AUTHENTICATED
U.S. GOVERNMENT
INFORMATION
GPO

REVIEW OF HYDRAULIC FRACTURING TECHNOLOGY AND PRACTICES

HEARING

BEFORE THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

ONE HUNDRED TWELFTH CONGRESS

FIRST SESSION

WEDNESDAY, MAY 11, 2011

Serial No. 112–17

Printed for the use of the Committee on Science, Space, and Technology

Available via the World Wide Web: http://science.house.gov

U.S. GOVERNMENT PRINTING OFFICE

66–221PDF WASHINGTON : 2011

For sale by the Superintendent of Documents, U.S. Government Printing Office
Internet: bookstore.gpo.gov Phone: toll free (866) 512–1800; DC area (202) 512–1800
Fax: (202) 512–2104 Mail: Stop IDCC, Washington, DC 20402–0001

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HON. RALPH M. HALL, Texas, *Chair*

F. JAMES SENSENBRENNER, JR., Wisconsin
LAMAR S. SMITH, Texas
DANA ROHRABACHER, California
ROSCOE G. BARTLETT, Maryland
FRANK D. LUCAS, Oklahoma
JUDY BIGGERT, Illinois
W. TODD AKIN, Missouri
RANDY NEUGEBAUER, Texas
MICHAEL T. McCAUL, Texas
PAUL C. BROUN, Georgia
SANDY ADAMS, Florida
BENJAMIN QUAYLE, Arizona
CHARLES J. "CHUCK" FLEISCHMANN, Tennessee
E. SCOTT RIGELL, Virginia
STEVEN M. PALAZZO, Mississippi
MO BROOKS, Alabama
ANDY HARRIS, Maryland
RANDY HULTGREN, Illinois
CHIP CRAVAACK, Minnesota
LARRY BUCSHON, Indiana
DAN BENISHEK, Michigan
VACANCY

EDDIE BERNICE JOHNSON, Texas
JERRY F. COSTELLO, Illinois
LYNN C. WOOLSEY, California
ZOE LOFGREN, California
DAVID WU, Oregon
BRAD MILLER, North Carolina
DANIEL LIPINSKI, Illinois
GABRIELLE GIFFORDS, Arizona
DONNA F. EDWARDS, Maryland
MARCIA L. FUDGE, Ohio
BEN R. LUJÁN, New Mexico
PAUL D. TONKO, New York
JERRY McNERNEY, California
JOHN P. SARBANES, Maryland
TERRI A. SEWELL, Alabama
FREDERICA S. WILSON, Florida
HANSEN CLARKE, Michigan

CONTENTS

Wednesday, May 11, 2011

	Page
Witness List	2
Hearing Charter	3

Opening Statements

Statement by Representative Ralph M. Hall, Chairman, Committee on Science, Space, and Technology, U.S. House of Representatives	11
Written Statement	12
Statement by Representative Eddie Bernice Johnson, Ranking Minority Member, Committee on Science, Space, and Technology, U.S. House of Representatives	13
Written Statement	14

Witnesses: Panel I

Mrs. Elizabeth Ames Jones, Commissioner, Texas Railroad Commission	
Oral Statement	17
Written Statement	19
Dr. Robert M. Summers, Secretary, Maryland Department of the Environment	
Oral Statement	23
Written Statement	25
Mr. Harold Fitch, Michigan State Geologist; Director, Office of Geological Survey, Michigan Department of Environmental Quality; and Board Member, Ground Water Protection Council	
Oral Statement	29
Written Statement	31
Dr. Cal Cooper, Manager, Worldwide Environmental Technologies, Greenhouse Gas, and Hydraulic Fracturing, Apache Corporation	
Oral Statement	34
Written Statement	36
Dr. Michael Economides, Professor of Chemical and Biomolecular Engineering, University of Houston	
Oral Statement	39
Written Statement	40

Witnesses: Panel II

Dr. Paul Anastas, Administrator, Office of Research and Development, U.S. Environmental Protection Agency	
Oral Statement	76
Written Statement	77

Appendix I: Answers to Post-Hearing Questions

Mrs. Elizabeth Ames Jones, Commissioner, Texas Railroad Commission	96
Dr. Robert M. Summers, Secretary, Maryland Department of the Environment	103

Page

Mr. Harold Fitch, Michigan State Geologist; Director, Office of Geological Survey, Michigan Department of Environmental Quality; and Board Member, Ground Water Protection Council 106

Dr. Cal Cooper, Manager, Worldwide Environmental Technologies, Greenhouse Gas, and Hydraulic Fracturing, Apache Corporation 108

Dr. Michael Economides, Professor of Chemical and Biomolecular Engineering, University of Houston 112

Dr. Paul Anastas, Administrator, Office of Research and Development, U.S. Environmental Protection Agency 116

Appendix II: Additional Material for the Record

Additional Material Submitted for the Record by Dr. Michael Economides, Professor of Chemical and Biomolecular Engineering, University of Houston 146

REVIEW OF HYDRAULIC FRACTURING TECHNOLOGY AND PRACTICES

WEDNESDAY, MAY 11, 2011

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, DC.

The Committee met, pursuant to call, at 10:03 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Ralph M. Hall [Chairman of the Committee] presiding.

RALPH M. HALL, TEXAS
CHAIRMAN

EDDIE BERNICE JOHNSON, TEXAS
RANKING MEMBER

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
2321 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515–6301
(202) 225–6371
www.science.house.gov

Review of Hydraulic Fracturing Technology and Practices

Wednesday, May 11, 2011
10:00 a.m.-12:00 p.m.
2318 Rayburn House Office Building

Witnesses

Panel I

Mrs. Elizabeth Ames Jones, Commissioner, Texas Railroad Commission

Dr. Robert M. Summers, Secretary, Maryland Department of the Environment

Mr. Harold Fitch, Michigan State Geologist; Director, Office of Geological Survey, Michigan Department of Environmental Quality; and Board Member, Ground Water Protection Council

Dr. Cal Cooper, Manager, Worldwide Environmental Technologies, Greenhouse Gas, and Hydraulic Fracturing, Apache Corporation

Dr. Michael Economides, Professor of Chemical and Biomolecular Engineering, University of Houston

Panel II

Dr. Paul Anastas, Administrator, Office of Research and Development, U.S. Environmental Protection Agency

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HEARING CHARTER

Review of Hydraulic Fracturing Technology and Practices

Wednesday, May 11, 2011
10:00 a.m. to 2:00 p.m.
2318 Rayburn House Office Building

PURPOSE

On Wednesday, May 11, 2011 at 10:00 a.m. the House Committee on Science, Space, and Technology will hold a hearing to review the technology and practices of hydraulic fracturing for energy production.

WITNESSES

Panel I

- **Mrs. Elizabeth Ames Jones,** Chairman, Railroad Commission of Texas
- **Dr. Robert M. Summers**, Secretary, Maryland Department of the Environment
- **Mr. Harold Fitch**, Michigan State Geologist; Director, Office of Geological Survey, Michigan Department of Environmental Quality; and Board Member, Ground Water Protection Council
- **Dr. Cal Cooper**, Worldwide Manager, Environmental Technologies, Greenhouse Gas, and Hydraulic Fracturing, Apache Corporation
- **Dr. Michael J. Economides,** Professor, University of Houston

Panel II

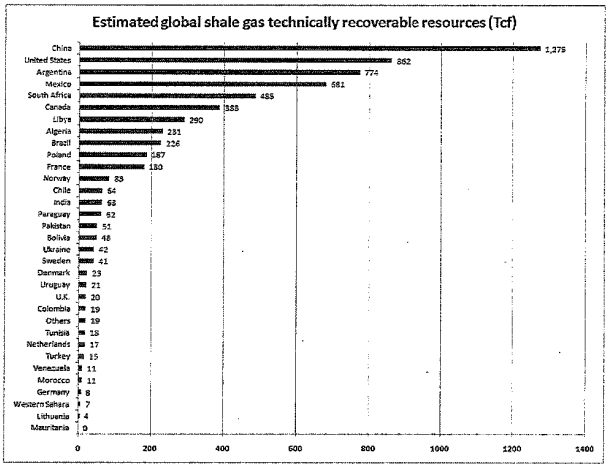
- **Dr. Paul Anastas,** Assistant Administrator, Office of Research and Development, Environmental Protection Agency.

BACKGROUND

The United States possesses 2,552 trillion cubic feet (Tcf) of potential natural gas resources. [1] To put this amount into perspective, the Energy Information Administration (EIA) reported that the U.S. consumed 22.8 Tcf of natural gas in 2009. At this rate, the 2,552 Tcf resource would supply almost 110 years of use.[2] Over 32 percent of these reserves are in the form of shale gas, ranking the U.S. second only to China in terms of technically recoverable shale gas resources (Figure 1).

[1] Energy Information Administration, http://www.eia.doe.gov/energy_in_brief/about_shale_gas.cfm Accessed April 21, 2011.
[2] Ibid

Figure 1: Global Shale Gas Resources[3]

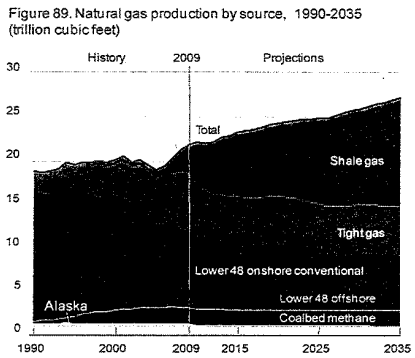


According to EIA, domestic production of natural gas from shale resources has increased substantially during the last decade, growing from 0.39 Tcf in 2000 to 4.87 Tcf in 2010, and now represents 23 percent of total U.S. natural gas production. Further increases in shale gas production are expected, with total production growing by almost threefold from 2009 to 2035 to become almost 50 percent of total U.S. natural gas production.[4]

It is projected that this increased production will enable natural gas to provide 60 percent of electricity supply increases necessary to meet demand through 2035.[5]

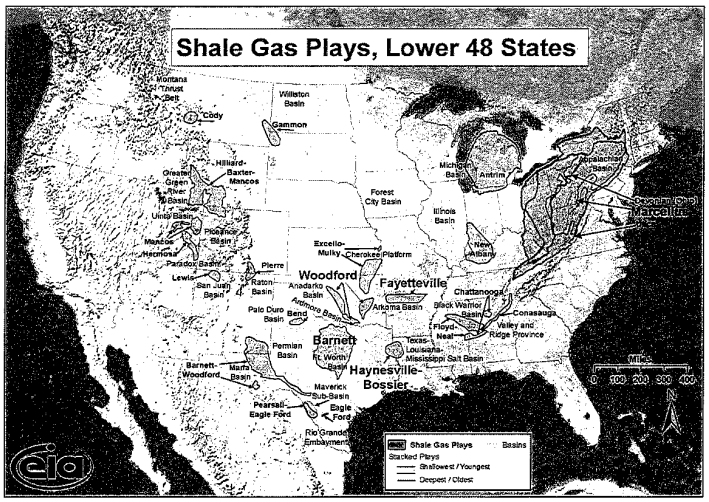
The two technological advances that have been credited with opening up shale gas are horizontal drilling and hydraulic fracturing. Although these technologies have long been used in the production of natural gas in the United States, recent advances have made their combined application to the production of shale gas economical, triggering new production activities across the U.S. The use of advanced technologies has opened the door for production of natural gas in shale formation in areas of the country that have not been typically thought of as energy producing. Figure 3 shows the major shale gas plays in the continental U.S.

Figure 2. Natural gas production by source, 1990-2035.[6]



[3] Energy Information Administration, http://www.eia.doe.gov/forecasts/aeo/ Accessed May 9, 2011 and http://www.greencarcongress.com/2011/04/eia-20110406.html Accessed May 9, 2011.
[4] Ibid.
[5] Ibid.
[6] http://www.eia.doe.gov/forecasts/aeo/images/figure_89-lg.jpg

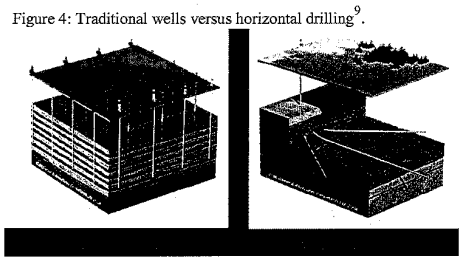
Figure 3: Shale Gas Plays, Lower 48 States[7]



Source: Energy Information Administration based on data from various published studies.
Updated: March 10, 2010

Both horizontal drilling and hydraulic fracturing are technologies with established track records. Horizontal drilling dates back to the 1930s and hydraulic fracturing has been in use since the 1950s.[8] Furthermore, horizontal drilling allows for a smaller footprint on the ground. Whereas before, dozens of wells would be drilled to access a reservoir, in many cases, now only one well needs to be drilled.

Figure 4: Traditional wells versus horizontal drilling[9].



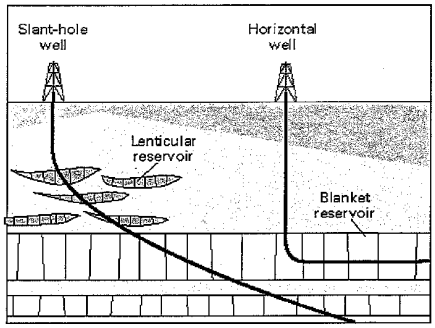
In addition, according to a 2009 report sponsored by the Department of Energy, "horizontal drilling can significantly reduce the overall number of well pads, access roads, pipeline routes, and production facilities required, thus minimizing habitat fragmentation, impacts to the public, and the overall environmental footprint."[10]

[7] Energy Information Administration, http://www.eia.doe.gov/oil_gas/rpd/shale_gas.jpg Accessed April 21, 2011.
[8] Department of Energy, *Modern Shale Gas, Development in the United States: A Primer*. April 2009.
[9] America's Natural Gas Alliance, http://www.anga.us/media/41084/safe%20responsible%20drilling.pdf. Accessed April 21, 2011.
[10] Department of Energy, *Modern Shale Gas, Development in the United States: A Primer*. April 2009.

Process of Horizontal Drilling and Hydraulic Fracturing

The advances in directional drilling sought to make use of the natural characteristics of the natural gas formations. Traditional directional drilling attempts to make a 90 degree turn by slanting the well over a distance of up to 2,000 feet. Modern horizontal drilling allows for the 90 degree turn within just a few feet.

Figure 5: Slant and Horizontal Drilling[11]



In Figure 5, the vertical lines in the reservoir represent natural fractures, an important factor in the economic production of natural gas. In order to create additional permeability in the producing gas formation, hydraulic fracturing is used to create spaces in the rock pores or fractures enabling natural gas to flow more freely to producing wells. The combination of directional drilling and hydraulic fracturing has allowed producers to economically develop shale gas plays that were previously too expensive or technologically difficult to tap into.

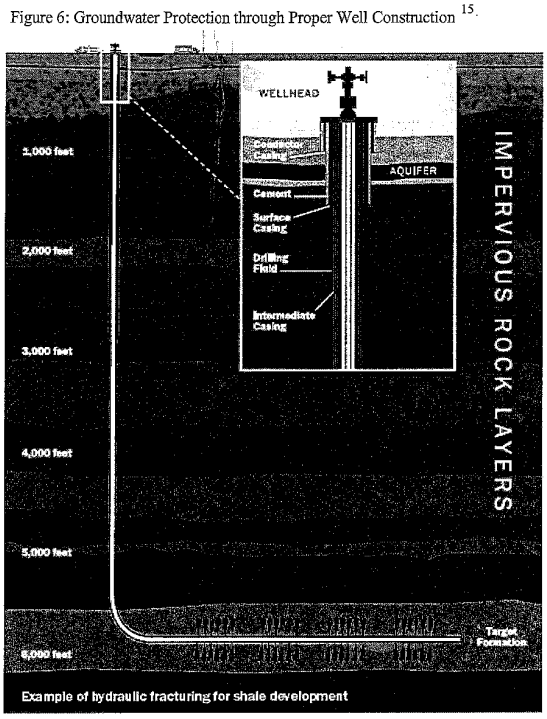
While in use for approximately 60 years, hydraulic fracturing technology has evolved since its first application, and is now a highly sophisticated and commonly employed technique used on many thousands of wells. The process involves pumping a fracturing fluid into a formation at a calculated, predetermined rate and pressure to generate fractures in the target formation.[12]

Modern hydraulic fracturing is a controlled process designed to the specific conditions of the target shale formation.[13] Knowledge of the formation details such as thickness of the shale and rock fracturing characteristics is critical to designing a successful fracture. Given the complexity of this technology, fracture design can incorporate state-of-the-art techniques including modeling and microseismic fracture mapping. These techniques are used to maximize the effectiveness of the design and then map the fractures once they are created to strategically place additional wells if needed.

Proper well construction is necessary for the protection of groundwater. As in the case with conventionally drilled wells, a steel pipe called a surface casing is cemented into place at the top part of a well and its depth is determined by, among other things, necessary groundwater protection measures. (Figure 6). This well casing and cementing is critical not only for environmental protections, but also for effective production of natural gas. Industry has developed a series of equipment-specific and standard operating practices for use in drilling and production activities.[14] These standards are often adopted by Federal and state agencies as the regulatory standards needed to comply with Federal and state permitting requirements. Such standards for well design are used regardless of whether or not hydraulic fracturing or directional drilling technologies are employed.

[11] U.S. Geological Survey, http://energy.usgs.gov/factsheets/Petroleum/drilling.html . Accessed April, 2011.
[12] Department of Energy, *Modern Shale Gas, Development in the United States: A Primer*. April 2009.
[13] Ibid.
[14] Ibid.

Figure 6: Groundwater Protection through Proper Well Construction [15].



Hydraulic fracturing uses a mixture of fluids pumped into a well to create enough pressure to fracture or "frack" the gas formation. The fracturing fluids are composed of approximately 90 percent water, 9.5 percent sand, and 0.5 percent additives such as sodium chloride and citric acid.[16] The sand proppant is used to prop open the fractures once the pumping of fluids has stopped. The additives are used for many different purposes, including maintaining fluid flow, eliminating bacteria, and thickening the water to suspend the sand.

Depending on the specific characteristics of the formation and the design of the fracture job, anywhere from 30 to 70 percent of fracturing (fracking) fluids are returned to the surface through the well.[17] The remaining, unrecovered fluids are usually trapped in the fractured formation, isolating them from underground sources of water.[18]

Environmental Management

The use of hydraulic fracturing has raised questions regarding the potential effect of this technology on drinking water supplies. The purpose of injecting fracking fluids into the ground is to create enough pressure to fracture subsurface structures. There are two distinct areas of concern regarding this process: first, the injection itself, or the creation of subsurface fractures, could allow fracking fluid to contaminate underground sources of water; and second, the handling and disposal of fracking fluids returning to the surface.

---

[15] American Petroleum Institute, *Hydraulic Fracturing: Unlocking America's Natural Gas Resources.* July 19, 2010.
[16] Ibid.
[17] Department of Energy, *State Oil and Natural Gas Regulations Designed to Protect Water Resources*. May 2009.
[18] Environmental Protection Agency. *Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs*. June 2004.

The risk of contamination of underground water sources is managed in different ways. Risks associated with leakage of the fracking fluid during the injection and fracturing job are reduced by: adherence to state well construction requirements; the vertical distance between the fractured zone and ground water; the presence of other zones between the fractured zone and the deepest ground water; and, the presence of vertically impermeable formation that act as geologic barriers to the movement of fluid from the fractured zone into groundwater resources.[19]

After drilling and fracturing are completed, the production well produces water along with the natural gas. Some of the water is returned fracture fluid and some is naturally occurring water in the formation. This produced water is managed through a variety of mechanisms including underground injections, treatment and discharge, and recycling.[20]

Federal and State Government Oversight of Hydraulic Fracturing

Natural gas development is subject to a series of Federal laws that govern certain aspects of the exploration and production processes. They include:

- The Clean Water Act (CWA) – regulates surface discharges of water associated with drilling and production in addition to storm water runoff from production sites.
- The Safe Drinking Water Act (SDWA) – regulates the underground injection of fluids.
- The Clean Air Act (CAA) – regulates emission from engines, industrial equipment, and other sources associated with drilling and production.
- The National Environmental Policy Act (NEPA) – requires exploration and production be thoroughly analyzed for potential environmental effects.[21]

State agencies are responsible for implementing the regulatory requirements set out in Federal laws. Additional State laws and requirements provide for most direct and day-to-day oversight of natural gas production operations. This oversight is usually more specific than the Federal laws, and address issues such as localized geological and geographical considerations. Separately, a national non-profit organization, originally created and sponsored by the Environmental Protection Agency (EPA), regularly reviews the adequacy of state programs to manage exploration and production waste. This organization, the State Review of Oil and Natural Gas Environmental Regulations (STRONGER), systematically analyzes individual state programs and measures program improvement over time.[22]

EPA Regulations and Studies Related to Hydraulic Fracturing

Prior to 1997, EPA considered hydraulic fracturing to be a well stimulation technique associated with production and therefore not subject to the regulatory requirements of Underground Injection Control (UIC) under the SDWA. This position was legally challenged, and the 11th Circuit Court of Appeals ruled that hydraulic fracturing of coalbed methane wells was indeed subject to the SDWA and UIC regulations under Alabama's UIC program in 1997.

---

[19] Department of Energy, *State Oil and Natural Gas Regulations Designed to Protect Water Resources*. May 2009.
[20] New York State Department of Conservation. *Draft Supplemental Generic Environmental Impact Statement: Appendix 15 Hydraulic Fracturing – 15 Statements from Regulatory Officials.* September 2009.
[21] Ibid.
[22] http://www.strongerinc.org/

In response, in 1999 EPA began to study hydraulic fracturing used in coalbed methane reservoirs and evaluate potential impacts to underground sources of drinking water. In its 2004 report "Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs", EPA concluded that injection of hydraulic fracturing fluids into coalbed methane wells poses little or not threat to [Underground Sources of Drinking Water] and USDWs and does not justify additional study at this time."[23]

In the Fiscal Year 2010 Department of the Interior, Environment, and Related Agencies Appropriations Act (P.L. 111-88), EPA was directed to carry out a second study on hydraulic fracturing, in accordance with the following report language:

> *"Hydraulic Fracturing Study.--The conferees urge the Agency to carry out a study on the relationship between hydraulic fracturing and drinking water, using a credible approach that relies on the best available science, as well as independent sources of information. The conferees expect the study to be conducted through a transparent, peer-reviewed process that will ensure the validity and accuracy of the data. The Agency shall consult with other Federal agencies as well as appropriate State and interstate regulatory agencies in carrying out the study, which should be prepared in accordance with the Agency's quality assurance principles."*

On February 8, 2011, EPA released its draft study plan for public comment and review by its Science Advisory Board (SAB)[24]. EPA has stated that, "the overall purpose of the study is to understand the relationship between hydraulic fracturing and drinking water resources. The scope of the proposed research includes the full lifespan of water in hydraulic fracturing, from acquisition of the water, through the mixing of chemicals and actual fracturing, to the post-fracturing stage, including the management of flowback and produced water and its ultimate treatment and disposal."[25]

The draft study plan includes the following fundamental research areas and questions:

- *Water Acquisition: How might large volume water withdrawals from ground and surface water impact drinking water resources?*
- *Chemical Mixing: What are the possible impacts of releases of hydraulic fracturing fluids on drinking water resources?*
- *Well Injection: What are the possible impacts of the injection and fracturing process on drinking water resources?*
- *Flowback and Produced Water: What are the possible impacts of releases of flowback and produced water on drinking water resources?*
- *Wastewater Treatment and Waste Disposal: What are the possible impacts of inadequate treatment of hydraulic fracturing wastewaters on drinking water resources?*

On April 28, 2011, the SAB released a draft of its report on the EPA draft plan.[26] Deliberations on this draft response are expected to be completed in May or June of 2011, after which will review and

[23] Environmental Protection Agency. http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/wells_hydrowhat.cfm. Accessed May 4, 2011.
[24] http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/HFStudyPlanDraft_SAB_020711.pdf
[25] Ibid.
[26] http://yosemite.epa.gov/sab/sabproduct.nsf/55EAFA25D3F322AA8525788000697B34/$File/SAB%20Report-Review%20of%20EPA%E2%80%99s%20Draft%20Hydraulic%20Fracturing%20Study%20Plan-4-28-11%20draft.pdf

consider revisions to its study plan and then immediately begin the study. EPA plans to release preliminary results of this study by late 2012 with a final report completed by 2014.

