Departmental Responses to Comments Received from the Marcellus Shale Advisory Commission Members on Maryland's Draft Risk Assessment

Table of Contents

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Comments from Commissioner Bristow

Dear MDE Staff,

Thank you for this opportunity to respond to the October 2014 DRAFT "Assessment of risks from unconventional gas well development in the Marcellus shale of western Maryland." I had planned a much more detailed response, having read and made notes on the entire document. However, given the change in events with the recent election, most of my comments will be broader and of a more general nature. Should you wish to communicate with me about my more detailed analysis, please do not hesitate to contact me.

Sincerely, Ann Bristow

Failure to consider GHG Emissions in the risk assessment:

This is the overarching issue. If it were addressed, then none of the following would be under consideration. That the EPA fails to recognize fugitive methane emissions in their analyses, does not mean the state of MD should follow suit. This research area is not controversial within the scientific community; only in the political community. If MDE and DNR do not use science to base decisions, they should state what bases they do use for their decisions. Unsupported industry practices?

Response: The air emissions risk assessment (Appendix B) did consider fugitive methane release during both the hydraulic fracturing and production/processing phases of UGWD. In both cases, these emissions were considered a moderate risk (high probability and low consequence). Appendix B also explained, as follows, why climate change impacts of UGWD were not included in the above assessment: "According to EPA, methane has 21 times more global warming potential than carbon dioxide over a 100-year timeframe and studies (Alvarez & Paranhos, 2012) have found oil and gas development activities to be the largest U.S. source of methane emissions. Howarth (2012) suggests that when methane contributions from UGWD are considered over a shorter timeframe (20 years), they may be responsible for almost half of the warming impact from current emissions. A recent study by Brandt et al. 2014 reviewed technical literature from the last 20 years on natural gas emissions in the U.S and Canada and concluded: (1) EPA estimates consistently underestimate methane emissions with the oil and gas industry as consistent

contributors; (2) a small number of "super emitters" may be responsible large emissions; (3) recent atmospheric studies showing large methane emissions are likely not representative of the oil and gas industry as a whole; and, (4) 100-year impacts from leakage is likely not large enough to outweigh natural gas benefits over coal.

In short, the scientific community is still divided on whether GHGs emitted during the production and transmission of natural gas outweigh the lower GHG emissions of natural gas when it is burned and over what timeframe. EPA's current emissions estimates were developed in the early 1990s and did not consider current extraction levels or UGWD techniques. Maryland's proposal to require rigorous leak detection systems and methane offset BMPs will help reduce overall emissions. However, to accurately assess whether UGWD creates an overall unacceptable risk to global warming, it will be necessary to empirically measure the life-cycle greenhouse gas emissions from other fuel sources, such as coal and petroleum, for relative comparison. This type of analysis would include analyzing different energy sectors across the country and recalculating life-cycle energy emissions inventories. Since this level of effort is outside the scope of this risk assessment, increased risks to global warming from shale gas extraction in Maryland has not been considered in this analysis.

Use of the Precautionary Principle:

In Appendix E, pg. 5, the precautionary principle is invoked:
"Lacking information regarding the specific fracturing fluid additives that will be used in Maryland, for purposes of this risk assessment, we will utilize the precautionary principle. For the purposes of this risk assessment, it will be assumed that fracturing fluid additives are harmful to people and environmental receptors."

Recommendation:
The Departments' RA should use the precautionary principle whenever a knowledge gap prevents you from assessing risk. In risk analysis, this is the standard. If the risk is unknown (often, in this draft, due to lack of research), the Departments should assume that the probability of a serious consequence is high (rather than NOT assigning a ranking due to "insufficient data to determine").

Response: The departments do not agree that wherever there is insufficient information to determine a consequence that it should, by default, be rated as having serious consequences. However, the Departments do agree that wherever there are insufficient data to rank risk that this identifies a critical data gap that needs to be addressed through appropriate additional monitoring and/or modeling efforts.

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Definition of Risk Factors (Executive Summary, pg. 5-6):

As will be noted in the minutes of the 11/5/14 MSAC meeting, I take issue with the definition of a MODERATE consequence:

"Considerable adverse impact on people or the environment; could affect the health of persons in the immediate vicinity; localized or temporary environmental damage."

The result of application of this definition is illogical with respect to the rural nature of the very area for which this risk assessment was performed. Though you have determined that considerable adverse impact has a high or medium probability of occurring, the ranking of severity is reduced due to "immediate vicinity" or "localized" damage.

The net effect of such a definition is that because Garrett County is sparsely populated, risks have been downgraded. This is an inappropriate, if not an unethical (from a research perspective) use of the risk ranking methodology. This also has significant social justice implications. It suggests that rural areas are dispensable or disposable and of little import when compared to more populated or urban areas. Inherently, this process places lesser value on human life in remotely populated areas.

On another note, this definition fails to embrace the connection between western MD and non-regional effects; for example, (1) headwaters of streams that could receive contaminate downstream water supplies, including those in urban areas; (2) food supply/agriculture. (What % of agricultural "products" are exported from county?)

Unfortunately, this risk assessment failed to address the food chain, animal health and the effects on farm-based income for the county.

Recommendation:
Change the definition to remedy the illogical approach. Additionally, your definition is not sensitive to severity to receptors; just how many receptors are affected.

Response: The risk assessments did not factor population density into their risk rankings. Rather, localized was used in the context of spatial extent. So, the difference between a moderate and serious consequence had to do with whether risks were likely limited to human/ecological receptors in relatively close proximity to the well pads or broadly impacted receptors over a wide geographic area.

