25% of the time along the worst-case exposure vector (e.g., the SE to NW vector). Notably on other vectors (NW to SW), a lingering exposure would be rare (less than 10% of the time). Given the diurnal pattern of winds (heating with atmospheric instability and air movement in the morning through the afternoon), seven days of 24 hour continuous exposure (i.e., 168 uninterrupted hours over 7 diurnal cycles) to the maximum measured concentrations is not a reasonable assumption.
- Assuming that indoor concentrations are equivalent outdoor concentrations is also unreasonable. Typically, when conditions warrant an air pollution "alert", the public is counseled to stay indoors to garner the sheltering effects of the structure. In exposure modeling, a conservative indoor/outdoor factor of 40% to 50% is frequently used to assess indoor exposure from out of door sources<sup>3</sup>.
  - Combining these two physical features alone, and assuming the hypothetical resident could reside on a major wind vector, does not leave the residence, and further assuming 4 hours outdoors and 20 hours indoors results in an approximate 10-fold overestimate of exposure. If the receptor spends time away from the residence during the 7 day continuous period, exposure is reduced proportionally (e.g., 2-3 hours away results in a 2.5/24 ~ 10 % reduction in aggregate daily exposure).
- Once again selection of data is an issue. It seems that the authors searched the database of constituent's concentrations and assembled a group of maximums for populating the spreadsheet and performing calculations. Apparently no attempt was made to lend a physical representation of the data relative to potentially exposed populations. Bringing all maximum concentration measured over five years over a spatial domain of many tens (maybe 100) square miles, without recognition of common meteorological factors, does not result in a representative condition. The possibility of such an assemblage actually occurring is remote (see footnote 2).

<sup>3</sup> The Department of Energy's RESRAD model uses a factor of 40% (DOE 2009).

- The BM-HHRA has misinterpreted guidance on evaluating the toxicological aspects of the scenario. The intakes presented in Table 5-4 were apparently computed in accordance with EPA's RAGS Volume I (Subpart F Supplemental Guidance for Inhalation Risk Assessment). According to RAGS (2009) which states "Exposures with a duration lasting between 24 hours and 30 days should be treated as subchronic for the purposes of this document (i.e., RAGS Subpart F)".
  - The reference concentrations labeled as (RfC – acute) used in Table 5-4 are an assortment chronic and acute toxicity benchmark values which according to EPA's guidance as stated above, are inappropriate for the use to which they are applied (additional comments are also provided).

On this basis of these observations, the HQ's presented in Table 5-4 are seriously flawed, incorrect, and are not be suitable for any risk management decision processes.

**Figure B – Wind Rose Bell-Melton Site**



Source ARS 2009.

## 2. Specific Comments

### **W62** 2.1. Data Quality Assurance and Useability

The BM-HHRA uses data compiled from several studies. The quality of the data has not been evaluated and the results drawn from its use must be questioned from a risk assessment process standpoint and from a realism perspective. Quality is defined here in terms of the EPA's Data Quality Objectives (DQO) theme where data needs are identified in response to defined objectives. Plans and strategies are then followed to fulfill the data needs. Implementation includes: working with bounds on uncertainties, conventional quality assurance/quality control, data validation and data assessment (precision accuracy representativeness, comparability and completeness; collectively known as data quality indicators). While the Garfield County air quality studies do clearly reflect some planning and quality has been pursued using conventional analytical methods, there does not appear to be a cohesive DQO based programmatic approach.

Apparently the data from the four studies identified in BM-HHRA Section 2.1 have been collected as needed in response to concerns as they emerged. The data has not been prescribed and collected in accordance with a quality assurance project plan (QAPP) as is typical for risk assessment. Moreover, the data has not been subjected to a data quality assessment, data quality indicators review, validation, or useability for risk assessment evaluation<sup>4</sup>. This is evidenced by the absence of a data quality review which is a common element in a risk assessment. Again, this represents a serious deviation from EPA RAGS guidance when combining data (USEPA 1989) as follows:

"If the methods used to analyze samples from different time periods are similar in terms of the types of analyses conducted and the QA/QC procedures followed, and if the concentrations between sampling periods are similar, then the data may be combined for the purposes of quantitative risk assessment in order to obtain more information to characterize the site."