Department of Energy Working Group on Hydraulic Fracturing

On March 30, 2011, President Obama released "Blueprint for a Secure Energy Future," outlining a number of energy policy activities by his administration. Included among these was a directive to the Secretary of Energy to establish an advisory committee to "identify, within 90 days, any immediate steps that can be taken to improve the safety and environmental performance of fracking and to develop, within six months, consensus-recommended advice to the agencies on practices for shale extraction to ensure the protection of public health and the environment." The Members of this advisory group were named on May 5, 2011.

Chairman HALL. Okay. The Committee on Science, Space, and Technology will come to order, and we all say good morning and welcome to today's hearing entitled a Review of Hydraulic Fracturing Technology and Practices.

In front of each of you are packets containing the written testimony, biographies, and truth in testimony disclosures by today's witnesses. Today's hearing includes two panels which is not the typical practice of our Committee. I will have more to say about that a little bit later.

All right. I recognize myself for the first five minutes for an opening statement.

I want to welcome everyone here today for this hearing to review hydraulic fracturing technology and practices, and I thank you for your time. I know it took time to prepare yourself to travel here and to give us this time, and we are very grateful to you. The empty seats here shouldn't startle anybody because everybody has two or three Committees, and they are on them. They will be in and out of here today, but your testimony has been taken down by experts here, and it will be in the Congressional Record for the next 200 years for people to read. So we do read these things.

The primary focus of today's hearing is our study on hydraulic fracturing, and hydraulic fracturing, so far as I understand it, or fracking, is the process by which water, sand, and a small amount of additives are pumped into a well to create enough pressure to fracture formations deep within the earth. That is pretty simple, but that is what they wrote out for me to say here.

Advances in this 60-year-old technology, combined with horizontal drilling, have transformed the production of natural gas along with the natural gas industry.

Access to shale gas that was until recently uneconomical and technically unrecoverable is driving state and local economic growth all around the country with providing new sources of domestic energy to meet growing demand. As with all energy development, deep gas drilling is not without risk and concerns about potential environmental effects. This has to be examined.

However, we have to be careful to ensure that such concerns are evaluated with objectivity and within the proper context and with care taken to avoid the influence of political rhetoric. Science must drive that discussion. For example, the University of Texas just announced a comprehensive study that will do just that, separate fact and try to look at facts separate from fiction regarding the potential environmental studies of hydraulic fracturing.

Unfortunately, objectivity is not EPA's strong suit, and its draft study plan is yet another example of this Administration's desire to stop domestic energy development through regulation.

The study intends to identify the potential impacts of hydraulic fracturing on drinking water, without even taking into consideration the probability that such an effect may occur or the ability of industry best practices, state laws and direct oversight, and existing Federal laws to manage the risk associated with hydraulic fracturing. No regulation or law can totally eliminate risk. A study that does not quantify environmental risks using standard practices is useless to regulators and risk managers and as such, is a waste of taxpayers' money.

With that in regards to process, that is the process we are going through today, I want to note my disappointment with the lack of cooperation from the Administration in assembling this hearing. I am well aware that many of the members sit on multiple Committees and as such, we try to be as respectful as possible on the time demands of our members. Unfortunately, this Administration is not so respectful. We have invited six witnesses to testify this morning on hydraulic fracturing, and as you can see, there is plenty of room at the witness table to accommodate all six. However, the Environmental Protection Agency refused to permit Dr. Anastas to testify unless he was given his own panel.

This demand is counter to longstanding Committee precedent. In the last decade, EPA Senate-confirmed officials testified on single panels alongside with non-government witnesses at least eight times that we have records of. I personally wrote Administrator Jackson several weeks ago inquiring as to the rationale behind EPA's decision to treat this situation differently from prior practice and consistent with this Administration's refusal to work with the Congress, this Administrator failed to even acknowledge, let alone, respond to my letter.

The lack of courtesy and the lack of professionalism being displayed is counter to President's stated goal that his Administration would work cooperatively with the 112th Congress. Of course he wants to work cooperatively, work together now, especially in the House, and his previous attitude was we won. I hope we never go that far. EPA's actions are unacceptable, are absolutely unacceptable and going to be long remembered.

I thank the witnesses for even being here.

[The prepared statement of Mr. Hall follows:]

PREPARED STATEMENT OF CHAIRMAN RALPH HALL

I want to welcome everyone here today for this hearing to review hydraulic fracturing technology and practices.

The primary focus of today's hearing is EPA's draft study of hydraulic fracturing. Hydraulic fracturing, or fracking, is the process by which water, sand, and a small amount of additives are pumped into a well to create enough pressure to fracture formations deep within the Earth.

Advances in this 60-year old technology, combined with horizontal drilling, have transformed the production of natural gas along with the natural gas industry.

Access to shale gas that was until recently uneconomical and technically unrecoverable is driving State and local economic growth all around the country while providing new sources of domestic energy to meet growing demand. As with all energy development, deep gas drilling is not without risk and concerns about (potential) environmental effects must be examined.

However, we must be careful to ensure that such concerns are evaluated objectively and within the proper context and with care taken to avoid the influence of political rhetoric. Science must drive this discussion. For example, the University of Texas just announced a comprehensive study that will do just that—separate fact from fiction regarding the potential environmental risks of hydraulic fracturing.

Unfortunately, objectivity is not EPA's strong suit, and its draft study plan is yet another example of this Administration's desire to stop domestic energy development through regulation.

The study intends to identify the potential impacts of hydraulic fracturing on drinking water, without ever taking into consideration the probability that such an effect may occur, or the ability of industry best practices, state laws and direct oversight, and existing Federal laws to manage the risk associated with hydraulic fracturing.

No regulation or law can totally eliminate risk. A study that does not quantify environmental risks using standard practices is useless to regulators and risk managers and as such, is a waste of taxpayer money.

With regards to process, I want to note my disappointment with the lack of cooperation from the Administration in assembling this hearing.

I am well aware that many of our Members sit on multiple Committees and as such, we try to be as respectful as possible on the time demands our Members have. Unfortunately, this Administration is not as respectful.

I have invited six witnesses to testify this morning on hydraulic fracturing, and as you can see, there is plenty of room at the witness table to accommodate all six.

However, the Environmental Protection Agency refused to permit Dr. Anastas to testify unless he was given his own panel.

This demand is counter to long-standing Committee precedent—in the last decade, EPA Senate-confirmed officials testified on single panels alongside non-government witnesses at least eight different times. I personally wrote Administrator Jackson several weeks ago inquiring as to the rationale behind EPA's decision to treat this situation differently from prior practice.

Consistent with this Administration's refusal to work with this Congress, the Administrator failed to acknowledge, let alone respond, to my letter.

The lack of courtesy and professionalism being displayed is counter the President's stated goal that his Administration would work cooperatively with the 112th Congress. EPA's actions are unacceptable and will be remembered.

I thank the witnesses for being here, and I now recognize Ranking Member Johnson for five minutes for her opening statement.

Chairman HALL. And I now recognize Ranking Member Mrs. Johnson for five minutes for her opening statement. Ms. Johnson.

Ms. JOHNSON. Thank you very much, Mr. Chairman, and I must say that this is my third meeting this morning and the last two that I left many of the Committee members were still there, so I am sure they will drift in.

Thank you for holding this hearing. As Texans, Chairman Hall and I know well the importance of oil and natural gas in this country. Fossil fuels power our manufacturing base, our transportation sector, our culture sector, and more, and for the foreseeable future we rely on these resources and technologies to achieve our energy, economic, national security, and in some cases our environmental objectives.

Unconventional shale gas produced through hydraulic fracturing may very well be an integral part of our future energy mix, however, we also know that fossil fuels carry significant environmental risks. In this I am speaking of the oceans we fish, the soil we farm, the air we breathe, and the water we drink, all of which have real economic value. Nobody gets rich from clean water and air. But everybody benefits, and nobody should have the right to take those away. The Congress has acted in the past to protect these commons through legislation such as the Clean Air Act and the Safe Water Drinking Act, and results have been just that, cleaner air and safer drinking water.

However, in 2005, Congress exempted hydraulic fracturing from the Safe Drinking Water Act, and now we need to understand at what cost. Today we will hear that such regulations hinder the development of unconventional oil and gas and that more stringent regulations are not needed to protect public health and the environment.

That may or may not be the case, but we simply do not have enough data yet to say, nor will we if industry refuses to disclose the chemicals it uses and if EPA cannot do its job of determining the risks. EPA study is just in the beginning. In the next few years efforts by other agencies, various state regulators, and academic groups such as the one being undertaken by the University of

Texas Energy Institute will add to our understanding of hydraulic fracturing.

In the process EPA has also identified a number of serious issues which will be covered in subsequent studies beyond the effects on drinking water. Contrary to the industry's claim that it has been doing this safely for 60 years, this is a new suit of technologies that may have very different environmental impacts, especially given the scale of operations we see today.

Ultimately, I believe the science will speak for itself, and I sincerely hope that hydraulic fracturing proves to be as benign as the industry asserts. Regardless of the outcome of these studies let us not be fooled into believing that the drilling industry alone out of sheer benevolence will implement cleaner and potentially more costly technologies and practices. It has never worked that way and likely never will.

Without regulations to level the playing field there are few incentives to improve the environmental performance. Precaution is warranted here. We have seen recently how flawed industry practices, inadequate training and technologies, poorly-designed systems, short-sighted risk assessments, lacks governmental oversight, and sheer bad luck can have tragic and unimaginable consequences. Major disasters such as Fukushima and the Deep Water Horizon remind us of the real risk of catastrophic accidents, but they also overshadow the frequency of smaller safety incidents and spills and the pollution that escapes regulators' attentions every day. We do not have to accept this as the cost of our energy addictions. We can do better.

That said, I want to focus on what I believe is a guiding principle of this Committee, which is that technology should evolve and in the case of drilling for unconventional oil and natural gas become more efficient, safe, environmentally sustainable, and economically viable. I want to hear how advances in drilling technologies, chemicals, and practices can protect public health while providing energy to our Nation.

As the President has said, natural gas can a viable domestically-sourced option for significantly decreasing both air pollution and America's reliance on oil. I agree with the President, but I don't believe we have to compromise our values and violate the rights of Americans to cleaner water and air in the process. If hydraulic fracturing has problems, let's acknowledge it and work to advance technologies to get around them.

I look forward to this hearing and any future ones on this subject. Thank you, Mr. Chairman. I yield back.[The prepared statement of Ranking Member Eddie Bernice Johnson follows.]

PREPARED STATEMENT OF RANKING MEMBER EDDIE BERNICE JOHNSON

Thank you, Chairman Hall, for holding this important hearing.

As Texans, Chairman Hall and I know well the importance and the impact of oil and natural gas development in this country. Our economy has relied on fossil fuels to power our manufacturing base, our transportation sector, our agricultural sector, and more. And, for the foreseeable future, the country will continue to develop these resources and technologies to achieve our energy, economic, national security, and, in some cases, our environmental objectives. Unconventional shale gas produced through hydraulic fracturing may very well play an integral role in meeting these goals.

However, we must acknowledge that the development of any fossil resource can have significant negative environmental impacts. I am not speaking of the environment for its own sake, but of the very oceans we fish, the air we breathe, and the water we drink. Like oil and gas, these too have real economic value. While few people get rich from clean air and water, everybody benefits. Likewise, nobody should have the right to take those away, regardless of the potential for financial profit. This strikes me as something on which most all of our constituents would agree.

The Congress has acted in the past to protect these commons through legislation such as the Clean Air Act and the Safe Drinking Water Act, and the results have been just that —cleaner air and safer drinking water. However, in 2005, anticipating the boom to come, Congress awarded drillers with an exemption from the Safe Drinking Water Act for hydraulic fracturing.

Today we will hear from some Members and witnesses that such regulations make it difficult and more costly to extract unconventional oil and gas, and that industry does not need more stringent regulations to protect public health and the environment. Maybe we do, or maybe we don't. We simply do not have enough data yet to say, nor will we if industry is not forthcoming in disclosing the chemicals it uses and if Congress does not allow the EPA to do its job of determining the risks of these practices.

EPA's work is just the beginning. In the next few years efforts by the Department of Energy, various state regulators, and interdisciplinary academic projects, such as the one being undertaken by the University of Texas Energy Institute, and others will add to the overall understanding of the impacts of this new suite of technologies known as hydraulic fracturing. And, let us be clear that, contrary to industry claims that it has been doing this safely for 60 years, this is a new suite of technologies that may have very different and lasting environmental impacts, especially when compounded by the sheer scale of operations we see today.

If there is conclusive evidence that the chemicals and practices used by the drilling industry contaminate water supplies, Congress has a responsibility to acknowledge these new risks and protect the public. I believe the science will ultimately speak for itself, and I sincerely hope that hydraulic fracturing proves to be as benign as the industry claims.

No matter what the outcome, let us not be fooled into believing that we can rely on the industry, out of sheer benevolence, to change the way they operate or to implement cleaner, but potentially more costly, technologies. With very few exceptions, it has never worked that way, and likely never will. Without regulations to level the playing field, they simply do not have the financial incentive to do so.

It is not alarmist to exercise precaution here, nor is it unwarranted. Too often we are reminded of how flawed industry practices, inadequate training and technologies, poorly designed systems, shortsighted risk assessments, lax governmental oversight, and sheer bad luck can contribute to tragedies in the energy industry. Major disasters such as Fukushima and the Deepwater Horizon serve to remind us of the risk of truly catastrophic, and previously unimaginable, events. But, they also overshadow the frequency of smaller safety incidents and spills, as well as the lower-level pollution that escapes regulators' attention every day. We do not have to accept this as the cost of our energy addiction. We can do better.

That being said, I want to focus on what I believe is a guiding principle of this Committee, which is that technology should continue to evolve, and, in the case of drilling for unconventional oil and natural gas, become more efficient, safer, environmentally sustainable, and economically viable. I want to hear from this panel how advancements in everything from casing technologies to the recycling of water and the greening of chemicals can protect public health while still producing domestic energy sources.

Additionally, I want to hear what role the Federal Government should play in both developing and understanding the impacts of these technologies. The Department of Energy was instrumental in developing new technologies to make extraction of unconventional natural gas from shale formations feasible, and I would like to hear how such federal resources could now be leveraged to clean up these processes.

So I look forward to learning about the study that Congress has directed EPA to conduct on the impacts of hydraulic fracturing on water. While I had hoped that EPA would have been able to cover some important issues related to hydraulic fracturing other than drinking water, such as air quality, it is clear that this may have to be covered in a different study.

As the President has said, natural gas has the potential to be a viable domestically-sourced option for significantly decreasing air pollution while reducing America's reliance on oil. I agree with the President, but I don't believe we have to compromise our values and violate the rights of Americans to cleaner water and air to

get there. If there are problems with hydraulic fracturing, let's acknowledge them and work to advance technologies that remedy them.

I look forward to this and future hearings on this subject.

Thank you.

Chairman HALL. The gentlelady from Texas yields back.

If there are other members who wish to submit additional opening statements, your statements will be added to the record at this point.

At this time I would like to introduce the first panel of witnesses.

Our first witness is Mrs. Elizabeth Ames Jones, Chairman. She is the leader of the Texas Railroad Commission. That is the state agency that oversees all aspects of Texas oil and gas, natural gas industry. Mrs. Jones is a member of the Interstate Oil and Gas Compact Commission and a former member of the National Association of Regulatory Utility Commissioners and the Southern States Energy Board. Prior to her appointment to the Railroad Commission Mrs. Jones served as a member of the Texas House of Representatives. Her family are and have been long-time leaders in the energy field, and Chairwoman Jones is recognized as knowing as much or more about energy than most public servants. We are very happy to have you with us, and thank you for traveling from Austin and leaving that legislature in session there, and I hope they are working on a good Congressional District for Mrs. Johnson and for me and for the others.

Our second witness is Dr. Robert Summers, and at this time I yield to Mr. Sarbanes, the gentleman from Maryland, to introduce Dr. Summers.

Mr. SARBANES. Thank you, Mr. Chairman, for the opportunity to introduce to the Committee Dr. Robert Summers, who was very recently named by our governor, Martin O'Malley, to be the Secretary of the Maryland Department of the Environment, but he has served in the Maryland Department of the Environment for many years. He was Deputy Secretary from January of 2007, he became Acting Secretary in December of 2010, and Dr. Summers leads the Department's planning, regulatory, management, and financing programs focusing on restoring public health, insuring a safe and reliable water supply, restoring and protecting air quality, wetlands and waterways, et cetera.

He has served the citizens of Maryland for over 27 years in a variety of capacities within Maryland's environmental programs, emphasizing scientific and technical issues related to water pollution control, drinking water protection, and federal, state, and local government environmental laws and regulations.

He has a very, I think, sophisticated understanding of the interplay between the different levels of government oversight relating to these kinds of issues. It is a pleasure to have him before the Committee today, and I yield back.

Chairman HALL. The gentleman yields back. Reclaiming my time I thank you, Mr. Sarbanes, for that introduction.

Our third witness is Mr. Harold Fitch. Mr. Fitch is a Michigan State Geologist, Director of the Office of Geological Survey at the Michigan Department of Environmental Quality and a Board Member of the Groundwater Protection Council. He oversees the regula-

tion of oil, natural gas, and mining operations in the State of Michigan, and we thank you for being here.

Our fourth witness, Dr. Cal Cooper, is the Worldwide Manager of Environmental Technologies, Greenhouse Gas, and Hydraulic Fracturing for Apache Corporation. For the past few years he served on technical committees for industry associations and has spearheaded the move to publicly disclose fracturing fluids and produced waters. Prior to the service with Apache, Dr. Cooper worked for several multinational oil and gas companies throughout his career and is considered an expert in subsurface geosciences.

Our final witness on the first panel is Dr. Michael Economides, a Chemical and Petroleum Engineer and expert on energy geopolitics and a Professor at the Cullen College of Environmental at the University of Houston. Dr. Economides, am I saying that right?

Dr. ECONOMIDES. Pretty close.

Chairman HALL. He served as a technical advisor at the energy companies in Europe, Asia, and South America. He is also Editor-in-Chief of the Energy Tribune and of the Peer Reviewed Journal of Natural Gas, Science, and Engineering.

As our witnesses should know and probably do know, your testimony is limited to five minutes. We hope you can stay there, but if you go over a little, we respect that. We are not going to have a hard gamut. You have given us your time and preparation and you are here, which is more than some of the others would do. After which each Member here will have five minutes to ask each of you questions or all of you together questions, and we will stay pretty close to that five minutes if we can.

I recognize our first witness, Mrs. Elizabeth Ames Jones from the Texas Railroad Commission. Mrs. Jones.

STATEMENT OF MRS. ELIZABETH AMES JONES, COMMISSIONER, TEXAS RAILROAD COMMISSION

Mrs. JONES. Thank you, Chairman Hall and Ranking Member Johnson and Members of this Committee for the opportunity to be here before you today. I am delighted to represent the interests of Texas, a state that you so eloquently stated is prominent in the regulation of oil and natural gas. We are, in fact, the top-producing state in the country, and we regulate, have a lot of hydraulic fracturing that goes on and has been ongoing in the State of Texas for over 50 years.

So to that extent I would say that we have a little bit of expertise in this arena that everybody across the country is so interested in now. As chairman of the Texas Railroad Commission I am head of the agency that oversees Texas's rich energy resources.

Over 45 percent of all of all the rigs running in the America are running in Texas, so it is fair to say I have a bird's eye view of American energy production in the world's most prolific shale but not quite the biggest yet but the most prolific, the Barnett Shale.

My statutory obligation as an elected official who is, in fact, very, very happy to be here today, Chairman, I might add, on a panel with these distinguished panelists, it is my obligation to protect private property rights of mineral owners and to see that our energy assets, oil and natural gas, are not wasted.

As a steward of Texas's energy resources I am also a steward of the environment. As an elected official I am accountable to the people, and I must have a targeted focus and particular sensitivity to protecting public health and public safety.

The regulation of oil and gas activities including hydraulic fracturing and horizontal drilling but not limited to that, fall under the jurisdiction of the states, and we are doing a good job in this arena. The state-centered approach assures a win-win for citizens, industry, and the environment. Part of that win-win is increased energy security for America. When we produce more oil and gas in America, we import less. By putting the newest technologies to work for us across the Nation, we increase our domestic supply of oil and natural gas, and it can be quantified.

Last month the U.S. Energy Information Agency reported that natural gas imports to America declined in 2010, for the third consecutive year. Over the past 4–1/2 years we have cut our reliance on imported natural gas by a third.

So what happened? America's shale gas production more than tripled from 2007, to 2010. The point is this. Producing more of our own resources really does mean energy security for our country, and I mean, if that is—these facts are not a definition of that energy security, I don't know what is.

The good news is the American people have a reliable energy source we can call our own, and we have it because the technologies developed in America, by Americans, and I might add that was primarily right there in the Barnett Shale field today, in the last 20 years, this technology is making it possible.

The bad news is the current proliferation of misrepresentation and myths regarding this proven technology, and I am talking about hydraulic fracturing, the subject of today's Committee hearing. It is a technology that generates American jobs and lowers energy costs for American consumers, and it has the potential to fuel the economic recovery of this country.

It would be a travesty if the mistruths succeeded in driving up energy costs and forcing Americans to abandon the most promising and prolific energy source to come along in 100 years, natural gas. The truth is that all Americans benefit mightily from hydraulic fracturing and the horizontal drilling that is going on and the oil because it is also producing oil and natural gas resources produced.