Furthermore, much of the consideration regarding contamination of waterways was related to site-specific, localized impacts. The assumption was based on the understanding that BMPs would minimize risk and when adverse impacts did occur, they would be localized and promptly contained. The downstream water

supply impacts of water appropriation necessary for HVHF were identified and addressed in Appendix G.

Using the definitions in this report*, the following may represent errors in assignment of risk.

***LOW probability + SERIOUS consequence = MODERATE risk**
(Table 3: Risk Ranking Methodology (p. 7 of 1st section: "Risk Assessments")

1. Appendix E (Transportation of frack fluids):

   Frack fluids assumed to be harmful (SERIOUS) to human & environmental receptors (pg. 5) + incidence of release LOW = LOW risk

   This should be MODERATE risk.

Response: Good catch and this has been changed in the risk assessment document.

2. Blowout (explosion/fire/contamination), applicable to three phases:

   explosion/fire/contamination (SERIOUS) to human receptors + LOW probability of occurrence = LOW risk

   These should be MODERATE risk.

Response: Not sure what appendix you are referring to, but assuming it is Appendix B (air emissions). The consequence for blowouts in the air emissions risk assessment is rated as minor because no literature was found indicating injuries or fatalities to people off site. Workers on site are outside the scope of this risk assessment.

Assessment of Cumulative Risk:

You have NOT attempted a traditional (for the field of risk analysis) assessment of cumulative risk. Without this, you have a matrix of 67 "aspects" by 5 different "phases" of unconventional gas development and production that results in an unwieldy 335 different rankings (Appendix A, "Risk Ranking Summary Chart," many of which are NA), that does not at all communicate how risks may be additive or synergistic with one another. Even a simple, additive model is not attempted.

Recommendation:

Since there is likely insufficient time and resources to develop a cumulative risk ranking before the final report, AND many of the research findings covered in MIAEH's health study are not included in the Departments' risk assessment, at a minimum MDE should adopt the health-based MODERATELY HIGH hazard evaluation for cumulative exposures/risks. Though I also think that the MIAEH cumulative exposures/risk rating is flawed and underestimates cumulative exposure, it is a more accurate statement for citizens to digest than attempts to understand what cumulative risk can be deduced from this risk assessment.

Response: The Departments considered cumulative and/or synergistic effects in a couple of ways. First, two scenarios, the 150 and 450-well development levels were considered in each teams' assessment. Where there was sufficient information to rank risks differently between these two scenarios, the Departments did so.

Secondly, the air emissions and traffic risk assessments (Appendices B and C) specifically considered cumulative impacts because air emissions and truck traffic will occur during all UGWD phases, regardless of best practices. This is unique from the other risk assessments where human or ecological receptors will only be impacted if there is an accident, spill, or BMP failure.

Thirdly, in the air risk assessment there is some discussion of synergistic impacts which states: "Air pollution emissions during UGWD are unique compared to other potentially affected environmental media because these emissions occur during every phase of the UGWD process whereas water or land impacts will typically only occur if there is an accident, spill, BMP failure, or illegal disposal of drilling waste. Every single phase of UGWD relies upon internal combustion engines to either power equipment or deliver it to the site and once drilling begins methane itself may be emitted. Some emissions (compressors, productions leaks, condensate tank emissions, vehicles) will occur year-round, while other emission sources (noncombustion emissions during drilling, venting and flowback) are of shorter duration. Nearly all sources emit pollutants known to have human health risks (e.g., benzene) while emissions less problematic from a human health standpoint (e.g., methane) have climate change implications. In addition, certain pollution emissions (nitrogen oxides and VOCs) are already known to combine into constituents (ozone) with harmful health effects. Recent health risk assessments (McKenzie et al., 2012) have identified uncertainty regarding the public health impact of this complex chemical mixture. As a result, there is a high probability of emissions that overlap spatially as well as temporally and which singly, or in combination with other pollutants, have the potential to impact human health. Maryland's proposed BMPs and setbacks will minimize health and environmental effects, but by how much,

under which scenarios and whether residual risks are ultimately acceptable cannot be determined without more rigorous, location-specific monitoring and modeling."

NORM and TENORM:

Radionuclides should be separately addressed. Some discussion occurs in some appendices, and the summary appendix (A) has brine and produced water documented, however, the novice reader of this risk ranking summary chart will not realize that NORM and TENORM may characterize these contaminants. Inclusion of Radon and Radon's daughters should also be addressed with methane and other gas migration.

Response: NORM and TENORM are not specifically itemized in Appendix A because they were not identified in the risks the Advisory Commission tasked the Departments to assess, nor did they result in significant risks that would drive an overall risk ranking. Appendix I on waste disposal specifically evaluated radioactivity associated with drill cuttings, muds, sludges and brines, but current regulations require proper testing and handling of potentially radioactive materials resulting in a low overall risk assessment. As to radon, this also was not a key risk that surfaced during literature review of air impacts. However, since radioactivity is something that came up in Advisory Commission discussions, the Department of the Environment is working with a graduate student to further explore risks and report on findings. This work is expected to be complete by Spring 2015.

Risk Analysis of Regulations and Enforcement:

As I stated at the 11/5/14 MSAC meeting, because enforcement plays such a significant role in the BMPs, a separate risk analysis of the effectiveness of enforcement of BMPs would significantly contribute to this report.

According to your criteria, (pg. 5 of the Executive Summary), there is limited effectiveness of BMPs that "are not prescriptive and can be difficult to verify or enforce." Other BMPs "may allow exceptions and require Departmental resources." Both of these caveats indicate the susceptibility of the BMPs/regulations that should be scaled as a risk.