Since QA/QC procedures have not been developed or provided as would be in a Quality Assurance Project Plan (See USEPA 2001), it is not possible to verify whether data used in the risk assessment is appropriately specified, collected and suitable for use in the risk assessment. It is troubling that apparently quality assurance field blanks and/or duplicates were not routinely submitted or evaluated. Thus, there are no data qualifiers and it appears that all data on the analytical reports were taken at face value. This is particularly problematic beginning with the identification of Chemicals of Potential Concern (COPCs) (discussed below) and the ensuing use of the data since it cannot determine whether the various listings used in the screenings are reliable. This is a significant oversight when coupled with HHRA's statement in the uncertainty section that overall risk assessment probably understates actual risk because of the absence of toxicity information for many potential COPCs. Without data QA/QC, the reliability of the analytical results used to identify potential COPCs is uncertain.

### **W63** 2.2. COPC Identification Process

In addition to the face value use of all data as discussed above, the COPC identification show the effects of a rote handling process without the benefit of experience in, or consideration of, the environmental occurrence of chemicals, understanding of process chemistry, and the recognition of the common limitations of analytical chemical results. Examples include:

- Identification of 1,3 Butadiene as a COPC. Butadiene (1-3) is commodity chemical that requires petrochemical processing for production (Morrow, 1990, USDHHS 2009). Therefore it would not be expected to be emitted from the upstream raw gas production processes found in Garfield County and planned by Antero. It is notable that low levels of 1,3-butadiene are continuously emitted to the atmosphere from many sources including exhaust from motor vehicle engines

<sup>4</sup> The data was subjected to minimum reporting level versus risk based benchmark comparison.

using petroleum-based fuels. (USDHHS 2009). Butadiene is incorrectly carried though the risk assessment and appears in Tables 5-1 and 5-3 as a risk driving constituent. The USDHHS (2009) reports background 1,3-butadiene ambient air concentrations from 0.1 to 2.2  $\mu\text{g}/\text{m}^3$  in the US. The maximum concentration reported in Table 2-8 is 0.15  $\mu\text{g}/\text{m}^3$ ; it was detected in just 7% of 129 samples.

- Identification of methylene chloride as a COPC. Methylene chloride also requires petrochemical processing for production and is a common laboratory contaminant (USEPA 1991) frequently associated with organic analytical procedures. Notably, in Table 2-4, methylene chloride was detected in less than 5% of the samples which, according to EPA (1989) normally qualifies as a low frequency of detection and is omitted as a COPC. According to EPA (1989), methylene chloride is a common laboratory contaminant that frequently emerged in conventional environmental analyses. Importantly, methylene chloride carries though the risk assessment and appears in Tables 5-1 and 5-3 as a risk driving constituent. This observation reinforces the previous comment(s) on the apparent lack of analytical process quality integration and data validation.
- Identification of 1,4-dichlorobenzene as a COPC. According to the USDHHS (2006), chlorinated benzenes are produced in petrochemical processes, typically by reacting liquid benzene with gaseous chlorine in the presence of a catalyst. Therefore, it would not be expected to be emitted from the upstream raw gas production processes found in Garfield County and planned by Antero. The report further notes that 1,4-dichlorobenzene is widely used in commerce with common applications such as a space deodorant for toilets and refuse containers, and as a fumigant for control of moths, molds, and mildews. In Table 2-4, 1,4-dichlorobenzene was detected in less than 5% of the samples which, according to EPA (1989) normally qualifies as a low frequency of detection and is omitted as a COPC. Once again, 1,4-dichlorobenzene carries though the risk assessment and appears in Tables 5-1 and 5-3 as a risk driving constituent. It is of interest that in their 2007 air toxics risk assessment, CDPHE reported the occurrence of 1,4-dichlorobenzene in all sectors including urban and rural background. Further, CDPHE reported 1,4-dichlorobenzene up to 4.6  $\mu\text{g}/\text{m}^3$  at the Daley rural background site; USDHHS reports concentrations up to 2.7  $\mu\text{g}/\text{m}^3$  at one semi-rural location (the maximum concentration reported in Table 2-8 is 2.3  $\mu\text{g}/\text{m}^3$ ).
- Identification of n-hexane as a COPC. According to USDHHS n-hexane is commonly used in laboratories (1991). Moreover, hexane is listed a reagent used in Method TO 14a (USEPA 1999). Method TO 14a was used extensively to develop the data used in the risk assessment. Hexane (-n) is carried though the risk assessment and appears on Tables 5-3 and 5-4 as a risk driving constituent. This observation reinforces the previous comment(s) on the apparent lack of analytical process quality integration and data validation.
- Identification of 2-hexanone as a COPC. According to USDHHS 2-hexanone is commercially produced by the catalyzed reaction of acetic acid and ethylene under pressure. Accordingly it would not be expected to be emitted from the upstream raw gas production processes found in Garfield County and planned by Antero. In Table 2-4, 2-hexanone was detected in less than 5% of the samples, which according to EPA (1989), normally qualifies as a low frequency of detection and is therefore omitted as a COPC.