There are those, unfortunately, who are willing to undermine this technological innovation by raising false specters of environmental hazards and unsafe drinking water. Americans deserve better. Americans deserve the truth, not a fractured fairytale. I will tell you right now. As an elected official of the State of Texas, not once has a case of groundwater contamination from hydraulic fracturing ever been confirmed by the Railroad Commission of Texas. For fracturing fluid or the natural gas or oil to affect the water table in Texas, those substances would have to migrate upwards of thousands of feet of rock, sometimes even miles. It is simply geologically impossible. The stories of environmental damage or contaminated drinking water from hydraulic fracturing are simply untrue. You have a better chance frankly of hitting the moon with a Roman candle than fracturing into fresh water zones by hydraulic fracturing shale rock.

Furthermore, I believe it is morally wrong to deprive Americans of the benefit of their God-given natural energy resources because a few special interest Grimm Brothers insist on perpetrating fairytales. If the EPA falls victim to this disinformation and institutes the new regulations that are being considered today, over half our oil and natural gas wells would be eliminated. Nearly 200,000 barrels of oil per day, 245 billion cubic feet of natural gas a year would stay buried in the ground. The Federal Government would lose billions, up to $4 billion supposedly in revenue, states could lose $785 million in revenue, not to mention the lost jobs.

I appreciate the opportunity to be here today. You can tell that I do have an opinion on this subject, and I am glad to be able to share it and will look forward to the questions. Thank you.

[The prepared statement of Mrs. Ames Jones follows:]

PREPARED STATEMENT OF MRS. ELIZABETH AMES JONES, COMMISSIONER, TEXAS RAILROAD COMMISSION

Introduction

The regulation of oil and gas exploration and production activities, including hydraulic fracturing and horizontal drilling falls within the jurisdiction of the states. The Texas Railroad Commission (RRC) has been regulating the mining of hydrocarbons for 100 years. The Commission no longer over sees the rail industry.

Texas is the largest producer of oil and natural gas in the country. From the drill bit to the burner tip, the oversight of the oil and natural gas industries that operate in Texas, including the responsibility to prevent and to abate surface and ground water pollution related to oil and gas development in state lands and waters, falls under the jurisdiction of the Railroad Commission of Texas. With over one million wells drilled, the RRC is responsible for more oil and gas wells than any other entity in the nation. Currently, 45% of all the rigs running in the United States of America are in Texas. Market forces and the introduction of new technologies developed in Texas, like hydraulic fracturing and horizontal drilling, made shale gas production profitable in the 1990s. Since then, Texas' natural gas production has increased more than 50 percent. Never in this period has hydraulic fracturing been a contributor to groundwater contamination.

The Railroad Commission of Texas and Hydraulic Fracturing

The RRC's regulatory framework for well construction and water protection, which extends well beyond just hydraulic fracturing, protects surface water and groundwater in a very effective manner. Like other aspects of our comprehensive regulatory framework that covers virtually all oil and gas activities, our regulatory practices addressing hydraulic fracturing are the culmination of over 50 years of experience. The recent expansion in hydraulic fracturing activity in the Barnett Shale produced more than 13,000 gas wells. Even with such a dramatic increase in activity, not once has Texas experienced a case of groundwater contamination caused by hydraulic fracturing. I do not know of a single reported case of contamination nationwide.

The Texas regulatory framework emphasizes well construction with multiple layers of protection for groundwater. Our inspectors conduct thousands of inspections and tests annually to ensure regulatory compliance.

Protection of water resources that can be used for human consumption should be of the utmost importance to every community, and it certainly is to the RRC. The location and depth of the underground strata from which that water is taken is very important when discussing hydraulic fracturing. While those depths vary regionally, in Texas the strata from which water to be used for human consumption is generally thousands of feet, perhaps miles, above the targeted formations during the hydraulic fracturing process. For example, the water table can extend to a depth of 1000 feet in some areas of the Barnett Shale. The horizontal lateral pipes are located more than one and a half miles below the surface.

Additionally, the volumes of fluids other than water that are being injected must also be kept in mind. Water typically makes up more than 99% of the liquids in fracturing fluid; e.g., the percentage of non-H_2O compounds may be approximately 0.05% in a job utilizing 5 million gallons of water.

Cooperation among governmental agencies is a necessity to successfully ensure environmental mitigation. Before permitting a well for hydraulic fracturing, we

must receive certification from our sister agency, the Texas Commission on Environmental Quality (TCEQ), that identifies where the location and depths of groundwater must be protected by cement and steel casing. TCEQ geologists and hydrologists evaluate the well logs from previous wells in the area around any proposed well to determine the required depth of surface casing to ensure the protection of fresh water formations. An operator must obtain this certification from the TCEQ and must present it to the RRC before we will even consider issuing a drilling permit. In every new well, the RRC requires that heavy steel surface casing extend beyond the deepest fresh water formation. Surface casing must be pressure tested for leakage before restarting drilling activity as an additional safeguard.

Whether it is fracturing fluid, oil or natural gas, to affect the usable quality of water, those substances would have to migrate upward through thousands of feet of rock. That is physically impossible. For produced water that is recovered at the surface from the well to contaminate fresh water formations, a leak in the heavy steel surface casing and a breach of the other protections would have to occur. There is no evidence or history of that ever occurring in Texas.

Interstate Coordination

Since the regulations of these activities fall under the states' jurisdiction, it is essential for oil and gas producing states to work cooperatively and to share information. The RRC actively participates in the Interstate Oil and Gas Compact Commission (IOGCC), the national Groundwater Protection Council (GWPC), and STRONGER (State Review of Oil and Natural Gas Environmental Regulations). The RRC is proud to state that our Chief Geologist was the chair of the STRONGER workgroup that developed their guidelines for hydraulic fracturing. Our staff may be some of the most talented available today.

Participation with the GWPC and the IOGCC led to the initiation of a national registry to voluntarily disclose the chemicals used during hydraulic fracturing. Our heavy involvement with the GWPC and the IOGCC led to the development of the website-FracFocus. This coordinated effort worked closely with producers and service companies to develop a format allowing the submission of well and chemical data. Many of the active shale gas producers have stated their intent to provide this information, and numerous regional and national oil and gas associations have endorsed the project.

STRONGER was initially directed to review state drilling fluids and produced water management. This purview was expanded in 2010 to address hydraulic fracturing regulations in response to public concerns. As stated above, the RRC was heavily involved in that process. Since then, STRONGER has conducted reviews in multiple states. These reviews provide significant benefits to the states demonstrating the effectiveness of regulatory programs by bringing in experts from across the nation to identify possible regulatory improvements. Some of these experts are RRC employees. STRONGER reviews demonstrate in a clear and public process that state programs are sound and effective. Our program is sound and effective.

Risk Management and Drinking Water

The best avenue to risk management is concentrated and prudently developed experience. The history of hydraulic fracturing goes back decades. It was first commercially employed in 1948. As many of you know, the Safe Drinking Water Act (SDWA) was enacted in 1974 to protect public water. Hydraulic fracturing had been commercially utilized for 25 years at that time, and the SDWA never considered it as an issue. For the next 22 years the SDWA was debated and amended only twice, and both times hydraulic fracturing was never discussed. In 1997, a court case, Legal Environmental Assistance Foundation (LEAF) vs. Environmental Protection Agency (EPA), brought the process of hydraulic fracturing into question without considering any legislative history or environmental impacts.

In 2002, for the first time ever, the EPA released a draft study on hydraulic fracturing concluding the process does not pose a risk to drinking water. To lay the alarm to rest, the US House passed the bipartisan 2005 Energy Bill clarifying that Congress never intended for hydraulic fracturing to be regulated under the SDWA. Only recently has there been a growing impetus to further regulate the fracturing process even though over 50 years of history record no harm to drinking water from the process. And, for over those 50 years, the RRC has cautiously, expeditiously and thoroughly monitored the process and collected data while upholding our goals to protect public health and safety and to prevent the waste of our mineral assets.

Through our many years of experience with the hydraulic fracturing process, we have developed a reliable regulatory framework based on sound science, technical expertise and common sense. The RRC regulations address pad site surface oper-

ations, water use and wastewater disposal/storage, casing requirements and injection procedures. Any state experiencing the economic blessings of shale developments concerned with acquiring appropriate regulatory schemes should look to Texas.

A very important aspect of being a regulator is managing complaints and properly conducting inspections by competent geologists, engineers and other scientists to ensure regulatory policies are upheld and enforced. At the RRC, handling complaints is one of the most critical functions of our Field Operations section. Frequently, responsible industry participants will notify us of bad operators in an attempt to avoid the industry-wide problems and publicity caused by irresponsible oil and gas operators.

Once a complaint is received and a docket is assigned, an initial inspection is made with or without the complainant. This inspection is immediate in the case of imminent danger due to pollution or a threat to public health. Both parties, the complainant and the respondent, are entitled to our inspection report to ensure transparency and due process.

Once the field personnel are deployed to investigate a contamination, they utilize a variety of procedures to confirm if contamination exists, what the source is, and how to eliminate the source and to initiate clean up if necessary. To make this determination, field staff collects water samples from the well and other water wells in the area for testing and comparison analysis. They also collect samples of produced water from oil or gas wells within a quarter-mile of the subject water well. Bacteriological samples are forwarded to the local health department, and the surrounding area approximately a quarter-mile from where the subject water well is inspected. This area inspection includes an investigation into disposal or injection wells, oil and gas storage and treatment facilities, both current and abandoned pits, flow-lines, evidence of past leaks or spills, any creeks and streams, and any other situation that may shed light on a possible contamination. If a water contamination is verified, the case is sent to the Site Remediation division for clean up efforts. If enforcement action is necessary, our Office of General Counsel pursues the necessary filings.

A recent case of interest where the RRC applied these sound principles and due process is the situation in which the EPA alleged that natural gas from a well operated by Range Resources, a Texas-based company, migrated into water wells in North Texas. Our Commission field staff fully vetted the area and sent those investigative reports to our administrative hearings' examiners to either confirm a contamination had occurred and if so then to determine the source. After weeks of technical and legal investigations and the presentation of arguments in keeping with the Administrative Procedures Act, my fellow commissioners and I ruled there was no evidence of natural gas contamination attributed to Range Resources. We are confident in our ruling, and we stand behind the RRC process. This case exemplifies the RRC's success in properly regulating the Texas energy industry, which regulation includes making decisions based on sound science and accepted and approved testing methods, while ensuring that mineral interest owners can enjoy the monetary benefit of their property ownership and that the state benefits accordingly.

EPA's Draft Plan

The EPA's original charge was not to study the "full life cycle" of an oil and gas well, inclusive of all oil and gas exploration and production activity such as site selection and development, production, storage and transportation, all of which are unrelated to hydraulic fracturing. EPA's own Science Advisory Board rightfully concluded that the scope of the study should be restricted, at least initially, to researching sources and pathways of the potential impacts of hydraulic fracturing on water resources. The RRC submitted comments on the draft plan a month and a half ago. We concur with the EPA's Science Advisory Board and believe that the scope of the draft plan remains broader than that which Congress may have intended. This raises concerns of scope creep.

Our two main concerns about the EPA's study are that it proposes to delve into areas beyond the reach of federal law and that it also proposes to study areas beyond the practice of hydraulic fracturing. Specifically, the EPA now includes a study of how water withdrawals might impact water availability and water quality. Water availability and water withdrawal have historically been the issues of state law, and we believe is beyond the reach of federal law and regulation. In addition, the EPA proposes to study the potential impacts of spills, containment, treatment, and disposal of wastewaters resulting from hydraulic fracturing. There is no need for the EPA to enter into these issues since there already exist controls on oil and gas activities in federal law, which include the SDWA, Clean Water Act (CWA), Clean Air Act (CAA), and Resource Conservation and Recovery Act (RCRA). Furthermore,

there are a myriad of state laws and regulations actively being enforced by the states that care just as deeply for our state and national resources. Another federal study is just a waste of taxpayer money.

The EPA has performed similar studies in the past. In the 1980s, the EPA performed an exhaustive study of oil and gas activities and wastes with respect to the Resource Conservation and Recovery Act (RCRA). There is no need for new information on the comprehensive process of oil and gas exploration and production. For this reason and in an effort to save time and money, we recommended the scope of study return to that directed by Congress-focus on practices directly associated with hydraulic fracturing and drinking water resources. With that said, I have offered the RRC and its staff as a resource to both the EPA and the Science Advisory Board in this endeavor to conduct an evaluation of the chemicals used in the fracturing process. Furthermore, I would eagerly join the discussion on the development of other alternatives, the evaluation of well construction and maintenance, evaluation of fracture development, and development of best management practices. As stated above, we have been doing this in Texas for over 60 years, the technology to advance these practices and make shale development possible was pioneered in Texas, and we have the most experience with the largest shale play in the nation.

Finally, when operators complete the required RRC forms, they list the amount and kind of material used during hydraulic fracturing. Additionally, service companies are required by the Office of the Safety and Health Administration (OSHA) to post on site Material Safety Data Sheets of all chemicals used on a drilling location for on-site employees and emergency first responders.

Economic Generator

Hydraulic fracturing has made the impossible possible. It allows access to oil and natural gas trapped in areas that were unobtainable in the past. This process is responsible for 30% of the nation's domestically recoverable oil and natural gas. Seven billion barrels of oil and 600 trillion cubic feet of natural gas have been recovered by hydraulic fracturing.

Some say that up to 90% of wells operating today are because of hydraulic fracturing and 60–80% of new wells will need hydraulic fracturing to continue to production.

In 2007, $226 billion was invested in domestic exploration and production. This is an economic generator that supports local businesses and creates American jobs. Royalties paid totaled $30 billion in 2007. Without delving too far into how this business drives up local, state and federal tax revenue, it is exciting to note that 33 school districts in Texas are funded mostly by oil and gas dollars alone.

If some of the new EPA regulations considered today are implemented, more than half our oil and natural gas wells could be eliminated. America's production of domestic energy resources would diminish by 183,000 barrels of oil per day and 245 billion cubic feet of natural gas annually. The Federal Government would lose $4 billion in revenue, and the states would lose $785 million in taxes, not counting the additional jobs lost.

The American Petroleum Institute engaged IHS Global Insight to study potential impacts of policy changes for hydraulic fracturing. They reported that all states will feel a decline in economic activity, but some states are more affected than others. The most affected will be Texas. By 2015, Texas could lose up to 364,000 jobs. These are jobs that paid an estimated $30,000 per job in taxes and royalties to Texas in 2009 and provide the average oil and gas worker with a salary of about $107,000 per year. For comparison, consider that the rest of the private sector workforce in Texas earns an average of $44,000 per year. The report concludes that Texas could experience a loss of nearly $37 billion in gross state product. The country will suffer when a domestic homegrown energy source is diminished.

Texas is not the only state affected. The analysis concludes that in addition to Texas, Oklahoma, Kentucky and West Virginia will suffer the largest natural gas production decline. Wyoming joins the aforementioned group in terms of employment and real output declines in the excess of 7%. Nevada, Colorado, Montana, Arizona, and Florida are all mentioned. And, if development does not continue in New York and Pennsylvania, then they will see a loss also.

Summary

In closing, I understand there is a broad concern in the public related to hydraulic fracturing. I am not here to belittle or to disregard that concern. Rather, I am here to provide confidence to the public that these activities can be, and in Texas are, safe, secure and sufficiently regulated. Furthermore, the production increase due to these operations is a blessing to our nation, and we should be proud of the technological innovations discovered and perfected in America, more specifically, in Texas.

There is a French delegation back in Texas meeting with RRC staff learning how to establish appropriate regulatory protocols for all activities related to natural gas production via the process of hydraulic fracturing and horizontal drilling. These foreign officials are already convinced of the benefits. These are not the only foreign officials to visit. In the past year, we have had numerous foreign consulates and ambassadors knocking on our door wanting to learn from our successes in Texas and apply our process to their respective countries. Technology is working the way it was intended- improving our quality of life.

The numbers do not lie. In Texas alone, we could lose over 364,000 jobs and almost $37 billion if this practice is outlawed. The numbers for the entire country are even greater. The truth is that America and Texas benefit substantially due to the practice of hydraulic fracturing and horizontal drilling. Any stories of environmental damage or contamination of drinking water from hydraulic fracturing are fairy tales.

From 2007 to up until last year, net imports of natural gas have decreased by about 1.2 trillion cubic feet. My goal as Chairman of the Railroad Commission is energy security for our country; a diminished reliance on imported energy of any kind, be it natural gas or oil. Declining imports that are a direct result of increased domestic supply that result from putting technology to work is the news the American people want to hear. They are sick and tired of fractured fairy tales and they deserve to hear the truth. Thank you for the opportunity to speak it today.

Chairman HALL. Well, I do thank you, and at this time I recognize Dr. Robert Summers, Secretary for the Maryland Department of the Environment, to present his testimony.

Dr. Summers.

STATEMENT OF DR. ROBERT M. SUMMERS, SECRETARY, MARYLAND DEPARTMENT OF THE ENVIRONMENT

Dr. SUMMERS. Thank you, Chairman Hall and Ranking Member Johnson and Congressman Sarbanes for your introduction and other Members of the Committee. Thank you for the opportunity to share Maryland's experience and concerns with hydraulic fracturing.

I am Bob Summers, newly-appointed Secretary of the Environment. Portions of the Marcellus Shale formation underlie Garrett County and part of Allegheny County in Western Maryland. In these two counties gas companies have leased gas rates on more than 100,000 acres so far. An industry representative has estimated as many as 2,200 wells could be eventually drilled on 180,000 acres in Maryland, so obviously, we are fairly small compared to my—the previous speaker.

But this represents about one well for every 80 acres leased, and Western Maryland is a very popular recreation destination for millions just living 3–1/2 hours to the east in major metropolitan areas, and citizens and businesses in Western Maryland are very concerned about the potential impact of widespread drilling.

The Department of the Environment is the regulatory agency with the responsibility for permitting gas wells in the state. We currently have applications pending for drilling and hydraulic fracturing, but no permits have been issued at this point. We are mindful of the tremendous benefits that we just heard about that can accrue to the economy by exploring and developing our gas reserves.

At the same time we have observed events in Pennsylvania during the first few years of drilling there, and we are equally alert to the potential adverse impacts on public health and the environment.

As a result, we are proceeding in a cautious and deliberative manner. We have issued no permits, and we do not intend to allow drilling and fracking in Maryland until the issues are resolved to our satisfaction. There are numerous issues that must be addressed before Maryland can conclude whether and how drilling in Marcellus Shale can be done safely. There include the adequacy and sustainability of regional surface water and groundwater supplies needed for fracking, minimum requirements for constructing, casing, cementing, integrity testing of wells, installing and testing blow-out prevention equipment, potential migration of gas from the well, including migration from induced or naturally-occurring faults and fractures. Toxicity transport and fate of fracking fluid, proper handling and disposal of naturally-occurring radioactive materials, best practices for managing and disposing of flowback, drilling mud and drill cuttings, the need for refracturing, its potential effect on well integrity, measures to control air pollution, including greenhouse gas emissions and ozone production.

We are also concerned about impacts to aquatic ecosystems, habitat fragmentation, introduction or spread of invasive species, and damage to wetlands and streams from access roads, drill pads, gathering lines, and ancillary operations. Not to mention increased truck traffic, public safety, and emergency response services.

We anticipate moving forward in two stages. First, during the next year to 18 months we will survey existing practices, select best practices for drilling and fracking of wells. The Department will consider permits for a small number of exploratory wells to be drilled and fracked in the Marcellus Shale using these standards and cites eligible for these exploratory wells must be those who would present minimum risks to human health and the environment.

The permits will be conditioned on the company's commitment to collect and share data with the state regarding all aspects of the drilling and fracking process, monitoring of wastes, monitoring of surface and groundwater quality in the zone of influence and the risks and adequacy of best practices.

Second, we will use the data from these wells, along with the results of other research as it becomes available, to evaluate the environmental viability of gas production from the Marcellus Shale in Maryland. This phase will focus on long-term and cumulative risks, including landscape level effects like I mentioned with forest fragmentation. If we determine that gas production can be accomplished without unreasonable risks, the Department would then make decisions on applications for production wells.

We are also concerned about the impact on our waters and citizens from drilling and fracturing-associated activities in nearby states. We are, in fact, pleased that EPA Region 3 has recently taken a more active role in overseeing drilling operations. The region has provided guidance on important issues such as the need to reopen discharge permits of facilities that treat Marcellus Shale fracking water and to initiate monitoring to ensure drinking water supplies are not impacted by the discharge of the treated waste water.

We need the Federal Government to take an active role in studying, providing technical support to the state. We commend Con-

gress for directing EPA to conduct research to examine the relationship between hydro fracking and drinking water resources, and while we firming believe the states need to retain the authority to enact more stringent requirements, the Federal Regulatory floor would ensure at least basic protection of the environment and public health.

Interstate waters such as the Susquehanna and Potomac Rivers, Chesapeake Bay, are critical resources to all of the jurisdictions in the region and provide drinking water for millions of people. We need to ensure that these critical water supplies are protected, and toward that end existing federal regulatory exemptions for oil and gas drilling activities should be re-examined. In this regard we support Fracturing Responsibility Awareness of Chemicals Act, H.R. 1084, which was introduced by Representative DeGette and cosponsored by Representatives Sarbanes, Tonko, and Woolsey, among others. This would reinstate regulation of hydraulic fracturing under the Safe Drinking Water Act, and we think this is an important step.

The states need the Federal Government to provide guidance and to lend its resources to this effort. We have a strong federal-state partnership in Maryland with EPA and EPA Region 3 to protect our public health, safety, the environment, and natural resources. And we need to maintain this. None of us have the resources we need by ourselves to deal with these very complex issues, and it is important that we have a strong team approach.

Thank you for taking the initiative to inquire about this important issue.

[The prepared statement of Dr. Summers follows:]

PREPARED STATEMENT OF DR. ROBERT SUMMERS, SECRETARY FOR THE MARYLAND DEPARTMENT OF THE ENVIRONMENT

"Hydraulic Fracturing Technology and Practices"—Major Points

Portions of the Marcellus Shale formation underlie Garrett County and part of Allegany County in western Maryland. We are mindful of the benefits that could accrue to the economy, but we are equally alert to potential impacts on public health and the environment.

Maryland has issued no permits for exploration or production of gas in the Marcellus Shale, and we do not intend to do so until the legitimate issues are resolved to our satisfaction. Among the most important are these:

- Construction standards for wells and pads;
- Testing standards for well integrity and blowout prevention devices;
- The potential for migration of gas from the well;
- The toxicity, transport and fate of fracking fluid that remain underground;
- The proper handling and disposal of flowback and other liquid wastes;
- Control of air emissions, including greenhouse gases and ozone; and
- Landscape level impacts such as habitat fragmentation, introduction or spread of invasive species, and damage to wetlands and streams from access roads, drill pads, gathering lines, and ancillary operations.

