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Director – Environmental and Regulatory Affairs Southern Division

February 28, 2011

Mr. Edward Hanlon
Designated Federal Officer
EPA Science Advisory Board Staff Office (1400R)
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Comments of Chesapeake Energy

Environmental Protection Agency's Draft Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources

Chesapeake Energy (Chesapeake) appreciates this opportunity to comment on the Environmental Protection Agency's (Agency) *Draft Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources* (Draft Study Plan) that was released February 8, 2011.

Chesapeake is the second-largest producer of natural gas, a Top 20 producer of oil and natural gas liquids and the most active driller of new wells in the U.S. Headquartered in Oklahoma City, the company's operations are focused on discovering and developing unconventional natural gas and oil fields onshore in the U.S. Chesapeake owns leading positions in the Barnett, Haynesville, Marcellus and Bossier natural gas shale plays and in the Eagle Ford, Granite Wash and various other unconventional liquids-rich plays across the country.

Chesapeake has a vested interest in ensuring sound scientific and non-bias research is utilized during the Study, and, therefore, has provided comments that we believe will assist in accomplishing this goal. The comments are generalized into three types; clarification, content, and scope. The definition of each type is provided below with a summary of key themes.

Clarification – Request for additional information, definitions, and/or explanations.

- Definitions of fundamental terms are needed.
- Clarification and basis of statement that appear bias.
- Requested methodologies and techniques not provided.

Content – Comments based on content inclusion, exclusion and sources of information.

- Suggestions for additional content to provide accurate context to Study.
- Identification of bias, unreliable references and inaccurate/outdated statements.

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Scope – Comments regarding the relevance and/or practicality of the scope of work.

- Suggestions regarding scope based on industry experience.
- Identification of work outside the intent of Congress' and SAB's requests.
- Recommendations for addition work that would add value to the Study.
- Identification of significant discrepancies between the Study Plan and existing State legislation and policies regard water acquisition.

Chesapeake is prepared to expand on or provide further explanations regarding these comments as appropriate. Again, we appreciate this opportunity to provide comments on this very important study effort.

Respectfully,

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Page	Section	Study Plan Citation	Comment	Type
General	General	Use of the word "potential".	Will use of the word "potential" be considered in the context of current regulations and practices? In other words, will the EPA HF Study efforts consider current regulations and practices in considering whether a particular aspect of HF activities has the potential to cause a "potential impact?" As an example, if a release of produced water reaches a stream, there are existing regulations for reporting the release and responding and effecting clean-up or remediation. The EPA HF Plan does not state that existing regulations or practices will be considered in considering a "potential" for a particular impact. Given the regulations in place, does the potential for an "adverse", unaddressed, impact still exist or differ from the inherent risk associate with other industrial commerce? Perhaps the actual situation is that the "potential" for a particular "adverse" impact has already been identified by the states and oil and gas industry and regulations have been put in place at the state level to address that potential.	Clarification
General	General	General	It would appear that there are considerable efforts being expended in the study to evaluate the Marcellus shale play which may serve to potentially bias the study (Table 7). The Marcellus shale play is overlain by geologic formations which have been heavily impact by anthropogenic activities such as historic oil and gas production, mining, and heavier population densities. Further, infrastructure in these areas have not provided for strong potable water well standards which heavily impact the issues related to stray gas. For the results of this study to be credible, the study areas need to be geographically diverse and include areas which have not been subject to anthropogenic activities; otherwise, good conclusions based on unbiased data sets will be difficult. (pg. 44)	Content

General	General	General	There is an appearance of underlying bias against the natural gas industry. A number of the references cited in the document are taken from organizations which are known for their positions generally against the production of oil and gas. These documents have been cited as sources for scientific information to support statements about the effects of hydraulic fracturing on drinking water resources. Review of these documents has shown that they are primarily opinion pieces or based on antidotal information rather than actual data. Examples include: Lustgareten and ProPublica (cited on page 55), Michaels et al (cited on page 55), Sumi (cited on page 98) and Subra (cited on page 44). Further, the source cited as the major source for Table D3 actually acquired the information from an EPA document which cited another draft EPA document. A principle of good science is the proper use of scientific literature. This document does not meet that test.	Content
General	General	Use of the terms "potential impacts" and "change."	Consistent throughout the document is the use of words like "potential impacts" without qualification as to whether there is actual or if the "potential" is realized or adverse. There is repeated use of the word "changes", generally in the context of "changes to water quality" without qualification as to whether the change is adverse or would render the drinking water resource unsuitable for its intended purpose. (pg. viii, 16, 22, 44). Clarification of these terms is requested.	Clarification
ix	Exec. Summary	What are the possible....	Four of the 5 research questions start with "What are the possible...?" The questions might be better stated as "is there a reasonable expectation that a particular impact would occur given the current regulations and industry practices that are in place."	Content
vii	Exec. Summary	More specifically, the study is designed to examine the conditions that may be associated with the potential contamination of drinking water resources, and to identify the factors that may lead to human exposure and risks.	The study should incorporate standard risk assessment practices. In addition to the identification of factors and adverse impacts, probability or likelihood should be reported.	Scope

4	2.3	EPA used a risk-based prioritization approach to identify research that addresses the most significant risks at each stage of the hydraulic fracturing water lifecycle.	The risk-based approach utilized by the EPA was not documented, and the "other criteria considered" are not adequate to "ensure that resources are provided for the areas that potentially pose the greatest risk."	Content
4	2.3	Other criteria considered...Relevance:...Precedence:..Uniqueness of the contribution:...Leverage:...Application of the criteria listed above ensure the resources are provided for the areas that potentially pose the greatest risk to drinking water resources.	Relevance, precedence, uniqueness, and leverage do not appear to be criteria that ensure that resources are provided for the areas that potentially pose the greatest risk to drinking water.	Content
7	3	General	The unconventional natural gas production overview section provides no context as to the history of hydraulic fracturing. For example, hydraulic fracturing has been used in the oil and gas industry since the 1940s.	Content
15	5	Use of case studies, retrospective and prospective, to provide information in answering the questions related to the 5 identified water life cycle stages of HF.	Use of case studies as proposed is reasonable. However, there needs to be some context considered in the retrospective cases evaluated. In evaluating a particular circumstance where contamination associated with HF is investigated, the case study needs to be assessed in consideration of the site specific circumstances as well as the bigger picture. As such, groundwater contamination attributed to well casing failure needs to be evaluated in the context of "this has happened X number of times and there have been XXXXX number of wells installed where it did not happen."	Scope

16	5.2	The objective of this approach is to explore realistic, hypothetical scenarios across the hydraulic fracturing water lifecycle that may result in adverse impacts to drinking water resources based on current understanding and available data. The scenarios will include a reference case involving typical management and engineering practices in representative geologic settings. Typical management and engineering practices will be based on what EPA learns from case studies as well as the minimum requirements imposed by state regulatory agencies.	This is one of the few areas where the EPA HF Plan specifically addresses "adverse" impacts as opposed to just impacts, potential impacts or changes. That an impact should be "adverse" should be a given and "adverse" should be defined; possibly as exceeding a regulatory level. This section also addresses the inclusion of industry practices as well as state requirements, albeit minimum requirements, The use of industry practices and adherence to state regulations should be integral to assessing whether a particular activity has an actual "potential" and likelihood for causing an "adverse" impact.	Scope
17	5.3	When sufficiently tested models can also allow alternate hypothesis testing, which can help determine the plausibility of contamination of drinking water resources due to hydraulic fracturing activities.	EPA should list the models that are expected to be used and define the criteria that will be used to determine the models have been "sufficiently tested." Input for these models, as well as model development, will need to be carefully reviewed. This is a very complex modeling effort and could yield results that are not realistic if inputs, and the model itself, not properly vetted and validated.	Clarification

19	6.1	General	Fundamentally, water use and development is primarily the responsibility of the states and their political subdivisions. State legislatures and courts have developed laws and regulations over the years to regulate allocation of water within their borders. The proposed study work plan appears to be in conflict with this premise. The Western States Water Council issued Position #323 in July of 2010 that states in part "States and their political subdivisions share primary responsibility for planning and managing our nations water resources, both surface and groundwater, quantity and quality...and are primarily responsible for allocating and administering rights to the use of water for myriad uses; and are in the best position to identify, evaluate and prioritize their needs...and nothing in any act of Congress should be construed as affecting or intending to affect or in any way to interfere with the laws of the respective States relating to: (a) water or watershed planning; (b) the control, appropriating, use of distribution of water used in irrigation or for municipal or any other purposes, or any vested right acquired therein; or (c) intending to affect or in any way to interfere with any interstate compact, decree of negotiated water rights agreement.". The WSWC is an organization consisting of water resources representatives appointed by the governors of 18 western states through adoption of a resolution at the Western Governors' Conference in 1965.	Scope

19	6.1	General	Sections 6.1.2, 6.1.3, 6.1.4 all discuss issues related to water availability. As discussed above, determining water availability is a states right issue within their individual laws and regulatory schemes. The work plan appears to ignore this fact and even appears to set the stage for suggesting a prioritization of beneficial uses that may be totally contrary to existing state laws and may impact private property rights. The work plan also ignores the water management strategies and regulations that have developed over the years in state water plan processes.	Scope
19	6.1.1	This is equivalent to the total amount of water used each year in roughly 40 to 80 cities with a population of 50,000 or about 1 to 2 cities of 2.5 million people.	Section 6.1.1 compares 35,000 wells potentially fractured per year nationally to the water use of a range of cities. These are not comparable data. The EPA projected water use of the 35,000 frac wells (70-140 billion gallons/year) nationally should be compared to municipal water use nationally. In this regard, the USGS (2005) estimated water use across the United States in 2005. They report that municipal use totaled approximately 149,650 billion (i.e., almost 150 TRILLION gallons/year). This puts the frac well use in proper context nationally with municipal use. There are several references to the frac well water use being "large" without providing any proper context. See Scope comments pg 19 section 6.1 regarding water use rights.	Content
19	6.1.1	Source water can also be stored in impoundment pits on-site or in a centralized location that serves multiple sites.	There should be a discussion regarding the use of fresh water ponds to reduce the rate at which water is obtained from surface and ground water. The storage allows operator to store water during time of peak surface water flows, and minimize the temporary draw down of aquifers caused by higher pumping rates. In addition, the study fails to discuss the various river basin commission rules that are in place regarding the rate of withdrawals from surface water. See Scope comments pg 19 section 6.1 regarding water use rights.	Content

20	6.1.1	Estimates for the amount of fracturing fluid that is recovered during the first two weeks after a fracture range from 10 to 40 percent of the original fluid injected.	Based on CHK data, Haynesville Shale wells only produce 5 percent of the volume equivalent of that injected. Furthermore, implying the water produced is the same water injected is not an entirely accurate statement as there is some natural formation water that will accompany even this initial produced fluid.	Content
21	6.1	General	Section 6.1.4.1 and 6.1.4.2 discuss scenario analyses that clearly could be contrary to historical and ongoing water availability determinations by the states. States model/determine water availability in concert with their existing state laws, comprehensive water plans and beneficial use priorities. Examples include Texas groundwater conservation districts determining their Desired Future Conditions in the way they manage local groundwater resources. Colorado determination of tributary and non-tributary groundwater for appropriate regulation, pass by flow requirements in Pennsylvania, Cooperative Endeavor Agreement water use requirements in Louisiana, among others.	Scope
21	6.1.3	Furthermore, it is important to recognize that ground water and surface water are hydraulically connected (Winter et al., 1998); any changes in the quantity and quality of the surface water will affect ground water and vice versa.	The hydraulic connection of surface water and groundwater is site specific; they are not hydraulically connected in all areas. In addition, it is worth noting not all ground water is connected.	Content
21	6.1.4.1	A critical analysis of trends in water flows and water usage patterns in areas impacted by hydraulic fracturing activities will be conducted to determine whether water withdrawals for hydraulic fracturing activities alter ground and surface water flows.	An important element of this effort should be the recognition that HF water use is a relatively short term activity as compared to other consumptive uses; such as agriculture or power generation. As such, HF activities that "alter" ground and surface water flows may occur within a defined area are temporal and are not long term alterations. See Scope comments pg 19 section 6.1 regarding water use rights.	Content

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21	6.1.4.1	Control areas that have similar baseline water demands and have no oil and gas development will be compared to areas with intense hydraulic fracturing activity to isolate and identify the impacts of hydraulic fracturing on water availability.	There will be significant challenges associate with this task. No two areas are the same as far as the sources and quantity/quality of water available for use. The result of this analysis would likely have only one conclusion and that is that areas with shale development have greater water use, and hence less water availability, than similar areas without shale gas development. See Scope comments pg 19 section 6.1 regarding water use rights.	Scope
22	6.1.4.1	Scenario evaluations will assess the environmental futures and impacts of hydraulic fracturing operations at various spatial and temporal scales in the selected study areas using the existing data described above. The scenarios will include at least two futures: (1) average annual conditions in 10 years based on the full exploitation of non-conventional natural gas and (2) average annual conditions in 10 years based on sustainable water use in hydraulic fracturing operations.	It is recommended the study be modeled for 20 years. The inclusion of the second modeling scenario presumes that the "full exploitation of non-conventional natural gas" is not sustainable. EPA should develop a Reasonably Foreseeable Development (RFD) Scenario for shale gas within the region evaluated so that their modeling is not based on a worst case scenario and does not presume a level of development that is unsustainable. The model also needs to give consideration to the practice of storing water during wet periods for use during dry seasons as well as alternative sources of water (wastewater, cooling water, etc.) as well as reuse in determining use requirements and sustainability for surface and ground water resources withdrawals. See Scope comments pg 19 section 6.1 regarding water use rights.	Scope
22	6.1.4.2	EPA will use the data collected in collaboration with USACE, USGS, and others to analyze changes in water quality in areas impacted by hydraulic fracturing, and to determine if any changes are due to water withdrawals for hydraulic fracturing.	What criteria is EPA going to use to classify an area as "impacted" by hydraulic fracturing? Is this statement based on a general perception that all areas with shale gas development are "impacted by hydraulic fracturing"? It appears the EPA has presumed, prior to completing the analysis, an impact has taken place. This bias should not be included in the Study Plan. See Scope comments pg 19 section 6.1 regarding water use rights.	Clarification
22	6.1.4.2	The resulting data will be analyzed to determine if there are any changes in water quality, and if these changes are due to the large volume water withdrawals associated with hydraulic fracturing.	Use of the term "any changes" is very broad. Focus should be on "adverse" impacts See Scope comments pg 19 section 6.1 regarding water use rights.	Content

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23	6.1.5	General	Section 6.1.5 Potential Research Outcomes could result in conclusions that would be clearly contrary to existing state laws and could potentially impact existing state issued water rights and private property rights. See Scope comments pg 19 section 6.1 regarding water use rights.	Scope
26	6.2.5.1	EPA expects to identify a short list of 10 to 20 chemical indicators...	The study plan (p. 26) indicates that fate and transport information will be used to select indicators chemicals from the list of chemicals potentially used in hydraulic fracturing. The hope is to select 10 to 20 chemical indicators and use potential mobility in the environment as part of the selection criteria. The temperatures and pressures encountered at the depths of interest to hydraulic fracturing have the potential to markedly change the known fate and transport for many chemicals. In this environment, the most stable indicators will be total dissolved solids, chloride, and divalent cations.	Scope
26	6.2.5.2	Releases, in general, are not restricted to hydraulic fracturing operations, and can occur under a variety of conditions.	The Draft Study Plan clearly states fluid releases are not specific to hydraulic fracturing operations. The risk of a chemical release to surface water is not unique to hydraulic fracturing, and one could argue that there a plenty of chemical, not used in hydraulic fracturing, that pose a greater risk to drinking water during transportation. Existing regulations are in place to manage this risk.	Scope
30	6.3.1.3	Some or all of these substances may find a pathway to USDWs as a result of hydraulic fracturing activities. For example, if fractures extend beyond the target formation and reach aquifers, or if the casing or cement around a wellbore fails under the pressures exerted during hydraulic fracturing, these potential contaminants could migrate into drinking water supplies.	Presumptive statement incorporating a "may" qualified by two "ifs" and a "could". This is a poor justification for establishing a basis for potential groundwater contamination from HF injection activities.	Content

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30	6.3.2	While EPA recognizes that fracturing or refracturing existing wells may pose a risk to drinking water resources, EPA has not been able to identify potential partners for a case study, therefore, this practice is not considered in the current study. The issues of well age and maintenance, however, are important and warrant more study.	It would be beneficial to have a basis for EPA's recognition that "fracturing or refracturing of existing wells may pose a risk to drinking water resources." As presented, it is assumed that reentering and fracturing older wells represents a risk to drinking water resources due to the age of the well and casing etc.	Clarification
31	6.3.3	Fluid leak off during hydraulic fracturing can exceed 70 percent of the injected volume if not controlled properly and may result in fluid migrating into drinking water aquifers.	This is a very misleading statement. Shale plays have different characteristics than conventional reservoirs and attempting to apply conventional theories on fluid leak off (Glenn et al, 1985) is inappropriate. Outside of the Barnett Shale, most of the major Shale plays are very hydrophilic formations and when water comes in contact with the formation, the water molecules become bound to the shale. Experience has shown that this water binding does not significantly inhibit production of hydrocarbons as proven by the successful drilling programs in the major shale plays. Implying that "fluid leak off" is dangerous when "not controlled properly" and may "result in fluid migrating into drinking water aquifers" is highly unlikely and misleading when referring to the major Shale plays.	Content
31	6.3.3	EPA report on coal bed methane indicated that methane migration in the San Juan Basin was mitigated once abandoned and improperly sealed wells were plugged.	Existing improperly abandoned wells are an inherent risk, independent of hydraulic fracturing practices, to drinking water. The risk to drinking water exists without hydraulic fracturing. Stating that hydraulic fracturing is the cause of this risk is misleading. This fact should be stated in the study plan.	Content
32	6.3.4	For example, hydraulic fracturing itself is a physical process that may increase the mobility of methane into the surrounding media (GWPC and ALL Consulting, 2009).	The reference used for this citation was taken out of context. Regarding mobility GWPC and ALL Consulting, 2009 stated on pg. 54, "In addition to the protections provided by multiple casings and cements, there are natural barriers in the rock strata that act as seals holding the gas in the target formations...These strata also act as barriers to vertical migration of fluids upward toward useable groundwater zones."	Content

34	6.3.6.2	Maps of the AOEs for multiple injection operations can be overlaid on regional maps to evaluate cumulative impacts, and, when compared to regional maps of areas contributing recharge to drinking water wells (source water areas), to evaluate regional vulnerability.	A discussion is needed regarding the method of relating or projecting the Area of Evaluation (AOE), which describes the area of injection influence at depth, to the surface. An overlay of recharge areas will help in evaluating regional vulnerability as well.	Clarification
34	6.3.6.2	This investigation will determine the role of existing natural or artificial pathways in providing conduits for the migration of fracturing fluid, natural gas and/or naturally occurring substances to drinking water resources.	The study should include information obtained during this study regarding migration of natural gas and/or naturally occurring substances not caused by HF; coal seams, lignite or shallow oil or gas shales. Many of our early oil and gas fields were discovered on the basis of drilling where gas and/or oil were found to be present in seeps, streams and springs. It may be beneficial to study an area with similar geology and historic non-HF oil and gas exploration and production for comparative purposes.	Scope
35	6.4	Case studies will examine the extent of the impacts, if any, from these releases on surface and ground water resources.	EPA is commended for acknowledging the fact that there may not be any impacts to drinking water cause by hydraulic fracturing. This type of statement is rare throughout the study proposal.	Content
36	6.4.1	Estimates of the amount of fracturing fluid recovered as flow back in shale gas operations vary from as low as 25 percent to high as 70 to 75 percent.	This statement is inconsistency with what is mentioned earlier in the report. The statement from page 20 says "Estimates for the amount of fracturing fluid that is recovered during the first two weeks after a fracture range from 10 to 40 percent of the original fluid injected". It is recommend that if EPA distinguishes between "flow back water" and "produced water", they should define each so the reader understandsthe criteria being used. CHK does NOT acknowledge "flow back water" but only flow back as a process of temporary equipment onsite to manage the initial "produced water". CHK believes ALL water that flows to the surface from the wellbore is "produced water".	Content
37	6.4.2	A Thorough understanding of how the composition of flow back and produced water varies at both the local and national scales...	The sampling proposed under this study plan is too limited to identify the potential variations in hydraulic fracture fluids and produced water due to the variation between individual wells and within local and regional geographical areas as well as on a national level.	Scope

39	6.4.5.2	Case studies will examine the extent of the impacts ...	Retrospective case studies as described will utilize existing data to evaluate impacts on surface and ground water. It would appear that it will be difficult in these cases to make clear attribution to hydraulic fracturing.	Scope
41	6.5.2	The presence of bromide in source water to drinking water systems that chlorinate will produce a greater amount of brominated disinfection byproducts (DBPs) which have been shown to have greater health impacts than chlorinated DBPs.	This is an inaccurate statement NOT based in sound science. The report suggests than THM's are the result of bromide (from produced water) reacting with the chlorine used to disinfect drinking water. This is false. Trihalomethanes are a huge problem for all surface water treatment providers because they are formed by the reaction of chlorine with natural organic matter, with or without bromide. In the presence of organic matter EITHER chlorine, bromine or both can contribute to the creation of THM's. The key is the organic matter that must be present, not the bromide.	Content
42	6.5.4	Assess the short- and long-term effects resulting from inadequate treatment of hydraulic fracturing wastewaters.	A presumption is being made that hydraulic fracturing wastewaters are inadequately treated prior to gathering data.	Content
44	7.1	Retrospective Case Study Finalists	Three of the retrospective case studies finalists for consideration are associated primarily with stray gas migration. It is unclear what techniques EPA will use which have not already been used by the local and state agencies dealing with the issues that will allow clear attribution to hydraulic fracturing rather than other human activities that actually disturb shallow surface geology.	Clarification

47	7.3	Hydraulic fracturing of the production well	Table 9 - The timeframe to be considered for time series sampling following hydraulic fracturing activities. How long will be considered to be "long enough?" Data on chemical constituents in produced formation water available in the literature has evaluated up to 90 days after hydraulic fracturing; these data show no consistent trends with regards the concentrations of chemical constituents other than chloride, divalent cations, total dissolved solids, barium and strontium. Data available in the literature on the quality of produced formation water from operating wells (covering a wide range of operational time) document the presence of chloride, divalent cations, TDS and some metals. The variability in the published data makes any decision regarding length of sampling to be arbitrary.	Clarification
47	7.3	Baseline characterization of the production well site and areas of concern	Table 9 - The selection of locations for prospective studies must include an assessment of the true background UGDW aquifers, an understanding the nature of the shallow geology (including presence of fractures, presence of shallow gas, etc.), and a comprehensive analysis of pre-existing anthropogenic sources of contaminants potentially associated with hydraulic fracturing. Many of the areas listed in Table F2 as potential locations for the study have been heavily impacted by historic oil and gas production, mining, etc. At least one of the locations needs to be in an area in which there has been limited historic oil and gas production.	Scope

48	8	Characterization of Toxicity and Human Health Effects	EPA has indicated that there are several hundred potential drinking water contaminants for which toxicity data need to be developed. The presumption of this statement is that all of these chemicals are present in high enough concentrations that their potential migration through possibly miles of geological formations would result in concentrations which are high enough to be quantified in underground drinking water resources and that exposure to the public will occur to these chemicals. The plan includes potential evaluation of chemicals using a QSAR approach and perhaps the ToxCast program. Due to the rapidly changing nature of hydraulic fracturing activities, considerable efforts could be expended on chemicals for which their use could be dramatically lower by the time the results are available. The timeframe necessary to develop PPRTVs is sufficiently long that they would not be available in a timely manner to develop a meaningful risk assessment.	Scope
49	9	EPA will combine the data ... with demographic information (e.g., income and race) ...	EPA has proposed to use income and race data to evaluate environmental justice issues using assumptions which are designed for primarily urban areas. In many of the geographical areas associated with natural gas production activities, ranching and farming are the primary sources of income. As such, income (cash flow) does not represent true economic status in these rural areas. How does EPA propose to address these issues?	Clarification
98	Appendix D	Naturally occurring substances mobilized by fracturing activities	The data in Table D3 is referenced to two opinion pieces prepared by the NGO, Earthworks (Table 6). The original source for this table is a citation in a draft EPA document referencing another EPA document. Metals are known to occur in produced formation water. Many of the naturally-occurring substances "mobilized" by fracturing activities are naturally present and there is no data in the cited reference to support the claim of "mobilization".	Content

113	Appendix G	General	Current methods available for analysis of glycols and alcohols (EPA 8015) are insufficiently robust to adequately characterize these classes of compounds considering the matrix interferences presented by produced formation waters. This should be a priority for method refinement. With regards to radionuclides, gamma spectroscopy is necessary to achieve accurate activity levels.	Scope
113	Appendix G	Bomb Sampler	Use of pressurized sample containers to collect produced water is problematic. These devices must be careful decontaminated to protect sample integrity and prevent contamination. This has proven to be difficult.	Scope