## W64 2.3. Statistical Issues

- Numerous statistical summaries are provided in the BM-HHRA which relies on the assumption that the underlying data are independent<sup>5</sup>. This issue comes into prominence when summary statistics and EPCs are computed from the repeated sampling of the monitoring stations, particularly those sampled routinely. For example, in the 2008 to 2010 Garfield County Ambient Air Study, Summa canisters and DNPH samples were collected every 6<sup>th</sup> and 12<sup>th</sup> days respectively. Lumping all of these data and computing means, variances, confidence limits and EPCs as though 188 samples were independent is not a technically defensible technique (See Sokal and Rohlf, 1997). This issue may also be present in other data sets used and combined in the BM-HHRA. This observation reinforces the previous comment(s) on the apparent lack of integrated data planning and risk assessment usability. A conventional data usability assessment (EPA 1991) should have detected this problem.

### Specific Observations Include:

- The summary statistic compiled in Tables 2-4 and 2-8 could not be duplicated. Using benzene as tracking constituent, 178 Bell-Melton Ranch samples were counted from the 2005 to 2010 Monitoring Station; the BM-HHRA cited 128. There is no discussion of the sampling locations and the rationale for why aggregating the Bell-Melton data from these locations over the 2005 to 2010 period is suitable conceptually or statistically. As represented in the Tables 2-4 and 2-8 (and cascading to ensuing tables), each of the 128 sample benzene results are treated as if an independent measurement. As noted above, if the data were collected from the same location(s) every 6th or so day (as is stated), then the data are not random independent variables and the calculations are flawed from a statistical perspective and should not be relied upon as representative.
- The same comment from above applies again in Table 3-1 where the chronic EPCs are taken from Table 2-8. If Table 2-8 is flawed, then Table 3-1 is flawed.
- In Table 2-8 and 3-1, it is important to understand how the maximum concentrations from the 2008 Well Completion data are related to the chronic EPCs in space and time. It appears that the chronic EPC (benzene 1.67  $\mu\text{g}/\text{m}^3$ ) and the maximum concentration (benzene 68.5  $\mu\text{g}/\text{m}^3$ ) are not be related to the same location(s) and may not reflect the same time interval. If this is the case, then it is apparent that the data set has been mined and sorted to generate exposure point concentrations that are later presented as representative of the exposure a resident could encounter. This data handling system, if as it appears, cannot be regarded as technically defensible and cannot be relied upon representing conditions in the Bell-Melton area or Battlement Mesa.

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<sup>5</sup> As an example of independence in statistics, if 5 students are measured for their IQ, 5 times each, the average IQ and the 95% UCL of the average IQ is not computed as the simple average and 95% UCL of 25 individual measurements. These summary measures (mean, variance, 95% UCL) are computed from the average IQ measurements of each student. This is because the individual IQ measurements of any individual student are not independent – rather they are correlated. Suppose the measurement regime were imbalanced so there were 5 measurements for three students, 4 measurements for one student and 3 measurements for one student. The average IQ and 95%UCL of the 5 students would not be the simple average and 95% UCL of the 22 measurement.

## **W65** 2.4. Transparency

Overall, the data evaluation and selection set forth in Section 2.1 is far from transparent. Even with the aid of the original reports and spreadsheets, information in the various tables could not be duplicated. The inability for an observer to track where the data came from, how it was handled, if it being used for its intended purpose, and to duplicate calculations erodes confidence in the BM-HHRA.

## **W66** 2.5. Summary

According to the USEPA (2010), data validation is necessary to identify data with errors, biases, and physically unrealistic values before they are used for identification of exceedances, for analysis, or for modeling. It is apparent that common lab contaminants (methylene chloride, n-hexane) would have likely been identified by validation techniques. Additionally, the COPC identification reflects an unseasoned allegiance to the rote process. The statistical and data combining issues discussed above seem to reflect a lack of awareness and seriously undermine all data used to compute EPCs. These observations do not give comfort that the data underpinning the risk assessment is understood, is of satisfactory quality, or that it has been critically considered sufficiently to base the risk assessment and subsequently to reach any policy or regulatory determinations.