Maryland proposes to move forward in stages:

- Identify best practices for on site operations from site selection through fracking, and develop model permit provisions;
- Allow a small number of exploratory wells to be drilled and fracked in order to obtain data;
- Depending on the results, these wells may then be permitted to produce gas; and

- Use the information obtained from the exploratory wells, and other available information, to complete the evaluation of issues, and decide whether and how to proceed with permitting.

We need the Federal Government to take an active role in studying, providing technical support to States and assisting the States in regulating activities such as deep drilling, horizontal drilling, hydraulic fracturing, and waste disposal.

- The EPA draft Hydraulic Fracturing Study Plan is a good start, but there are important areas it does not address.
- With sufficient direction, States could collect monitoring data and data about drilling and fracking that EPA could use in its study.
- A federal regulatory "floor" would be helpful, especially given the interstate nature of the surface and groundwater.
- Existing federal regulations that exclude oil and gas drilling wastes from coverage should be reexamined.

"Hydraulic Fracturing Technology and Practices"

Chairman Hall, Ranking Member Johnson and honorable members of the Committee, thank you for the opportunity to share Maryland's experience and concerns with hydraulic fracturing.

The Marcellus Shale in Maryland

In these two counties, gas companies have leased the gas rights on more than 100,000 acres. The Department of the Environment is the regulatory agency with responsibility for permitting gas wells in the State. We currently have applications pending for drilling and hydraulic fracturing ("fracking") in the Marcellus Shale from two companies for a total of five wells. An industry representative has estimated that as many as 1,600 wells could be drilled in 128,000 acres in Garrett County and another 637 wells in 51,000 drillable acres in Allegany County. We are mindful of the tremendous benefits that could accrue to the economy by exploring and developing our gas reserves. Lease payments, royalties, and in Garrett County, severance taxes, and the economic activity associated with drilling-related jobs could bring significant economic benefits to these western counties. At the same time, we have observed events in Pennsylvania during the first few years of drilling there, and we are equally alert to potential adverse impacts on public health and the environment. Our paramount concern is protecting our ground and surface waters. As a result, we are proceeding in a cautious and deliberative manner. We have issued no permits, and we do not intend to allow drilling and fracking in Maryland until the issues are resolved to our satisfaction.

Environmental, Public Health and Public Safety Concerns

There are numerous issues that must be addressed before Maryland can conclude whether and how drilling in the Marcellus Shale can be done safely. They include:

- minimum requirements for constructing, casing and cementing wells
- minimum requirements for integrity testing of wells
- minimum requirements for installing and testing blowout prevention equipment
- the potential migration of gas from the well, including migration from induced or naturally occurring faults and fractures
- the toxicity, transport and fate of fracking fluid
- proper handling and disposal of naturally occurring radioactive materials
- best practices for managing and disposing of flowback
- best practices for managing and disposing of drilling mud and drill cuttings
- best practices for containment and management of fuels and other liquids
- air pollution, including greenhouse gas emissions and ozone production
- re-fracturing and its potential effect on well integrity
- habitat fragmentation, introduction or spread of invasive species, and damage to wetlands and streams from access roads, drill pads, gathering lines, and ancillary operations
- other impacts to aquatic ecosystems, including stream sedimentation from damaged roads and dust from truck traffic
- the adequacy and sustainability of regional surface water and ground water supplies needed for fracking
- public safety and emergency response services

Additional research and study is needed in each of these areas in order to be fully protective of public health and safety and the environment.

Maryland Legislation

Public interest and concern brought the issue of Marcellus Shale drilling to the attention of Maryland legislature this year, which recently concluded its 90-day session. One bill was introduced to accelerate the issuance of drilling permits, another to place the burden on each applicant for a permit to demonstrate the safety of drilling and fracking, and another to require a study before permits could be issued. The Governor and the Department supported a bill to require the State to perform a comprehensive study of short-term, long-term and cumulative effects of hydraulic fracturing, to be paid for by those gas companies holding leases in Maryland. None of the bills passed.

How the Maryland Department of the Environment Proposes to Proceed

We anticipate moving forward in two stages. First, during the next year to 18 months, we will survey existing practices [1]and select "Best Practices" for the drilling and fracking of wells. These Best Practices will cover all aspects of site preparation and design, delivery and management of materials, drilling, casing, cementing and fracking. After we develop this interim "gold standard" the Department will consider issuing permits for a small number of exploratory wells to be drilled and fracked in the Marcellus Shale using these standards. Sites eligible for these exploratory well permits must present minimum risks to human health and the environment. The permits will be conditioned on the company's commitment to collect and share data with the State regarding all aspects of the drilling and fracking process, monitoring of waste produced, monitoring of surface and ground water quality in the zone of influence of the operation and any other information needed to advance our understanding of the risks and the adequacy of the Best Practices.

Second, we will use the data from these exploratory wells, along with the results of other research as it becomes available, to evaluate the environmental viability of gas production from the Marcellus Shale in Maryland. This phase will focus on long-term and cumulative risks, and include landscape level effects like forest fragmentation. If we determine that gas production can be accomplished without unreasonable risk to human health and the environment, the Department could then make decisions on applications for production wells. Permit conditions would be drafted to reflect Best Practices and avoid environmental harm. At this time, we have not identified a source of funding for this work.

Maryland is also concerned about the impact on its own waters and citizens from drilling and hydraulic fracturing and associated activities in nearby states. Pennsylvania has experienced incidents of well blowouts and releases of flowback. It has been reported that inadequately treated hydraulic fracturing wastewater has been discharged to surface water in Pennsylvania. The potential risk to Maryland of repeated incidents in Pennsylvania, the most recent of which resulted in it release of flowback to a tributary of the Susquehanna River in April, prompted the Attorney General of Maryland to send a notice letter to the companies involved in the April release, asserting Maryland's right to bring a citizen suit for injunctive relief and civil penalties under the provisions of the Resource Conservation and Recovery Act (RCRA) and the Clean Water Act (CWA).

The Need for Federal Leadership

We need the Federal Government to take an active role in studying, providing technical support to States and assisting the States in regulating activities such as deep drilling, horizontal drilling, hydraulic fracturing, and waste disposal. In the absence of a strong federal regulatory program, the burden of assuring that wells can be safely drilled and hydraulically fractured in the Marcellus Shale falls on the states individually.

We commend Congress for directing the Environmental Protection Agency (EPA) to conduct research to examine the relationship between hydraulic fracturing and drinking water resources. EPA's Office of Research and Development has developed a solid, comprehensive plan for this study; however, we note that some important issues are beyond the scope of the study, including re-fracturing, and impacts to air quality and terrestrial and aquatic ecosystems. These issues also need to be studied.

At EPA's request, the Science Advisory Board (SAB) is reviewing the study plan. Preliminary indications are that the SAB recognizes the importance of the study,

[1] We will survey information from other states, but we note that there are regional differences in geology, climate, and formation composition that may limit the applicability of some methods in Maryland. For example, disposal of wastewater in underground injection wells, common in some areas, may not be feasible in Maryland.

as well as the challenges posed by the limited budget and time frame. It may suggest a narrowing of the focus of the study, but also additional research activities. Among those mentioned that Maryland considers to be of critical importance are: identifying best practices for well construction and whether those practices protect public water supply; and evaluating the potential release of contaminants to underground sources of drinking water through naturally occurring or induced faults.

While the states should retain the authority to enact more stringent requirements, a federal regulatory "floor" would ensure at least basic protection of the environment and public health. Federal regulation is particularly important given the interstate nature of surface and ground waters and the fact that states do not have jurisdiction over out-of-state drilling and fracking activities, even when those activities could have significant impacts on water quality in neighboring states. Interstate waters such as the Susquehanna and Potomac Rivers and the Chesapeake Bay, are critical resources to all of the jurisdictions in the region.

Existing regulatory exemptions for oil and gas drilling activities should be re-examined. For example, gas and oil exploration and production wastes are currently excluded from RCRA Subtitle C regulation. The Clean Water Act was amended to expand the regulatory exemption for stormwater runoff to cover all oil and gas field activities and operations, not just uncontaminated stormwater runoff from certain operations. The injection of hydraulic fracturing fluids is excluded from the Safe Drinking Water Act's Underground Injection Program. In this regard, we support the Fracturing Responsibility and Awareness of Chemicals Act, H.R. 1084, which was introduced on March 15, 2011, by Representative DeGette and co-sponsored by Representatives Sarbanes, Tonko and Woolsey, among others. The Bill would reinstate regulation of hydraulic fracturing under the Safe Drinking Water Act and require the person conducting hydraulic fracturing operations to disclose to the government all of the chemical constituents used in hydraulic fracturing. This is a positive step forward. Under the bill, however, proprietary chemical formulas could still be protected from public disclosure, and we encourage a reexamination of the scope of protection for proprietary information. The public has an important interest in knowing what chemicals are being injected underground.

We note also that Region III of the EPA has recently taken a more active role in overseeing drilling operations in the Marcellus Shale. It provided guidance on important issues, such as the need to reopen the discharge permits of facilities that treat Marcellus Shale fracking wastewater, and to initiate monitoring to ensure that drinking water supplies are not being impacted by the discharge of the treated wastewater. More recently, following a release of fracking fluid at the Chesapeake Energy gas well in Bradford County, Pennsylvania, EPA Region III used its authority under the Clean Water Act, the Comprehensive Environmental Response, Compensation and Liability Act (commonly called Superfund), and the Resource Conservation and Recovery Act to require Chesapeake Energy to provide information and documents regarding the release, including the exact chemical identity of each constituent in the fracking fluid.

We are also encouraged by President Obama's "Blueprint for a Secure Energy Future," which he announced on March 30. In particular, we welcome the plan to have the Energy Advisory Board establish a subcommittee to identify immediate steps that can be taken to improve the safety and environmental performance of fracking and to develop consensus recommendations for federal agencies on practices that will ensure the protection of public health and the environment. Secretary of Energy Chu named the group on May 5. The planned establishment by DOE and EPA of a mechanism to provide technical assistance to states to assess the adequacy of existing state regulations is also welcome.

The states need the Federal Government to provide guidance and to lend its resources to the effort. We need a strong state-federal partnership. Timing and other factors probably preclude using an exploratory well in Maryland for one of the prospective case studies planned for the EPA study, but we hope that EPA will provide expanded guidance on the study plan for the prospective case study so that Maryland can gather the most relevant data, if a permit is issued for an exploratory well. We would also welcome the technical assistance of the US Geological Survey in determining what to monitor in the process of drilling and fracking wells for exploration, and in analyzing the data we obtain. A compilation of Best Practices and, until the EPA study can' better delineate the subsurface zone that is potentially impacted by hydraulic fracturing activities, preliminary guidance on the proper spatial area for monitoring, would also be helpful. Lastly, we urge EPA to develop water quality criteria for conductivity (specific to chemical species), dissolved solids and salinity in freshwater, as well as pretreatment standards for fracking flowback that is protective of drinking water supplies and the health of the citizens who rely upon those supplies.

The Chesapeake Bay Foundation and other groups have filed a petition with the Federal Government for a Programmatic Environmental Impact Statement to address the risks and cumulative impacts of the extraction of natural gas from the Marcellus Shale formation in the Chesapeake Bay watershed. We support the goal of a comprehensive assessment, and we note that portions of the Marcellus Shale lie to the west of the Eastern Continental Divide, and that the environment outside the Chesapeake Bay watershed deserves protection, too.

Thank you for taking the initiative to inquire into this important issue and for the opportunity to share Maryland's perspective.

Chairman HALL. Thank you, sir.

I now recognize Mr. Harold Fitch, Board Member of the Groundwater Protection Council, for five minutes to present his testimony.

STATEMENT OF MR. HAROLD FITCH, MICHIGAN STATE GEOLOGIST, DIRECTOR, OFFICE OF GEOLOGICAL STUDY, MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY, AND BOARD MEMBER, GROUNDWATER PROTECTION COUNCIL

Mr. FITCH. Good morning, Chairman Hall and Members of the Committee. I appreciate the opportunity to be here this morning. In addition to my role as head of Michigan's Regulatory Agency for Oil and Gas and my role on the Board of Directors with the GWPC, I serve as Governor Snyder's official representative to the Interstate Oil and Gas Compact Commission, and I am chair of the IOGCC Shale Gas Director's Task Force. I also serve on the Board of Directors of State Review of Oil and Natural Gas Environmental Regulations Incorporated or STRONGER. STRONGER has conducted focused reviews of state hydraulic fracturing regulations in four states over the past year.

I would like to talk first about regulation of hydraulic fracturing by the states. Hydraulic fracturing has been utilized throughout the United States for more than 60 years, and the states have a long history of successful regulation of the practice. I would say in contrast to Maryland, Michigan has a longstanding regulatory program for oil and gas. We go back to about 1925. We feel we have a very good handle on hydraulic fracturing, as well as the other oil and gas issues out there, and we believe that the states are the proper place to retain that regulatory oversight.

In Michigan we have more than 12,000 wells that have been hydraulically fractured. We don't have one instance of groundwater contamination resulting from the practice.

The recent development of deep shale gas formations has raised concern in Michigan and other states over about five issues which I would like to address in turn.

The first issue is migration of gas or fracture fluids. There has been a few recent incidents of gas migration into aquifers in other states, but the cause has been well construction problems and not hydraulic fracturing itself. In fact, there are no cases of hydraulic fracturing directly causing gas or fluids to migrate into fresh water zones. The keys to preventing migration of gas or fluids are proper casing and sealing of oil and gas wells and proper plugging of abandoned wells.

The second issue is water use. A fractured treatment of a typical shale gas well may require three million gallons of water or more. To put that in perspective, three million gallons is about the volume of water used by five or six acres of corn in a year. The states

have the regulatory tools to address the issue in a manner tailored to their specific needs and legal structures. In Michigan we require application of a web-based water withdrawal assessment tool to evaluate those large withdrawals.

Third issue is management of flowback water. After fractures are created in the reservoir rock, 25 to 75 percent of that fracturing fluid is recovered as flowback. In Michigan and many other states flowback water is transported to licensed deep disposal wells where it is isolated from the environment. In some states flowback water may be hauled to wastewater treatment plants where it is treated and discharged into surface waters. There have been a few cases where that has caused legitimate concerns over water quality impacts.

The fourth issue is surface spills. As with any industrial operation, there is a potential for accidental spills or releases related to hydraulic fracturing. However, the states have requirements in place to minimize the risk of spills, to reduce their impacts, including secondary containment, spill reporting, and cleanup criteria.

And finally, the fifth issue is identification of chemical additives. A growing number of public interest groups are advocating for public disclosure of chemical additives used in hydraulic fracturing fluids. Federal law requires posting of material safety data sheets that provide information on hazardous chemicals and their potential health and environmental impacts. While the identities of some chemicals are protected under federal laws and trade secrets, we believe that the material safety data sheets provide enough information to respond to and track spills.

Next I would like to talk about the Groundwater Protection Council actions to address hydraulic fracturing. The GWPC has been engaged on the issue for some time and has published two very relevant reports on shale gas and state regulations to protect water resources. Last September the GWPC in cooperation with the IOGCC began development of a national registry of chemicals used in hydraulic fracturing. The result is a website called Frac Focus, www.fracfocus.org, launched on April 11. The website gives the public and regulators access to comprehensive information on chemicals used in hydraulic fracturing for individual wells nationwide.

The website also contains other useful information on hydraulic fracturing. Within its first month of operation 40 companies had agreed to participate, and information on more than 450 wells had been loaded into the system.

Michigan and other states are encouraging the industry to upload data to the Frac Focus website, and several states are considering using Frac Focus as part of future rule changes.

Finally, let me comment on the pending U.S. EPA study. While we believe the states have adequate programs, authority, and expertise for regulating hydraulic fracturing, we also acknowledge the potential benefits of a review by the EPA, particularly in light of the intense controversy surrounding the subject.

We appreciate the EPA's pledge to work with the states, GWPC, and other stakeholders in conducting a study, and we are committed to upholding our respective roles.

We do, however, have some concern with the scope of the draft study plan. The plan calls for addressing a broad range of questions, including the fracturing process itself, water withdrawals, releases of fracturing fluids and flowback water, and treatment of wastewaters. We are concerned that the study would cover general oil and gas practices that are not specific to hydraulic fracturing, and in addition, the broad scope of the study as proposed would make it difficult to produce a timely report.

EPA's Science Advisory Board has urged the agency to focus on waste discharges, and we agreed with that recommendation.

In conclusion, the states and GWPC are committed to dealing with the issues surrounding hydraulic fracturing and to supporting a focused study by the EPA.

Thank you, again, for the opportunity to appear here, and I would be glad to entertain any questions the Committee may have.

[The prepared statement of Mr. Fitch follows:]

PREPARED STATEMENT OF MR. HAROLD FITCH, MICHIGAN STATE GEOLOGIST, DIRECTOR, OFFICE OF GEOLOGICAL STUDY, MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY, AND BOARD MEMBER, GROUNDWATER PROTECTION COUNCIL

SUMMARY

I am representing the State of Michigan and the Groundwater Protection Council, or GWPC. I am the Director of the Office of Geological Survey (OGS) of the Michigan Department of Environmental Quality and a member of the Board of Directors of the GWPC.

I want to discuss the experience in regulating hydraulic fracturing in Michigan as well as other states, the GWPC's role in addressing some of the controversies surrounding the technique, and the study that is underway by the U.S. Environmental Protection Agency (EPA).

Hydraulic fracturing has been utilized throughout the United States for more than 60 years, and the states have a long history of successful regulation of the practice. Recent concerns center on five issues: (1) migration of gas or fracture fluids, (2) water use, (3) management of produced water, (4) surface spills, and (5) disclosure of chemical additives. I will discuss each in turn.

The GWPC has been engaged on the issue of hydraulic fracturing for some time, and has published two very relevant reports on shale gas development and hydraulic fracturing. On April the GWPC launched a website called Frac Focus. The website gives the public and regulators access to comprehensive information on chemical use in hydraulically-fractured wells nationwide and contains much additional information about hydraulic fracturing and related issues. It is already getting extensive use.

We support in principle the U.S. EPA "Draft Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources." While we believe the states have adequate programs and authority for regulating hydraulic fracturing and a very good understanding of the technology and its potential for impacts, we also acknowledge the potential benefits of a review by the EPA in light of the intense controversy surrounding the subject. The states and GWPC are committed to providing all pertinent information and other support to the EPA in conducting the study, although we do have some concern with the scope and timing.

TESTIMONY SUBMITTED TO THE HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

Good morning Chairman Hall and members of the Subcommittee. My name is Harold Fitch. I am here today representing the State of Michigan and the Groundwater Protection Council, or GWPC. I am the Director of the Office of Geological Survey (OGS) of the Michigan Department of Environmental Quality and have served in that capacity for the past 15 years. The OGS is charged with regulating oil, gas, and mineral exploration and production operations in Michigan. The Ground Water Protection Council is a national association of state ground water and underground injection control agencies whose mission is to promote the protection

and conservation of ground water resources. I am a member of the Board of Directors of the GWPC.

I am also involved in two other organizations that play prominent roles in hydraulic fracturing issues: the Interstate Oil and Gas Compact Commission, or IOGCC, and State Review of Oil and Natural Gas Environmental Regulations, Inc., or STRONGER.

The IOGCC is an organization chartered by Congress that represents the governors of more than 30 oil and gas producing states. Its mission is to conserve domestic oil and gas resources while ensuring environmental protection. I am Michigan's Official Representative to the IOGCC, and I serve as Chair of the IOGCC Shale Gas Directors' Task Force.

STRONGER is a non-profit organization representing states, industry, and public interest groups whose purpose is evaluate state oil and gas regulatory programs against a set of established guidelines. I serve on the Board of Directors of STRONGER. Over the past year we have conducted focused reviews of state hydraulic fracturing requirements for Pennsylvania, Ohio, Oklahoma, and Louisiana.

I appreciate this opportunity to address you on the important issue of hydraulic fracturing. I want to talk briefly about the experience in regulating hydraulic fracturing in Michigan as well as other states, the GWPC's role in addressing some of the controversies surrounding the technique, and the study that is underway by the U.S. Environmental Protection Agency (EPA).

Regulation of Hydraulic Fracturing by the States

Hydraulic fracturing has been utilized throughout the United States for more than 60 years, and the states have a long history of successful regulation of the practice. In Michigan more than 12,000 wells have been hydraulically fractured, beginning in the 1970s. Most of these are relatively shallow shale gas wells in the northern Lower Peninsula. More recently, there has been interest in a deeper shale formation that requires the drilling of long horizontal holes and larger volumes of fracturing fluid for effective development. It is this type of development that has raised concerns over hydraulic fracturing in Michigan and other states. The concerns center on five issues: (1) migration of gas or fracture fluids, (2) water use, (3) management of produced water, (4) surface spills, and (5) disclosure of chemical additives. Let me address each of those issues in turn.

Migration of gas or fracture fluids. Whenever an oil and gas well is drilled through a fresh water aquifer there is a potential for migration of gas or other fluids up the well bore and into the aquifer, whether or not the oil and gas well is hydraulically fractured. There have been a few recent incidents of gas migration in other states, but the cause has been well construction problems and not hydraulic fracturing itself. Because of rock characteristics and the physics of the fracturing process, it is virtually impossible for an induced fracture to propagate upward into fresh water zones. The key to preventing migration of gas or fluids is installation of steel pipe, or "casing," encased in cement. In addition, it is important to assure there are no abandoned and inadequately plugged wells in the vicinity that could constitute a conduit for movement of fluids or gas during a hydraulic fracturing operation or during subsequent production operations. The states have the regulatory tools to address these issues.

Water use. A fracture treatment of a typical deep shale gas well may require three million gallons of water or more. To put this in perspective, three million gallons is the volume of water typically used by five to six acres of corn during a growing season. While water withdrawal regulations vary across the U.S., the states again have the regulatory tools to address the issue in a manner tailored to their specific needs and legal structures. In Michigan we require evaluation of large water withdrawals for hydraulic fracturing using the same methodology required of other large water users.

Management of flowback water. After fractures are induced in the reservoir rock, pressure is released and a portion of the fracturing fluids is recovered from the well. The recovered fluid is termed "flowback." It typically constitutes 25 to 75 percent of the fracturing fluid originally injected. The remainder stays in the reservoir rock or is produced gradually along with the natural gas as "produced water." In Michigan, flowback water must be contained in steel tanks and transported to licensed disposal wells where it is injected into deep rock layers that are isolated from fresh water supplies. That is at least an option in many other states. In some states flowback water may be hauled to wastewater treatment plants where it is treated and discharged into surface waters. This has raised issues with water quality because treatment plants may not be capable of removing some constituents of the flowback water-particularly dissolved salts that may be in the native reservoir fluids

and be mixed with the flowback. In some areas flowback water is stored and recycled.