Additional factors suggesting risk:

- MDE has reported that they only have one person on staff with experience with the gas industry to write the regulations
- Industry technology outpaces development of regulations

Response: You are correct that enforcement will be critical to ensuring any UGWD activities do not pose unacceptable risks to human or ecological receptors and that

current staffing levels are inadequate. If UGWD does occur in Maryland, the Department has the necessary authority to implement permit fees sufficient for effective regulatory oversight. These fees will be used to fund the Department's enforcement program.

<u>High Risks from Air Contamination, Traffic and Traffic-Related Incidents</u>:

(from Appendix B: Air Emissions:)

Failure to Consider Health Data and Measurement Issues:

While the RA recognized "a high probability of air pollution emissions during all UGWD phases even with BMPs in place, they were unable to "reasonably determine consequences" because of insufficient data, especially for the multiple and interacting pollution vectors (p. 43).

There is a notable deficiency in a particular area of human health effects literature reviewed in this report (Brown, 2014; Hill, 2013; NIEHS, 2014 and 2014 NRDC symposium).

These reports indicate that traditional air pollution assessments are inadequate to assess human health impacts of UNGDP for the following reasons:

- Failure to measure episodic spikes in air pollution
- Failure to take meteorologic and topographic factors into consideration which render setbacks of little value
- Because of these two reasons, drill pad and drill perimeter assessments are inadequate to detect air pollution events for nearby residents

While this literature has been omitted, it does not change the conclusion of Appendix B: air pollution is highly probable and will not be mitigated by BMPs in place. Employing the precautionary principle, which would yield an unacceptably high rating of air pollution risk.

Response: The Departments' agree that this information does not change the conclusions in the air risks assessment. Also, see response above under the section on "Use of the precautionary Principle".

Accidents and spills are assigned a low probability of occurrence and evaluated to be of minor consequence, primarily due to putative protection from setbacks. The setbacks in the BMPs were based on water contamination, not air. They are inappropriate to evaluate air pollution risk due to the same issues raised above (they will, by nature, be episodic and are also influenced by weather and terrain). Rather than the LOW risk assessment

rendered, the assessment should either be MODERATE or undetermined due to insufficient data and evaluated as a SERIOUS risk.

Response: The accidents/spills portion of the air risk assessment was specifically looking at risks to offsite receptors from well explosions. In assessing these risks, well blowout data presented in Table 14 was used to determine probability and injury/fatality information from the literature was used to assign a consequence. No literature could be found on non-worker injury or fatality from a well blowout and worker impacts are not part of the scope of this risk assessment. This fact coupled with the low rate of well blowouts resulted in overall low risk.

The MIAEH assessment of air pollution, which did consider the reports on episodic spikes and meteorlogic and topographic factors, indicated a high hazard rating for negative human health impacts. Furthermore, based on traffic predictions alone, they indicated that proposed BMPs would not mitigate these negative health impacts.

Response: The Public Health assessment's high hazard rating for air pollution impacts did not specifically evaluate the effectiveness of Maryland's proposed BMPs in mitigating risks. The study did, however, recommend 2,000-foot setbacks from well pads and compressor stations as adequate to address, which is greater than the current proposed 1,000-foot setback from occupied dwellings.

TRUCK TRAFFIC and Air Emissions:

For selected phase analyses of "Estimated Number of Emissions Sources/Loads," when the sources/loads are truck trips per year, "insufficient data" are given as the reason why a consequence rating is not attempted (Phase 2, Drilling: Phase 3; Phase 4, Hydraulic Fracturing; see table below).

Impact on Human (Inhalation)

Phase/ Scenario	# Trucks (type)	Emissions Type	Probability	Consequence	Risk
Site Assessment1 & 2	1 + ?	Combustion (NOx, PM)	low	minor	low
Site Preparation1	225-360 (heavy + light)	Combustion & dust (NOx, benzene, PM)	high	minor	moderate
Site Preparation 2/2	675-1080 (heavy + light)	Combustion & dust (NOx, benzene, PM)	high	minor	moderate
Drilling 1 & 2	25,000-76,000 (most heavy)	Combustion (NOx, benzene, PM)	high	Insuff data	Insuff data

Drilling 1 & 2	25,000-76,000 (most heavy)	Non-Combustion (Dust/PM)	high	Insuff data	Insuff data
HF/Compl. 1	6,613 (most heavy)	Combustion (NOx, PM, benzene)	Moderate	Insuff data	Insuff data
HF/Compl. 1	6,613 (most heavy)	Non-Combustion (Dust/PM)	Moderate	minor	low
HF/Compl. 2	9,825 (most heavy)	Combustion (NOx, PM, benzene)	Moderate	Insuff data	Insuff data
HF/Compl. 2	9,825 (most heavy)	Non-Combustion (Dust/PM)	Moderate	Insuff data	Insuff data
Prod/Proc 1 & 2	825-2,475 (most light?)*	Combustion (NOx, PM, benzene)	High	Minor	moderate
Prod/Proc 1 & 2	825-2,475 (most light?)*	Non-Combustion (Dust/PM)	High	Minor	Moderate

* installing pipeline in production phase would use heavy (diesel) trucks; RA only mentions light trucks in this phase

Insufficient data is invoked in the two phases (drilling and hydraulic fracturing/completion) where truck traffic is heaviest. The following reason is given:

"However, because no existing fleet inventory is available to quantify emissions associated with mobile sources and no modeling has been completed for Maryland's scenarios, there is currently insufficient information (i.e., fleet composition and associated emissions controls) regarding combustion emissions from truck traffic to assess consequences" (p. 22).