### 3. Exposure Assessments

#### **W67** 3.1. Overall Conservatism

The exposure assessments do not reflect a RME concept. The scenarios and exposure factors are simple default assumptions selected without consideration of the Battlement Mesa population dynamics. This approach results in a highly conservative and skewed exposure assessment. Table 2 profiles the BM-HHRA exposure factors versus which, from a common sense perspective, are probably more representative of what is commonly called the "central tendency exposure" (CTE) or "average" collection. EPA Region 8 defines these as:

- **Average or Central Tendency Exposure (CTE):** CTE refers to individuals who have average or typical intake of environmental media.
- **Upper Bound or Reasonable Maximum Exposure (RME):** RME refers to people who are at the high end of the exposure distribution (approximately the 95<sup>th</sup> percentile). The RME scenario is intended to assess exposures that are higher than average, but are still within a realistic range of exposure.

**Table 2 - All Residents Chronic Exposures – Scenario Default Exposure Factors and More Representative Exposure Factors.**

<b>Exposure Assumption</b>	<b>BM-HHRA</b>	<b>More Representative Central Tendency</b>
Exposure Duration	30 year	8 - 9 year (mean rural duration EPA 2009)
Days at Residence (PUD)	350 / year	90% at home is more reasonable (329 full days)
Time of Day at Residence	24 hours	12 to 16 indoors (many work, attend community functions, shop)
Fraction of time Exposed to EPC	1.0	Leeward wind blows away from the most exposed receptor (Figure B) 70 % of the time.  Rifle, CO temperature indicates at least 4 months of heating with residence generally closed. Receptors predominantly indoors while at residence in these periods.  Portion of the 24 hour period is spent indoors where concentration is less than the outdoor EPC; nominal shielding, heating and cooling etc ( $C_{\text{indoor}} \sim 0.4 C_{\text{outdoor}}$ ).

The effect of using the BM-HHRA default exposure factor versus those more representative is illustrated below where the BM-HHRA/CTE factors are shown:

- Exposure Duration  $30/8.5 = 3.3$
- Days at Residence  $350/329 = 1.1$
- Time of Day at Residence  $24/14 = 1.7$
- Leeward wind fraction  $1/0.3 = 3.3$
- Days indoors with heating or cooling  $350/(350-120) = 1.5$
- Indoor shielding =  $1.5/0.4 = 3.8$

These factors can be multiplied to obtain an approximate BM-HHRA/CTE ratio which is 116. Thus, one can see that the BM-HHRA computes exposures that are over 100 times greater than the same exposure that would be computed with CTE factors. Based on work by Hamilton and Viscusi (1999), this large a difference (BM-HHRA/CTE = 116) is excessive. Their work indicates that EPA "RME" exposure factors typically overestimates the CTE or "average" based exposure by a factor of about 25.

**W68 3.2. Acute Risk Characterization for Child Resident Living Adjacent to a Well Pad Scenario 7-Day Duration the Maximally Exposed Individual**

In the case of the Acute Risk Characterization for Child Resident Living Adjacent to a Well Pad Scenario 7-Day Duration scenario, the BM-HHRA has extended to conventional Maximally Exposed Individual (MEI) concept. In air dispersion modeling, the MEI is the modeling node where the maximum modeled ambient air concentration occurs, regardless of whether there is a person there or not (EPA, 2004). This modeled point, characterized as defined x,y,z coordinate with a proximity and metrological relationship to the emission source, is referred to as the MEI. The MEI described in the Acute Risk Characterization for Child Resident Living Adjacent to a Well Pad Scenario 7-Day Duration scenario does not look at a specific point or time. The text on page 22 of 65 seems to suggest that MEI exposure point concentrations were obtained by filtering the body of reports searching for maximum concentrations regardless of the location and time interval of the measurement. The maximum concentrations from many points and times are gathered together (conceptually) where extreme default exposure factors are then applied. The author's conceptualization of the MEI is significantly different from the common regulatory usage. Moreover, it results in a scenario that is unconventional, lacks realism, and has no physical basis.

