HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

Review of Hydraulic Fracturing Technology and Practices

Wednesday, May 11, 2011

Questions for the Record
The Honorable Ralph Hall

---

1. EPA published a study in 2004 entitled "Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs."
    a. Does EPA still stand behind the central conclusion of this report that found "EPA has concluded that the injection of hydraulic fracturing fluids into [coalbed methane] wells poses little or no threat to [underground sources of drinking water] and does not justify additional study at this time."?

EPA's 2004 study was a narrow analysis limited to the direct injection of hydraulic fracturing fluids into shallow coalbed methane formations co-located with underground sources of drinking water (USDWs). Hydraulic fracturing was addressed as a well stimulation technique; the study did not extend to the management of fracturing fluids prior to injection, production wastes or any in situ reactions that occur within the host geologic formation. Within the scope of its narrow charge, the 2004 results were reasonable, and the decision that no additional study was justified at that time.

However, today's hydraulic fracturing activities differ from those prevalent at the time of the 2004 study. The pace of oil and gas production using hydraulic fracturing has increased, and the use of horizontal drilling techniques has extended to a wider diversity of geographic regions and geologic formations that were not addressed in the 2004 study.

Since the original study, there have been cases of ground water and surface water contamination across the nation linked to gas extraction and production activities. However, there are gaps in the science, which make it difficult to confirm which aspect of the production, including hydraulic fracturing, is the source of contamination. This is the reason that EPA scientists, at the direction of Congress, are undertaking a more comprehensive study to determine any potential relationship between hydraulic fracturing and drinking water. The new study will look at the entire lifecycle of fracturing and will include case studies with a focus on sources and pathways of potential impacts to water resources.

2. The 2004 EPA report found that there was little to no threat to underground sources of drinking water from the injection of hydraulic fracturing fluids into coalbed methane wells.
    a. Is it correct to say that these coalbed gas resources are geographically located either near or actually embedded in underground sources of drinking water?
    b. Given that coalbed methane resources were found to be embedded in underground sources of drinking water, and EPA still found that there was little to no threat to said water from the injection of hydraulic fracturing fluids, as a scientist, how does one make the leap that there is a possibility of contamination when the shale formation being fractured in this study's focus is thousands of feet below underground sources of drinking water?

It would be correct in saying that some, not all, coalbed methane formations can be located either near or within potential underground sources of drinking water. The 2004 study was largely a paper study relying on secondhand data and information. The current study is looking at potential impacts to drinking water from hydraulic fracturing and is not limited to coalbed methane formations. In the past five years, there have been numerous complaints throughout the country in many different geologic settings including coalbed methane and shale. While the study will look at all of these to some extent, there will be more emphasis on shale. While the shale target zone can be several thousand feet below the surface, there are other pathways of potential exposure to drinking water resources beside movement from the hydraulically fractured zone to overlying underground sources of drinking water. This study will evaluate existing data as well as collect new data from actual sites across the country and cover the entire water cycle in the hydraulic fracturing process.

 DIM0251782

3. While well drilling and cementing practices may be related to hydraulic fracturing operations, well drilling and cementing are (1) not part of hydraulic fracturing operations, (2) are common to drilling activities more broadly, (3) outside the scope of Congress's request to evaluate the impacts of fracturing on drinking water resources, and (4) regulated by the states.
    a. With these caveats in mind, why did EPA include well drilling and cementing practices as an appropriate area for the EPA to study?
    b. Does EPA have any expertise in well drilling and cementing?
    c. Considering that well drilling and cementing are broad categories in and of itself, and since they are practices used regardless of the use of hydraulic fracturing, why do you think that this would not be beyond the scope of the Congressional language authorizing the study in the first place?

A-C) Well drilling and cementing practices were included as part of the study because of documented cases (e.g., Dimock, PA) where this was a primary pathway for ground water contamination. While such practices are common to most drilling activities, the increase in production well construction across the country, and in particular, the use of high volume, high pressure horizontal fracturing has raised concerns regarding current drilling and cementing practices and their potential harm to underground sources of drinking water. EPA has expertise in this area through the Underground Injection Control Program. Additional concerns have been raised regarding the long-term performance of cements, especially where wells are refractured after a number of years to increase gas production.

4. Both the Department of Energy and the Department of the Interior are currently working on reviews of hydraulic fracturing best practices. Please describe the relationship between the team conducting the hydraulic fracturing study at EPA and the panels reviewing hydraulic fracturing best practices at the Departments of Energy and Interior.

    a. Has there been interaction between the three agencies on this issue?
    b. Have the review teams at Energy or Interior sought out advice or guidance from EPA experts on this issue?
    c. Likewise, has anyone on the EPA study team contacted the panels at the Departments of Energy or Interior to utilize their expertise on this issue?
    d. How much overlap is there between the EPA study and the in-depth technical reviews being conducted by the Departments of Energy and Interior?

A-D) Yes, agency experts are sharing information across the three agencies and with other agencies as well. As we proceed with our study, EPA is working closely with other agencies such as the Department of Energy (DOE), including DOE's National Energy Technology Laboratory; the Department of Interior (DOI), including the US Geological Survey; the US Army Corps of Engineers; and other agencies to identify opportunities for collaboration and to leverage resources. The agencies are also working together to support the hydraulic fracturing subcommittee under the Secretary of Energy's Advisory Board. For example, DOE, DOI, and EPA have had opportunities to brief the subcommittee on federal programs and expertise. Through this coordination, the agencies are striving to minimize any redundancy and efficiently utilize technical expertise across the federal government.

5. During the hearing, you were asked to describe the lengths at which EPA went to in order to incorporate stakeholder input into the study design. You replied that EPA held public workshops in which you received thousands of suggestions. Please provide a list of suggestions you received in these public workshops that were ultimately included in the study design.

    You also replied that in order to incorporate stakeholder input you went to the Science Advisory Board (SAB) to seek their input. However, the SAB's panel to review the hydraulic fracturing study systematically excluded anyone who had practical and working experience in hydraulic fracturing from serving on the panel. Please describe how the exclusion of industry participants on the SAB panel allows for EPA to receive well-rounded and fully vetted feedback on the study design?

A) EPA has undertaken a series of efforts to involve stakeholders in the development of its draft study plan. These efforts have included:

- public meetings held in Texas, Colorado, Pennsylvania, and New York;
- webinars and meetings with federal, state, interstate, and tribal partners;
- webinars with representatives from industry and non-governmental organizations; and
- written and electronic comments from interested stakeholders.

For example, the following suggestions—provided by stakeholders through the above efforts—were incorporated into the draft study plan:

- limit the scope of the study to hydraulic fracturing and drinking water,
- conduct the study in a transparent manner,
- use a scientific approach,
- engage with state agencies and technical experts to share information and data, and
- provide opportunities for stakeholder involvement.

The following suggested research topics have been included in the draft study plan:

- potential impacts to ground and surface water;
- sources of water used in hydraulic fracturing operations;
- chemical identification, fate and transport, and toxicity;
- chemical tracers or markers for hydraulic fracturing fluids;
- construction of gas wells;
- abandoned wells as a potential pathway for fluid or gas migration;
- methane migration into drinking water wells;
- interaction of fractures with existing faults;
- treatment, disposal and recycling of flowback; and
- radioactive isotopes in hydraulic fracturing wastewaters.

Finally, 48 suggestions for possible case study locations were provided by stakeholders through the public meetings and submitted written and electronic comments. The list of possible case study locations can be found in Appendix F of the draft study plan. Six out of seven of the final case study locations have been chosen from this list.

B) We believe that the membership of the current SAB panel possesses the necessary breadth and depth of knowledge and expertise for this review. In particular, several panel members have extensive industrial experience in the field of hydraulic fracturing. In addition, as part of the ongoing review, the SAB Panel is considering public comments on EPA's draft research study plan, including many written comments and oral statements from experts representing the hydraulic fracturing industry. Please also see our response to the Honorable Dan Banishek.

6. During the hearing, you stated that the study will cost in its entirety approximately $12 million. In fiscal year (FY) 2010, EPA was appropriated $1.9 million. In FY2011 budget request, EPA requested $4.3 million.

    a. Given the reductions in the FY2011 appropriations cycle, how much funding will EPA dedicate to the hydraulic fracturing study in the current fiscal year?
    b. How much did EPA request for the study in the FY2012 budget request?

A) EPA's FY 2011 Operating plan dedicates $4.3 million to hydraulic fracturing research.
B) The FY 2012 President's Budget requests $6.1 million for EPA's hydraulic fracturing research.

7. Please describe the division of labor between your office and the Office of Water as it relates to the hydraulic fracturing study.
    a. Does the Office of Research and Development maintain responsibility for final decisions associated with the study design, implementation, and reporting of results?
    b. Approximately how many staff (or FTEs) within each office are and will be dedicated to the study? Please distinguish between permanent ORD staff and those detailed from other EPA line offices.
    c. If the EPA research office is responsible for carrying out this study, why are all of the online materials and information related to this study are located on EPA's Office of Water website?

A) Yes, EPA's Office of Research and Development is responsible for final decisions associated with the study design, implementation, and reporting of results.
B) Over 30 people in the Office of Research and Development are contributing portions of their time to the hydraulic fracturing research effort (for a total of 8.9 federal work years in the FY 2011 Enacted budget).

ORD Permanent Staff	6.9 work years
ORD detailees (detailed from R8 and OW)	2.0 work years

C) EPA tries to present information on the web site in a way that best meets the public's needs. It therefore made most sense to post ORD's materials on the existing established website rather than, in an effort to reflect EPA's internal structure, require the public to look for it on a page run by a different EPA office.

8. The SAB seems to recommend that EPA develop a "vulnerability index" to rank water supplies in terms of susceptibility to harm. The concept of a vulnerability index does not appear to contribute new or valuable information. Rather, it seems more likely that it could unnecessarily frighten the public. If pollution enters a drinking water source, it is

the volume, concentration and nature of the contaminant that causes damage to water quality. It also exceeds the scope of Congress's request, which is simply to evaluate the impacts of hydraulic fracturing on drinking water resources.

a. Does EPA have the experience and expertise to develop and utilize a vulnerability index of this sort?
b. Has EPA ever developed any sort of vulnerability index to evaluate potential impacts to water quality and quantity?
c. How would EPA develop such an index?
d. What resources would EPA need to sufficiently develop a vulnerability index?
e. What additional information would EPA hope to learn by developing a vulnerability index that would not otherwise be learned from the study? Aren't all water sources susceptible to damage if they are polluted? Isn't it mainly the nature and concentration of the pollutant that may cause harm?

A: EPA does not intend to develop a "vulnerability index" as part of the Hydraulic Fracturing Study to rank water supplies in terms of susceptibility to harm.

9. The SAB may recommend that EPA "carefully consider the quality" of the data that would be used in its hydraulic fracturing study, pointing to industry and local and non-industry data as examples. The SAB may also recommend that EPA include an assessment of the uncertainties of its research findings and conclusions. Some providers of data are long-time advocates for outside special interest groups.

a. How does the EPA plan to ensure that its final study plan is free from any negative bias, and is built solely on objective criteria? For example, the SAB in its draft report stated that "partners involved in the prospective case studies will likely follow best management practices and take extra precautions, therefore, these limited number of case studies may not provide answers about the management practices to mitigate impacts to drinking water resources at a more typical HF site." This statement suggests that companies do not typically employ best management practices or other precautions as part of their daily operations.

The final study plan will be written so as not to prejudge the results of the research. EPA's study will make no assumptions as to whether or not there may be impacts of hydraulic fracturing on drinking water resources.

b. Does EPA plan to ensure that the data it uses are not biased? Will EPA make that information known to the public? How does EPA plan to convey any such biases to the public relying on the results of EPA's analysis?

Yes, EPA will ensure that the data used in this study are not biased by following the Agency's quality assurance guidelines. This study will be conducted following the Agency's most rigorous quality assurance approach, which includes audits of data quality and data quality assessments. This will ensure that all data used in EPA-funded research projects will be of the highest quality or is qualified appropriately in resulting reports.

All reports produced from EPA-funded research projects will include a readily identifiable quality assurance section in which data quality assessments will be included. These sections will convey all relevant data quality information to policymakers and the public.

c. How does EPA plan to ensure that any biases do not misinform EPA's analysis?

EPA has engaged multiple stakeholder groups, and will continue to engage these groups, in an effort to ensure that the study is conducted in an unbiased and objective way. These stakeholder groups include the public, industry, non-governmental organizations, federal, state, interstate, and tribal agencies.

The results of the study will be synthesized in a 2012 report and a 2014 report that will undergo several thorough peer review processes, including an internal Agency review, a federal agency review and an external peer review by the Science Advisory Board.

d. How does EPA plan to distinguish objective data from anecdotes?

The study will be conducted following the Agency's most rigorous quality assurance approach. This process includes the use of data quality audits and assessments to ensure that all data used in EPA-funded research projects will be objective and of the highest quality.

e. How does EPA plan to consider uncertainties in drafting its draft and final reports?

EPA will place all study results in the appropriate context, ensuring that any uncertainties associated with the research are addressed in all draft and final reports. Appropriate data quality indicators such as precision, accuracy, representativeness, comparability, completeness and sensitivity will be used by EPA to place the results in context, as is required by the Agency's quality assurance approach.

f. How does EPA plan to ensure that any limits to and uncertainties associated with its findings are communicated to policymakers and the public?

EPA will place all study results in the appropriate context, ensuring that any uncertainties associated with the research results are communicated in its draft and final reports.

10. The SAB seems poised to recommend that EPA significantly broaden the definition of "drinking water resources," currently defined as those waters with less than 10,000 mg/L of total dissolved solids, taking into account advances in technology and potential future changes to what is considered potential drinking water resources. It seems, however, that this would exceed the scope of Congress's request.
    a. Wouldn't such an expansion broaden the scope of Congress's request?
    b. Shouldn't the study be conducted based on current standards? Isn't that why EPA defined "drinking water resources" as those waters with less than 10,000 mg/L of TDSs?
    c. If EPA did decide to change its definition of "drinking water resources," how would it go about determining what should someday be considered a drinking water resource?
    d. Is this something properly addressed in a study?
    e. Would EPA have the budget and time to make this determination?

EPA currently defines "drinking water resources" to be any body of water, ground or surface, which could currently, or in the future, produce an appropriate quantity and flow rate of water to serve as a source of drinking water for public or private water supplies. This includes both underground sources of drinking water (USDWs) and surface waters. Our study looks at drinking water resources as they are currently defined by the EPA. Your reference to waters with less that 10,000 mg/L of total dissolved solids accounts for only part of EPA's current definition, namely the USDWs.

EPA is conducting the study based on the current definition and standards.

11. The SAB seems poised to recommend that EPA not focus on maximum contaminant levels in analyzing the potential impacts of hydraulic fracturing on water quality.
    a. Wouldn't this approach also exceed the scope of Congress's request?
    b. Aren't MCLs among the factors that are used nationally to evaluate the safety of our drinking water?
    c. Should the study not be conducted based on current drinking water standards?
    d. Wouldn't the introduction of new, possibly unknown or not approved standards be likely to lead to confusion for the public about the general safety of our drinking water?
    e. Wouldn't the process of identifying and getting appropriate sign-off on new standards just slow the process down?
    f. Don't you believe that Congress probably had MCLs in mind – as a means of comparing apples to apples – when it asked EPA to take up this study?
    g. How would EPA go about deciding which alternative parameters to use?

a. Congress requested that EPA examine the relationship between hydraulic fracturing and drinking water resources, "…using a credible approach that relies on the best available science, as well as independent sources of information". EPA will use relevant, accepted measures to evaluate potential impact, including MCLs, health advisories, and PPRTVs. EPA does not intend to develop new MCLs as part of the study. There is therefore no issue regarding the scope of the request from Congress.

b. Yes. MCLs are one among several established factors that are used nationally to evaluate the safety of drinking water.

c. Drinking water standards measure certain contaminants, and these contaminants are among those being considered in the study. However, given the scope of the study—to understand the impact of hydraulic fracturing on drinking water resources, we must look at other factors in addition to these standards. All of this information will help us understand the impact of hydraulic fracturing on drinking water resources.

(d) EPA will consider any existing relevant drinking water standards in the conduct of the study. If EPA determines that an MCL exists for a chemical of concern that is used in hydraulic fracturing, the MCL will be used along with appropriate environmental sampling data, as available. No new drinking water standards will be developed for the purposes of this study. Where drinking water standards are lacking, we will consider other accepted measures of health risk [health advisories, PPRTVs, etc].

e. EPA does not intend to develop new drinking water standards as part of the study. Therefore, the potential to slow the development of the study down in the course of getting sign off on new standards is not an issue.

f. Congress specifically asked EPA to conduct this study with a reliance on "...the best available science, as well as independent sources of information." The approach that EPA has taken to develop the Study Plan is consistent with this directive. The study itself will be conducted using the most rigorous scientific practices. Congress provided no specific or implied direction with respect to MCLs.

g. The approaches to be used by EPA to characterize the toxicity and potential human health effects of contaminants are described in Chapter 8 of the Study Plan (www.epa.gov/hydraulicfracturing). This will include the use of data from the peer reviewed literature and existing toxicity data bases, as well as from the types of tests described in the Study Plan.

A, B, C: The study is focused on answering the direction from Congress, which is to study the relationship between hydraulic fracturing and drinking water. To achieve this objective, EPA will conduct research to identify key factors that may be associated with the potential contamination of ground or surface water due to hydraulic fracturing activities. This study has not been designed to assess risks related to hydraulic fracturing, although understanding the risks associated with hydraulic fracturing is important to inform decision making and, as appropriate, will be investigated further.

Questions for the Record
The Honorable Chip Cravaack

I represent Minnesota's Iron Range. We have a proud history of mining and protecting our beautiful environment. Minnesotans know the importance of protecting the environment because we live there, it is our home. However in recent years the EPA has systematically expanded their authority and ignored the will of Congress and the American people. For example, regulating the use of greenhouse gases, despite the fact that Congress never authorized this action. Now Northern Minnesota is hurting and people need jobs. However, despite the best efforts of me and countless numbers of my constituents to work with the EPA, our mining projects still remain blocked behind an impenetrable wall of EPA bureaucracy. Therefore, when I hear about the EPA expanding the parameters of this study on hydraulic fracturing, I am skeptical. Not because I believe you have malicious intent, but because my constituents have lived this before.

1. Do you believe that EPA will expand its regulatory framework surrounding hydraulic fracturing in the future?
2. Do you see any glaring holes in the regulatory framework of states that currently regulate the process of hydraulic fracturing?
3. In 2004, EPA released a draft study on hydraulic fracturing and concluded that the process does not pose a risk to drinking water. Why do you think the results of this study will be any different?

1. Congress determines EPA's regulatory authority. The Agency will carry out its responsibilities with the authority granted to us through statutes such as the Safe Drinking Water Act, the Clean Water Act, and the Clean Air Act.

   As the federal environmental agency, it is EPA's responsibility to ensure that the goals of these Congressionally mandated statutes to help protect our resources are met. EPA is working to clarify and review existing regulations as appropriate to make sure that we are fulfilling this responsibility. We are also studying the potential environmental problems associated with hydraulic fracturing and working with state and local governments in aiding the implementation of current regulations.

EPA will continue to use its legal authorities to address threats to human health and the environment caused by hydraulic fracturing, including its imminent and substantial endangerment authority under several environmental statutes, if necessary.

2. The Agency is looking nationally at issues associated with hydraulic fracturing to ensure that it is done safely and with public health as a priority. We are studying potential environmental problems, applying applicable national regulations as requested by Congress and the public, and promoting consistency in environmental protection across the country.

   The state regulatory framework was largely developed before advanced technologies—such as hydraulic fracturing used along with horizontal drilling—led to the recent expansion of natural gas production. States are moving to make sure their regulations are protective of new concerns, and several have taken important steps to seriously address the impacts of hydraulic fracturing. States will continue to listen to concerned citizens and monitor the need to review state regulations in light of the expansion of hydraulic fracturing as a method of natural gas extraction.

3. Natural gas extraction is expanding rapidly as a result of our increased ability to extract gas from unconventional sources such as shale gas reservoirs. The 2004 study was limited in scope and only looked at the potential for fracturing fluids to be introduced into USDWs as a direct result of injection into coalbed methane formations and did not cover advanced drilling techniques such as horizontal drilling. In the years since that study was published, the pace of hydraulic fracturing has increased, and the practice now occurs in a wider diversity of geographic regions and geologic formations. In addition, we have heard from many citizens around the country that they are concerned about impacts from hydraulic fracturing, including to drinking water, and we believe these concerns deserve serious consideration.

   At the direction of Congress, EPA scientists are undertaking a more comprehensive study of this practice to determine the relationship between hydraulic fracturing and drinking water resources. The new study is intended to both provide data where there is a lack of adequate information and contribute to resolving scientific uncertainties. It will look at the relationship between hydraulic fracturing and drinking water resources, including the full lifespan of water in hydraulic fracturing, from mixing of chemicals and actual fracturing, to management of flowback/produced water and its ultimate disposal.

Questions for the Record
The Honorable Dan Benishek

During the hearing, I asked you if members of the Science Advisory Board panel on hydraulic fracturing had experience in hydraulic fracturing. You responded in the affirmative, that there were panel members that had technical experience in hydraulic fracturing. However, when Panel I was recalled to provide statements in response to your testimony, Dr. Economides indicated that this was not the case, and that none of the panel members actually had any experience in hydraulic fracturing.

Please provide the biographies of the SAB hydraulic fracturing panel members, indicate which panel members were the ones you thought had technical experience in hydraulic fracturing, and describe what specifically in their biographies led you to believe they possessed this technical experience.

Biographies of all SAB Panel members are below. Attached, please find CVs of specific panel members that we believe demonstrate technical experience related to hydraulic fracturing.

Biographies for SAB Hydraulic Fracturing Study Plan Panel Members

Alexeeff, George
California Environmental Protection Agency
Dr. Alexeeff is Deputy Director for Scientific Affairs, Office of Environmental Health Hazard Assessment (OEHHA) of the California Environmental Protection Agency and an adjunct Professor in the Department of Environmental Toxicology at the University of California at Davis. He earned his Ph.D. in Pharmacology and Toxicology from the University of California at Davis and has been certified as a Diplomat of the American Board of Toxicology, Inc., (DABT) since 1986. He has reviewed over 140 documents evaluating human epidemiological or animal toxicological evidence for OEHHA or other agencies such as U.S. EPA. Dr. Alexeeff has recently served on the following National Academy of Sciences Committees: Review of the Federal Strategy to Address Environmental, Health, and Safety Research Needs for Engineered Nanoscale Materials (2008); Evaluating Efficiency of Research and Development Programs at the U.S. Environmental Protection Agency (2007); and Review the Office of Management and Budget Risk Assessment Bulletin (2006). Dr. Alexeeff's professional activities include: President of the Northern California Chapter of the Society of Toxicology (2006-2007);

President of the Genetic and Environmental Toxicology Association of Northern California (1995); member of the Society of Toxicology; charter member of the Society for Risk Analysis.

Ballestero, Thomas P. University of New Hampshire

Dr. Ballestero is an Associate Professor of Civil Engineering at the University of New Hampshire, where he teaches in hydrology and water resources engineering. Dr. Ballestero holds B.S. and M.S. degrees in Civil Engineering from the Pennsylvania State University and a Ph.D. in Civil Engineering from Colorado State University. His teaching and research interests are broadly in the field of water resources computer simulation and field measurement of parameters. His current and past research projects include: surface water-groundwater interactions; instream flow; artificial recharge; movement, monitoring and biodegradation characteristics of organic contaminants in soils and ground water; innovative drilling and field techniques for characterization of contaminated sites and investigating environmentally sensitive locations; bedrock hydrogeology; hydrofracturing; landfill leachate recirculation; ground water mounding under community septic systems; land application of biosolids; evaluation of new drilling and ground water monitoring techniques; and groundwater flow into coastal and estuarine systems. By Request, Dr. Ballestero taught a bedrock hydrogeology course for the National Groundwater Association and also taught groundwater short courses for professionals in both Brazil and Colombia and academic groundwater courses at the University of Puerto Rico Mayaguez and the Federal University of Ceará, Brazil. Dr. Ballestero peer reviews articles submitted to at least six different technical journals and he also provides peer review of proposals and serves on expert review panels for the National Science Foundation, the U.S. Environmental Protection Agency, and the U.S. Department of Agriculture. He served for ten years on the Editorial Review Board for Ground Water Monitoring and Remediation, and six years as an Associate Editor for the Journal of the American Water Resources Association. He is also active with private consulting work on a large spectrum of water resources issues.

Benjamin, Mark M. University of Washington

Dr. Mark M. Benjamin is a Professor in the Environmental Engineering and Science Program of the Department of Civil and Environmental Engineering at the University of Washington, where he has been on the faculty since 1977. He holds a B.S. in Chemical Engineering from Carnegie-Mellon University (1972), an M.S. in Chemical Engineering from Stanford University (1973), and a Ph.D. in Environmental Engineering from Stanford University (1978). Dr. Benjamin is an expert in physical/ chemical treatment processes in general, with long-term research interests in the behavior of natural organic matter (NOM) and its removal from potable water sources, and in the development of adsorption-based processes for removal of metals, NOM, and other contaminants from solutions. For the past 13 years, a major focus of Dr. Benjamin's work has been membrane treatment of drinking water, and in particular, approaches for interfering with membrane fouling by NOM. In addition to the topics noted above, he has published research on conventional coagulation and filtration processes, diffusion dialysis, and mineral dissolution kinetics. Dr. Benjamin's work has been recognized by a Fulbright fellowship and several awards for best publications in various journals, and three of his students have won awards for best doctoral thesis in environmental engineering. In addition to his research activities, he has served on the Board of Directors of the Association of Environmental Engineering and Science Professors (AEESP), has written a widely adopted graduate-level textbook on Water Chemistry (McGraw-Hill, 2002), and is preparing another text on Physical-Chemical Treatment of Water with Professor Desmond Lawler of the University of Texas. Dr. Benjamin has twice held five-year appointments to endowed Chairs, and was recently selected as the AEESP Distinguished Lecturer for 2009-10.

Boufadel, Michel Temple University

Dr. Michel Boufadel is a Professor of Environmental Engineering and the Chair of the Department of Civil and Environmental Engineering at Temple University. He holds a B.S. in Civil Engineering (Hydraulics) from the Jesuit University at Beirut, Lebanon (1988), and an M.S. (1992) and a Ph.D. (1998) in Environmental Engineering from the University of Cincinnati. He is a Professional Engineer (Environmental Engineering) in the Commonwealth of Pennsylvania, and a Professional Hydrologist (hydrogeology) as accredited by the American Institute of Hydrology. Dr. Boufadel's area of expertise is Environmental Hydrology and Hydraulics, where he develops methods to understand the behavior of complex hydrologic and environmental systems. He has been the lead researcher on various projects funded by the Oil Spill Research program within the U.S. Environmental Protection Agency (USEPA). Dr. Boufadel is currently investigating the lingering of the Exxon Valdez oil (1989) in the beaches of Prince William Sound. He has conducted floodplain delineation studies for the Federal Emergency Management Agency (FEMA) using hydrologic and hydraulic models developed by the U.S. Army Corps of Engineers and Geographic Information System (GIS). Dr. Boufadel also conducted vulnerability studies of watersheds. He is Associate Editor of the Journal of Water Quality, Exposure and Health. He is author of numerous articles in publications such as Nature Geoscience, Environmental Science and Technology, and Journal of Geophysical Research.

Boyer, Elizabeth Pennsylvania State University

Dr. Elizabeth Boyer is an Associate Professor of Water Resources in the School of Forest Resources at the Pennsylvania State University. She serves as the Director of the Pennsylvania Water Resources Research Center, and as Assistant Director of Penn State Institutes of Energy & the Environment. Prior to her current position, Dr. Boyer was on the faculty at the State University of New York at Syracuse (assistant professor) and at the University of California at Berkeley (associate professor). She holds a B.S. in Geography from The Pennsylvania State University, and an M.S. and Ph.D. in Biology from the University of Virginia. Dr. Boyer's research explores hydrological and ecological processes that affect water quality (e.g., nutrients, major & trace elements, and sediments) and water quantity (e.g., streamflow and water yield) issuing from watersheds. She is particularly interested in how human activities and environmental variability influence conditions and trends in streams, rivers, and estuaries. Students and staff in Dr. Boyer's Lab typically conduct projects that involve field sampling, laboratory analyses, or modeling to identify the important processes operating in watersheds. The Lab's work aims to provide a scientific basis for design and implementation of land management programs and policies to mitigate the effects of pollution, and to protect, conserve, and restore surface waters. Dr. Boyer is a member of the American Geophysical Union, American Water Resources Association, American Society of Limnology and Oceanography, and the Ecological Society of America. She has served as the Chair of the international Gordon Research Conference on Catchment Science: Interactions of Hydrology, Biology and Geochemistry.

Burnett, David Texas A&M University

Mr. David Burnett is the Director of Technology for the Global Petroleum Research Institute (GPRI) and Research Project Coordinator for the Department of Petroleum Engineering at Texas A&M University. He holds a B.S. and an M.S. in Chemistry from Sam Houston State University and an MBA from Pepperdine University, Los Angeles California. He recently served as the Managing Partner for a U.S. Department of Energy Project on Field Testing of Environmentally Friendly Drilling Systems. This is a multi-million dollar joint partnership among university/industry and government organizations dedicated to reducing the impact of oil and gas operations in environmentally sensitive areas. For the past 10 years, Burnett has led Texas A&M's integrated research program on desalination and reuse of produced water and hydraulic fracturing flowback brine from gas shale operations. He received the 2006 Hearst Energy Award for Technology in the oil industry and his research team received Gulf Publishing's 2008 World Oil Awards (environmental, health and safety).

Davis, Thomas Colorado School of Mines

Dr. Tom Davis is Professor of Geophysics at the Colorado School of Mines. He is also Director of the Reservoir Characterization Project, a research consortium on leading edge technologies for modeling complex reservoirs. He holds a B.E. in Geological Engineering, Geophysics option, from the University of Saskatchewan, an M.S. in Geophysics from the University of Calgary, and a Ph.D. in Geophysical Engineering from the Colorado School of Mines. Author of over 200 professional papers, Dr. Davis is a world-renowned expert with world-wide teaching and consulting experiences. His research in remote sensing of reservoir characteristics also involves fracture propagation investigation and modeling. Finally, Dr. Davis is internationally renowned, with experience in basins around the world - and is headed to Poland this fall to consult on their shale gas development plans.

Dunn-Norman, Shari Missouri University of Science and Technology

Dr. S. Dunn-Norman is Associate Professor and Head of Petroleum Engineering at Missouri University of Science and Technology. She holds a B.S. in Petroleum Engineering from the University of Tulsa, Tulsa, Oklahoma (1978), and a Ph.D. in Petroleum Engineering from Heriot-Watt University, Edinburgh, Scotland (1990). After working a number of years in both domestic and international

assignments for the Atlantic Richfield Companies (ARCO), Dr. Dunn-Norman joined Herriot-Watt University to finish her PhD, developing a computational model of well completion design. Since that time, her research has focused on well construction and offshore operations. In this effort, Dr. Dunn-Norman has secured several grants from both government agencies and private companies. She is currently serving as a consultant for well completion of tight gas reservoirs and is completing a multi-year project with Chevron on well completion design methods. Dr. Dunn-Norman has active research examining the incorporation of statistics in hydraulic fracturing and wellbore construction for CO2 injection.

Dzombak, David A. Carnegie Mellon University

Dr. David Dzombak is the Walter J. Blenko, Sr. Professor of Environmental Engineering in the Department of Civil and Environmental Engineering at Carnegie Mellon University, Pittsburgh, PA. He is also Faculty Director of the Steinbrenner Institute for Environmental Education and Research at Carnegie Mellon. Dr. Dzombak holds a B.S. in Civil Engineering from Carnegie Mellon University, a B.A. in Mathematics from Saint Vincent College in Latrobe, PA, an M.S. in Civil-Environmental Engineering from Carnegie Mellon University, and a Ph.D. in Civil-Environmental Engineering from Massachusetts Institute of Technology. The emphasis of his research and teaching is on water quality protection and restoration. Dr. Dzombak's professional interests include: aquatic chemistry; fate and transport of chemicals in surface and subsurface waters; water and wastewater treatment; soil and sediment treatment; hazardous waste site remediation; abandoned mine drainage remediation; river and watershed restoration; deep geologic CO2 sequestration; and public communication of environmental science and technology. He has published numerous articles in leading environmental engineering and science journals; book chapters; articles for the popular press; and two books (Surface Complexation Modeling: Hydrous Ferric Oxide, Wiley-Interscience, 1990; Cyanide in Water and Soil, CRC/Taylor&Francis, 2006). Dr. Dzombak also has a wide range of consulting experience. He has served on the Environmental Engineering Committee of the U.S. Environmental Protection Agency's (EPA) Science Advisory Board since 2002 and as its Chair since 2007. In addition, he has served on the EPA National Advisory Council for Environmental Policy and Technology, Environmental Technology Subcommittee (2004-2008), chaired the National Research Council's Committee on the Mississippi River and the Clean Water Act (2005-2007), and serves as an Associate Editor of Environmental Science & Technology (2005-present). He is a registered Professional Engineer in Pennsylvania, a Diplomate of the American Academy of Environmental Engineers, a Fellow of the American Society of Civil Engineers and a member of the National Academy of Engineering. This past year, Dr. Dzombak served as Chair of the EPA SAB Environmental Engineering Committee (EEC) Panel that provided advice to EPA on its draft Hydraulic Fracturing Research Scoping Study Plan.

Giesy, John P. University of Saskatchewan

Dr. John P. Giesy is currently Professor and Canada Research Chair in Environmental Toxicology in the Department of Veterinary Biomedical Sciences and Toxicology Centre at the University of Saskatchewan. He is also Distinguished Professor Emeritus of Zoology at Michigan State University in East Lansing, Michigan, where he was a Professor for 26 years. Dr. Giesy is also Chair Professor at Large of Biology & Chemistry, at City University of Hong Kong and Concurrent Professor of Environmental Science at Nanjing University, China. He holds a B.S. in Biology from Alma College, Alma, Michigan, and an M.S. and Ph.D. in Fisheries & Wildlife (Limnology) from Michigan State University. Dr. Giesy is a world leading eco-toxicologist with interests in many aspects of eco-toxicology, including both the fates and effects of potentially toxic compounds and elements, particularly in the area of ecological risk assessment. He has conducted research into the movement, bioaccumulation, and effects of toxic substances at different levels of biological organization, ranging from biochemical to ecosystem. Dr. Giesy has done extensive research in the areas of metal speciation, multi-species toxicity testing, biochemical indicators of stress in aquatic organisms, fate and effects of PAHs, halogenated hydrocarbons, including chlorinated dibenzo-p-dioxins and -furans, PCBs and pesticides. He discovered the phenomenon of photo enhanced toxicity of organic compounds, such as PAHs and was the first to report the occurrence of perfluorinated chemicals in the environment. Dr. Giesy's studies include both laboratory and field as well as mesocosm studies and apply tools from molecular biology to ecosystem-level. He was the first to report the occurrence of perfluorinated compounds in the environment. Dr. Giesy has published 712 books and peer-reviewed articles and presented 1,134 lectures, world-wide. His research is much used and cited by other researchers - Dr. Giesy is in the top 0.01% of active authors (Institute for Scientific Information (ISI) Current Contents) and was the 2nd most cited author in the field of Ecology/Environmental Science over the period 1997-2007 over 15,000 citations, and his h-score is 62. He served six years on the USEPA Board of Scientific Councilors He is currently a chartered member of the U.S. Environmental Protection Agency (EPA) Science Advisory Board and has served a member of six National Academy of Sciences panels, including: 1) Endocrine Disruptors, 2) Remediation of PCB-Contaminated Sediments, and 3) Bioavailability of Residues from Sediments and Soils. Dr. Giesy currently serves on the Boards of Scientific Councilors (BOSC) and the EPA Office of Research and Development (ORD) (Executive Committee). In 2009 he was named Einstein Professor by the Chinese Academy of Science and in

2010, he became a Fellow of the Royal Society of Canada as a member of the National Academy of Science.

Griffiths, Jeffrey Tufts University

Dr. Jeffrey Griffiths is currently Director of Global Health, in the public health program at Tufts University School of Medicine. He is Associate Professor of Public Health, Medicine, Nutrition, and Civil and Environmental Engineering at Tufts University, with a primary appointment in the Department of Public Health and Family Medicine at Tufts University School of Medicine. Clinically, he is an Associate Physician, Division of Geographic Medicine and Infectious Diseases, New England Medical Center; Physician, Department of Infectious Diseases, St. Elizabeth's Medical Center, and Consulting Physician, Divisions of Infectious Diseases, Carney Hospital and Quincy Hospital. Dr. Griffiths holds an A.B. in Chemistry in 1977 from Harvard College, an M.D. from Albert Einstein College of Medicine, and a MPH & TM in Public Health and Tropical Medicine from Tulane University (both in 1982). His major research interests lie in the study of waterborne diseases (especially cryptosporidiosis) and their relationship to environmental factors; respiratory infections and their linkage to malnutrition and air pollution; and the development of an ultrastable measles vaccine for use where refrigeration is not present. He has served on numerous national committees or advisory groups including: the U.S. Environmental Protection Agency (EPA) Science Advisory Board (SAB) Drinking Water Committee, the National Drinking Water Advisory Council of the EPA; the National Academies' Committee on Drinking Water Contaminants and the Public Interest Advisory Forum of the American Water Works Association, Public Health Subgroup. Other service has included being the Federal representative for the National Association of People with AIDS (NAPWA) to the EPA Drinking Water Microbial Disinfection and Byproducts Committee, and a member of multiple National Institutes of Health (NIH) AIDS Clinical Trials Groups dealing with enteric infections. He is a 2008 American Society of Microbiology International Professor, and is co-editor of the Communicable Diseases section of the International Encyclopedia of Public Health (8th edition, published by Elsevier). He completed residencies in both Internal Medicine and Pediatrics at Yale-New Haven Hospital during 1982-1986. This past year, Dr. Griffiths served as an ad hoc member of the EPA SAB Environmental Engineering Committee (EEC) Panel that provided advice to EPA on its draft Hydraulic Fracturing Research Scoping Study Plan.

Gschwend, Phillip M. Massachusetts Institute of Technology

Dr. Philip Gschwend is a Professor in Civil and Environmental Engineering at Massachusetts Institute of Technology where he joined the Department of Civil and Environmental Engineering in 1981. He holds a B.S. in Biology from the California Institute of Technology (1973), and a Ph.D. in Chemical Oceanography from the Woods Hole Oceanographic Institution (1979). Dr. Gschwend joined the Department of Civil and Environmental Engineering at MIT in 1981. Dr. Gschwend's research interests include environmental organic chemistry, volatilization, sorption, transformation processes, modeling fates of organic pollutants, and roles of colloids and black carbons. His research seeks to learn what happens to organic chemicals in natural and engineered environments. Recently published papers of Dr. Gshwend include "Evaluating activated carbon-water sorption coefficients of organic compounds using a linear solvation energy relationship (LSER) approach and sorbate chemical activities" and "Measurement of freely dissolved PAH concentrations in sediment beds using passive sampling with low density polyethylene strips". He is one of the authors of Environmental Organic Chemistry, Wiley-Interscience (2nd edition, 2003). Dr. Gschwend has received several teaching awards for excellence from MIT, as well as MIT's Frank E. Perkins Award for excellence in graduate student mentoring.

Harris, Cynthia Florida A&M University

Dr. Cynthia Harris attended the University of Kansas, where she received a B.A. (Honors' degree) in biology (1978) and a M.A. in genetics (1981). She received her Ph.D. in the biomedical sciences from Meharry Medical College in 1985, with concentration in the areas of nutritional biochemistry and toxicology. Dr. Harris was awarded a postdoctoral fellowship in the Interdisciplinary Programs in Health of the Harvard School of Public Health, where she conducted research regarding the effects of heavy metals on pulmonary function and environmental risk assessment. She is a Diplomat of the American Board of Toxicology (DABT). From 1990-1996, Dr. Harris served as a staff toxicologist and branch chief with the Agency for Toxic Substances and Disease Registry, a sister agency of the Centers for Disease Control and Prevention, in Atlanta, Georgia. Dr. Harris was the first African American branch chief of the Agency for Toxic Substances and Disease Registry. As branch chief of the Community Health Branch, she was responsible for the administration and management of staff who conducted environmental health assessments, at the request of individual citizens and community groups across the nation. In 1996, Dr. Harris accepted the position of Director of the Institute of Public Health at Florida A&M University. Since her tenure, she has been actively engaged in the general planning and development of the MPH program. The 1997 Florida State Legislature approved and appropriated funding to support the MPH program and the MPH program received full, maximum accreditation for its initial review (2000-2005). Dr. Harris has served on numerous committees and panels, which includes

membership on the Board of Directors for the Florida Public Health Association, Chair of the Florida Public Health Partnership Council on Stroke, member of the Pregnancy Mortality Review Board, member of the Florida Sickle Cell Task Force, member of the American Public Health Association, member of the editorial board of the Harvard Journal of Public Health, reviewer for the Journal of Environmental Health, and board member for the Panhandle Chapter of the Florida March of Dimes. She has also provided a review for the Food and Nutrition Board of the National Academy of Sciences. She is a Full Member of the Society of Toxicology and was appointed by the Secretary of the U.S. Department of Health and Human Services to the Agency for Toxic Substances and Disease Registry Board of Scientific Counselors. In addition, she has served on numerous grant reviews for several federal agencies such as CDC, NIOSH, NIEHS and HRSA. She was also a panel member for the IOM Committee on the Gulf War and Health and was recently appointed by Congresswoman Donna Christensen to the Congressional Black Caucus Homeland Security Advisory Board. In December of 2004, Dr. Harris was appointed to the Council on Education for Public Health (CEPH) Board of Councilors for a three year term. CEPH is the national accrediting agency for all public health programs and schools of public health.

Kim, Nancy Health Research, Inc.

Dr. Nancy Kim is affiliated with Health Research Incorporated (HRI), which is a not-for-profit corporation affiliated with the New York State Department of Health (DOH) and the Roswell Park Cancer Institute (RPCI). She held a number of positions in the Center for Environmental Health in the New York State Health Department before retiring in April 2009, and continues to work there post retirement, part time, on several priority projects. She is also an adjunct associate professor in the Department of Environmental Health Sciences in the School of Public Health at the State University of New York at Albany. Dr. Kim holds a B.A. in Chemistry from the University of Delaware (1964), and an M.S. (1966) and Ph.D. (1969) in Chemistry from Northwestern University. Her primary professional interest is in chemical risk assessment and exposure assessment. Dr. Kim was Interim Director of the Center that provides environmental epidemiological, toxicological, and risk assessment expertise in support of environmental health and protection programs. Most of her tenure at the Department of Health involved serving as the Director of the Division of Environmental Health Assessment. This Division has the primary responsibility for assessing the potential risk for adverse health effects from exposure to toxic substances and to study, monitor and evaluate the effects of exposure to them in homes and communities. Dr. Kim's recent panel memberships include: a) The National Academies, Board on Environmental Studies and Toxicology, Member of the Committee on Assessment of the Health Implications of Exposure to Dioxins, September 2004 to summer 2006, b) The National Academies, Water Science and Technology Board, Member of the Committee on Water System Security Research, December 2004 to December 2006, c) The National Academies, Water Science and Technology Board, Member of the Committee on USGS Water Resources Research, Committee on the United States Geological Survey's National Water-Quality Assessment (NAWQA) Program, March 2009 to February 2011, and d) U.S. Environmental Protection Agency's Scientific Advisory Board, 2009-2012.

Lee, Cindy M. Clemson University

Dr. Cindy M. Lee is a Professor of Environmental Engineering and Earth Sciences and of Environmental Toxicology at Clemson University. She holds a PhD in Geochemistry from the Colorado School of Mines. She joined the faculty at Clemson in 1990. Dr. Lee's major teaching and research interests are the chemistry of environmentally significant organic compounds and environmental sustainability. Her specific research interests involve the use of chiral chemistry as a tool for investigating the fate and transport of pesticides, pharmaceuticals, and persistent organic pollutants (POPs) in the environment; the bioremediation of chlorinated contaminants; and the role of black carbon and natural organic matter in the fate of contaminants. From July 2006 to July 2007, Dr. Lee served at the National Science Foundation as the founding Program Director of the Environmental Sustainability Program in the Division of Chemical, Bioengineering, Environmental and Transport Systems (CBET), Directorate of Engineering. She has a national perspective on engineering and science research and research needs in environmental sustainability. Dr. Lee served as a member of the Energy and Environment Coordinating Group for development of the National Aeronautical R & D Plan under the auspices of the Office of Science and Technology Policy (OSTP). She participated on the Feedstocks Task Force of the U. S. Department of Energy's Biofuels Action Plan. Dr. Lee is an editor for Environmental Chemistry for the journal Environmental Toxicology and Chemistry. This past year, Dr. Lee served as a member of the EPA SAB Environmental Engineering Committee (EEC) Panel that provided advice to EPA on its draft Hydraulic Fracturing Research Scoping Study Plan.

Patten, Duncan Montana State University

Dr. Duncan Patten is Research Professor with the Department of Land Resources and Environmental Sciences and affiliate faculty with the Big Sky Institute at Montana State University. He is also Professor Emeritus of Plant Biology and past director of the Center for Environmental Studies at Arizona

State University. Dr. Patten holds an A.B. degree from Amherst College, an M.S. from the University of Massachusetts at Amherst, and a Ph.D. from Duke University. His research interests include arid and mountain ecosystems, especially the understanding of ecological processes of riparian, wetland, and riverine ecosystems. Dr. Patten's research has also involved studies of ecosystem indicators of watershed condition including remote sensing of indicators, biocomplexity of natural and human system interactions in western rangelands, and conceptual modeling of national park ecosystems. He was Senior Scientist of the Bureau of Reclamations Glen Canyon Environmental Studies, overseeing the research program evaluating effects of operations of Glen Canyon Dam on the Colorado River riverine ecosystem. Dr. Patten was founding president of the Arizona Riparian Council, president of the Society of Wetland Scientists, and Business Manager of the Ecological Society of America. He is a Fellow of the American Association for the Advancement of Science, has been a member of eleven National Academy of Science/National Research Council committees, chairing two; the National Academy of Sciences (NAS) Board on Environmental Studies and Toxicology; and the NAS Commission on Geoscience, Environment and Resources. He also has served on the National Science Foundation Environmental Biology/Ecological Sciences Panel. Dr. Patten presently serves on the U.S. Environmental Protection Agency Science Advisory Board. He was involved with the Heinz Center's "State of the Nation's Ecosystems" project and served on an Independent Science Board guiding restoration and science for the California Bay Delta Authority river/water/levee programs. This past year, Dr. Patten served as an ad hoc member of the EPA SAB Environmental Engineering Committee (EEC) Panel that provided advice to EPA on its draft Hydraulic Fracturing Research Scoping Study Plan.

Randtke, Steve University of Kansas

Dr. Steve Randtke is a Professor in the Department of Civil, Environmental, and Architectural Engineering at the University of Kansas in Lawrence, KS. He holds a B.S. degree in Civil Engineering from Loyola University of Los Angeles and M.S. and Ph.D. degrees in Civil & Environmental Engineering from Stanford University. Dr. Randtke is a licensed professional engineer in Kansas and Illinois, and a diplomate in the American Academy of Environmental Engineers. Professor Randtke's teaching and research activities focus primarily on water quality and drinking water treatment. He is a member of the American Association for the Advancement of Science, the American Water Works Association (AWWA), the Association of Environmental Engineering and Science Professors, the North American Lake Management Society, the Water Environment Federation, and the International Water Association. Dr. Randtke has served as a member of the Research Advisory Council of the AWWA Research Foundation (1986-1988), as President of the Association of Environmental Engineering and Science Professors (1994-95), and as chair of the Research Division of the American Water Works Association (1995-1998). He is currently serving as a technical editor for the 5th edition of Water Treatment Plant Design a design handbook prepared under the auspices of AWWA and the American Society of Civil Engineers.

Reible, Danny University of Texas – Austin

Dr. Danny Reible is the Bettie Margaret Smith Chair of Environmental Health Engineering at the University of Texas and Coordinator of Environmental and Water Resources in the Department of Civil, Architectural and Environmental Engineering. In 2004 he joined the University of Texas after 23 years in the Department of Chemical Engineering at Louisiana State University (LSU). Dr. Reible holds a B.S. in Chemical Engineering from Lamar University, and an M.S. and Ph.D. in Chemical Engineering from California Institute of Technology. His research career has been focused on understanding the fate and transport of contaminants in the environment, evaluating the risks posed by these contaminants, and devising effective measures for risk mitigation. Dr. Reible has been active in technical and policy issues associated with the assessment and in-situ remediation of contaminated sites. He has coauthored four National Research Council committee reports on risk assessment and remediation of contaminated sites, is the author of the textbooks "Fundamentals of Environmental Engineering" and "Diffusion Models of Environmental Transport", and has authored more than 100 refereed technical papers. Dr. Reible currently serves on the National Research Council Board of Environmental Studies and Toxicology. He is an Associate Editor of the Journal of the Air and Waste Management Association, the Journal of Environmental Forensics, and the Journal of Environmental Engineering. Dr. Reible is a Fellow of the American Institute of Chemical Engineers and the American Association for the Advancement of Science. He is a Board Certified Environmental Engineer, a Professional Engineer (LA) and in 2005 was elected to the National Academy of Engineering for the "development of widely used approaches for the management of contaminated sediments". This past year, Dr. Reible served as a member of the EPA SAB Environmental Engineering Committee (EEC) Panel that provided advice to EPA on its draft Hydraulic Fracturing Research Scoping Study Plan.

Schreppel , Connie K. Mohawk Valley Water Authority

Dr. Connie K. Schreppel is the Water Quality Director for the Mohawk Valley Water Authority (MVWA), a water utility serving urban and rural areas of upstate central New York State. She holds a B.S. in Laboratory Technology from Syracuse University, an M.S. in Environmental Science from Greenwich University, and a Ph.D. in Environmental Engineering from Kennedy Western University. Prior to employment in the water industry, Dr. Schreppel was trained as a clinical microbiologist. She has over thirty three years experience in the water industry and heads a team of well-qualified scientists who engage in water quality research studies and investigate emerging concerns to the water industry. The research initiatives of the MVWA Water Quality Laboratory concerning water quality monitoring techniques, contaminate warning systems and water system security has been recognized nationwide by the water industry. As a result of this pro-active initiative, Dr. Schreppel has been invited to provide leadership on committees and working groups addressing the issues of water quality monitoring, water treatment techniques, contaminate warning systems, and water system security on national, New York State and regional levels.

Thyne, Geoffrey University of Wyoming

Dr. Geoffrey Thyne is Senior Research Scientist at the Enhanced Oil Recovery Institute at the University of Wyoming and a registered Professional Geologist. He holds a B.A. in Zoology and Chemistry from the University of South Florida (1975), an M.S. in Oceanography from Texas A&M University (1980), and a Ph.D. in Geology from University of Wyoming (1991). Dr. Thyne was a Research Geochemist at Arco Oil and Gas (1979-1986), Assistant Professor at California State University-Bakersfield in the department of Physics and Geology (1991-1996) and Research Associate Professor at Colorado School of Mines, department of Geology and Geological Engineering (1996-2008). He also served as project manager for the Colorado Energy Research Institute (2005 to 2006) and served on the National Research Council's Committee on Management and Effects of Coalbed Methane Development and Produced Water in the Western United States (2008-2010). Dr. Thyne works on the geochemistry of petroleum and hydrologic systems, contaminant remediation, carbon sequestration and statistical analysis of hydrochemical data. Over the past ten years he has focused much of his research on impacts to water resources from human activities including work on projects in western Colorado involving the impacts of petroleum activities. Dr. Thyne is the author or co-author of over 50 peer-reviewed scientific papers and technical reports.

VanBriesen, Jeanne Carnegie Mellon University

Dr. Jeanne VanBriesen is a Professor of Civil and Environmental Engineering at Carnegie Mellon University, and Director of the Carnegie Mellon Center for Water Quality in Urban Environmental Systems (WaterQUEST). She holds a B.S. in Education (Chemistry) from Northwestern University (1990), and an M.S. (1993) and Ph.D. (1998) in Civil Engineering (Environmental) from Northwestern University. Her expertise is in water quality engineering, and in particular environmental biotechnology. Dr. VanBriesen is leading a study of the impacts of hydraulic fracturing flowback water on surface water sources of drinking water. In particular, she is examining the potential for increased production of brominated organic compounds in drinking water systems due to increases in bromide concentrations in source water. Dr. VanBriesen is also participating in design and implementation of a real-time water quality monitoring system in the Monongahela River, to monitor for impacts of shale gas development and other activities.

Vidic, Radisav D. University of Pittsburgh

Dr. Radisav D. Vidic is William Kepler Whiteford Professor of Environmental Engineering and Chairman of the Department of Civil and Environmental Engineering at the Swanson School of Engineering, University of Pittsburgh. Dr. Vidic holds a B.S. in Civil Engineering from the University of Belgrade (1987), an M.S. in Civil and Environmental Engineering from the University of Illinois (1989), and Ph.D. in Civil and Environmental Engineering from University of Cincinnati (1992). His research efforts focus on advancing the applications of surface science by providing fundamental understanding of molecular-level interactions at interfaces, development of novel physical/chemical water treatment technologies, water management for Marcellus shale development, and reuse of impaired waters for cooling systems in coal-fired power plants. Dr. Vidic published over 150 journal papers and conference proceedings on these topics. He received 2000 Professional Research Award from the Pennsylvania Water Environment Federation for his research accomplishments and dedication to the profession, was a Fulbright Scholar in 2003/04 and a was elected by the Pittsburgh section of American Society of Civil Engineers as 2008 Professor of the Year.

Questions for the Record
The Honorable Eddie Bernice Johnson (D-TX)

1. Dr. Anastas during the hearing there was a discussion on risk assessments versus hazards and exposure. Can you please explain the difference between conducting a risk assessment and understanding hazards and exposure?

2. The recent peer-reviewed study "Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing" published in the *Proceedings to the National Academy of Sciences* indicates significantly higher than previously believed methane contamination of groundwater near hydraulically fractured wells.
   a. Please explain the findings of this study.
   b. What is known about methane leakage from wells, pipelines, and processing facilities related to hydraulically fractured natural gas production?

1. In order to conduct a human health risk assessment, one must have an understanding of the hazard of the chemical, the dose-response properties, and the human exposure to the chemical. In other words, risk is a function of hazard, dose-response and exposure. Hazards from chemicals will depend upon their inherent chemical properties and how those properties interact with the body. For example, the chemical structure, biological activity of the chemical, absorption of the chemical into the body, distribution of the chemical throughout the body, metabolism and excretion of the chemical are all important elements that help one understand the overall hazard. Dose-response provides information on the relationship between various doses of a chemical and the health effect or response of concern. Exposure is contact between a person and a chemical, and the route by which one might be exposed can vary depending on the specific media in which a chemical is found and which media a person has contact with. For example, one might be exposed orally (via ingestion) if a chemical is in the drinking water or via inhalation if the chemical is in the air. Exposure is influenced by inherent chemical properties and how the chemical interacts with the physical environment. In conducting a risk assessment, hazard and dose-response information are combined with specific exposure information to develop estimates to characterize risk on either a site-specific or national basis.

2. A) The referenced study concludes that there is a correlation between elevated methane in private wells and proximity (<1 km) to gas production wells in NY and PA locations. The stable isotopic data from the study suggest that the source of methane for the elevated methane cases are deeper thermogenic sources such as the Marcellus shale rather than shallower sources which tend to possess biogenic or mixed biogenic-thermogenic methane isotopic signatures. The study found no evidence for the presence of deep saline brine water or fracturing fluids in the private wells.
   B) Methane migration from deep and shallow sources has been documented to occur in the process of gas well drilling and well construction/cementing.

Questions for the Record
The Honorable Ben Lujan (D-NM)

1. Dr. Anastas, my home state of New Mexico is the sixth largest natural gas producing state in the United States. My district is home to part of the San Juan Basin, one of the largest natural gas fields in the country. I believe that harnessing our abundant natural gas resources is a critical step toward ending our dependence on foreign oil and bringing down gas prices. Encouraging the use of domestic, clean burning natural gas has the potential to reduce air pollution and support cleaner burning vehicles, creating good jobs here at home.

   Extraction of natural gas should be done in a way that respects our land and protects the health of our community. Because I come from a district where many fracking activities take place, I realize the gravity of this issue and strongly urge EPA's thorough consultation with all stakeholders throughout this process.

   EPA's study plan looks to include extensive outreach to states and other stakeholders, but beyond the study, can you discuss EPA's plans to continue to support collaboration with states, industry, and other stakeholders on natural gas production activities across the country?

EPA is committed to addressing concerns about the environmental and health impacts of hydraulic fracturing so that we can realize the benefits of a critical and rapidly expanding energy resource. If produced responsibly, natural gas from shale formations has the potential to improve air quality, reduce greenhouse gas emissions, create economic activity and jobs, enhance our energy security, and provide greater certainty about future energy reserves. The Agency is also committed to full transparency and providing opportunities for individual citizens, communities, tribes, state and federal partners, industry, trade associations, and environmental organizations to provide input on all Agency actions related to natural gas development.

Beyond the study, EPA has conducted extensive outreach on agency efforts related to hydraulic fracturing and natural gas development. For example, EPA held meetings and webcasts with state and federal regulators, tribes, industry, environmental nongovernmental organizations (NGOs) and the public in May and June 2011 to obtain input on key questions related to developing guidance to protect underground sources of drinking water during diesel fuels hydraulic fracturing. Total attendance at these meetings was approximately 500 people. Written comments on the key guidance development questions were accepted through June 29, 2011. For more information about the outreach effort go to:
http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/wells_hydroout.cfm

The Agency also conducted extensive outreach during development of the Oil and Gas NSPS and NESHAP currently under OMB review. The website for the NSPS/NESHAP rulemaking is: http://www.epa.gov/airquality/oilandgas/. EPA consulted with the oil and gas industry to explore control technology and implementation issues, met with both trade associations and individual companies engaged in oil and natural gas production, and held two public meetings. EPA also conducted extensive consultation with NGOs, tribes, and states representing a broad range of interests and geographic regions.

Questions for the Record
The Honorable Paul Tonko (D-NY)

1. For the record, it is my understanding that the practice of hydraulic fracturing includes fracturing technology combined with a number of different technologies, some which have been developed in the last 20 years, are being used to access shale gas. My question for the panel is why do we continue to hear that these technologies have been used to access shale gas for 60 years?

2. What is the industry doing to continue this technological evolution to cleaner technologies?

1. While hydraulic fracturing has been going on for 60 years, the most significant, relatively recent change has been the use of horizontal drilling in conjunction with hydraulic fracturing. Borehole lengths can now exceed 15,000 feet and each hydraulic fracturing job can use more than 6 million gallons of water per well depending on the depth of the formation and the length of the lateral in the targeted fracturing zone. These large volumes of water and increased pressures used for injection raise serious concerns regarding exposure of hydraulic fracturing fluids to drinking water resources. In addition, the use of new chemicals has continued to evolve and change.

2. Service companies engaged in hydraulic fracturing are increasingly moving toward using fewer and "greener chemicals" used in the fracturing process where this can be accomplished. These trends will lower the risk of exposure of toxic constituents to the environment and public.

Questions for the Record
The Honorable David Wu (D-OR)

1. An investigation by Representatives Waxman, Markey, and DeGette showed that companies' fracking wells are still using millions of gallons of diesel fuel.
   a. Does EPA know how much diesel fuel is being used and where it's being injected underground?

EPA is looking into available information to better evaluate the extent of diesel use in hydraulic fracturing. The figures used in the House Committee on Energy and Commerce investigation come directly from the service companies themselves. Because data submitted to the House Committee is considered proprietary information, EPA is not legally able to view the information in order to verify it.