The unavailability of these same data did not stop the team from assigning minor consequence ratings in three other phases.

Throughout most sections of the RA, data from other states and Canada are used to assess risk. Furthermore, as *the MIAEH report documents, more is known about emissions from traffic than any other source of air emissions*. And, according to MIAEH, the human health risk from truck emissions is VERY HIGH. Accordingly, this aspect of Appendix C must be modified.

Furthermore, the moderate probability ratings given during the hydraulic fracturing/completion phase should be changed to HIGH. The moderate rating is based on:

"Due to the lower number of trucks used in this phase, the probability of emissions are considered moderate" (p. 30). Site preparation carries a high probability with

considerably fewer trucks (225-1,080 trucks) than used during hydraulic fracturing/completion (6,613-9,825 trucks).

Response: The original thinking for the site preparation phase of the air emissions risk assessment is that site preparation equipment needs to be on site during the entirety of that phase, whereas truck traffic during the hydraulic fracturing/completion phase are in transit to and from the site and not continually emitting on site. So, on this basis the site preparation emissions were considered a higher probability on site than during hydraulic fracturing/completion.

However, this is a valid comment and the Departments understand that this approach may be viewed as inconsistent with how traffic emissions were assessed in other phases. As a result, the probability of emissions has been changed to high for the hydraulic fracturing/completion phase and the minor consequence for noncombustion (dust/PM) has been changed to insufficient data. A minor consequence has been retained for the seismic assessment, site preparation, and production/processing phases due to the relatively small volume of vehicle traffic. See comments in the above table for additional details.

Other Appendix B comments:

Finally, Appendix B fails to attempt a cumulative impacts or synergistic effects assessment due a lack of research.

Response: See response to "Assessment of Cumulative Impacts" section above.

NORM and TENORM not included.

Response: See response to "NORM and TENORM" section above.

<u>Traffic and traffic incidents:</u>

My analysis of this and the air emissions sections were the most detailed, because health research is most abundant in these areas.

Superficially, my concerns are:

1. Reliance on NY State DOT findings, which are based on one data set, provided by industry. At least, this should be acknowledged in the report.

Response: The source is cited, described in the first sentence of Appendix C's "Number of truck trips" section as "prepared for the Independent Oil and Gas Association of New York," and the document is publicly available. No other source approached this level of detail for truck traffic scaling. The Departments used this

as a base, then made modifications to water hauling values based on additional information, as described in Appendix C's "Number of Truck Trips" section.

2. Truck trips data are internally inconsistent and missing (e.g., drilling fluids and drilling muds truck trips, # silica/proppant truck trips, #cement truck trips.

Response: The primary source for the table of truck trips, from a consultant to the industry, did not provide any further details to explain or break down truck contents within each provided category. The Departments made some effort to hypothesize details, but ultimately did not have enough information to determine whether the counts omitted or included certain hauls beyond those described for water hauling. Among those listed in this comment, "Drilling fluid" in the table describes drilling fluids and muds; "Hydraulic fracturing sand" describes silica/proppant trips; and "Drill pad construction" and "Non-rig drilling equipment" may include cement trips. Truck trip counts will vary for many reasons, as listed in the primary source; the numbers in the risk assessment are used to provide large-scale perspective on the scale of operations.

3. The approach taken to estimate number of truck crashes which would result in uncontained spills is skewed. MDE chose the most conservative probability estimate in the extant literature, 0.005%, which at the height of UNGDP in Garrett County would result in 1.2 such incidents over 10 years. Since MDE cannot make an evidence-based estimation (with research-based consensus), they should indicate insufficient data and use the precautionary principle.

Response: The Departments used all data available in the scientific literature and will consider any other literature estimates commenters provide.

Finally, as discussed at the 11/5/14 MSAC meeting, Eric Robison and I spent approximately 20 hours attempting to reconcile the truck traffic data and search errors of omission. We would be happy to share details of this research at your convenience. We could do this by conference call, as offered to Matt Rowe at the commission meeting.

Response: The Departments are always available to further discuss and thank you for the thoughtful comments provided herein.

Sincerely yours,
Ann Bristow, Ph.D., Emeritus Professor of Psychology
Frostburg State University;
Member, Marcellus Shale Advisory Commission

November 16, 2014

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Comments from Commissioner Vanko

Comments on the Risk Assessment
David Vanko

Executive summary, page 1:
Appendix H: Wells and Formations – change to "Well Construction"

p. 4- change "Wells and formations" to "Well Construction"

Response: The Departments appreciate your comment. The appendix evaluates risks other than from well construction and the title has been changed to reflect both more clearly.

p. 5 – "Error- Reference source not found" – fix.

Response: Noted and fixed.

p. 8- "Within MD, the Marcellus is between 5,000 and 9,000 feet below the surface." This is incorrect. The Marcellus crops out in Allegany County, meaning that its depth varies from about 9,000 feet to ZERO. Perhaps the statement is more or less correct for the Marcellus in Garrett County, although I am not sure. This is important, because we do not want fracking to take place where the Marcellus is less than about 2,000 or 2,500 deep.

Response: Corrected.

p. 8- "drilling horizontally through the shale for distances that can extend for miles." No, this is extreme. A typical horizontal runs for 3,000 to 8,000 feet – this is not "miles."

Response: Corrected.

Appendix B: Air emissions
p. 8- "Data from Maryland (Fig. 1) indicate that RO% values are >2." Not really – there are probably no data from Maryland. It's more precise to say "Indications are that RO% values in Maryland are probably greater than 2 (Figure 1), indicative of dry gas."

Response: Noted and clarification in text.

p. 23- blowout prevention – is 1.2 times the max expected well pressure sufficient? Where does this 20% safety margin come from? Is it industry standard?

Response: For the reconditioned casing, meeting the API standard seemed appropriate, and requiring testing at 1.2 times the expected pressure seemed like a reasonable margin of safety. For blowout protection, the Departments also chose 1.2 as a reasonable margin using best professional judgment.

p. 27- a typical flowback tank holds 21,000 gallons. But there are much larger, glass-lined tanks being used on some frac pads. Should MD adopt the practice of requiring 1 million gallon tanks?

Response: Restrictions on tank size are not currently under consideration as a BMP.

p. 38- Here and elsewhere, the RA seems to be relying quite a lot on MD having just dry gas (thus, e.g., benzene will be limited). Probably OK, but own up to the assumption and be prepared if it turns out to be unfounded.

Response: The fact that Maryland having dry gas is an assumption is brought into the risk assessment discussions (see "Risks from Noncombustion Sources" section for the hydraulic fracturing phase) and overall evaluation of risk.

p. 41- last paragraph – UQWD should be UGWD; and Garret should be Garrett

Response: Corrected.

Appendix C: Roads and traffic
p. 8- the cost per lane-mile damaged for each well is 100 (not 10) times higher ($331 vs. $3).

Response: Corrected.

p. 12- Table 7. "North Dakota" should be one cell lower in the table.

Response: The reasoning behind this edit is unclear; the table contents were double-checked to the original source and confirmed to be accurate.

p. 15- Sound waves directed downward can help characterize geological ~~layers and seismic conditions~~ structures such as faults.

Response: Corrected.

p. 17- (Figure 3Figure 3)

Response: Corrected.

p. 23- despite ~~that~~ the fact

Response: Corrected.

p. 25- the expected federal rate is 24 to 30%???? That's outrageous. And in the next paragraph, the death rate for O&G workers is 7 times the rate for that of all US workers. Wow!

Response: Though the source lists 24-30%, the author cited the Federal Motor Carrier Safety Administration (FMCSA) as the primary source. In response to this comment, an FMCSA document was found that listed counts of Level I inspections and out-of-service violations from 2009 to 2013 (new citation, FMCSA 2014). An out-of-service violation indicates that at least one violation was found, and a Level I inspection is "Full," the most stringent. Those percentages ranged from 25% to 27%, so in deference to the primary source, this range replaced the 24-30% in Appendix C. Also yes, the death rate for O&G workers vs. all US workers was double-checked and confirmed to be 7 times higher.

p. 28- second to last paragraph: Table 9, not Table 8

Response: Corrected.

p. 29, Table 9 – Proposed BMPs should refer to <u>enforcement</u> as a BMP?

Response: Enforcement is part of the existing permitting process and a fee structure will be proposed in regulation to support implementation.

Appendix D: Drill fluid and cuttings

p. 2- perhaps need to explain what a choke manifold and an accumulator are. I do not know. I doubt if many others do.

Response: Edits have been made to the document to address this comment.

p. 7- fifth bullet: 10^{-7}, not 10-7

Response: Edits have been made throughout the entire document to address this comment.

p. 8- delete "transporting:" spill of drilling fluid additives ~~transporting~~ directly into a stream

Response: Edits have been made to the document to address this comment.

p. 10- line 9- These release<u>s</u>

Response: Edits have been made to the document to address this comment.

p. 10- after Risk Mitigation: There should not be a bullet before "Maryland proposes."

Response: Edits have been made to the document to address this comment.

p. 13- add "No" to the pathway at 6 o'clock from the upper left box.

Response: Edits have been made to the document to address this comment.

p. 21- Does this really mean a four inch berm, or a berm that is capable of enclosing the water from a four inch rainfall event?

Response: The height of the berm would be four inches which would contain the total volume of water from a four inch rain event over 24 hour period.

p. 27- onsite disposal of cuttings will be prohibited – good!

p. 27- paragraph two- if dump trucks transport drill cuttings, is there a rule about fluids dripping from the cuttings? Is it assumed they are completely dry?

Response: On site disposal of cuttings is not prohibited but determined on a case-by-case basis. No rule has been established regarding fluid dripping from cuttings. The cuttings are dewatered as a part of the separation process though this may not result in the cuttings being completely dry. Any residual moisture in the cuttings would be trapped within the particulate structure of the material therefore it is unlikely that fluid would drip from the cuttings.

p. 32- increased berm from 4 to 5 inches. Again, is this the berm height or the rainfall amount (in inches per 24 hours) that needs to be planned for?

Response: Please refer back to the response to Comment #24. A five inch berm will contain the total volume of water from a five inch rainfall event over a 24 hour period.

Appendix E: Additives and fluids

p. 2- Dry additives such as proppants are transported on flat-beds in bags or plastic buckets – this is not what we saw in West Virginia. We saw sand transport trucks.

Response: sand transport trucks added to sentence

p. 3- if we assume … 50 miles per hour. Bad assumption. I would estimate 4-5 hours, not 2 hours.

Response: Not sure of the basis of this comment. No reason is given.

p. 12- third paragraph – flowback and production water are confused here, in that water returned during the remainder of the production life of the well is here termed "flowback." This is not standard usage. Flowback is the water returned immediately after HF stimulation, and this takes place for up to a couple of days. After the well is producing at a steady pressure, water that comes up with the gas is "produced water."

Response: Modified paragraph

p. 12- 5th paragraph- perhaps add that, now, about 88% of frac water in PA is being recycled.

Response: Statement added, not sure how I should cite source.

p. 13- "Produced water from the MS is characterized by high salinity and total dissolved solids and may contain a variety of elements such as potassium, calcium, silicon, sodium, magnesium… …arsenic, chromium, and several "naturally occurring radioactive materials – NORMs" such as radium." Delete the phrase, "some of which exhibit radioactivity." It's awkward.

Response: Done

p. 14- define TSS as total suspended solids(?).

Response: Done

p. 19- Summary Assessment of Impacts from Fracturing Additives and ???

Response: deleted "and"

p. 20- again, from 4" to 5"?

Response: Please refer back to the response to Comment #24. A five inch berm will contain the total volume of water from a five inch rainfall event over a 24 hour period.

Appendix F: Noise and visual impacts
p. 2- Table 1- It's not clear where this table is coming from. What's the meaning of 25 mph and 50 mph. Does this refer to a truck going these speeds? The 6 dBA drop per doubling of distance is apparent.

Response: Clarification has been provided in the text.

p. 5- Table 6.59???

Response: Corrections made in the text.

p. 12- Figure ___ - there's no figure.

Response: Corrections made in the text.

Appendix G: Water withdrawal
p. 1- If water usage is 3-7 M gal per well, then why not base our calculations on 7 M gal rather than 5 M gal? Would this make a difference?

Response: 7-million gallons was definitely on the higher end of the quantities estimated, so the Departments believed it more accurate to use a middle value. Even assuming 7-million gallons the Departments do not anticipate a change in risk given proposed best practices and existing permitting authority.

p. 6- If scenario 1 is 15 wells/yr with a range of 6-29, and scenario 2 is 45 wells/yr, why isn't the range for scenario 2 = 18-87 new wells per year? (instead of 12-72). 3*6=18. 3*29=87

Response: The ranges are based on Figures 12 & 13 on p. 31 of the RESI report. A reference to the RESI source has been added in Appendix G.

Appendix H: WILL ADD LATER

Appendix I: Waste disposal
General comment – insufficient attention to NORM and TE-NORM???

Response: Agreed and deleted.

p. 3- paragraph 3- this (spray on land) is a very bad idea.

Response: The Departments also share concern with this approach and would approve, if at all, on a case-by-case basis.

p. 3- last paragraph- "some of which exhibit radioactivity" is awkward. See comment for Appendix E, p. 13, above.

Response: Changed to "naturally occurring radioactive materials".

Departmental Responses to Comments Received from the Marcellus Shale Advisory Commission Members on Maryland's Draft Risk Assessment

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Comments from Commissioner Weber

Comments on Departments Risk Assessment Document dated October 2014
By Nicholas E Weber, member of the Marcellus Shale Safe Drilling Initiative Advisory Commission
November 17, 2014

The Departments are to be commended for their effort to provide a Risk Analysis for Unconventional Gas Development in Western Maryland (UGDW). This attempt to accomplish what no other State has attempted is extraordinary. It is an attempt to address the statement in the Governor's June 6, 2011 Executive Order whose purpose is "The Marcellus Shale Safe Drilling Initiative will assist State policymakers and regulators in determining whether and how gas production from the Marcellus shale in Maryland can be accomplished without unacceptable risks of adverse impacts to public health, safety, the environment and natural resources."

As discussed below there are instances within the document as noted below and by others that warrant comment.

General Comments
The document in my risk vocabulary actually attempts to go past risk assessment which embodies hazards, how bad are they, and the likelihood or probability they will occur. The document attempts to address mitigations via application of the Best Management Practices (BMPs) which would be ordinarily addressed in an analysis of risk. Perhaps a central critique of the process developed by this risk assessment is that it does not begin with an actual assessment of risks that public health, safety, the environment and natural resources will be exposed to without any additional regulations, statutes or policies from where the State currently stands. This is what the State and its citizens would be exposed to if UGDW were to go forward with current regulatory conditions. An assessment of the current risks, a situation that we may be exposed to if UGDW were to proceed without significant BMPs and regulation, would show that citizens and the environment would be subjected to significant risk of harm. This undoubtedly is one of the major reasons why the Governor promulgated his Executive Order and that impending risks would be addressed. At the same time, it is clear that without significant development and application of BMPs and encompassing regulations, catastrophic problems would almost certainly arise with UGDW. A shortcoming of the document is the lack in many cases for rendering reasons for specific judgments by not using a clear because statement backed up by data or something else that can be pointed to. In addition, many risk rankings are not addressed (NA) or identified with insufficient data. These situations are a serious concern throughout the document and point out that research or data are needed in many situations. This should signal that those risks cannot be adequately characterized in many cases. As such, they should be given an increased rating due to the lack of information.

Such an approach is embodied in the use of the Precautionary Principal which is mentioned in the document on page 5 of Appendix E. Perhaps the Risk Ranking Table 3 in the Introduction should have an additional column under Probability for Insufficient Data whose outcomes of Moderate, High, and High would correspond to consequence considerations of Minor, Moderate and Serious. Insufficient data is also used in the consequence discussion again without being captured in the Risk Ranking Methodology. The bottom line - leaving insufficient data out of final recommendations without comments on potential outcomes is a serious shortcoming that policy makers should be made aware of.

Response: An important purpose of the risk assessment is to apply the current BMPs and existing regulations to determine where risks still remained and, if so, highlight areas where additional BMPs or regulations will be necessary to mitigate risks. Other studies under the Executive Order (i.e., the Public Health Study) looked at risks independent of Maryland proposed BMPs. The Departments are confident this combination of approaches provides complete and independent analyses of risks that best protect public health and the environment, as well as provides decision makers with the best available information. Having said this, the Departments' also acknowledge that there is uncertainty in the risk assessment findings (additional language has been added in the summary document to indicate this) and that best professional judgment is used in risk conclusions. Further, a robust and compliance and enforcement program will also be required to ensure proposed practices are followed.

As far as risks not assessed, they were not assessed either because they did not apply to that phase of operations or because risks were deemed too insignificant during that phase to assess. So the risk assessment focused on the UGWD phases most likely to result in human or ecological exposures. In other words, risks not assessed did not rise to a level of concern that merited risk ranking.

As to concerns about insufficient data and that those findings should be better highlighted in the report, the Departments concur and have done so in a revised Appendix A.

An examination the Risk Ranking Summary Chart indicates an increased risk was considered only four times out of 335 when Scenario 2 (that employs an increased number of wells) was invoked. It is unclear whether separate cumulative risks are being imposed with drilling and completing the six or more wells on a single pad over a period of many months which by many is considered to be normal. Even with that consideration, the risks to the public and the environment will undoubtedly will be significantly increased under Scenario 2 where the number of wells is tripled.

Response: There are two reasons the risk assessment generally didn't identify a difference in risk between the two scenarios. The first reason is that for many risks (e.g., spills, well failures, noise, water withdrawals, etc.), increases in the number of wells drilled either did not change either the probability or consequence enough to change the overall risk ranking. For example, a low probability and a minor consequence has the same overall risk ranking (i.e., low) as a medium probability and a minor consequence or a low probability and moderate consequence. The second reason is that in some cases where a numeric value was provided (e.g., the rate of accidents associated with increases in well drilling) it was a flat rate and independent of the number of wells drilled.

Furthermore, and in specific instances like truck traffic, the differences between scenarios were much smaller than the differences between UGWD phases. For example, moving from the Site Identification to the Drilling phase, the increase in truck trips is 15x, about one magnitude, as well as a shorter time frame in which to complete those trips. Between Drilling and Hydraulic Fracturing & Well Completion, there is another 5x increase in trips, about another magnitude, again to be completed within a short time frame. Finally, moving from that step to Production, Site Reclamation, & Well Abandonment, there is a drop down of about 1/20th, and two magnitudes. This final step also takes place over a longer duration, making the intensity of truck traffic lower. However, comparing between Scenarios, the difference is not as great. Within each step, Scenario 2 is 3x greater than Scenario 1. Visually, the graph demonstrates that steps are more indicative of truck trip intensity categories than Scenarios. Therefore, steps were used to inform probability designations for each traffic- and road-damage-related risk.

Overall, the only place where risks changed between the two scenarios was for air emissions during flowback and for gathering lines. The difference in air emissions was a result of the second scenario being projected to result in almost year-round emissions, whereas the first scenario was projected to occur for approximately one-third of the year. This has been clarified in the core document.

It is of interest that the definitions in Table 2, Risk Factors Used has variable wording for low, moderate, and high relative to the current versus potential future conditions. This is unacceptable. The low probability appears to assume that BMPs would be in place by suggestive words like future circumstances, current knowledge, and existing controls. The moderate probability mentions best practice standards and occurrence occasionally or potentially occurring under foreseeable circumstances. Finally, high is defined as occurring frequently under ordinary conditions – presumably with best practices in place although not mentioned specifically. The lack of parallel construction of these probabilities shows a lack of discipline or is stated variously to confuse the reader. Nine risks are listed as high presumably with BMPs in place.

There are 32 identified moderate risks (approximately 10 %) in the Appendix A Summary Chart without considering the higher risks of Scenario 2 except in 4 cases identified in the chart under scenario 2. The question arises why is risk under Scenario 2 not considered for all stated risks. This is unacceptable. In a referenced Ricardo Risk Assessment document, virtually all of the risks increased with cumulative well development activity. It is reasonable to consider tripling the number of wells from Scenario 1 to Scenario 2 to also increase the exposure and impacts as did the cumulative approach used by Ricardo. Although 4 risks were increased with Scenario 2, 331 were not. As mentioned earlier, the best practices are currently not in place and we have no guarantee that they will be developed or in a form that will address all current risks as well as unevaluated risks – particularly those involving public health, safety, and ancillary infrastructure. On its face, the risk assessment is incomplete.

Response: The risk definitions for both probability and consequence were shared with the advisory commission on several occasions in advance of the draft risk assessment. During that time no written comments or proposed edits to the definitions were requested by the Commission. Since the definitions drive the categorization of risk assessment findings, it is not possible to revisit these now as it would require redoing the entire risk assessment. Also, I is important to keep in mind that the risk assessment assumes the BMPs are in place, so regardless of whether BMPs are specifically mentioned in the probability definition they are nevertheless considered when applying those definitions to characterize risk. As far as the risk assessment for scenario 2, please see above response.

The conclusion to the risk assessment discussion on p.12 comments that "If risks are found to be unacceptably high, additional mitigation steps could be taken or gas extraction could be deferred until risks can be reduced by new technology or practices, or until additional data demonstrate that the proposed practices are effective in reducing risks." Although not stated implicitly, the statement suggests that unacceptably high equates to high in the risk ranking chart. To many, moderate can equate to an unacceptable risk. The Executive Order did not say unacceptably high risk. It said unacceptable risk. Since unacceptable risk is not defined, it may be left up to the risk manager perhaps with input from the persons who might be affected. Many risk analysis paradigms include risk communication to help risk managers make final decisions. This aspect should be covered by the comments on the risk analysis due to the Departments on November 17. It is important and informational to learn what is said by the people about the risks of UGDW. It is also important that a multitude of comments stating the same thing or who does or does not live in certain areas should not be dismissed out of hand and not considered.

Response The purpose of the Departments' risk assessment was never to determine what level of risk is acceptable or unacceptable. Specifically, the purpose of the risk assessment is stated "to provide a comprehensive risk evaluation for UGWD in the Marcellus Shale in Western Maryland. Specifically, risks are evaluated through a qualitative assessment of probability and consequence to achieve an overall risk ranking. This RA does not seek to determine a single aggregate risk evaluation for UGWD in Maryland. The RA findings are intended for consideration by the State of Maryland and the Marcellus Shale Advisory Commission to determine if UGWD can be conducted safely in Maryland with current proposed BMPs."

Appendix B is one of the most developed in the document. On p. 43 under conclusions, it clearly states that "there is a high probability of air pollution during all UGWD phases even with BMPs in place". This gives rise to serious questions regarding current technology to safeguard the people and communities where they live and work and clearly states that it supplies no BMPs ameliorate this situation. This is a significant unacceptable risk. Although the Health Report released earlier this year mentions many health related issues, it does not claim to be a risk assessment document nor does it have extensive BMPs to address all of the issues including air emissions. For example, Dr. McCawley, one of the reviewers of the current document listed on the MDE web site, recommends that 1000 foot setbacks are not adequate in addressing air pollution concerns since topography in areas like Western Maryland affects air currents and valley stagnation far from an actual well pad and is likely to yield persistent high levels of risk to diesel exhaust.

Response: The Departments' did review and respond to Dr. McCawley's comments, as well as provided edits to Appendix B to address, so please refer to that comment response document for details. It is correct that the risk assessment found a high probability of air emissions during virtually all phases of UGWD. However, it is not correct to say that the risk assessment "clearly states that it supplies no MBPs to ameliorate this situation." On the contrary, the Departments' proposed many BMPs (top-down BAT, EPA's tank regulations, limits on flaring, green completions, etc.) to address air emissions associated with UGWD development. Because the Departments did not have sufficient data regarding efficiencies for these BMPs/setbacks and emissions from mobile sources were not modeled, it was determined that insufficient information was available to determine the overall risk consequence.

Under Methodology on p.4 under Literature and other information sources, peer reviewed original papers in established scientific journals were considered generally credible and other sources of information including reports from federal, state, and local agencies were considered to be generally credible. At the 11/5/2014 meeting of the MSAC a list of seven reviewers for the current document was given. Reviews from two of them are currently available. None of the seven reviewers are listed as members of the Society of

Risk Analysis which questions whether any of them will or can give a valid or credible assessment of this risk methodology and procedures found in the document. This is not to say that the reviewers are not expert in some areas addressed by the document, but that the actual document itself may not be professionally reviewed as a risk analysis document. It is interesting that Professor Weisman states that "I think that there are at least two types of data that are not yet available in the literature: 1) data on the efficacy of technology-based BMPs in terms of the degree to which they result in lower harm to receptors when properly deployed; and 2) the expense of the BMPs as compared to their effectiveness in reducing harm/risk." This statement suggests that at present, technology based BMPs have not been shown to lower harm to receptors and begs the question whether and to what extent application of BMPs will actually lower risk which is the basis of the current document.

Response: Both the State, in issuing the Executive Order that established the Advisory Commission, and the Departments', in terms initiating the peer-review and providing for broad-scale public comments, undertook substantial efforts to develop scientifically-based and independent-minded studies and reports. This process produced comments from individuals with wide-ranging expertise, including risk assessments. The Departments' do concur in some cases that BMP efficiencies have not been developed and, where so, this information was included in the overall risk assessment findings.

Conclusions

The comments speak to a number of shortcomings some of which point to a number of incomplete findings or are found unacceptable. Some of those are found in the methodology which is troublesome since risks that may currently exist without application of BMPs and regulation are not assessed. This leaves the reader with the dilemma concerning the amount of improvement likely to be observed by application of BMPs. At the same time Professor Weisman suggested that data are not available to confirm the degree to which BMPs lower harm to receptors. Concern also exists on the interpretation of moderate risk. It is clear that use of this delineation in the current assessment where 10% of the risks occur occasionally with varying levels of consequence would significantly impact people and the environment. In addition, air pollution and traffic impacts will have high risks that cannot readily be reduced. The risk ranking activity does not appear to have considered increased risk for Scenario 2 for all risks except 4 when increased exposure to risk are seen which parallels the Ricardo cumulative risk scenario leading to increased risk. Although the risk approaches are different in the two models, increased exposure to risk leads to increased risk. As mentioned above, unacceptably high does not necessarily only equate to unacceptable risk. An argument can be developed that moderate risk is also unacceptable risk.

The Departments are to be commended for attempting what no other State government has done by embarking on this as well as other documents it has developed over the

course of three and a half years. The State has been immensely served by the process it has undertaken in this and other documents it has rendered even with their imperfections as noted here and by thousands of comments it has received in the process of rendering its positions. It is hoped that much of what has been learned and shared will significantly provide protections for our people, the communities they live in as well as the environment and natural resources we all enjoy, if or when unconventional gas development proceeds in Western Maryland.

Response: The Departments' also greatly appreciate the work and input of the Advisory Commission whose comments and feedback during the Advisory Commission meetings provided invaluable feedback for the risk assessment process. The Departments and Maryland's citizens owe the Commission many thanks for helping to protect public health and Maryland's environment.

Sincerely,
Nicholas E. Weber, Ph.D. Member of the Governor's Marcellus Shale Advisory Committee