**Table 3 – Impact on Trimethylbenzene HQ's Using Subchronic Toxicity Information**

Chemical	HQ Chronic RfC 7 µg/m <sup>3</sup> From Table 5-4	HQ sub-chronic RfC 70 µg/m <sup>3</sup> <sup>a,b</sup>	HQ sub-chronic RfC 100 µg/m <sup>3</sup> <sup>a,c</sup>
1,2,3- Trimethylbenzene	1.67	0.2	0.1
1,2,4- Trimethylbenzene	11.9	1.2	0.8
1,3,5- Trimethylbenzene	11.1	1.1	0.8

<sup>a</sup> Based on animal studies and embodying an uncertainty (safety) factor of 300.  
<sup>b</sup> Hematological effects (blood clotting effects)  
<sup>c</sup> Pulmonary effects (inflammatory lesions in the bronchiolar region)

As indicated in Table 3, use of the appropriate toxicity information changes the complexion of the HQ's from an issue of concern to one of mild hesitation<sup>6</sup> in the case of 1,2,4 and 1,2,5 trimethylbenzenes (Using the more conservative RfC of 70 µg/m<sup>3</sup>, which is based on hematological effects). When considering the pulmonary effects, applying the 100 µg/m<sup>3</sup> RfC results in all HQ's to be less than one.

In either case, use of the appropriate toxicity information changes the interpretation dramatically. In Table 5-4 the erroneous trimethylbenzenes HI's collectively account for 71% of the summed HQ.

- **N-Nonane**

The same mistake is made with n-Nonane. EPA's PPTRV (2009) derives a subchronic RfC for n-Nonane of 2 mg/m<sup>3</sup> (2,000 µg/m<sup>3</sup>). The RfC- acute listed Table 5-4 is 0.2 mg/m<sup>3</sup> (200 µg/m<sup>3</sup>) is the same as the one listed in Table 4-1 as an RfC chronic.

Using the correct RfC (2,000 µg/m<sup>3</sup>) in Table 5-4 takes the HQ from 1.51 to 0.15. In the Table 5-4 HQ summation n-Nonane contributed 4.4% to the total.

- **Benzene**

In Table 4-1, the Benzene RfC<sub>acute</sub> (2.9E-2 mg/m<sup>3</sup>) is actually lower than the RfC<sub>chronic</sub> (3E-2 mg/m<sup>3</sup>). The same is observed for Toluene RfC<sub>acute</sub> (3.8 mg/m<sup>3</sup>) is lower than the RfC<sub>chronic</sub> (5 mg/m<sup>3</sup>). This conflicts with conventional toxicology thought. Is this correct? If so please explain. The BM-HHRA should understand the information it uses in the assessment.

- **Crotonaldehyde**

In Table 4-1 crotonaldehyde is identified as an EPA Weight of Evidence Group "C" compound. The Group C "possible human carcinogen" designation is based on a 1986 rodent (rat) water ingestion study. The USEPA notes:

- EPA's IRIS data indicates this the Group C designation is based on no human data and an increased incidence of hepatocellular carcinomas and hepatic neoplastic nodules (combined) in male F344 rats. EPA further states that this is the only animal carcinogenicity study of crotonaldehyde available; it is limited by the use of only one sex of one species. In addition, fewer tumors were observed in the high-dose group than in the low dose group (USEPA 2010).

<sup>6</sup> Generally a HQ marginally in excess of 1.0, and based on an animal study with an uncertainty factor of 300 would not be cause for alarm.

The text on Page 22 of 65 also contains information that conflicts with the discussion in the second paragraph in Section 3.5.3 beginning with “The EPC for ambient.....”. The third bullet indicates that the (EPCs) shown in Table 5-4 were obtained from data collected from the 2005 to 2007 odor measurement events. Please clarify how the acute intake data Table 5-4 was derived (sample number, location, date, indoor / outdoor, etc.).

## **W69** 4. Toxicity Information

The identification and selection of acute toxicity data in Table 5-4 (the RfC – acute) is erroneous, misleading and needs to be resolved, in some cases, as illustrated below:

- **Trimethylbenzenes**

The RfC – subchronic and acute concentrations used to compute HQ’s for 1,2,3, 1,2,4, and 1,3,5 trimethylbenzene are actually the same chronic RfC’s used in Table 5-3 to assess chronic risk. The BM-HHRA has mistakenly misused EPA’s toxicity information with the result being a serious misstatement of risks of the 1,2,3, 1,2,4, and 1,3,5 trimethylbenzene risks in the Acute Risk Characterization for Child Resident Living Adjacent to a Well Pad Scenario 7-Day Duration scenario.

Table 4-1 identifies toxicity constants for use in the risk assessment. For 1,2,4 trimethylbenzene a chronic RfC of  $7E-3 \text{ mg/m}^3$  ( $7 \text{ } \mu\text{g/m}^3$ ) is identified and referenced to EPA’s Provisional Peer Reviewed Toxicity Values (PPRTV) documents. Within the same PPRTV document (EPA 2007), EPA derives two sub-chronic RfCs:

- $0.07 \text{ mg/m}^3$  or  $70 \text{ } \mu\text{g/m}^3$  based on the potential for hematological effects, and
- $0.1 \text{ mg/m}^3$  or  $100 \text{ } \mu\text{g/m}^3$  based on the potential for pulmonary effects.

It is not clear why the authors would use the chronic RfC’s when sub-chronic RfC’s were presented in the same document. According to EPA RAGS Subpart F (2009) exposures with a duration lasting between 24 hours and 30 days should be treated as subchronic for the purposes of this document”. The Acute Intakes shown in Table 5-4 were computed via RAGS Subpart F.

Both of the PPRTV sub-chronic RfCs are appropriate for use in the risk assessment where the exposure scenario does not involve chronic exposure, specifically:

- In the 10 month portion of the Residents Living Adjacent to Well Pads scenario, and
- In the Child Resident Acute Exposure Scenario. While the sub-chronic RfCs are entirely appropriate for this 7 day scenario according to EPA RAGS Subpart F.

Importantly, use of either of the sub-chronic RfCs would make a significant difference in the computed HQ’s and their interpretation as illustrated in Table 3.

Further in Table 4-1, the authors cite an inhalation unit risk factor of  $5.4 \text{ E-4 } (\mu\text{g}/\text{m}^3)^{-1}$  referenced to the USEPA's 1997 HEAST Table. Review of the HEAST Table indicates only an oral unit risk factor of  $5.4\text{E-5 } (\mu\text{g}/\text{L})^{-1}$ . There is no inhalation unit factor cited.

It is unclear how the BM-HHRA got to the inhalation unit risk factor  $5.4 \text{ E-4 } (\mu\text{g}/\text{m}^3)^{-1}$  in Table 5-1. Moreover, in the uncertainty section (pp 46 of 65), the authors state that there is insufficient evidence that inhalation is a route of exposure that results in crotonaldehyde induces liver lesions or neoplasia.

The significance of this production is revealed in Table 5-1 where a crotonaldehyde inhalation cancer risk of  $4.5 \text{ E-5}$  is computed. This cancer risk ( $4.5 \text{ E-5}$ ), computed from a Group C designation "possible carcinogen" with no traceable path to inhalation toxicology, represent 63% of the overall risk of  $7.1 \text{ E-5}$  shown in Table 5-1. In essence, the cancer risk driver in Table 5-1 is wholly unsubstantiated and even refuted in the author's own uncertainty discussion. Similarly, in Table 5-3, the computed crotonaldehyde inhalation risk ( $4.51\text{E-5}$ ) represents 55% of the computed total risk of  $8.3\text{E-5}$ .

It is important that the BM-HHRA substantiate all information sources, critique them for applicability, and report to readers in cases such as crotonaldehyde – a risk driving constituent in two scenarios – when highly uncertain information is being used.

## 5. Risk Characterization and Uncertainty

### W70 5.1. Cancer Risk Estimation – Character and Uncertainty

A common theme observed in the BM-HHRA and a frequent criticism of the EPA RAGS risk assessment process is that when applied in its default mode (i.e., default assumptions) it produces very conservative results. The results are generally called "Deterministic Point Estimates" because the combination of single point estimates (e.g., exposure duration = 30 years) will determine the risk estimate. Deterministic point estimates are the simplest and easiest to perform risk assessment. All of the Garfield County risk assessments performed to date have been deterministic point estimates. They are best used for initial hazard screening for which the BM-HHRA is intended.

In order to investigate the extent of fixed uncertainty and the possibility of overestimation in the HHRA, an examination of the All Residents 30-year Chronic Exposure assessment was performed for benzene risk using techniques discussed in EPA's RAGS Volume III Part A, Process for Conducting Probabilistic Risk Assessment (PRA). The benzene examination can be used as a moniker of the uncertainty in other constituents in the BM-HHRA. This is because all of the calculated risk and HQ's use the same exposure equations and derive their toxicity information from the same sources.

A PRA, unlike a deterministic point estimate, uses distributions of values for exposure estimates (e.g., exposure duration = 1 to 70 years) to capture the distribution of information going into the exposure and risk assessment equations. The technique uses a method known as "monte carlo" simulation to capture and express the variability and uncertainty in the exposure and risk assessment factors.