Surface spills. Spills of chemical additives or flowback water can have adverse environmental or public health impacts. As with any industrial operation, there is a potential for accidental spills or releases associated with hydraulic fracturing. However, the states have safeguards in place to minimize the risk of spills and reduce their impacts. Michigan requires secondary containment in areas where spills may be most likely, and has strict requirements for spill reporting and cleanup.

Identification of chemical additives. A growing number of public interest groups are advocating for public disclosure of chemical additives used in hydraulic fracturing fluid. A few states are taking actions to require disclosure to a state regulatory agency, although not to the general public. Under federal law information on chemicals and potential health and environmental effects must be provided in Material Safety Data Sheets (or MSDSs), which are posted wherever the additives are stored, transported, or used. However, the chemical identities and concentrations of some of the chemicals are exempted from disclosure as trade secrets. Those details must be provided to medical personnel in the event of an emergency. In Michigan we believe the MSDSs provide enough information to respond to and track spills. We are working to make that information more readily available to the public.

GWPC Actions to Address the Hydraulic Fracturing Controversy

The GWPC has been engaged on the issue of hydraulic fracturing for some time, and has published two very relevant reports. The first of these reports is called *Modern Shale Gas Development in the United States: A Primer.* The primer discusses the regulatory framework, policy issues, and technical aspects of shale gas resources and provides accurate technical information on hydraulic fracturing.

The second report is entitled *State Oil and Gas Regulations Designed to Protect Water Resources.* The report is a comprehensive state-by-state evaluation. It concludes that state oil and gas regulations are in general adequately designed to directly protect water resources. The report also recommends consideration of flexible Best Management Practices; commends the STRONGER, Inc. process of reviewing state programs; and supports increased digitization of state data.

Last September the GWPC began a project in cooperation with the IOGCC to develop a national registry of chemicals used in hydraulic fracturing. The result is a website called Frac Focus, www.fracfocus.org, launched on April 11. The U.S. Department of Energy provided funding support for the project. The initiative provides oil and gas exploration and production companies with a single-source means to publicly disclose the chemical additives used in the hydraulic fracturing process.

The Frac Focus website features an easy-to-use interface that gives the public and regulators access to comprehensive information about hydraulically-fractured wells nationwide. Searchable fields allow users to identify wells by location, operator, state, and county, as well as a standard well identification number, known as an API number.

The website also contains information about the process of hydraulic fracturing, groundwater protection, chemical use, state regulations, publications, and links to federal agencies, technical resources and each participating company. Within its first months of operation 40 companies had agreed to participate in the effort, more than 450 wells were loaded into the system by 18 of these companies, and the website was visited more than 28,000 times by people in 78 countries.

Future enhancements to the site will include an improved uploading system that should result in quicker posting of greater numbers of records, a Geographic Information System interface that will aid the public in locating records more easily and links to more publications, state agencies and other resources.

My agency in Michigan joins other states in strongly encouraging the industry to upload data to the Frac Focus website. Several states are considering using Frac Focus as part of future chemical disclosure rule changes.

The Pending U.S. EPA Study

I have reviewed the U.S. EPA "Draft Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources" that was published February 7, 2011. We support the study plan in principle. While we believe the states have adequate programs and authority for regulating hydraulic fracturing and a very good understanding of the technology and its potential for impacts, we also acknowledge the potential benefits of a review by the EPA in light of the intense controversy surrounding the subject.

We appreciate the EPA's pledge to work with the states, GWPC, and other stakeholders in conducting the study and are committed to upholding our respective roles. In particular, we want to assure that the study adhere to the directive of Con-

gress that the study utilize the best available science; rely on independent sources of information; be a transparent, peer-reviewed process; and incorporate consultation with stakeholders.

We do have some concern with the scope and timing of the study. The EPA intends to produce an interim report in 2012, and provide additional results in a 2014 report. The EPA has identified a number of questions to be addressed, including impacts of water withdrawals; releases of fracturing fluids, flowback, and produced water; the injection and fracturing process itself; and inadequate treatment of hydraulic fracturing wastewaters. EPA's Science Advisory Board has urged the agency to focus on waste discharges, and we agree with that recommendation, particularly with respect to the interim report. We believe that management of flowback and produced water is the primary concern in hydraulic fracturing. We are concerned that the broad scope of the study as proposed will make it difficult to produce a timely report.

We have one final concern: President Obama has directed the Department of Energy to establish a panel to address concerns regarding potential negative impacts associated with hydraulic fracturing. Within six months, the panel is to offer advice to other agencies on how to better protect the environment from shale gas drilling. It is unclear how the panel's study will be combined with the ongoing EPA study.

Conclusion

In conclusion, we believe the laws and rules in Michigan and other states effectively protect water and other natural resources as well as public health and safety from potential adverse effects of hydraulic fracturing. Michigan is typical of the oil and gas producing states in taking a proactive approach to address large-scale hydraulic fracturing as well as other issues associated with deep shale gas development. The GWPC will continue to assist states with their regulatory needs for the purpose of protecting water, our most vital natural resource.

Thank you again for the opportunity to appear here today. I would be glad to entertain any questions the Committee may have.

Chairman HALL. Thank you, Mr. Fitch.

I now recognize Dr. Cal Cooper from Apache Corporation for five minutes to present his testimony.

STATEMENT OF DR. CAL COOPER, MANAGER, WORLDWIDE ENVIRONMENTAL TECHNOLOGIES, GREENHOUSE GAS, AND HYDRAULIC FRACTURING, APACHE CORPORATION

Dr. COOPER. Mr. Chairman Hall, Ranking Member Johnson, and Members of the Committee, thank you.

For the oil and gas business hydraulic fracturing is one of the most enabling technologies ever. It will unlock vast amounts of hydrocarbons not only in shales but also in mature fields and widespread unconventional reservoirs. Companies are testing new applications every day. Our energy future is being redefined, especially here at home. This is going to have a really major economic impact.

We all agree we must rationally understand its risks. Based on existing knowledge and practical experience we believe these risks are minimum and manageable. We have faith that if a problem is identified, industry will be able to innovate, adapt, and resolve it.

Certainly the public deserves more than our assurances. As a Nation our choice is to employ high-quality science to frame and investigate concerns and then have rigorous scientific review that validates our conclusions.

That means calm, dispassionate reasoning and analysis and focused investigations, objectivity. The common good is not advanced by emotionally-charged distortions and confrontational media. This is not a game of gotcha. It is not entertainment. It is about our future in every sense of the word.

Maybe some folks believe this is just about the Marcellus. Well, Apache doesn't currently operate in the Marcellus Shale Play, but we have a big acreage position in British Columbia where the second-largest hydrocarbon producer in the Permian Basin, and we have been doing quite a bit of fracking in Western Oklahoma and the Texas Panhandle in the Granite Wash.

We know this technology is truly revitalizing production in the North American Oil Patch, and it will rapidly expand internationally.

Developing oil and gas resources requires continued innovation to reduce costs, never compromising efforts to improve environmental protection and safety. Ultimately we all benefit from doing this correctly, but no formula applies everywhere. Apache operates in states and provinces where we are permitted to re-inject 100 percent of flowback and produced water into deep underground reservoirs, completely isolated from freshwater aquifers. We believe this is the safest option, and it eliminates many potential conflicts. This is not done in the Marcellus.

Recently we proved for our Canadian operations that we can use high-sailing water instead of fresh water for our frack jobs. Working with our partner, EnCana, we extract and treat water from a deep saline reservoir known as the Debolt formation. We do some treatment to it, and after fracking we then re-inject the flowback and produce water into that same formation in a closed loop system.

High-flow-rate brackish or salt water systems like the Debolt, well, they are not present everywhere, and they are probably not present in the Marcellus. But in the Permian Basin we think that the Santa Rosa groundwater system can be adapted for a similar purpose, and we are working hard to advance that as fast as we can.

Apache has also made a real effort to help the industry reach consensus regarding disclosure of the composition of hydraulic fracturing fluids. We have committed to post the composition of every U.S. frac job operated by us on the FracFocus website that Mr. Fitch just described.

Well, the success of any scientific evaluation can usually be predicted by the quality and commitment of the team assembled to do the work, the clarity and focus of the investigation to prioritize testing of what is important, and the availability of the necessary tools and resources to get the job done. Good oversight also helps. Based on those criteria it is frankly difficult to expect much of value from this EPA study. It aspires to do too much with too little, in too short a time frame. It has no direction of priorities based on testing existing knowledge. It reads like a shopping list for research funding. Buy one of each.

The national interest may be well served by changing the tone of the study. What can be done quickly for that budget? Perhaps the EPA could collaborate with industry to identify and prioritize concerns, perhaps rapid progress could be made to identify the chemical additives of greatest concern based on regionally-specific information and analysis about the ultimate presence of those chemicals in produced waters and the quantification of actual risks to the public. This would help all of us.

I have met and discussed hydraulic fracturing with a great many talented people, including some exceptional scientists in industry, the EPA, national labs, universities, and committed environmentalists. I consider it a privilege to have served as a technical theme lead for an EPA hydraulic fracturing workshop. We all have different perspectives, but we all agree. Ultimately science must be objective. Sometimes it takes awhile to realize that truth, and hydraulic fracturing is far too important to be dismissed for the wrong reasons.

Thank you.

[The prepared statement of Dr. Cooper follows:]

PREPARED STATEMENT OF DR. CAL COOPER, MANAGER, WORLDWIDE ENVIRONMENTAL TECHNOLOGIES, GREENHOUSE GAS, AND HYDRAULIC FRACTURING, APACHE CORPORATION

Mr. Chairman, and members of the committee,

Thank you for this opportunity to provide an industry perspective on the exciting, technology driven opportunity of hydraulic fracturing. Today I hope to share with you some perspectives on both the technology as a whole and on the proposed EPA draft plan to study the potential impacts of hydraulic fracturing on drinking water resources.

Apache considers hydraulic fracturing (HF) one of the most enabling technologies in the oil and gas business. It is a technique that continues to evolve; and it benefits from constant innovation as companies explore new applications every day. Literally the future of the world energy supply is being re-written as economically recoverable oil and gas supplies increase at dramatic rates thanks to advances in hydraulic fracturing. With so much potential it is essential that we, as a nation, investigate and rationally understand the risks associated with hydraulic fracturing techniques by employing high quality science and rigorous scientific review to validate our conclusions. The public may not want to engage in the analytical techniques required for understanding scientific tests, but it has every right to believe that regulators, the scientific community and industry will collaborate to investigate and ensure public safety, and especially to preserve precious resources such as groundwater and clean air.

Given the rapid expansion of the technique, many are uncomfortable and even afraid of the changes it brings. To complicate matters, public understanding is not advanced by emotionally charged distortions and confrontational media. It appears that many are content to criticize techniques they barely begin to understand, and jump to conclusions without also acknowledging that innovation is likely to overcome obstacles as they are properly understood. The Society of Petroleum Engineers has estimated that there have been over two million fracture stimulation jobs done worldwide—more than one million in the United States alone in the last 60 years; there is no doubt the technique has improved considerably in the past five years. Science is about testing ideas and solving problems. The oil and gas business has a long tradition of technical innovation based on applied science and engineering that has created enormous wealth for this country and allowed Americans to enjoy high standards of living with relatively low-cost energy.

Apache's hydraulic fracturing operations

Most focus on hydraulic fracturing in shale gas plays. Apache believes hydraulic fracturing will unlock vast amounts of hydrocarbons in both existing conventional and new unconventional reservoirs. While Apache does not currently operate in the Marcellus shale play, it is both a major player and a significant innovator elsewhere. We have a leading acreage position in the Horn River Basin shale gas play in British Columbia, Canada. Apache is the second-largest hydrocarbon producer in the Permian Basin of West Texas and New Mexico, where we are applying high-volume horizontal hydraulic fracturing techniques to increase oil production from a very large inventory of drilling targets in fields that have been producing for 60 years or more. In the Anadarko basin of western Oklahoma and the Texas Panhandle, we have achieved great success in advancing the Granite Wash play, producing high flow rates of natural gas and condensate from a laterally extensive tight sandstone reservoir that was originally developed using fraced vertical wells beginning in the 1970s. We recently announced we have extended this concept to another reservoir, the Hogshooter formation, where two hydraulically fractured wells have provided initial flow rates in excess of 2,000 barrels of oil and 3 million cubic feet

(MMcf) of gas per day. Hydraulic fracturing is revitalizing production in the North American Oil Patch, and we are convinced it will rapidly expand internationally. Apache is actively engaged in hydraulic fracturing tests in unconventional reservoirs or resource plays in Argentina and we expect to go forward with tests in the Western Desert of Egypt. We recognize that our competitors also have global ambitions to expand the use of the technology.

Hydraulic fracturing is a major transformative technology that expands and leverages long-proven drilling standards and techniques in order to massively increase the energy available to the growing population of the planet. The question before you and the industry is not whether it should be continued. Developing this expected flood of supply will require continued innovation to reduce cost and increase efficiency, aligned with efforts to improve environmental protection. Sustainable performance requires us to consider how we can reduce the footprint of our operations, best provide the water required and protect local aquifers with responsible practices, and carefully select and use the necessary chemicals. Ultimately we all benefit from doing this correctly.

Managing risks and operating in a safe and responsible manner

Apache takes great care to protect drinking water and manage risks associated with drilling and production everywhere it operates. It surprises many that some places have little or no effective regulation governing the standards of common water supply wells. We are not aware, however, of any jurisdiction around the globe where drilling practices and well-design standards do not explicitly address protection of potable aquifers. Wells are drilled, fresh water is isolated behind steel and cement barriers, and the barriers are tested before hydraulic fracturing operations begin. Performance testing includes pressure tests of each cemented section and full wellbore pressure tests before hydraulic fracturing competitions begin. It is increasingly common for months to pass between the time drilling operations cease and a well is completed using hydraulic fracturing. Detailed continuous pressure monitoring is standard with hydraulic fracturing operations, and sometimes we employ micro-seismic monitoring techniques to help define the shape and the lateral and vertical extent of the fractures and injected fluids.

Apache operates in states and provinces where we are permitted to re-inject 100 percent of flow-back and produced water into deep underground reservoirs completely isolated from freshwater aquifers. In Oklahoma and Texas, we normally make-up our frac fluids by mixing fresh water produced from shallow groundwater sources and surface sources that are purchased from land owners. Recently, we have learned a great deal from our Canadian operations about using relatively high saline water instead of fresh water, contrary to the general practices and expectations of the industry. In the Horn River Basin, working with our partner EnCana, we have developed a system for extracting water from a saline aquifer in the Debolt formation and treating it in a built for purpose plant to eliminate H2S. The water is piped to our well pad where we add a minimum of chemicals to create an effective frac fluid. After fracing we then re-inject the flow-back and produced water into the Debolt formation in a closed-loop system. This water source provides many operational advantages, and compliments efficiencies provided by innovative high-density well pads that allow a minimum surface footprint. We intend to continue to innovate to protect a pristine environment using a minimum of surface water and disposing of none into waterways.

High-flow-rate brackish or salt water aquifer systems are not present everywhere. In the Permian Basin, Apache believes the brackish Santa Rosa groundwater system can be adapted for a similar purpose as the Debolt in parts of the Horn River Basin. We are currently investigating tests of our concept for frac systems in oil reservoirs using recycled brackish water as a base fluid. This has many environmental advantages, and well as practical reservoir management efficiencies, but it is especially good because if we are successful, we will minimize our need for fresh water. This is a clear example where technology enables our business and we aggressively explore what is possible in order to succeed. So do many others, and we all benefit.

In addition to our general practice of water re-injection, we have developed a program that tests the chemical composition of our make-up water, whole frac fluid, flow-back and produced water at representative wells. We test this water even though it gets re-injected into deep reservoirs and would never be used for drinking. Information from these tests helps us communicate with our service companies to reduce or improve the chemical formulations in our operations.

In addition we have undertaken many performance-based comparisons to aid in our selection of chemical additives. Basically, no one wants to pay for chemicals they don't need, and we have found that we can often replace non-biodegradable biocides with much less intrusive chemicals or even with ultraviolet light in some cir-

cumstances. We frequently eliminate clay control additives without detrimental reactions.

Beyond our direct operational choices, Apache has made a real effort help the industry reach consensus regarding disclosure of the composition of hydraulic fracturing fluids; we have committed to post the composition of every U.S. frac job operated by Apache on the FracFocus hydraulic fracturing chemical registry. The www.fracfocus.org website is a joint project of the Ground Water Protection Council and the Interstate Oil and Gas Compact Commission.

The EPA Draft Plan

Apache Corporation would be pleased if the U.S. scientific community were to conduct robust scientific investigations that better establish the risks of hydraulic fracturing on drinking water resources. Based on existing knowledge and practical experience we believe these risks are minimal and manageable; we have faith that if a problem is identified, industry will be able to innovate and resolve it. Society benefits from high-quality research that advances knowledge and ultimately makes us more comfortable with the difficult choices we face. Alarmist sensationalism, especially when it purports to be science, is destructive, and this topic has enjoyed more that it's fair share of that already.

The success of any scientific evaluation can usually be predicted by the quality and commitment of the team assembled to do the work, the clarity and focus of the investigation to prioritize testing what is important, and the availability of the necessary tools and resources to get the job done. Good oversight and guidance also helps. Based on those criteria it is frankly difficult to expect much of value from this study. It aspires to do too much with too little, in too short a time frame. It has no direction of priorities based on testing existing knowledge. If this committee believes that the topic merits investigation, then Apache supports making adequate funds and oversight available to achieve a well-defined goal.

One fundamental problem underlying this study is an unresolved conflict: Is it intended to be a study of risks of hydraulic fracturing in the Marcellus shale basin or fracturing throughout the United States? Issues related to surface water discharge and use of publicly operated treatment works (POTW) appear to be limited to the Marcellus, yet the study tends to consider these major national issues, deserving the highest priority.

Water resource management, at the scale required for hydraulic fracturing, normally is the prerogative of states and local governments, and there is substantial variation across geology and jurisdiction about the net effect of water demand for any given water resource. States are equipped with the skills required to manage water resources and there is no need for this study to include the topic. Any evaluation of the water resources required for hydraulic fracturing needs to be made in the context of other major demands on water.

Lifecycle analysis of hydraulic fracturing techniques, in terms of impact on water and air emissions, may deserve critical investigation, but in this study it contributes little to the essential question proposed by Congress. Likewise the proposed focus on repetitive toxicology studies seems a misplaced priority at this level of funding. Existing information should be mined and leveraged and focused studies undertaken to test the conclusions.

The national interest may be well served by changing the tone of the study. Instead of casting a wide and shallow net hoping to catch something quickly, focus on developing more insightful fishing techniques. It would be helpful for EPA to collaborate with industry to identify and prioritize the chemical additives of greatest concern based on regionally specific information and analysis about the ultimate presence of these chemicals in produced waters and the actual risks to the public. There are likely to be different answers for different formations, and this aspect of study would help all parties focus on the development of alternative additives and practices to best protect the environment.

I would like to end on a very personal note. In my journey to understand the real issues of hydraulic fracturing, I have met and discussed technical material with a great many talented people including some exceptional scientists in industry, the EPA, national labs, universities and committed environmentalists. I consider it a privilege to have served as a technical theme lead for an EPA hydraulic fracturing workshop. It is true that there is simmering distrust between scientists with different perspectives, but that is probably healthy at some level. Government science sometimes seems to encourage and expose our worst tendencies, especially when non-scientific issues may be the root cause of polarization. Ultimately science is objective. Sometimes it takes a while to realize that truth. Hydraulic fracturing is far too important to be dismissed for the wrong reasons.

Chairman HALL. Thank you very much.

Now we will have Dr. Michael Economides, and I know I pronounced it right that time. Recognize you for five minutes, sir.

STATEMENT OF DR. MICHAEL ECONOMIDES, PROFESSOR OF CHEMICAL AND BIOMOLECULAR ENGINEERING, UNIVERSITY OF HOUSTON

Dr. ECONOMIDES. Thank you, Mr. Chairman. I have some prepared remarks, but I am going to forego very much because I don't want to review some of the——

Chairman HALL. Turn on your microphone, Doctor.

Dr. ECONOMIDES. Can you hear me now?

Chairman HALL. Now you can start over, and your time will start now.

Dr. ECONOMIDES. Okay. Thank you. I said I have some prepared remarks. I am going to make my presentation a bit shorter because I don't want to repeat the things you have heard already.

I want everybody in this room to realize a truism. No frack, no gas. In other words, you cannot produce natural gas anywhere in the world without hydraulic fracturing. The business has evolved into a $13 billion exercise right now, and personally I have worked in about 70 countries thus far on hydraulic fracturing, and I can assure you that debates like this are not going to find anywhere else except here. That is fracturing is the quintessential way to produce natural gas. End of the story.

Now, it has been the reason that natural gas has been sustained as a very legitimate energy source in the United States. You have heard earlier on that essentially we are almost self-sufficient in natural gas, and in particular shale gas is arguably the best story in the energy industry in the last decade. We have ramped up production from about 0 percent from shale gas about only four years ago to 17 percent of our natural gas in the United States. There has never been a story like this in the entire history of the oil and gas industry.

And yet there is a study by the EPA that they have assembled together and the panelists, who are acknowledged experts in their respective fields, but almost none of those guys have any experience in fracturing. In fact, people like myself, we are almost deliberately excluded from this panel because we obtained it just because we have worked in hydraulic fracturing. That is why.

The study plan fails to recognize some very salient points. First of all, the entire report focuses on nanodarcy permeability. This is shale gas, extra tight reservoirs, and yet it is purported to draw conclusions for hydraulic fracturing that can apply to just about everywhere else from 100 millidarcy to 200 millidarcy wells in the Gulf of Mexico to everything in between.

One frack treatment in the Marcellus Shale may actually have the EPA draw conclusions that would condemn an entire industry, regardless of any technical differences in the fracturing process.

There is even more drawbacks. For instance, the study does not distinguish between 40 well construction, that is casing problems, cementing problems, and so on, or some entirely mythical subsurface communication as suggested in silly documentaries like Gasland. In the study plan they are listed under well injection, and

this is supposed to be the Science and Technology Committee, so here you have some scientific results. What you see here is the depths of water table, the top blue bars, and underneath are fractured heights that have been actually measured in a great number of fracturing treatments in the Marcellus Shale.

You can see they are separated by several thousand feet. There is no physical way that fractured height migration due to hydraulic fracturing can actually reach drinking water aquifers.

And in summary, hydraulic fracturing has been used for six decades without significant environmental consequence. The approaches have been studied extensively ad nauseam by a number of agencies, including the EPA, and the EPA study plan, the one that is under question right now, in the review panel, have been carefully designed in my view and selected to lead to only one conclusion, in favor of EPA control at the crippling cost to the production of U.S. natural gas.

Thank you very much.

[The prepared statement of Dr. Economides follows:]

PREPARED STATEMENT OF DR. MICHAEL ECONOMIDES, PROFESSOR OF CHEMICAL AND BIOMOLECULAR ENGINEERING, UNIVERSITY OF HOUSTON

One Page Summary

1. Virtually all wells require hydraulic fracturing to produce commercial quantities of gas (or oil).
2. It has taken industry over 20 years to figure out that horizontal wellbores combined with hydraulic fracturing are the key to producing commercial quantities of natural gas from shale formations.
3. Shale and tight gas now accounts for over 2/3 of the daily gas produced in the United States, and has led to 87% of our natural gas supply being produced domestically. **It is important to realize that this gas production wouldn't be possible without hydraulic fracturing.**
4. Despite EPA having conducted several historical reviews of hydraulic fracturing, **and clearing the process as recently as 2004,** cap-and-trade proponents in Congress directed a new study in 2010. However, this time the internet tools of facebook, privately funded documentaries such as Gasland, and the national media have fueled a frenzy of anti-fracturing sentiment previously unknown.
5. So the EPA initiated a study of hydraulic fracturing in 2010, ostensibly to study the potential effects of hydraulic fracture on drinking water.
6. I will show with a few examples, this process has been anything but sound. The panel excludes outright some of the most highly regarded individuals in the technical area of hydraulic fracturing; presumably being an expert on the subject immediately condemns one as an industry shrill.
7. Despite having thousands of hydraulically fractured wells to consider, EPA "stakeholder" meetings identified several handfuls of wells for their potential contamination to drinking water. Of these, **only four will receive forensic examination** within the context of a hydraulic fracturing water life cycle. The risk **is that one bad well will condemn an entire fracturing process with this study approach.**
8. There are many, many deficiencies and concerns with respect to EPA's hydraulic fracturing study. The examples given today illustrate why the EPA's Hydraulic Fracturing Study is a Peep Show. On the outside the world is seeing one thing, from within the view is quite different. From within it is clear that the intent is to gain regulatory authority over hydraulic fracturing. And the consumer will bear that cost.
9. My contention is that the hydraulic fracturing process is safe, already well regulated by the various States, and the hysterical outcry over this process is completely unjustified. Ultimately, the frenzy of arguments over hydraulic fracturing distill to this single fact: **Either the United States wishes to utilize its natural gas resources, or it doesn't.** For development of shale or tight gas goes hand-in-hand with hydraulic fracturing. **Saying "no' to hydraulic fracturing really means you are saying "no" to natural gas production in the United States.**

The Beverly Hillbillies entertained many generations, each program starting with Jed Clampett shooting at the hills with crude oil bubbling out of the ground. But the widely known image of Jed teaches us two things that are simply not true. First, recovering hydrocarbons isn't easy, particularly today, and secondly, the oil industry is far more concerned for the environment than this.

It took many years for industry to realize that, by pumping hydraulic pressure into a subsurface hydrocarbon filled rock, one could create a crack that would make it much easier for oil, or gas, to flow out of the rock. Today virtually all wells require this process to produce commercial quantities of gas (or oil). And, as shown here, it has taken industry over 20 years to figure out that horizontal wellbores combined with hydraulic fracturing are the key to producing commercial quantities of natural gas from shale formations.

This realization, combined with advancements in the ability to pump multiple fracture treatments in tight rock and shale formation has led to a huge boom in gas production. As shown here, shale and tight gas now accounts for over 2/3 of the daily gas produced in the United States, and has led to 87% of our natural gas supply being produced domestically. **It is important to realize that this gas production wouldn't be possible without hydraulic fracturing.**

Despite EPA having conducted several historical reviews of hydraulic fracturing, **and clearing the process as recently as 2004,** cap-and-trade proponents in Congress directed a new study in 2010. However, this time the internet tools of facebook, privately funded documentaries such as *Gasland,* and the national media have fueled a frenzy of anti-fracturing sentiment previously unknown.

So the EPA initiated a study of hydraulic fracturing in 2010, ostensibly to study the potential effects of hydraulic fracture on drinking water. Their study was issued through their own Office of Research, their hand-picked Science advisory council, and ultimately through the Hydraulic Fracturing Review Study Panel—a group of academics also selected by the EPA. The study is currently awaiting feedback from the Study Panel.

Now, the mandate to EPA was to employ a transparent, peer review process in this study of hydraulic fracturing. However, as I will show with a few examples, this process has been anything but that. For sure many of the 22-member Hydraulic Fracturing Study Panel are experts in their own area of groundwater, public health, etc., but almost all have no experience in hydraulic fracturing and no understanding of current industry practices. The panel excludes outright some of the most highly regarded individuals in the technical area of hydraulic fracturing; presumably being an expert on the subject immediately condemns one as an industry shrill.

And the lack of industry representation on the Panel is telling.

At the Stakeholder meetings held around the country (meetings the Study Panel themselves could not attend) and subsequent to those meetings, the public was encouraged to provide information about their water wells—cases that might form the bedrock of a forensic review to determine if fracturing had caused contamination.

Despite having thousands of hydraulically fractured wells to consider, EPA "stakeholder" meetings identified several handfuls of wells for their potential contamination to drinking water. Of these, **only four will receive forensic examination** within the context of a hydraulic fracturing water life cycle, including water source and availability, chemical mixing, well injection, flowback and disposal.

Key drivers in selecting the four retrospective cases are focused much more on data availability and likeliness of identifying problems, rather than applicability in representing the normal range of fracturing outcomes. From these limited cases EPA expects to draw massive conclusions, stemming from a hurried, single year of 'research'.

There is simply no way four retrospective case studies can be considered a representative, or fair sampling *of any process,* regardless of how carefully those cases are selected. **Our risk as a nation is that one bad well will condemn an entire fracturing process with this study approach.**

And the expectation of research results in one year demonstrates even more clearly the lack of credibility. I have been a professor for many years and I rarely see funded projects that can even get started in a year's time. With the EPA's approach we must already know the answers.

Texas, Oklahoma, Kansas, Colorado and Wyoming each have over 60 years of extensive experience with the hydraulic fracturing process and these States have well developed regulatory processes in place. Treatments must be noticed to the State before they are performed, and each State regulatory agency elects to witness treatments. There are defined casing points, cementing and testing procedures, and treatment monitoring. An overwhelming majority of hydraulic fracturing treatments are witnessed by regulatory personnel.

In addition, STRONGER [*State Review of Oil and Natural Gas Environmental Regulations, a non-profit, multi-stakeholder organization*], is playing a clear role in unification of hydraulic fracturing oversight a the State level.

Yet, amazingly, the EPA study specifically excludes the State agencies experiences from the Study plan. There can be no question that this omission is a deliberate attempt to direct the conclusions of the fracturing study.

But ask yourself this question: Would it be more effective to have experienced field engineers and regulators witnessing each treatment, or an EPA clerk shuffling a stack of permits?

Last week there was a blowout from a tight gas well in the Marcellus Shale. Wisely, the leadership in Pennsylvania calmly noted that when we repeat a process thousands of times occasionally there is a rare problem. An unexpected equipment failure allowed a release of frac fluids at the surface. However, this was quickly rectified. My point in raising this is the frenzy of negative press, both before and after this event, is focused on *creating the fractures,* rather than wellbore or equipment reliability. Wellbore construction and hydraulic fracturing are completely different and after reading the Study Plan it isn't clear that the committee even recognizes that.

So let me show you a picture of fracture treatments mapped by Pinnacle in the Marcellus Shale. Each stage of fracture treatment is plotted with the red line representing the mid depth where the fractures originate. The shallowest point and deepest points are plotted. At the top, the blue is a plot of the deepest groundwater. As you can see, the fracture treatments are well confined heights, at least a mile below the deepest groundwater. The chance of propagating a fracture upward into groundwater is nil. You have a better chance of winning the lottery.

Interestingly, we also see another aspect. As the depth of fracture becomes shallower, fracture height decreases, reflecting the fact that the overburden is becoming the smallest subsurface stress. With continued decreases in depth, the fracture will become horizontal, also preventing the fracture from propagating into groundwater.

But since all of this is happening in the subsurface, where it cannot be seen, it's tough to overcome that frenzy of fear.

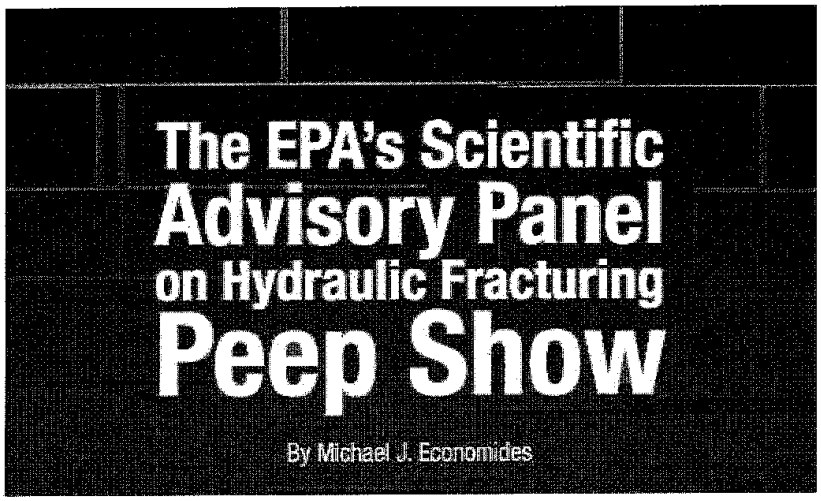
There are many, many deficiencies and concerns with respect to EPA's hydraulic fracturing study. The examples given today illustrate why the EPA's Hydraulic Fracturing Study is a Peep Show. On the outside the world is seeing one thing, from within the view is quite different. From within it is clear that the intent is to gain regulatory authority over hydraulic fracturing. And the consumer will bear that cost.

My contention is that the hydraulic fracturing process is safe, already well regulated by the various States, and the hysterical outcry over this process is completely unjustified

Ultimately, the frenzy of arguments over hydraulic fracturing distill to this single fact: **Either the United States wishes to utilize its natural gas resources, or it doesn't.** For development of shale or tight gas goes hand-in-hand with hydraulic fracturing. **Saying "no' to hydraulic fracturing really means you are saying "no" to natural gas production in the United States.**

The EPA's Scientific Advisory Panel on Hydraulic Fracturing Peep Show

By Michael J. Economides
Posted on Mar. 21, 2011



There is no ending to the energy wars that have become culture wars and they have infested even ostensibly technocratic agencies of the government that ordinarily should be held above ideology. Not so in the imagery-loaded EPA under the Obama Administration.

The agency's latest foray is the establishment of a 22-member Scientific Advisory Board (SAB) Panel, referred to as "Panel for Review of Hydraulic Fracturing Study Plan for Assessment of the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources." Now one would think that this is a noble undertaking but a look at the roster of the panelists, investigative approach, exclusivity and ramrod urgency would put this notion to immediate rest.

Certainly many of the review panelists are experts in their respective fields of ground water hydrology, toxicology, forestry, and public health, etc., but almost all have little to no experience in the well fracturing process and no understanding of current industry practices. The panel excludes outright any of the arguably most famous names on the subject: Holditch (author of 300 papers, author/editor of SPE Monograph on the subject), Meyer, Barree, Cleary, Smith (the creators of the four industry standard design softwares that could actually model fracture dimensions and fracture height) and myself, the author of 200 papers and five books on the subject. Presumably publications on the subject would be against the candidacy of these individuals as panelists, an outrageous presupposition that their technical prowess would render them to be industry shills.

The almost surely intentional absence of industry participation, except for briefly orchestrated public testimony, is to say the least, curious. Coupling the absence of industry experts with the study plan itself provides even greater insights.

Despite having thousands of wells to consider, EPA has held "stakeholder" meetings in which several handfuls of wells have been identified for their potential contamination to drinking water. Of these, four will receive forensic examination within the context of a hydraulic fracturing water life cycle, including water source and availability, chemical mixing, well injection, flowback and disposal.

Key drivers in selecting the four retrospective cases are focused much more on data availability and likeliness of identifying problems, rather than applicability in representing the normal range of fracturing outcomes. From these limited cases EPA expects to draw massive conclusions, stemming from a hurried, single year of 'research'. Given that the research has not yet been awarded, one wonders if the answers are already foregone conclusions.

Other aspects of the study are equally worrisome; the entire report focuses on nanodarcy, such as shale, rock completely ignoring the fact that most wells are fracture stimulated upon completion, including those in high permeability environments. Presumably one villain frac treatment in shale condemns an entire industry practice regardless of any technical differences in the fracturing process.

Most panel members simply could not distinguish (or probably would not even care) whether any observed contamination could be the result of faulty well construction (a rare but real possibility) or some entirely mythical "subsurface communication" as suggested in silly documentaries like Gasland. Wellbore construction and the fracturing processes are not at all the same things, yet lack any separate commentary under the header "well injection' in the flawed study plan. Only newly minted Ivy PhD's in public policy (likely those who wrote this plan), or those predisposed against the production of any natural gas, would fail to make this distinction.

Another concern is the wholesale disregard for current State regulatory practices. The efficacy of existing regulations are not even considered in the EPA draft study plan, discounting the efforts that organizations such as STRONGER [State Review of Oil and Natural Gas Environmental Regulations, a non-profit, multi-stakeholder organization], have clearly played a unification and enforcement role at the State level. Their work is not considered as part of the proposed EPA Hydraulic Fracturing Study.

Even the outcomes of EPA modelers are misled. The study plan makes no mention of the hydraulic fracturing models developed by industry experts such as those noted herein, nor is there any mention of modeling with the use of microseismic post fracture morphology (fracturing height length) verifications from hundreds of treatments. Rather, esteemed modelers of the EPA will "assume" a fracture within the context of their subsurface hydrologic flow models, perhaps without any geological context. This assumed fracture may bear no resemblance whatsoever to the actual fractures resulting from a pumped treatment.

And the list goes on and on.

Let's fast forward a year and imagine the results, assuming that EPA limits itself to study the four or so cases (out of hundreds of thousands) where suspicions may have arisen of water contamination either from natural gas production (unrelated to the fracturing itself, even if the well was fractured) or to the even rarer possibility of contamination because of fracturing fluid additives. Assuming that 3 out of 4 of these cases find some connection (the two Gasland examples were debunked) then one can see the headline: "EPA SAB finds that 75% of water contamination incidents were in fact caused by hydraulic fracturing," clearly a hatchet job, a truism that conveniently ignores the incredible rarity of the three case out of hundreds of thousands wells that are hydraulically fractured and, perhaps exactly, satisfying the latent motives of the creators of the EPA SAB on hydraulic fracturing.

A finding that contamination can happen through an accidental defect in well construction, even if it has happened in one case in 100,000, is something that simply cannot be determined from limited retrospective case studies, and any single official "finding" would have only one effect: alarm unnecessarily the public and reinforce the opinions of those that already have opinions on either side of the issue.

There is a "peep show" quality to the whole affair, with EPA actions occurring within the public eye but only 'glimpses' of the real picture within. With the introduction of the phrase "area of evaluation" in the study plan, it becomes clear that the" show within" is to impose area of review studies around any hydraulically fractured well in the United States. Such regulatory authority could shift the "frac, no frac" decision from State authorities to the EPA, resulting in gas well drilling moratoriums similar to the drilling largess now experienced in the Gulf of Mexico.

To somebody that understands (and believes in) the importance of natural gas to the country's welfare it is clear that only those predisposed against any hydraulic fracturing could be pleased with this study. The EPA panel has served their role in sanctifying this EPA hydraulic study plan, positioning researchers and other so-called experts to legitimize a clearly illegitimate and ideologically loaded attack on "fracking", done by people that are predisposed against any natural gas production.

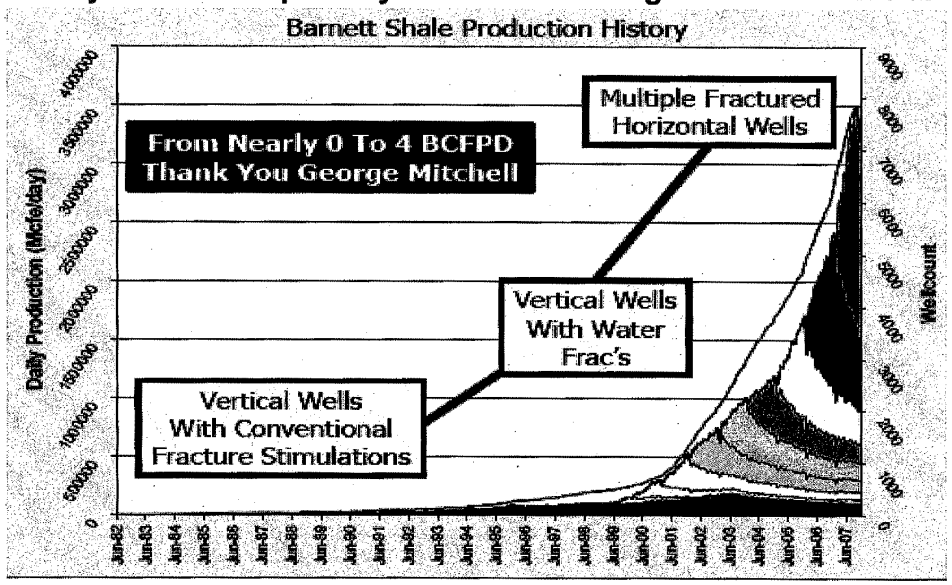
Rarely have intentions been more transparent.

Hydraulic Fracturing Congressional Testimony

Presented by Dr. Michael J Economides

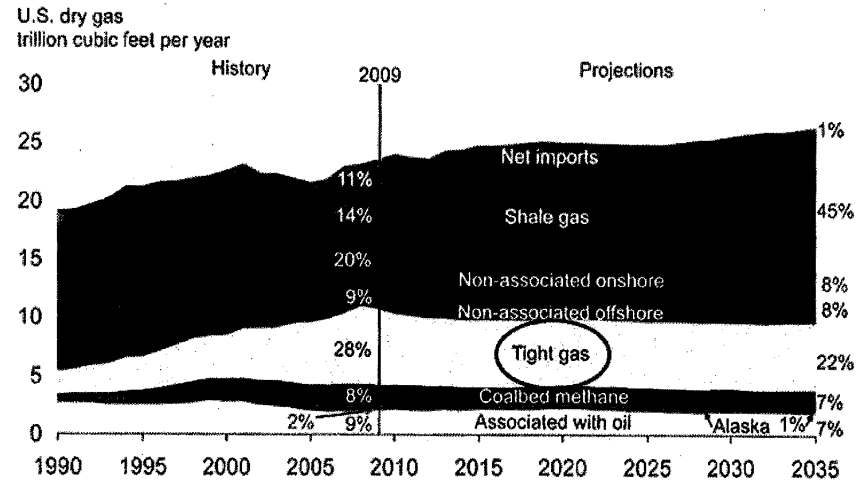
Importance of Hydraulic Fracturing

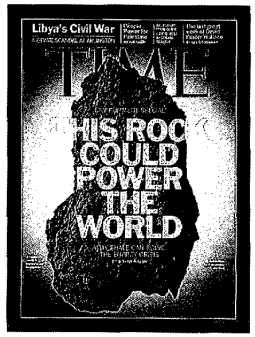
Virtually all wells require Hydraulic Fracturing to be Commercial



It took over 20 years to figure out the development of the Barnett Shale

Shale Gas Revitalizes US Gas Industry





eia

Source: EIA, *Annual Energy Outlook 2011*

In 2009, hydraulic fracturing of shale gas and tight formations led to 87% of our natural gas supply being produced domestically.

EPA's Hydraulic Fracturing Study – The Process You See

- Panelists are experts in their respective fields but almost all have no experience in well fracturing

- The panel excludes outright any of the arguably most famous names on the subject

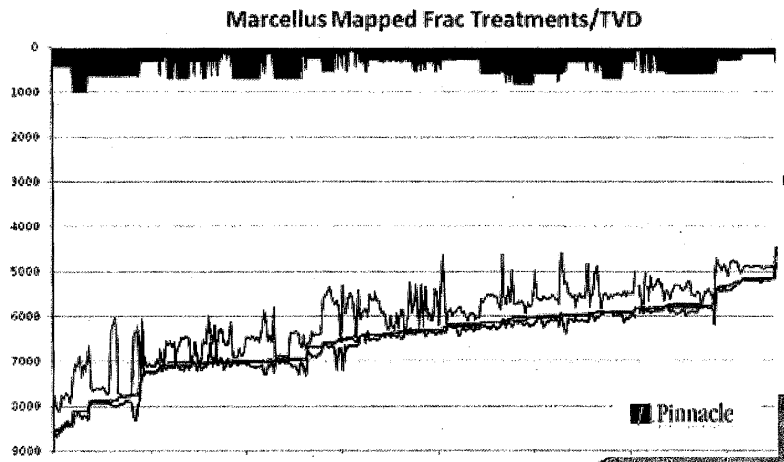
Study Plan Fails to Recognize Range of Hydraulic Fracturing Treatments…

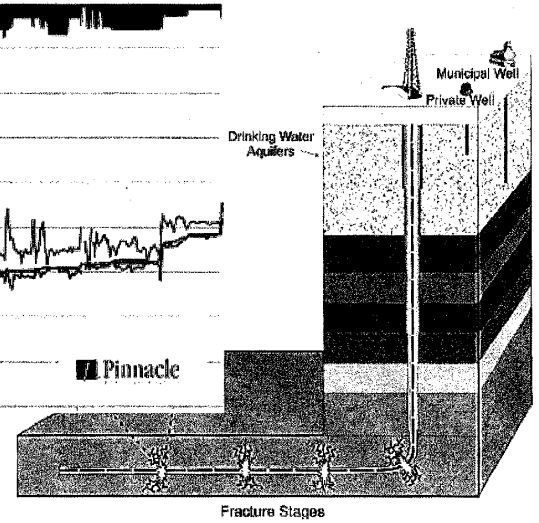
- The entire report focuses on *nanodarcy* permeability, such as shale rock
- Completely ignores that most wells are fractured upon completion, including those in high permeability environments
- One villain frac treatment in shale condemns an entire industry practice regardless of any technical differences in the fracturing process.

Other major misconceptions…

- Must distinguish any contamination resulting from faulty well construction (a rare but real possibility) or some entirely mythical "subsurface communication" as suggested in silly documentaries like *Gasland*.
- In the study plan they are all listed under "well injection"

What People Cannot See Scares Them… but we understand fracturing height and communication





Microseismic mapped Marcellus and Barnett Treatments show Hydraulic Fracture treatments do not reach groundwater

Summary

- Hydraulic Fracturing has been used for six decades without significant environmental consequence.
- The process was studied extensively by the EPA in 2004 and found to be an acceptable practice that could adequately be regulated by state environmental agencies.
- The EPA Study Plan, and associated Review Panel have been carefully designed and selected to lead to one conclusion, in favor of EPA control at a crippling cost to the production of US natural gas.

Chairman HALL. Thank you, sir, and I thank all of you for your testimony.

I remind all of our Members the Committee rules limit our questions to five minutes, and the chair at this point will open the round of questions, and I recognize myself for five minutes.

I will start with Mrs. Jones, and it is hard to get a yes or no answer, witnesses, but try to give me a yes or no on these because I am going to try to get through—I want to ask the last gentleman a question, and I am not sure how long it is going to take him to answer it for me. I want to save as much time as I can there. But I listened very closely to what you said. It made a lot of sense to me.

Mrs. Jones, Madam Chairman, given that Texas produces more oil and gas than any other state in the U.S. and that is not just bragging, that is a hard cold fact. You know, Dizzy Dean said it ain't bragging if you can do it.

The Railroad Commission is probably the most experienced state regulator or as experienced a state regulator when it comes to issues like hydraulic fracturing. So my question is have any incidents regarding hydraulic fracturing arisen since your tenure on the commission that you felt the state was unable to respond to?

Mrs. JONES. No.

Chairman HALL. Can you think of any situation in which you felt that the state regulatory mechanisms were inadequate to properly oversee the use of this technology?

Mrs. JONES. No.

Chairman HALL. By golly I did get a yes or no.

There was an incident in Texas the past year that was widely reported involving Range Resources in which the regional office of the EPA shut down operations of the company in order to investigate a claim of contamination of a drinking water well. What was the Railroad Commission's role in this investigation?

Mrs. JONES. The water well owner filed a complaint to the Railroad Commission on August 6 of 2010. Apparently the EPA was notified on August 17. We had ongoing investigation for several months. It takes awhile when you are investigating a potential contamination, and then I guess it was October 21, several months later, we gave the EPA a recommendation. They had also come in and were taking a parallel investigation and gave them some recommendations of what to sample at that Range production well, which was—the claim was made there was natural gas in a water well.

We had worked very, very diligently. We concluded our investigation in spite of the early pronouncements by the EPA. We brought Range in, gave them the due process that our process allows. The EPA, much like today, also did not show up at those meetings at the Railroad Commissions Hearing Examiners, but we found, in fact, through our DNA testing and the isotopes they test and compare that, in fact, the natural gas in the water well did not come from Range Resources, and to this day we are still trying to determine the source, but there is a low-level naturally-occurring gas field in which many of these water wells for years have seen natural gas occurring in their water wells.

So it is a phenomenon that is not—or whether it is not unique. It is very ordinary over there where those water wells are, and that is what we found, and in fact, after a very thorough investigation and an ongoing thorough investigation will determine where the natural gas is coming from.

But I would suggest that the EPA failed in their processes to determine where that natural gas was properly.

Chairman HALL. Do you have any idea why the EPA stepped in to shut down these operations?

Mrs. JONES. I have no idea, sir.

Chairman HALL. Did the EPA in your opinion overstep their authority in doing so?

Mrs. JONES. Yes. I think they did.

Chairman HALL. How did the incident eventually turn out?

Mrs. JONES. We found through deliberate scientific processes that the natural gas was not coming from the Range Resources wells as the EPA had alleged, and in fact, I sleep very well at night every single night. I have complete confidence in the testing process of the Railroad Commission of Texas. We are the gold standard, and we look forward to helping the EPA if they would like to consult us, and in fact, have made suggestions earlier on in the investigation.

Chairman HALL. I thank you for that.

Mrs. JONES. Thank you.

Chairman HALL. And thank you for your testimony.

Dr. Economides, are you aware of the Duke study on May the 9th, a study on methane contamination of drinking water? Are you familiar with the study?

Dr. ECONOMIDES. Yes, I am, sir.

Chairman HALL. Have you read that before?

Dr. ECONOMIDES. Yes.

Chairman HALL. I call your attention to the report itself. Do you have it?

Dr. ECONOMIDES. Not here in front of me. No.

Chairman HALL. Actually, they say our results show evidence for methane contamination of shallow drinking water systems in at least three areas of the region and suggest the important environmental risks accompanying shale gas exploration worldwide.

You know, you see that, that is in there. That is where they say they found those things.

Dr. ECONOMIDES. Yes.

Chairman HALL. Then if you go on over to page 4 quickly——

Dr. ECONOMIDES. Yes, sir.

Chairman HALL. On page four, line, down about ten lines, read me what they say there beginning with table two.

Dr. ECONOMIDES. "Based on our data we found no evidence for contamination of the shallow wells near active drilling sites from deep brines and/or fracturing fluids." Is that what you mean?

Chairman HALL. Yes.

Dr. ECONOMIDES. Yes, sir.

Chairman HALL. And does it go on down there to say in sum, the——

Dr. ECONOMIDES. In sum, yes.

Chairman HALL. —geochemical and isotopic features for water we measured?

Dr. ECONOMIDES. Yes. "In sum, the geochemical and isotopic features for water we measured in the shallow wells from both active and non-active areas are consistent with historical data and inconsistent with contamination from mixing Marcellus Shale formation water or saline fracturing fluids."

Chairman HALL. My time is over. Just give me a quick, about a 1-minute opinion on the Duke study and what their first contention was and then they answered their own by saying there was nothing found.

Dr. ECONOMIDES. Well, you know, if this was not such a serious issue, this would have been almost a comedy routine because their first statement is that they just discovered there is natural gas over there. You realize natural gas methane in water has traditionally been an exploration tool for the oil industry. We find it, we call them to come and drill for gas. That is what they have found out.

In fact, had they had a baseline for their measurements, most likely the methane in drinking water would have gone down because production reduces the reservoir pressure, which is the driving force for this gas, and therefore, it would have a negative impact. They would have concluded that drilling reduces manifestation of natural gas. It happened many times before. It is not evidence of it here for their baseline.

Finally, their conclusion there is no fracturing speaks in itself, and yet their conclusion which defies any kind of technical in my view——

Chairman HALL. Okay. I could go on and listen to you all morning, but my time is up.

Dr. ECONOMIDES. Thank you.

Chairman HALL. And I owe them some time back.

I now recognize Ms. Johnson for five minutes.

Ms. JOHNSON. Thank you very much, Mr. Chairman. It is clear that a variety of perspectives on this panel, that we need more information about hydraulic fracturing and other technologies, and that is one of the reasons I do not understand why there is resistance to getting more information, more research, and better understanding as to what actually is going on across the country.

For example, the chemical composition of fracturing fluid should be made available to the public. It is a simplistic issue. We are pumping chemicals into our environment, and these chemicals might have an impact on public health.

Why should this information be hidden from the public? Well, I know that the regulation to disclose the information are outside the jurisdiction of this Committee. The EPA study is not.

Therefore, I have to say that the EPA study is an opportunity to gain more knowledge about the hydraulic fracturing, and it should not be wasted by narrowing the scope so much that we keep ourselves ignorant to this technology's impact. And although I would have liked to have seen a broader study with a scope that covered the impacts of hydraulic fracturing on air quality, wildlife, or habitat and other impacts, I understand that EPA does not have the funding or the time to implement such a comprehensive study since the deadline is upon them.

That being said, the public expects us to spend its dollars wisely, so my question to this panel is what research is needed to understand the impacts of the suite of technologies used along the hydraulic fracturing to release unconventional natural gas from these previously-untouched geological structures such as the Marcellus Shale.

And any member of the panel or all.

Chairman HALL. Are you asking that of the panel?

Ms. JOHNSON. Yes.

Chairman HALL. Who wants to make a suggestion? Mrs. Ames.

Ms. JONES. I will——

Chairman HALL. Mrs. Jones.

Mrs. JONES. —suggest what studies that you were requesting, what studies should we do. There have been a lot of studies done. There are ongoing studies almost everywhere coming out of every city. UT is now doing a study on fracturing. There have been—is that what you were talking about?

Ms. JOHNSON. The research that is needed to understand the impact.

Mrs. JONES. Well, we do a lot of studies. The companies, it is incumbent upon these companies to not want to go drill a well where it is not going to be economic to the extent that they try and minimize dry holes, and dry holes, in spite of all this new technology and 3–D seismic things that they can look at to determine, in fact, they still do drill dry holes. But I would say that the research on what is down there is done even by the companies who want to go and drill there.

But the research about the effects of hydraulic fracturing have been—there has been so much research done and now with seismic, I think we just saw the slide, which I think is fascinating, about we are seeing firsthand the seismic of exactly where those frack, the fractures are, and they are very—they are thousands of feet below the Marcellus water table. So there is a lot of information out there for people who would like to stay up all night and read it to feel comfortable that this is a safe technology.

So to the extent that universities want to do more research, I—that is fine. I am also a steward of taxpayer dollars, and I think it is important that research, less research is funded by government where research has already been done before, and we minimize duplicative research, but I think information is available out there for people who want to know. I know there are more studies and more research being done, and we always want to be vigilant at all times on the effects of things that are going on in industry and commerce.

But I have got to tell you hydraulic fracturing has been fairly covered up in research that I know of, and I am still, in spite of all the research, I feel very confident——

Ms. JOHNSON. Thank you. Let me get a few remarks from Dr. Summers.

Mrs. JONES. Thank you.

Dr. SUMMERS. Thank you. Obviously in Maryland we have limited experience so far, and Marcellus Shale is just within the last couple of years been—begun to be developed. There have been a number of issues that have occurred due to in some cases improper

well casing or failure of well casing. There have been spills, there have been explosions and fires and releases.

In Maryland, obviously we don't have a lot of experience with this. We, as I said, are very anxious to see the results of the EPA study. Their Science Advisory Board states that they believe EPA's research approach as presented is appropriate. I think the linkage between a lot of these things we have been talking about and drinking water is very important, and citizens would like to know that this is a safe practice.

So we would like to see a gathering of appropriate information specific to the Marcellus Shale as I have outlined in my remarks.

Ms. JOHNSON. My time is expired. Thank you.

Chairman HALL. The gentleman from California, Mr. Rohrabacher, is recognized for five minutes.

Mr. ROHRABACHER. Thank you very much, Mr. Chairman, and thank you for holding this hearing, Mr. Chairman. It is really important to the wellbeing of the citizens of this country that we discuss this issue and do so in a very honest and scientific way. Our people are suffering right now. My people in California are suffering and throughout the country. We are in the middle of an economic crisis that is affecting the standard of living, the wellbeing of our people.

One of the reasons perhaps, the most important reason we are suffering now and in the middle of a budget crisis here, as well as family budget crises across America is—there have been no new oil refineries in 30 years. There has been no hydroelectric dams in 30 years. There has been no nuclear power plants in 30 years. We, in fact, have seen any new offshore and oil development deposits just controlled and regulated perhaps to the point that they were unable to provide the oil and gas that has been so important for our economy. Even in solar energy we found that the Bureau of Land Management has been refusing to grant permits for people who want to build solar energy plants out in the middle of the desert.

So what we have had is an anti-energy policy in this country, and Americans are suffering because of it. One of the shining lights of hope is that we can now have a new source of natural gas and oil because of a new methodology of bringing it out of the earth and making it available to the people.

I am afraid—I was a young reporter, and I will tell you I remember seeing the environmental movement come forward about all sorts of things, and when I tried to check out what they were talking about, it wasn't true. I mean, they would make statements that just weren't true.

And so we better make sure we get to the truth of the matter in this issue or our people are going to continue to suffer.

Let me go straight to an important issue. Dr. Summers, you have used the word drinking water probably about four or five times since you have been here this morning. Can you give us an example of where fracturing has polluted the drinking water, give us one or two examples of where that has happened.

Dr. SUMMERS. Well, there have been spills in Pennsylvania that have gone into the rivers or the water supply. Monitoring has not indicated so far that there has been contamination of drinking

water supplies from any of these incidents in Pennsylvania that I am aware of——

Mr. ROHRABACHER. Okay. So——

Dr. SUMMERS. —but it is a very significant water supply for millions of people in the Susquehanna and the Potomac Basin.

Mr. ROHRABACHER. And has that been——

Dr. SUMMERS. And we want to make sure that——

Mr. ROHRABACHER. —polluted? Has there been an incident where that drinking water has been——

Dr. SUMMERS. There have been spills into that water supply, that river. What I am saying is it has not been documented to actually have gotten into a drinking water intake so far.

Mr. ROHRABACHER. Okay. So you have used the word drinking water now again four times, but there is no example of where the drinking water of the American people has been compromised because of this. Is that right?

Dr. SUMMERS. I am not familiar with things all over the country. I can just say within the Susquehanna Basin where we have had most of our experience with drilling, I am not aware of any drinking water contamination.

Mr. ROHRABACHER. Well, let me just note that you are someone with a Ph.D. in environmental sciences, and you are someone who holds authority. If there was a case around the country, you probably would know about it, wouldn't you?

Dr. SUMMERS. We are actively gathering that information now. As I indicated this hydraulic fracturing is relatively new to our region.

Mr. ROHRABACHER. Well, it may be new to your region, but I understand from Mrs. Jones that it is not new to Texas or the rest of the panelists. It doesn't seem to be new to them.

Do any of you have an example where drinking water was contaminated by this new process, by fracking? No. Why have we heard the word drinking water being used over and over again, and Mr. Summers, are you using this as a reason—you went through all of these things that people are going to have to go through in order to develop this new energy source for the American people. I mean, from what you outlined in your plan, we are talking about roadblock after roadblock after roadblock just to make sure, and you are basing that on a situation where you never had even one example of the pollution of water, of drinking water.

I mean, this—you want to know why we haven't had any hydroelectric dams, why we haven't had any nuclear power plants? It is that type of attitude that is destroying the economic wellbeing of our people.

Thank you very much, Mr. Chair.

Chairman HALL. Thank you. You could suggest that EPA came in 1,000 feet of it being truthful, so that is one example he could have used.

I recognize the gentleman from Maryland, Mr. Sarbanes, for five minutes.

Mr. SARBANES. Thank you very much, Mr. Chairman. I appreciate it. I want to thank the panel.

I have been trying to step back and assess where the fault lines in this conversation are, and I think part of what is going on is you

have one group that has got long experience with hydraulic fracturing in one set of circumstances that vows up and down that it is very safe. You have another group that is new to it and is having to analyze the potential risks associated with it under a different set of circumstances. Those can be geologic, geographic, in terms of the density of population, and other kinds of things, how you dispose of the fracking fluid. These are all factors that are different in one area from another area.

So we could make a deal. We could make a deal that you won't brush with broad strokes the desire on the part of people in the states affected by the Marcellus Shale to understand more about the implications for there based on experience in other places, and we will make a deal that we won't automatically try to indict the whole industry for things that have happened other places based on our concerns about what is going on in the area of the Marcellus Shale, which is the perspective I am bringing to this hearing because I represent a state in the Chesapeake Bay watershed, and I share some of the concerns that have been relayed to you by Dr. Summers about the potential risks as this Marcellus Shale is explored.

Now, you have New York State, I believe Delaware and Maryland either have formal or sort of unofficial moratorium in place. West Virginia and Pennsylvania have moved ahead. In some instances I think there has been a kind of head-long rush by the industry to lay stakes in those areas. A lot of permits have been issued, and there are things that are happening, and I want to, I mean, Congressman Rohrabacher referred, Dr. Summers, to your perspective as an attitude that is problematic.

I want to thank you for bringing a perspective that says we got to make sure this is done safely in an area where the technology is relatively new and in an area where there have already been some incidents that could cause real concern.

So I would encourage the industry as we head into this discussion, I think it only would strengthen the position of the industry, and valid points have been made on behalf of the industry here today, to be absolutely transparent.

The ranking Member has raised a couple of times the issue of the chemical additives and being completely transparent about that. I think if industry steps up and goes sort of beyond the call of duty in demonstrating that it is willing to be open and candid about what is involved in these processes, that puts you in a good position going forward in this discussion, because we all understand the promise of this and the potential benefits that it can yield.

So let us do it right on the front end, and doing it right in places like Maryland and New York and Pennsylvania where this new discovery has raised great hope may involve some things that haven't been part of the mix in other parts of the country. That is all I am saying. In many respects it is sort of apples and oranges.

Dr. Summers, I am running out of time, of course, because I took the first four minutes just to say something, but let me ask you this question, and it goes, I think, to the importance of having some baseline perspective that the Federal Government can bring, and then obviously states can add layers of additional oversight and requirements if they feel that that is important.

But when I think of the Chesapeake Bay watershed, it knows no state boundaries. We are talking about six states and the District of Columbia that affect the health of the Chesapeake Bay, the tributaries that flow into it.

And you just speak very briefly to why it is important to get a perspective that can cut across state lines, even as the states bring their own particular, you know, views to the table? Thank you.

Dr. SUMMERS. Thank you. Not only do we share the quantity of water and I sit on our Susquehanna River Basin Commission, which regulates withdraws from the river, and we have been authorizing withdrawals from Marcellus Shale gas fracking in the basin, so we share the quantity of water, and that same water that is taken out there is critical for drinking water supplies and for the Chesapeake Bay, which receives 50 percent of its fresh water from the Susquehanna River.

Similarly, the Potomac River is the water supply for Washington, D.C., and many communities in Maryland, and we need to make sure that whatever we do is fully protective of that, so not only the quantity of water but obviously the quality of water, and as I indicated there have been some spills, and the kinds of things that we say that we want to put in place before we move forward with hydraulic fracturing are exactly the kinds of protections and best management practices that it sounds like the other states in the west have been doing for years.

So I think we need to gather that information. I appreciate Congressman Sarbanes' remarks to that regard. Thank you.

Chairman HALL. The gentleman yields back.

Now recognize Dr. Harris, the gentleman from Maryland, for five minutes, maybe six minutes.

Dr. HARRIS. Thank you very much, Mr. Chairman, and thank you very much for holding this hearing because it is full of surprises. For instance, I am actually surprised to learn that there is actually no instance of drinking water having been contaminated, no known instance, because if you read the lay press and the environmental press, you would think it happened everywhere.

So, Mrs. Jones, a question for you. So let me get it straight. In Texas this has been going on for years, I mean, the hydraulic fracturing, the—and you know, my analogy is to medical care. I mean, you know, if you have a medical procedure that has been going on for years and years and years, and you are going to find either a new location or a new application for it. It doesn't mean that you have to forget your experience over all those years.

So this has been going on for years in the State of Texas I take it.

Mrs. JONES. Absolutely. Decades, Congressman.

Dr. HARRIS. Okay, and my daughter actually goes to college in Dallas, and my understanding is Dallas sits in one of the areas of this shale formation, and when I flew there, over there, Dallas uses reservoirs, don't they? For water. For drinking water.

Mrs. JONES. Yes. I believe they do, but more Fort Worth, but, yes, in the Dallas, Fort Worth area.

Dr. HARRIS. Yeah. The Dallas, Fort Worth area.

Mrs. JONES. Absolutely. Yes.

Dr. HARRIS. So your concern would be exactly the same as any concern anywhere in the country with regards to the use of hydraulic fracturing in proximity to drinking water sources.

Mrs. JONES. Absolutely. It doesn't hold any water, if you would pardon——

Dr. HARRIS. Sure. No. I kind of get that. So, Dr. Summers, I am just puzzled, and you know, in the context of, you know, an executive branch versus legislative branch struggle, it just went on in the State of Maryland, because my understanding is the State of Maryland attempted to pass the House, lower House pass date a two-year study moratorium on hydraulic fracturing which the Senate did not agree to.

Did the Department support that two-year moratorium?

Dr. SUMMERS. Actually, sir, it was a two-phase study. Wells would be authorized after the first year. As I described in my testimony, we referred to them as exploratory——

Dr. HARRIS. Very limited numbers but did the Department support the moratorium?

Dr. SUMMERS. Yes.

Dr. HARRIS. So you had kind of the same—even in Maryland you had the same struggle between the executive branch and the legislative branch.

Now, Dr. Summers, I have got to ask you because, you know, and I was concerned when I first read about what was going on in Pennsylvania, but, you know, you bring up the flow of the Potomac, you bring up the Potomac and other rivers. Let's put it in perspective. It is up to three million gallons in one well. What is the flow rate of the Potomac River in a given day?

Dr. SUMMERS. I don't know, and——

Dr. HARRIS. Could you get back to me on that because I suspect——

Dr. SUMMERS. It is under——

Dr. HARRIS. Right, but even if, you know, my gosh, ten percent of the hydraulic fracturing fluid would flow right into the river, you would be measuring parts per billion, maybe parts per million of some of these things, and what is the largest spills that have occurred of raw sewage coming out of Baltimore into the bay? Because when I was on the Committee I recall spills of a quarter million gallons in one day. Is that right?

Dr. SUMMERS. A quarter million sounds a little high but certainly millions of gallons have—sewage have been——

Dr. HARRIS. Right, and do we allow the sewage system to still exist in Baltimore City? Because this is a direct analogy. I mean, and I will tell you as a physician, I would almost rather, much rather drink a slight amount of drilling fluid, hydraulic drilling fluids, than I would—of this that was thrown into the bay.

What has the Department done about the hundreds of thousands of gallons of raw sewage that flow into the bay out of the Baltimore City system? This Department that wants to put our economic vitality of the country at stake by limiting access to energy because that, you know, and, again, and I represent a part of the state like Western Maryland but it is economically disadvantaged. The Eastern part of the state that I represent has high unemployment or economic disadvantage, and what you are doing is by this policy

you are actually not only hurting that economically-disadvantaged part of the state, I think, and I agree with the Congressman from California, actually harming our economy and the country.

So if you could just tell me what the Department has done for that—those sewage spills, which are known spills, have absolutely contaminated drinking water sources in the state. What do you do?

Dr. SUMMERS. We have issued judicial consent decrees in conjunction with the Department of Justice and EPA. Baltimore City, specifically right now is spending over $1 billion to make corrections and upgrades to its system. Systems throughout the watershed all the way up the Susquehanna and the Potomac have very similar problems. It is a national issue, and we are taking very aggressive action to deal with that, and I am not suggesting that we can't do Marcellus Shale gas development in Maryland. I am just suggesting that we need some more facts, and I think based on what I have heard today there is a lot of good information that ought to be able to help us move forward with this. It needs to be pulled together, though.

Dr. HARRIS. Thank you very much, and I don't have anymore time unless that 6-minute limit was there. I yield back.

Chairman HALL. The chair now recognizes the gentleman from North Carolina, Mr. Miller, for six minutes.

Mr. MILLER. Thank you, Mr. Chairman.

Mrs. Jones, in your testimony you said that recently a French delegation had come to Texas to meet with your staff to hear all about fracking procedures, and they left very convinced, your testimony is, these foreign officials are already convinced of the benefits. They went back to France apparently saying we can't wait to get back there so we can do more fracking.

But there was an article in Bloomberg this morning, this morning, today, France should ban shale explorations on risk, minister says. And the minister is a minister of the environment. I will not attempt to pronounce the name because I would prove myself to be a bumpkin, which everyone knows anyway.

But it says, " I am against hydraulic fracking, we have seen the results in the U.S., they are risk for the water tables, and these risks we don't want to take." She said it was an error to have issued some exploratory permits, they should never have been granted—an environmental evaluation should have been done before giving permits and not after. She said it is a technology we haven't totally mastered. There is only one technology that can be used today to produce shale gas, and that is hydraulic fracturing, and we don't want it, and it violated the precaution prevention requirements of their environmental laws.

Do you have any idea what happened after that delegation got back to France?

Mrs. JONES. Excuse me, Congressman. Actually, they were there yesterday, and I was here, so I haven't had the time to talk and find out how the meeting went, but I suspect that they—I can't put words in their mouth, but as soon as I have the report back I will call you and let you know what their impression was. I can't imagine that they were over trying to find out our protocols unless they had some interest in pursuing the same for their country.

Certainly I think France could benefit mightily from the production of their energy resources, and that brings me to something I think that is very interesting, and I would like to share with this Committee.

Mr. MILLER. Well, actually, it is——

Mrs. JONES. We have had several delegations——

Mr. MILLER. Particularly on this point of the French delegation, but I would otherwise like to move on because I don't have——

Mrs. JONES. Okay. Well——

Mr. MILLER. —that much time.

Mrs. JONES. —anyway, we have a lot of delegations coming and going.

Mr. MILLER. All right. Thank you.

Mrs. JONES. Thank you.

Mr. MILLER. Dr. Economides.

Dr. ECONOMIDES. Yes, sir.

Mr. MILLER. In your testimony or the shortened version, the one page summary, you said that pretty much anyone associated with the industry who were the only ones who really had expertise in the area, was immediately condemned as being an industry shill from having been in the industry.

You mentioned a Duke study, and you were very critical of that study, and in general I would—generally I embrace anyone who criticizes Duke, but in this one case do you have any—do you fault the qualifications of those scientists at Duke who performed that study? Were they unqualified to do the study?

And second, do you know of any economic interests they may have had that would have affected, might have affected their judgment?

Dr. ECONOMIDES. I do not know the people, I do not know their motives, but I do have some very serious reservations about their conclusions. If they were my students, I would give them an F.

Mr. MILLER. Okay. Well, you did, again, that you—and I agree with you. I don't think it is fair to say anyone who is associated with industry is an industry shill, but do you not think it is that the American people and Congress have a right to know if anyone offering expertise has a financial interest in the subject matter about which they are offering their expertise?

Dr. ECONOMIDES. No question about that.

Mr. MILLER. Okay. Well, in your biographical sketch, your statement of economic interest for the Committee was unrevealing as they all are, but you say that you are—you have a faculty position at the University of Houston. Is that correct? And you are managing partner of Dr. Michael J. Economides Consultants, Inc.

What percentage of your income comes from your faculty position and what comes from your consultancy?

Dr. ECONOMIDES. I get paid only $1 a year from the university. I give my salary back to the university.

Mr. MILLER. Okay, and how much do you make from your consulting?

Dr. ECONOMIDES. You mean personally?

Mr. MILLER. Yes.

Dr. ECONOMIDES. About a million dollars a year.

Mr. MILLER. Okay, and you say that your clients include national oil companies. What are those national oil companies?

Dr. ECONOMIDES. I am the senior advisor to Sinopec and CNOC to Chinese companies. I am the senior advisor to ENI, international oil company. I am—I work for two Australian oil companies on retainer. I work in Angola, Nigeria, Ghana, and Kazakhstan.

Mr. MILLER. And what is the nature of the consulting that you provide them?

Dr. ECONOMIDES. I am a technical person. I am an engineer. I am the person that has written the textbooks on hydraulic fracturing.

Mr. MILLER. Okay. So you are providing engineering expertise to companies doing fracking?

Dr. ECONOMIDES. Fracturing.

Mr. MILLER. Fracturing wells?

Dr. ECONOMIDES. Yes. I have personally done more than 2,000 fracturing jobs through the world. I am one of the first persons to start the fracturing on the wells in West Texas, so I have worked in 70 countries as I testified.

Mr. MILLER. Okay. My light is red in error, but I will yield back the last 21 seconds of my time.

Chairman HALL. The gentleman yields back.

The chair now recognizes the gentleman from Texas, Mr. Neugebauer.

Mr. NEUGEBAUER. Thanks to Chairman Hall, and thank you for having this important hearing.

Mrs. Jones, I think you wanted to enlighten the Committee on something that you started, and I would yield you some time to do that.

Mrs. JONES. Thank you, Congressman, so much.

We have missions, if you will, trade missions come over from all over the world to the Railroad Commission offices to see how we implement regulatory oversight of oil and gas operations, and in fact, I would like to extend the opportunity for those from Maryland, Dr. Summers, we may have some ideas that you might be able to apply on the ground in Maryland, because certainly it is true that we have had a lot of experience in doing this.

But this natural gas, this new renaissance, if you will, and energy is not just for America. It is for the entire globe, Congressman Neugebauer, and it is very important, I believe, that other countries, in fact, can benefit from the energy security that their own natural gas resources under their ground might give them as well.

So I would go so far as to say that natural gas is indeed a great development for America but also for the entire world as these people want to employ the great minds that we have here sitting at this table, in fact, for advice and to consult on how to safely and responsibly get their natural gas out.

I would suggest also that there is not one size fits all as you all have seen. Certainly Maryland and the Marcellus has different challenges, and there are some challenges that they will have to meet that we don't have here in Texas, and I am very cognizant of that, and I think the argument can be made that, in fact, yes, it is true, one size does not fit all, and that is why it is incumbent

upon the states to regulate their own patch, if you will, and Maryland will get put to speed, they will get the experience and the know how, you ought to be seeking the information from us, from your sister producing states now that you are going to become one. Welcome aboard, but you should be seeking our advice and other states in how you accommodate the groundwater or rather dispose of the flowback and how best practices are used.

And so that is how states can work together. The Interstate Oil and Gas Compact Commission is there for us to work together. You might establish your own compact on your oil and gas drilling operations in the Chesapeake Basins.

So I welcome the states, I welcome new kids on the block. I think it is exciting for America, and we serve to serve at the Railroad Commission, and I am not saying that we don't need, they don't need oversight. I am just repeating, and you certainly know full well from your home district, which is very important what we do to you all, that we must let the states regulate and oversee this process because only we know what is best for our citizens.

Thank you.

Mr. NEUGEBAUER. Dr. Michael.

Dr. ECONOMIDES. Yes.

Mr. NEUGEBAUER. I wasn't going to try that last name because you probably won't try my last name.

Dr. ECONOMIDES. It is all Greek to me. Don't worry.

Mr. NEUGEBAUER. I hear you. I hear you. Well, I knew you weren't from East Texas, so I think that one of the most important things that you started off with, and you threw your presentation up there, but you said no frack, no gas.

Dr. ECONOMIDES. Right.

Mr. NEUGEBAUER. You know, and I think maybe it would be helpful for people just a little bit of time here left to talk about the geology and why that, the statement that you made is a true statement.

Dr. ECONOMIDES. Okay. Most gas wells in the world are in what we call very low permeability formations. There is no difference between oil and gas. Gas has been older and broke down. Long hydrocarbons have become short, methane. And so the same reason that made it gas made also the rock very tight. So you cannot have economic production with what we call ready flow. It is very inefficient.

Fracturing alters the way the fluid enters the well. We clear the reservoir. That is a hydraulic fracture. So if you do not fracture, you cannot produce gas.

There is another problem with higher level complexity called turbulence effect. The higher the reservoir permeability, the gas jumps itself. It is almost like a lot of people trying to run out of a stadium that want to kill each other. That is the same thing that happens, and it commits suicide.

So in other words we want to frack again to alleviate turbulence in high permeability reservoirs. So air forces the double negative. You cannot afford not to frack any gas well in the world and expect to make any money.

Mr. NEUGEBAUER. Thank you, and just one last question. You know, I think the chart that you put up there showing where the groundwater is in relationship——

Mr. ECONOMIDES. Right.

Dr. NEUGEBAUER. —to where most gas wells—I think another thing that most people don't realize is the depth of gas wells, but I am going to go back to Mrs. Jones just for a quick one.

What do you think the average depth of a gas well in Texas is?

Mrs. JONES. We have some that are over a mile deep, so it is geologically impossible for those fracks to get anywhere close to the water table in Texas.

Mr. NEUGEBAUER. And just for the folks——

Mrs. JONES. About 10,000 feet deep. The Barnett Shale and the Eagle Ford Shale that is in South Texas that is producing oil, too, I want to reiterate that there is also an increase in oil production due to hydraulic fracturing as well.

Mr. NEUGEBAUER. I thank the Chairman for my six minutes.

Chairman HALL. The gentleman from Michigan, Mr. Clark, is recognized for five minutes.

Mr. CLARKE. Thank you, Mr. Chair. Just, to any of the panelists, I come from Detroit. I represent metro Detroit. We are the home of the auto industry which is a very fuel-intensive industry which has innovated greatly in the last few years to power automobiles from energy sources, different energy sources, including natural gas.

Now, there are concerns that hydraulic fracturing, and I'm looking at the whole process including, you know, well construction issues, could release contaminants into the air and the water. How do you believe that we can innovate in this area to reduce the likelihood of those contaminants getting into the air and water? How can we apply that same type of innovation to hydraulic fracturing so we can make this a more clean and green process?

Dr. COOPER. I think the industry is actively engaging quite a bit to figure out many different innovative ways to clean up the water that has to be disposed on the surface. Now, I want to reiterate that in a lot of the United States, there is no reason to dispose of water on the surface. But in areas where it is necessary, or maybe there is some beneficial reason to put the water on the surface—you know, a lot of this so-called frack water, produced water, isn't that far from a drinking water standard, and it can be cleaned up. So I would say that there are literally hundreds of entrepreneurs and a lot of very big companies that are working on a lot of different techniques to clean up water, and there are existing techniques that are very simple that have been used for decades. So a lot of action is happening there.

I think in the air, pretty much the same story. It is a little harder to collect air, but it is definitely not so hard to figure out ways to reduce some of the major pollutants that might be going into the air.

Mr. FITCH. If I could add, I know a lot of the service companies that conduct the hydraulic fracturing operations are working on greener additives. They are already making a lot of progress that way, and I think that is another area that could bear fruit.

Mr. CLARKE. Thank you. With the time that I have remaining, I would like to pose another question, and that comes from my review of the EPA's draft plan to study the potential impact of hydraulic fracturing on drinking water resources, and this is the issue that was raised on page 49. It is not a technical, it is regarding environmental justice, and what I mean by that is how can we help minimize the environmental justice impact of hydraulic fracturing, meaning this, reduce the likelihood that poorer people or certain communities that have certain ethnic or racial populations are disproportionately impacted by the contaminants that they could be exposed to as a result of hydraulic fracturing? Let me illustrate the point clearly. In the area that I represent, we have got an incinerator, refinery, waste water treatment plant, and even though I represent Detroit in the suburbs, all of those facilities are located in Detroit in poor, African American areas. Those are my people that are being impacted by those operations. I just want to make sure that that doesn't happen with hydraulic fracturing.

Mr. FITCH. I would be glad to respond to that as a fellow Michigander. The real issue here is that natural gas is where nature puts it. You can't move a well. You can move a well a certain, a little bit, but you know, not miles. You have to tap those reservoirs where they occur in nature. So I will say though that most—there is kind of a bias toward developing in more rural areas because it is lot easier to obtain land, it is a lot easier to obtain drilling sites. So there is kind of a natural mechanism there that would tend to move that kind of development out of the cites, out of the more built-up areas.

Mr. CLARKE. Let me just for the brief time mention what my concern is. Typically because the drilling agreements are between the well operators and landowners, I am concerned that neighbors and tenants may not really have a voice in this process.

Mr. FITCH. That is a part of the scheme of development of oil and natural gas. The people that own or control the mineral rights have a right to benefit from their development. I am not sure beyond that what the answer would be.

Mr. CLARKE. Thank you. I yield back my limited time.

Chairman HALL. The gentleman yields back his time. The Chair now recognizes the gentleman from Texas, Mr. Smith.

Mr. SMITH. Thank you, Mr. Chairman. Mr. Chairman, I know you have already welcomed Elizabeth Ames Jones, our Texas Railroad Commissioner, to the Committee hearing today, but I would like to do so as well.

Over the years, I have been her constituent, and she has been my constituent, so I am pleased to have her expertise available for Members right now.

Mrs. Jones, I have a couple of questions for you. You mentioned in your written testimony, and I will quote you, "Our two main concerns about the EPA study are that it proposes to delve into areas beyond the reach of federal law and that it also proposes to study areas beyond the practice of hydraulic fracturing."

Mrs. JONES. Yes.

Mr. SMITH. Could you go into more details about why you have those concerns?

Mrs. JONES. Yes, and thank you so much, Congressman. I will report back home how great it is to see you, to your family.

It is called scope creep or mission creep, and the intent was first to study the effects on water. They are now supposedly going to be looking at more, in fact, upstream, well pad site, how water is procured by operators, so not just the hydraulic fracturing and any affect it might have anything, but in fact, if you will, the contract, the private contract between willing buyers and sellers on how to put a well together and how to drill a well. I think this is scope creep and it is not within the purview of the Federal Government or the EPA to, in fact, go that far, be that broad, if you will, and I have grave concerns about that.

Mr. SMITH. Has the EPA asked you for your opinion or your input in any way considering the expertise you bring and considering the role of Texas in the production of oil and gas?

Mrs. JONES. We have made comments. We have provided comments to this draft study for the EPA. We submitted, if you will, comments to that, and that would be the extent. We don't get called and asked for our expertise often.

Mr. SMITH. I assume that they have not addressed your concerns, is that correct as well? ——

Mrs. JONES. No.

Mr. SMITH. Mrs. Jones, I want to ask you another question, and this is actually a question we might ask the witness in the second panel, but I would like to get your opinion as well.

You may or may not be aware of this, but the 2011 definition by the EPA of hydraulic fracturing is far broader than the 2004 definition of hydraulic fracturing that they used back then. We can find no basis whatsoever for this broadening of their definition, no basis in fact, no basis in any kind of a reputable source. I would ask you to speculate a little bit here, but why do you think the EPA would suddenly come up with such a broad definition of hydraulic fracturing that is broader than they have ever used before?

Mrs. JONES. Thank you. I can only, or if it would not be too bold for me to assume, that they would like to expand their footprint when even since then, in 2004, the footprint of drilling operations gets smaller and smaller every year. Technology is used the way it is meant for. It allows the industry to go in with a smaller footprint and be more efficient and in fact efficient in water use that they need to frack a well, and we at the Railroad Commission look at pilot projects of water reuse and hope and encourage them to do that. The market affects that, and it is moving very quickly. Technology is moving quickly. They are getting smaller, their footprint is smaller, we encourage it. The EPA seems to want a larger footprint.

Mr. SMITH. That is my explanation as well. Thank you, Mrs. Jones. Thank you, Mr. Chairman.

Chairman HALL. The gentleman from New Mexico, Mr. Luján.

Mr. LUJÁN. Thank you very much, Mr. Chairman, and I appreciate all the witnesses' time today as well.

Mr. Chairman, based on the testimony that I heard today and that was filed, I would just like to ask the witnesses, and I appreciate your efficiency, Mr. Chairman, when you were able to get a yes or no answer, and I only strive to be able to live up to those

expectations, Mr. Chairman. So I will do my best to be like you, Ralph Hall, and see what we can do there, Mr. Chairman.

But with that being said, Mrs. Jones, I appreciate you being here as well. Do you believe there are best practices that exist within hydraulic fracturing today across the country, but especially in Texas?

Mrs. JONES. I do.

Mr. LUJÁN. Dr. Summers, do you believe there to be best practices?

Dr. SUMMERS. We do not have them in place for the Marcellus I believe, and as I have said, I think we need to look at other areas.

Mr. LUJÁN. Mr. Fitch?

Mr. FITCH. Yes, we do.

Mr. LUJÁN. Dr. Cooper?

Dr. COOPER. Yes, I believe so.

Mr. LUJÁN. Dr. Economides, is that correct, sir?

Dr. ECONOMIDES. Yes, of course. I mean, we do 80,000 fracturing jobs in the United States per year right now.

Mr. LUJÁN. With that being said, Mr. Chairman, do any of the witnesses believe that those best practices should be adopted? Commissioner Jones?

Mrs. JONES. I think that one size does not fit all because the different areas of the country have different—even their road makeup, their population, their disposal of frack water. So I would like to help Maryland have a railroad commission of Maryland and just be able to regulate their industry so that they can reap the benefits like we have here in Texas.

But what I am saying is that they have to look at the facts of what is really happening because if they don't, they will be distracted, and there may be something that really does need attention. And so I think it is incumbent on public servants to look at the facts so that they are actually addressing a problem if it does exist and not basically just chasing rainbows.

Mr. LUJÁN. I appreciate that. Dr. Cooper, when you have teams that are training to do fracking jobs in different parts of the country, different parts of the world in our local areas, they train to do a fracking job, and they have standards that they operate under. Is that fair to say?

Dr. COOPER. Yes.

Mr. LUJÁN. And so if we are talking about creating certainty for the industry, certainty across the country and also certainty with the workforce and the teams that I have seen move forward with this, does it make sense that we have standards so that way when they are drilling in Texas and they are fracking in different parts of the country, that they are able to know how to go in, do that most efficiently and make sure that they are protecting that groundwater as well?

Dr. COOPER. I think we have very high standards, especially in New Mexico.

Mr. LUJÁN. So does it make sense that there should be some standards so that when those teams are fracking in Texas or fracking in New Mexico that they should live up to those same standards, even if they are minimum?

Dr. COOPER. I think they already exist.

Mr. LUJÁN. So if there are already minimum standards, is there objection by any of the witnesses that we should adopt minimum standards that should be followed, at least a floor, across the country? Any objection?

Dr. COOPER. I think we would prefer if the State of New Mexico regulated the State of New Mexico and the State of Texas regulates the State of Texas and on and on.

Mr. FITCH. I would just like to add I think each state is best equipped to deal with the issues that are unique to their state. There are differences in terrain, differences in climate obviously, differences in the geologic formations where the gas occurs, and I think the states are best equipped to tailor their regulations to those specific instances.

Mr. LUJÁN. Real quick there. In New Mexico, there are no direct fracking laws, but there is underground injection control law that prohibits drilling out of zone or into drinking water. Is that something that makes sense that should be adopted nationally?

Mrs. JONES. I am perfectly comfortable with our Railroad Commission standards. I don't need to adopt New Mexican standards for Texas.

Mr. LUJÁN. That is fair. I appreciate that, Commissioner. And Commissioner, the water that was talked about by the Chairman a bit ago in Texas where the EPA went in, did that meet safe drinking water standards when the EPA stepped in there?

Mrs. JONES. Which water?

Mr. LUJÁN. The water that you answered that there was no contamination——

Mrs. JONES. Oh, the Range Resources water. In fact, that water well owner——

Mr. LUJÁN. Well, Mr. Chairman, if I may, Commissioner Jones, did that water meet safe drinking water standards?

Mrs. JONES. It had gas in it before we even came into the picture. So he had already cut the pipe from his house and was not drinking from it. But several people do use it to water their lawn.

Mr. LUJÁN. Commissioner, would you drink that water?

Mrs. JONES. In fact, one of the homes did have a vent, and they were venting out the natural gas and using it.

Mr. LUJÁN. That is not my question.

Mrs. JONES. If I was at their house and they served it to me? Yes, I would drink it.

Mr. LUJÁN. Well, I have been around some areas that meet some safe drinking water standards that I wouldn't drink and I wouldn't want kids or nephews or nieces exposed to. The one thing I hope, Mr. Chairman, that we can agree on is that as we look as what needs to be done in this area, understanding the needs of what needs to be done to be able to take advantage of natural gas across the country, is understand that I don't think there is any fault in trying to adopt some minimum standards at the very least. In New Mexico, several groups have gone forward and adopted some closed-loop standards which I would look forward to hearing from some of the witnesses as well, Mr. Chairman, but I certainly hope that we can find some common ground on this and at least adopt some agreement to begin the conversation about adopting minimum standards as opposed to saying, you know, what is good for us is

not good for anyone else when we are looking at protecting our water as opposed to accommodating our water resources. Thank you, Mr. Chairman.

Chairman HALL. Thank you. The Chair recognizes the gentlelady from Florida, Mrs. Wilson, for five minutes.

Ms. WILSON. Thank you, Mr. Chair, and Ranking Member Johnson for holding this hearing.

This is a question for all of the panelists. I am from Florida, and we had fallout from the BP tragedy, Deepwater Horizon tragedy. And that particular tragedy illustrated tremendous forces and inhospitable conditions in which modern-day deepwater drilling takes place as well as increased risk that comes with these activities. Equipment and operators must be up to the task with no room for error. In that case, they were not.

We learned that relatively simple things such as greater automation and more monitoring to catch irregularities could prevent accidents. Just last month a blowout at a gas well in Pennsylvania demonstrated that these risks are not confined to the deepwater. In the business of hydraulic fracturing, what steps is industry taking to reduce and manage these risks; how are wells monitored, and are all wells monitored this way; and how do safety-related lessons learned in the off-shore industry transfer to the on-shore, unconventional sector and vice-versa?

Mrs. JONES. Thank you, Congresswoman. I would like to say that unlike the Federal Government oversight of the off-shore, the Railroad Commission's oversight of the Texas oil and gas operations has not generated such a traumatic event. And I would be willing also to work with BOEMRE and any other federal agency, formerly the Minerals Management Service, to apply the maximum standards that we use at the Railroad Commission to ensure the responsible operations.

One of the things you mentioned, specifically, hydraulic fracturing. We have spacing rules that operators come in when they want to get a permit to drill a well, distance rules. Communities are putting in some of their own distance rules, but mainly our oversight is of the down hole and the disposal of any water that comes back. In our State, we have strict well casing rules to make sure that water cannot migrate out of the well. Cementing, they run cement logs. We have pages of rules and regulations to ensure responsible down-hole drilling operations of the industry, and we also want to make sure that people benefit who own the minerals. And now with urban-suburban drilling, there are a lot more people who are reaping the financial benefits because they own the minerals. But it is true, if they don't own the minerals, sometimes they are inconvenienced by a well that might go in near to their neighborhood. But the severance tax that they pay off the top from that natural gas goes into state coffers and funds schools, permanent school fund to some extent, but a rainy-day fund primarily. And 33 school districts are funded by the taxes of oil and natural gas production right off the top at the well head, for them in taxes and for the State as well.

So we have a protocol in place that is ensuring that we maximize our resources, use them to the best of our ability and one of our mission statements is the protection of the environment as well.

And I can tell you, I remain vigilant every single day. In fact, I would prefer that Texans remain vigilant in Texas, and perhaps if the Federal Government had been as vigilant as we are, the BP accident or disaster would not have taken place.

Chairman HALL. Yes? You yield back?

Ms. WILSON. