

**Comments from Members of the Chartered SAB on *Advisory on EPA's Research Scoping Document Related to Hydraulic Fracturing (5/19/2010 Draft)***

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## Comments from Lead Reviewers

### Comments from Dr. Taylor Eighmy

#### **Review of Advisory on EPA's Research Scoping Document Related to Hydraulic Fracturing**

Taylor Eighmy  
June 8<sup>th</sup>, 2010

EPA has developed scoping materials for the initial design of a hydraulic fracturing research study. The study is in response to a request from Congress to carry out a study on the relationship between hydraulic fracturing and drinking water. The scoping materials are designed to frame the research questions and the focus of the framing is on the characterization of the hydraulic fracturing lifecycle, potential relationships to drinking water resources, and potential health and environmental risks. In their scoping, EPA also describes their approach for compiling background data and information, provides potential elements for the research study, and offers an approach for transparent stakeholder involvement.

In seeking input from the SAB EEC, four charge questions were provided around three broadly framed issues around the proposed scope of the study, the proposed research topics, and the stakeholder process:

1. (Under the Proposed Scope of the Study): #1---*What recommendations does the SAB EEC have regarding this question of scope?*
2. (Under the Proposed Research Topics): #2a---*What recommendations does the SAB EEC have regarding these proposed research categories and related questions in the scoping paper?*
3. (Under the Proposed Research Topics): #2b---*What process does the SAB EEC suggest for prioritizing research needs given the Congressional request and a desire by the Agency to complete initial research products by the end of calendar year 2012?*
4. (Under stakeholder Process) #3---*What advice does the SAB EEC offer for designing a stakeholder process that provides for balanced input in developing a sound scientific approach for the overall research strategy?*

Quality Review Questions:

#### **1. Whether the Original Charge Questions to the SAB were Adequately Addressed:**

The four charge questions were adequately addressed.

The four charge questions posed reflect the appropriate focus on the three broadly framed issues around the proposed scope of the study, the proposed research topics, and the stakeholder process.

The response to charge question 1 around scope includes helpful recommendations around focused, short-term research goals and broad, long-term research needs. Specific recommendations for short-term research goals include focusing on sources and pathways of potential impacts to drinking water. Recommendations for long-term research needs include a focus on impacts to water resources and aquatic ecosystems. The response also discusses the need for a larger scale of analysis, the utility of an initial informal lifecycle framework without economic analyses, and the observation that the research plan will be relevant to policy formulation. Finally, the response appropriately emphasizes that the scope should focus--- as appropriate--- to issues of hydraulic fracturing and not so broadly on the oil and gas production activities.

The response to charge question 2a around the three research categories (characterization of the hydraulic fracturing lifecycle, potential relationships to drinking water sources, potential health and environmental risks) includes useful recommendations around life cycle components, focus, boundary definition, scale (e.g., functional unit), time horizon and metrics, focus on drinking water impacts, prioritization, use of case studies, and data needs on occurrence, volume, composition, treatability of fluids (fracturing fluids, flowback water, produced water), sources and pathways for exposure, secondary effects (e.g., biogeochemical), use of GIS for exposure assessments, and opportunities to leverage informational needs from related groundwater and hydrogeologic research.

The response to charge question 2b around prioritization very appropriately discusses compilation of existing information and how that can inform priorities and also encourages the use of risk-based prioritization. The response includes a number of additional fundamental questions to address--- these are good questions. One additional fundamental question to consider is the scale- and magnitude-dependent long-term consequences of bore hole drilling, aquitard penetration, hydraulic fracturing, and post-fracturing solute communication between geologic formations (e.g., shales) and overlying aquifers, especially around transport of methane and TDS.

The response to charge question 3 around transparent stakeholder processes addresses the need for advisory groups. One additional thought here--- the USGS has had a number of research programs tied to fractured bedrock biogeochemistry, solute transport in fractures, borehole-fracture reactive transport, etc. and that might be useful knowledge partnership to develop.

## **2. Technical Errors or Omissions in the Report or Issues That Are Inadequately Dealt With**

I found no technical errors or omissions.

## **3. Whether the Report is Clear and Logical**

The report is clear and logical.

## **4. Whether the Conclusions Drawn or Recommendations Provided Are Supported by the Report**

The recommendations offered to the EPA by this advisory around their scoping of their research are fully supported.

## Comments from Dr. Joan Rose

ADDRESS the following:

1. whether the original charge questions to SAB Standing or Ad Hoc Committees were adequately addressed;
2. whether there are any technical errors or omissions in the report or issues that are inadequately dealt with in the Committee's report;
3. whether the Committee's report is clear and logical; and
4. whether the conclusions drawn or recommendations provided are supported by the body of the Committee's report.

SAB was charged with a review of the following:

1. Scope of the Research Program
2. Proposed research categories and topics areas
3. Design of a stakeholder process.

The report of the SAB is very well written, all three charges were addressed and the report is clear. This is not my area of expertise but from the general science view there are no obvious errors and it does not seem that there are any grave omissions. Some further discussion and clarifications may improve and strengthen the recommendations.

### Scope of the Research

The SAB review identified that there would be short term and long term goals and it seems that given the desire that research products are going to be forthcoming by 2012, it is reasonable to suggest that the road map should focus on the short term goals. Research on the impact of the hydraulic fracturing process on drinking water and public health was suggested as the focus in the short term. The technique of hydraulic fracturing used to recover oil and gas has been used for decades and it appears only recently that events regarding contamination of ground water have suggested a public health risk and that a research program is warranted.

The SAB reviewers have suggested that a Life cycle frame work but not a detailed life cycle assessment could provide a road map for knowledge gaps and research direction. However it is not clear why a full life-cycle assessment could not be undertaken (particularly when it is suggested later in the report in regard to topics that in depth case studies could be part of the research projects). How would one clearly delineate between a LCA framework and a LCA? Thus, the report should clarify why a full LCA should not be done. In addition, on Line 43, page 16, the report discusses how a LCA is useful and the authors may want to use a different abbreviation if they believe only a framework is needed so there is no confusion. The authors also state that details on occurrence, volume, and composition of source fluids, flow back water and produced water are needed. Is the best way to accomplish this through a LCA?

It is also not clear why in the first two years that research on ecosystem protection could not be addressed simultaneously. It seems that the flow back waters and the types of chemical impacting both natural and wastewater ecosystems could be part of the suggested literature review. It may be that various types of EIS that were undertaken (for example from oil shale extraction operations in the 1980s) could provide information that would be useful in this regard.

### Proposed research categories and topics areas

The idea of setting up monitoring plans and the use of GIS and mapping seem to be incredibly important in the early stages and perhaps that can be emphasized more.

What about an inventory along with the literature review?

How many operations are there? Where are they located? What is the duration/ or life of some of the operations?

It seems that characterization of the pathways would be very site specific and that in order to choose the pilot case-studies that a broad view of the hydraulic fracturing activities in location and time be better understood.

### Design of a stakeholder process

These case studies would lend themselves to piloting how to bring in the stakeholders. The states and oil and gas industry scientists and leaders would need to be brought into the process early on. I think that may be where much of the data and grey literature will be found. In regard to Stakeholders, it seems that the USGS would also be seen as government partners. Multidisciplinary science perspectives should be brought to the table, (eg. fluid mechanics and experts in porous medium flow).

## Comments from Dr. Jerald Schnoor

I have reviewed the SAB EEC advisory on EPA's research scoping document related to hydraulic fracturing and drinking water. I believe the committee has done a good job of responding to the charge questions. The report is succinct, well written, and interesting reading.

The Charge Questions to the committee were the following:

**Charge Question 1:** What recommendation does the SAB EEC have regarding this question of scope? Should it be narrowly or broadly focused taking into account water resources and related public health and environmental issues over the lifecycle of hydraulic fracturing?

The Committee recommended that the research approach be broken into a short term program designed to study the sources, pathways, and potential impacts of hydraulic fracturing on water resources, especially drinking water resources; and a long term portion that focuses more generally on aquatic ecosystems and their ability to support fishing and recreation. A lifecycle framework was suggested.

**Charge Question 2A:** What recommendations does the SAB EEC have regarding these (below) proposed research categories and the related questions in the scoping paper?

- Characterization of the Hydraulic Fracturing Lifecycle
- Potential Relationships to Drinking Water Resources
- Potential Health and Environmental Risks

The Committee provided some good suggestions for EPA to consider for these research categories. One problem with hydraulic fracturing is it's impossible to know the details of the stratigraphy at depth and what the fracturing process actually does to the sub-surface structure and properties. We don't know what the extent of fracturing is going to be, the aperture openings, or the inter-connectedness between fractures that allows fracturing fluids to contaminate adjacent aquifers that are hydraulically connected to the shale formation.

The EEC Committee provided valuable suggestions as to the need for case studies by EPA ORD. However, the suggestion of 5-10 seemed somewhat arbitrary, although based on the "full range of regional variability". But later in the report, the EEC Committee suggests a GIS-based approach to find where major shale basins are co-located with major drinking water sources, and that seems like the best idea to determine the number of case studies necessary. For example, the Delaware River Basin's headwaters are underlain by the Marcellus Shale, a major gas reservoir, and five million people use groundwater and surface water for drinking water supply there (Kargbo, Wilhelm, and Campbell, *Environ. Sci. Technol.*, DOI: 10.1021/es903811p).

The above ground wastewater is a major issue that the EEC Committee has adroitly identified as one of high priority for EPA ORD. BMPs should be identified including how to dispose of brine reject waters following treatment, or solid salt products in some cases.

Regarding the relationship to drinking water resources and potential health risks, the committee suggests a life cycle approach, and it is incumbent on the EPA ORD to consider what constituents in fracturing fluids are too toxic to be used. Unfortunately, the Safe Drinking Water Act excludes the regulation of hydraulic fracturing by the U. S. Environmental Protection Agency (Kargbo, Wilhelm, and Campbell, *Environ. Sci. Technol.*, DOI: 10.1021/es903811p). This means that the ORD research program should be especially clear on the issue of identifying the most toxic chemicals that should not be part of proprietary formulations. For example in the Pavillion, Wyoming, shale development, EPA tested more than three dozen municipal and private water wells and found traces of 2-butoxyethanol, a foaming agent which is quite toxic (Hess, *C&EN*, May 31, 2010, pp. 42-45).

**Charge Question 2B:** What process does the SAB EEC suggest for prioritizing research needs given the Congressional request and a desire by the Agency to complete initial research products by the end of calendar year 2012?

I liked the “Fundamental Questions” laid out by the EEC Committee in this section of the report. I assume that the question on the “fate and transport of injected constituents” includes the necessity of identifying the variety of chemical in hydraulic fracturing fluids.

Within the Life Cycle framework suggested by the EEC Committee, the EPA ORD should identify the major threats to drinking water from hydraulic fracturing of shale in natural gas wells. For example, if Total Dissolved Solids (TDS), radium-226, and 2-butoxyethanol are the most hazardous contaminants associated with these operations, it would help to set research priorities for Agency completion in the near term (by the end of 2012). The EEC report fails to mention the risk from naturally occurring radionuclides, and that seems to be an important hazard based on the propensity for radium in shale formations.

Following the recent disaster of the Deepwater Horizon oil well explosion and oil spill, we are reminded of the need for worst case planning and technology development. One theme could be for the Agency to develop a Worst Case condition for natural gas development in shale formations. If the worst case happens, do we have technology to mitigate or abate it promptly?

**Charge Question 3:** What advice does the SAB EEC offer for designing a stakeholder process that provides for balanced input in developing a sound scientific approach for the overall research strategy?

This is an excellent section of the report which details some partnering opportunities. I would only add that EPA ORD should co-locate their research with the oil and gas development companies as suggested in the report, but the Agency must keep clear its regulatory mandate in terms of licensing these operations in conjunction with the states.

**SAB Review Questions:**

1. Whether the original charge questions to SAB Standing or Ad Hoc Committees were adequately addressed:

Yes, the charge questions have been adequately addressed.

2. Whether there are any technical errors or omissions in the report or issues that are inadequately dealt with in the Committee's report:

There are no errors that I found. I would add that a Worst Case scenario should be envisioned by EPA ORD in its first work product, and they should prioritize the greatest risks to drinking water. This would be highly responsive to Congress.

3. Whether the Committee's report is clear and logical:

Yes, the Committee's report is clear and logical.

4. Whether the conclusions drawn or recommendations provided are supported by the body of the Committee's report:

Yes, the report does a nice job of providing logical recommendations from the points made.

## **Comments from other SAB Members**

### **Comments from Dr. George Daston**

I thought the hydraulic fracturing recommendations were clear and well considered. The only point that I thought was missing was a recommendation to develop a public communication plan to explain the research prioritization and the research outcomes as they become available. Perhaps this can be something that the stakeholder group is tasked to develop, but it should be a reco here. This issue has captured a lot of attention nationally. I've even seen signs about it in southwestern Ohio, where this is not a local issue.

### **Comments from Dr. Otto Doering**

I believe that the charge questions were well addressed. I would add one notion here with respect to the stakeholder/advisory group. My view is that this group can be extremely important in the EPA gaining adequate knowledge in this area and that its' composition may be critically important. Stakeholders are one thing - those with useful knowledge may be outside a group so defined. The draft committee report does indicate the importance of this group. Do we need to say a bit more about the range of expertise needed?

I strongly endorse the notion of performing in depth case studies.

I did not find technical errors or omissions.

The report appears to be clear and logical.

I believe that the conclusions/recommendations are supported

**Comments from Dr. Rogene Henderson**

This report is outside my field, so I can make only general comments.

1. The report outline is based on the charge questions. Each charge question has been addressed.
2. I am not knowledgeable on this process and so am not capable of detecting any technical errors.
3. The one part of the report that I felt competent to comment on was the answer to Charge Question #3 related to stakeholder involvement. I suggest one minor change to clarify the bottom line in this section. One sentence (page 22, line 41) says the stakeholders should be involved throughout the research process. Another sentence (page 22, lines 29-30) says the stakeholders could be involved in the transition from research results to policy setting. Another sentence (page 22, line 38) says the EP should plan the goals and objectives and then involve stakeholders. I think somewhere in the first part of this section, it needs to be made clear that stakeholders should be involved in the whole process, from planning, to research to transition from research results to policy. I think that is what was meant, but it is not clear.
4. The conclusions seem to be supported by the body of the report.

### **Comments from Dr. Bernd Kahn**

The report addresses the charge questions, appears to have no technical errors or omissions, is clear and logical, and its conclusions are clear. The only possible problem that occurs to me is that the letter to the Administrator is far too detailed and could well be reduced in length about two-fold.

## Comments from Dr. Nancy Kim

Comments on the Chair's Transmittal letter

1. On page 2, line 31 the following statement is made, "As a priority, the Committee believes ORD should develop a risk-based research prioritization approach." On page 3, line 12, the following sentences occur. "Regarding potential health and environmental risks associated with hydraulic fracturing, the Committee believes that such potential risks can only be assessed after sources and pathways of possible exposure are much better understood. Several activities must occur before such potential risks are assessed, including: a) characterization of the composition and variability of the source fluids, flowback water and produced water that is co-mingled with the flowback water...(followed by a list of 4 other specific issues).

At first glance it seems as though it would be difficult to come up with a risk-based research prioritization approach if the risks can't be assessed until after the 5 specific issues are completed. Additional language is needed to clarify what is meant. For example, if the sentence on page 2 refers to a preliminary risk-based prioritization approach is meant, words like preliminary could be added. The sentence on page 3 could be revised to say that the potential risks can only be well characterized after sources...

This would be one way to handle the sentences, but the committee is in a better position to revise the language, based on its discussions.

This same problem occurs within the body of the report.

2. On page 3, line 30. It isn't clear what the word characteristics refers to. Perhaps some examples could be added, e.g. chemical/physical properties?

The same problem occurs in the body of the report.

Report

1. I recommend defining the terms short-term and long-term early in the report. The report uses these terms frequently and I assumed that short-term meant before the 2012 deadline and long-term meant afterwards. On page 17, line 41, the committee defines short term within one to three years and long term five to ten years or longer. It would help to move this up front. ORD might appreciate having the break point be 2012, but that may not fit the committee's discussion.
2. On page 19, line 28. The committee recommends assessing possible synergistic effects. Although I don't disagree with the concept, it is a very difficult thing for ORD or anyone to accomplish with complex mixtures. Could the committee add some language to give further guidance about how ORD should accomplish this, how much effort should go into it, give some discretion to ORD, etc?
3. On page 20, line 1 the report states, "...an initial analysis should be conducted that identifies the exposure routes likely to pose the greatest human health risk." Perhaps this language would help with my first comment on the letter.
4. On page 20, line 10. The end of the paragraph mentions using GIS mapping techniques for looking at spatial associations between hydraulic fracturing activities and human

diseases. I have many reservations about this recommendation. First, if this is going to be done, CDC should be heavily involved. Secondly, looking for associations between locations and diseases without knowing anything about whether or not exposure is actually occurring, to what, what type of health effects it may cause, what exposure routes, what level of exposure, correcting for other risk factors, etc., could identify a number of spurious “clusters” that some health agency will have to address and the likelihood that they will be caused by some exposure related to hydraulic fracturing activities (especially if EPA does a good job of limiting contamination and exposure) could be low, if any. I am not convinced that this is a good way to spend limited research dollars. I do support mapping the hydraulic fracturing activities, using these data to identify means of carrying out activities to monitor exposure and, if exposure occurs and it is appropriate, to monitor health status.

5. On page 21, lines 11 and 15. These are examples of two areas in the report that relate to my 2<sup>nd</sup> and 1<sup>st</sup> comment on the letter.
6. Did the committee consider making any recommendation about the need for thinking about research to develop or identify actions that should or could be taken with any accidental releases? This comment is related to the oil problems in the Gulf of Mexico.

#### Charge questions.

I believe that the committee has adequately addressed the charge questions. My comments point out some places where I think additional clarity could be added and where a couple of technical issues concern me.

#### Minor comments

1. page 12, line 11. The sentence states “the following charge,” but the charge isn’t given until the bottom of page 13. How about removing the word following?
2. Page 18, line 15. Period should be after the parentheses.

## **Comments from Dr. Cecil Lue-Hing**

In its charge to the SAB, the EPA on behalf of ORD requested that the Committee, review the Scoping Document, and provide comments on the following three areas:

1. Scope of the research program
2. Proposed research categories and topic areas, and process for prioritizing research needs given the Congressional request and a desire by the Agency to complete initial research products by the end of calendar year 2012; and
3. Design of a stakeholder process that provides for balanced input

### **General comments**

The EEC has satisfactorily addressed the charge questions posed by the EPA, and has offered some very meaningful recommendations in each of the three charge areas. While some of these recommendations, may, on their face appear to be commonsensical, they are nonetheless important. A few select examples:

- Be hydraulic fracture specific, and avoid the temptation of expanding the project to include environmental concerns that are common to all oil and gas production activities
- The need to recognize the usefulness of lifecycle assessment, but also to understand that it does not necessarily need to be undertaken in this case
- EPA should partner with industry who develop and operate the wellsites while EPA conduct research at the sites. This partnering would promote transparency, and avoid the need for scale-up of research data.
- EPA should partner with DOE on risk assessment approaches pertaining to geologic sequestration of carbon dioxide.

### **Other comments**

The following comment may be added with respect to caution:

- Since the behavior of hydraulic fractures in geologic formations once created, is not well understood, e.g., do they have the ability to heal naturally, the EPA should plan for the potential of a very long term involvement.

### **Summary**

I approve the report as is.

## Comments from Dr. L.D. McMullen

I have the following comments:

### A. Letter to the Administrator

1. It seems to me that the letter is a little long. While the content of the letter is good, the points could be more summarized with a letter that is more in 2 to 2 ½ page length.

### B. Report

1. I found the report a little hard to follow in places. It seemed to be a collection of thoughts and/or ideas put together without some connection language. In most cases an introductory paragraph may help. For example, the response to Charge Question 1 on Page 15, the first paragraph is the approach, the second paragraph is systems perspective, then life cycle framework, etc. If the second paragraph in this section outlined the issues, the reader would know how each section tied together.
2. I didn't understand A. Background and the B. EPA's charge to the Committee – Background. It seemed to me that A at the top of page 12 could be included in Part B Background on page 13.
3. Part C at line 27 on page 14. I don't think we need the first paragraph. The reader has just completed reading the questions above.
4. Page 15, line 3 states "The committee identified a hierarchy of issues...." It may be of value to include a list of those issues.
5. Page 17, line 28 states "As discussed under Charge Question 2B...". Since this is the first time this issue appears, address it here and reference it back to this point when Charge Question 2B is discussed.
6. Page 18, line 2 "research programs." An example here would be of value.
7. On page 18, the first paragraph has a discussion of case studies. It seemed to me that it was implied that new hydraulic fracturing systems be studied in partnership with industry. I am a strong supporter of case studies, but with deeper groundwater systems it may take many years before we know how they react to fracturing. While it may not be ideal, existing sites may provide similar valuable information. I may be reading more into this paragraph than what the committee intended.
8. I did not feel that we addressed Charge Question 2B. We talk about a risk-based research prioritization approach, but I think we need to give a little more detail to what we are thinking would be appropriate. We list a series of questions but don't indicate how that would guide the prioritization.

Charge Question 3 is extremely important. It seems that we may want to suggest that prior to developing a stakeholder group that EPA decides what it desires from a stakeholder process. Then bring together a small group of experts in participatory research to develop a process that

will accomplish the results EPA desires. Then would be the time for team selection. While EPA has some expertise, this is an issue that requires some expert guidance.

**Comments from Dr. Jana Milford**

We ask SAB members' specifically to address the four quality review questions below from the vantage point of your own expertise:

1. whether the original charge questions to SAB Standing or Ad Hoc Committees were adequately addressed;

Yes.

2. whether there are any technical errors or omissions in the Report or issues that are inadequately dealt with in the Committee's report;

I realize EPA's effort and correspondingly the SAB review were meant to be focused on the potential impact of hydraulic fracturing on drinking water. While this should clearly be the focus of the advisory, I wondered if the Committee's report should at least acknowledge the potential for other environmental impacts and human exposure routes for contaminants associated with hydraulic fracturing, such as air emissions and occupational exposures to fracturing fluids or wastes.

3. whether the Committee's report is clear and logical; and

Yes.

4. whether the conclusions drawn or recommendations provided are supported by the body of the Committee's report.

Yes.

## Comments from Dr. Judith Meyer

### Meyer Quality Review of Hydraulic Fracturing Advisory

5. whether the original charge questions to SAB Standing or Ad Hoc Committees were adequately addressed;

YES. I think the committee has made the appropriate recommendation that ORD needs to think beyond impacts on drinking water. That is a reasonable short term research goal, but considering impacts on aquatic ecosystems is also needed.

6. whether there are any technical errors or omissions in the report or issues that are inadequately dealt with in the Committee's report;

p. 22, lines 26-27: I was surprised that academia was not listed as one of the possible sources for experts for this advisory group. Surely there are professors who know something about this!

If the committee is recommending 5-10 case studies, are they suggesting a similar number of stakeholder groups? Or one national group? If so, did the committee consider representation from the areas represented by the various case studies? I think some mention is needed of how the stakeholder process and case study approach can be meshed. Some mention of interactions with communities at case study sites is made on p. 23, line 24, but I think some more specific attention is needed as to how these two aspects of the program could be better linked.

The last sentence of the report is directing ORD to interact with other federal agencies – which ones? As written, the directive is what Congress told them they had to do with no further guidance provided.

7. whether the Committee's report is clear and logical;

In general, YES with the following concerns as to structure of the report:

The Letter seems rather long. I question whether the paragraph starting on p. 2, line 36 is really needed in the Letter. At the very least it could be shortened. P. 3, lines 14-28 also seem very detailed for a Letter.

Where's the Executive Summary? Does the Letter supposedly replace this? I thought a Letter and an Executive Summary filled two different needs: the Letter a short communication to the Administrator that highlighted the main points, and the Executive Summary would provide a more technically detailed summary of the report's main points.

8. whether the conclusions drawn or recommendations provided are supported by the body of the Committee's report.

YES although the conclusions and recommendations are not singled out as such, but are presented as part of the general narrative.

**Comments from Dr. Amanda Rodewald**

The charge questions were well addressed, the report was technically correct, clear and logical. I found that the body of report supported the recommendations.

As an aside, I agree that careful and deliberate adherence to best social science practices for stakeholder involvement is especially important given that the hydraulic fracturing study has the potential to be particularly contentious as the movie, "Gasland" is currently in the national spotlight. I liked that the Committee highlighted the value of knowledge held by various stakeholder groups.

### **Comments from Dr. James Sanders**

Were the original charge questions to SAB Committee adequately addressed?

Yes, the committee did a very good job of clearly and completely addressing the three charge questions.

Were there are any technical errors or omissions in the report or issues that are inadequately dealt with in the Committee's report?

No. Not that are apparent to a non-expert

Was the Committee's report is clear and logical?

Yes. The report is brief and to the point, but easy to understand. I was impressed a the EEC's ability to simply address each of the charge questions, and felt that their answers were to the point and helpful.

Were the conclusions drawn or recommendations provided supported by the body of the Committee's report?

Yes. My only comment has to do with the fundamental questions developed under 2B. I expect that the EEC does not feel that this listing of questions are the sum of what should be addressed, merely examples? That concept is implicit in the wording, but the EEC should consider being a bit more explicit here.

Otherwise, an easily followed and well thought report.

## Comments from Dr. Gary Saylor, Liaison to the ORD Board of Scientific Counselors

BOSC recently provided SAB a copy of a case study workshop Decision Analysis (DA) report prepared for the Office of Research and Development. In discussion with the BOSC DFO it was concluded that the DA report had significance relevance to the Hydrofracture analysis that the SAB conducted for the Agency. Below are excerpts from the SAB report for which the DA report appears most relevant and the issues from the BOSC report that are significantly responsive to issues raised in the SAB report are underlined. If SAB finds utility in drawing on the results of the BOSC DA report, we are pleased to provide corroboration for the SAB analysis.

SAB was asked to comment on the following three areas of hydraulic fracturing:

- Scope of the research program;

### SAB Draft Response: “

“In general, the Committee found ORD’s overall approach and scope for the hydraulic fracturing research plan and program appropriate and comprehensive.”

- Proposed research categories and topic areas, and process for prioritizing research needs given the Congressional request and a desire by the Agency to complete initial research products by the end of calendar year 2012;

### SAB Draft Response:

“As a priority, the Committee believes ORD should develop a risk-based research prioritization approach that would provide the scientific knowledge necessary for characterizing the risk of human and ecological exposure to hydraulic fracturing fluids and products.”

“The ORD research plan provides several lists of possible specific research questions. The Committee recommends that ORD identify a few overarching, fundamental questions which can then be placed in order of priority before revising the research plan.”

- Design of a stakeholder process that provides for balanced input.

### From SAB Draft Response:

“The Committee recommends developing a balanced, collaborative advisory group of stakeholders representing a broad range of perspectives. In addition to providing information to ORD, the stakeholder group would be engaged throughout the research process. ORD’s objectives and process for stakeholder engagement with the research should be carefully designed. One important objective for engagement with stakeholders should be to gain access to and leverage the existing knowledge base on hydraulic fracturing and its environmental impacts. There is a wealth of data and experience in industry, advocacy groups, state agencies, and other groups for ORD to draw upon in the research effort. It will also be important for ORD to engage with other federal agencies to share data, collaborate, leverage expertise, and align research priorities for optimal use of limited resources.”

### From BOSC DA Report.

The following texts are from the BOSC DA Report. They address the second and third bullets, prioritization and stakeholders.

“Introduction

ORD is tasked with identifying and carrying out a diverse research agenda with the goal of protecting human health and the environment. Identifying and evaluating research priorities would benefit from more structured approaches as are offered through the use of decision analysis methods.”

“Recommendations

“Decision analysis” can be an intimidating term for some people. The emphasis should be on the process for making decisions, and the tools and approaches that allow key stakeholders to get involved and explicitly resolve potential differences and discrepancies. Influence diagrams and conceptual models are key tools for identifying relationships and linkages across components of a decision. Resource allocation with respect to identifying research priorities is a multi-objective, multi-stakeholder process that changes over time given new information, constraints, budgets, political priorities, and technical feasibility.”

*“Use of decision analysis techniques to support research prioritization within ORD is feasible and recommended. The BOSC commends ORD on the initiative to provide a more transparent and accountable process for determining research priorities. Decision analysis techniques are a useful means of organizing and interpreting different kinds of information and data across stakeholders. There are many examples of models and techniques that can be used to support such an effort; indeed, the models may exceed our ability to use them effectively. The model or approach will not make the decision—it will merely inform the process by providing a framework for integrating data and stakeholder opinions, and provide a means for explicitly evaluating uncertainty. The tools, methods, approaches, and software available for incorporating decision analysis methods into the decision-making process have grown tremendously in the last 15 years, so much so that it is difficult, indeed unnecessarily prescriptive, to recommend one particular approach or piece of software. Approaches range from spreadsheet-based tools (see Case Study #3) to sophisticated pieces of software that facilitate web-based stakeholder elicitation tools linked to optimization engines (see Case Study #1).”*

“Chicago Area Waterway System. Should the dams between the Chicago Area Waterway System be permanently closed to protect the Great Lakes against Asian Carp and other invasive species? There are benefits and limitations to consider in making this decision, and one way to evaluate the potential tradeoffs that might be made is through the use of multi-criteria decision analysis. In general, this process involves developing alternatives (there are other alternatives in addition to permanently closing the dams), developing criteria/objectives (to be maximized or minimized), and assigning weights to the criteria. Each of these steps requires a participatory process that includes all relevant stakeholders and agencies that have input to the decision. There are web-based software tools available for such a participatory process that allow for the application of rigorous methods in developing weights for each of the alternatives.”

“Gene-environment Interactions/Endocrine Disruptors/Pharmaceuticals. There is increasing emerging epidemiologic research on genetic/epigenetic alterations and disease outcomes, endocrine disruptors, and pharmaceuticals, but many unanswered questions remain. One approach to identifying what research to pursue would be to use a strategy similar to the one presented here for Case Study #1. This approach would use decision analytic tools to prioritize fruitful areas of research to pursue within a particular subject area.”

*“Engage staff in the effort.* Imposing a process on staff and personnel is unlikely to be successful. Any significant changes to management procedures and the way in which decisions are made require a “cultural” as well as logistical shift within ORD. Start to cultivate the culture internally such that EPA staff recognizes the utility and usefulness of these approaches in making decisions, rather than as an imposition of an external process. A key aspect to this is that decision analysis methods, regardless of the specific approach or piece of software being used, are fundamentally concerned with communication. From a transparent, formalized process for engaging stakeholders and engaging in a deliberative process to developing criteria with which to evaluate specific courses of action or to prioritize research, decision analysis requires communication across management and levels of responsibility.”

#### ***“Case Study Development and Conclusions***

Based on the comments from the workshop participants, we devised a simple example for resource allocation for the ecological research program using ExpertChoice software<sup>1</sup>. This software provides an intuitive web-based platform from which to include multiple stakeholders and to elicit stakeholder preferences in a consistent and transparent manner.”

*“Use of influence diagrams.* Influence diagrams represent an excellent first step to understanding determinants of a decision by developing a conceptual model of linkages and interrelationships across key aspects of the decision. Decision planners and analysts must communicate—as they are thinking about a research process—concerning the nature of the decision, the different elements, and how the linkages can be mapped. This allows analysts to better appreciate how their piece fits in, and what the specific uncertainties are that they face. Analysts and decision makers must agree on the completeness and complexity of the influence diagram. Different components emerge at different times, and will need to be added. Influence diagrams will assist in communicating decisions regarding funding and prioritization outward to interested stakeholders. In addition, influence diagrams ultimately allow analysts to capture complex mathematical relationships using decision analysis methods to identify preferred solutions and alternatives in a decision-making context. “

**Comments from Dr. Paige Tolbert**

I just wanted to convey that I was positively impressed by the Environmental Engineering Committee's draft report to EPA on the hydraulic fracturing research program. It is very well-written and appears to have given thoughtful treatment to the many questions relating to potential impacts of hydraulic fracturing.