The probabilistic approach captures variability's and uncertainties such as:

- Some people live in the same residence their entire lives; some do not. This was captured in the PRA by setting the exposure duration to a range from 1 to 70 years with an "expected duration of 8.5 years. According to EPA (2009), the median time for an individual to live in one location is 8 to 9 years.
- Some people stay at their residences all day; some do not. The PRA captured this by setting the exposure frequency to a range from 0 to 24 hours per day with an "expected frequency of 16 hours per day. This is based on professional judgment with the understanding that many people

work outside the home, attend school, and engage in numerous activities which take them outside the home or PUD.

Other exposure factor and benzene toxicity uncertainties and variability's captured by the probabilistic approach are shown in Figure C (see "Simulations Used").

Readers should note that the exposure factors used in the BM-HHRA (e.g., 30 years and 24 hours per day) are embedded within the distributions and therefore are included in the probabilistic risk assessment calculations. Their contributions in the 10,000 calculations (which are then statistically summarized), however, are weighted by their location in the distribution).

Figure C shows the results as well as the inputs of the probabilistic risk assessment for benzene. The key results are called out on Figure C and are shown in the table below.

**Table 4 Summary of Results All Residents 30 year Chronic Exposure Risk Assessment-Benzene**

Estimate of 30 year Benzene Risk	Probabilistic <sup>a</sup>	BM-HHRA Deterministic Point Estimate
Median	5E-8	5.4 E-6
Mean	1E-7	
95 <sup>th</sup> Percentile	4E-7	
Maximum	4E-6	
Range	1E – 10 to 4 E-6 (~ 40,000)	
<sup>a</sup> 10,000 simulations using @ Risk ver. 5.5.5 (Palisade 2009)		

As indicated, the probabilistic risk assessment generally gives much lower estimates of risk when compared to those developed by the HHRA deterministic point estimate. For example:

- The maximum probabilistic estimate is 4E-6 vs. the BM-HHRA's deterministic point estimate of 5.4E-6. Given the uncertainty in the risk assessment process, these are essentially the same.
- The median (50<sup>th</sup> percentile) probabilistic risk estimate is 5E-8 vs. the BM-HHRA's 5.4E-6. This could be thought of as the CTE or expected risk for any member of the population. This median is a factor of about 100 less than the BM-HHRA's deterministic point estimate (note the average benzene risk is about 50 times less than the BM HHRA estimate).
- The 95th percentile probabilistic estimate is 4E-7 vs. the BM-HHRA's 5.4E-6. This is a factor of about 14 difference. For reference, the EPA guidance on an RME exposure notes:

*The reasonable maximum exposure is defined here as the highest exposure that is reasonably expected to occur at a site. ... Estimates of the reasonable maximum exposure necessarily involve the use of professional judgment. ... The intent of the RME is to estimate a conservative exposure case (i.e., well above the average case) that is still within the range of possible exposures. This is generally regarded as "a combination of some lower values [50th percentile] and some upper values [90-95th percentile]."*

Additionally, while EPA's probabilistic guidance leaves selection of a "Percentile Estimate of Risk" for action up to the risk manager, the EPA document conveys the impression that this sentinel benchmark should be in the range of the 95<sup>th</sup> percentile. In this case, the 95<sup>th</sup> percentile benzene risk, 4E-7, is below the 1E-6 threshold.

As indicated on Figure C, the HHRA's 5.4E-6 deterministic point estimate is actually off the scale of all the estimates generated by the probabilistic approach.

This exercise is intended to illustrate the amount of conservatism and uncertainty that may be rooted in the BM- HHRA. The EPA's risk assessment process is a powerful tool generating risk screening

information. However, it is important to understand its limitations; especially with regard to uncertainty and conservatism. The BM-HHRA is archetypical of the EPA RAGS Deterministic Point Estimates process and the results, when compared to a probabilistic assessment are characteristic. This phenomena is often referred to as the “cascade of prudence” where by conservative assumption is cascaded atop conservative assumption often resulting in computed risks in the 99<sup>th</sup> percentile of the actual distribution of computed risks (Hamilton and Viscusi, 1999). There is extensive academic and practical literature on this topic (e.g., Paustenbach, et al., 1992, Cullen, 1994, and Hamilton and Viscusi, 1999).

On this basis, it is reasonable to presume that all of the risk estimates in Table 5-1 and probably those in 5-3 (Living Adjacent to a Well Pad – 30 year duration) contain the same level of uncertainty and conservatism.

**Figure C - Summary Probabilistic Risk Assessment for Benzene,  
Chronic Risk Characterization – 30 year Duration**

W71

## 5.2. Use of Constant Concentrations

Figures 2-1 and 2-2 show temporal trends for several constituents at the Bell-Melton monitoring station. The related text states that constituent concentrations are essentially stable. That may be true for the retrospective periods shown. However, this assertion is probably not correct looking forward. Recent Colorado Oil and Gas Commission (COGC) regulations coming on line in the near future will significantly reduce emission from oils and gas operations. Additionally, the impact of recent implementation of CDPHE and COGCC emission control requirements are not considered in the BM\_HHRA. Neither of these significant emission reduction regulatory programs is reflected in Figures 2-1 and 2-1. It is expected that measured Garfield County air quality parameters will decline in response to the reduction in emissions from implementation of these rules. In addition, Antero's has proposed best management practices for their development plan that go beyond existing air emission control regulations to further reduce potential emissions from their oil and gas production activities..

W72

## 5.3. COPCs without Toxicity Values.

The BM-HHRA cites the fact that many COPCs do not have toxicity reference values as a significant uncertainty and asserts that cancer and non cancer risks are likely to be understated. While it is true that toxicity information is not available for some constituents identified in the chemical analysis and the BH-HHRA may suffer from some lack of completeness, it is not true that the uncertainty associated with this lack of completeness has any bearing on the health status of Battlement Mesa residents currently or in the future. The assertion seems to imply that the inability to populate a spreadsheet with standard equations in some way influences the actual risk that Battlement Mesa residents.

All humans are surrounded by chemicals daily and we are constantly exposed to more chemicals than can be measured and reported. In considering the effect of a lack of completeness, several factors need to be kept in mind:

1. The recent work of Coons and Walker conducted in Garfield County found that incidence rates for all leukemia's in Garfield County were lower or the same (for women) than those in the comparison counties and the state during 2003 – 2005. More generally, they did not report a finding of health effects related to oils and gas operations in Garfield County.
2. The conservative risk screenings reported in Table 1 do not suggest anything contrary to the Coons and Walker work. As discussed in General Comment 1, the conservative theoretical risks calculated numerous times do not show a population based concern for increased absolute cancer rates. On a regulatory basis, individual risks have consistently been shown to be within EPA's acceptable ranges (even with the many layers of conservatism).

It is important to note than many entries shown on Table 4-2 as COPCs without toxicity values are light end alkane and alkenes, commonly encountered in the everyday environment with no structural or physical particularities to suggest that they would be toxic to human at the low doses associated with the measured concentrations. An example is propane identified on Table 4-2 because it was measured but there was no EPA RSL for screening. Propane has an occupational health threshold limit value (ACGIH 2010) of 1,000 parts per million (ppm) which converts to 1,670 mg/m<sup>3</sup>. This value can be roughly converted to 24 hour 7 day per week "RSL\*" by dividing it by 420<sup>7</sup> which gives a 4 mg/m<sup>3</sup> "range" screening value. The maximum propane concentration reported in Table 2-8 is 0.32 mg/m<sup>3</sup>, the average is 0.06 mg/m<sup>3</sup>. On this basis, propane, the common constituent in bottled fuels would screen out.

<sup>7</sup> 420 is a rule of thumb conversion from an 8 hour occupational setting threshold limit value to a full time exposure sentinel value by the following:  $1,670 \text{ mg/m}^3 / (24/8 * 7/5 * 100 = 420) = 4 \text{ mg/m}^3$ . Where 24/8 converts from a work day to a full day, 7/5 converts from a work week to a full week, and 100 is a safety factor to adjust for the healthy worker effect and individual sensitivity that might occur in the general population).

The purpose of this exercise is not to show that additional risk assessment screening techniques are available, but rather to demonstrate that just because the rote risk assessment technique cannot handle all chemicals; all chemicals that the process cannot handle are not present at hazardous concentrations.

#### **W73** 5.4. Overall Uncertainty

The overall tenor of the BM-HHRA uncertainty assessment is unnecessarily pessimistic, mainly because the absence of toxicity information called for in the RAGS process not does allow for completeness. It has been demonstrated that conservatisms in the assessment for information was available are large (a factor of 100 for benzene). While completeness is at issue, the principal constituent for which quality toxicity information is available, benzene, is thoroughly addressed. This dramatically diminished the uncertainty's stemming from incomplete characterization or toxicity information.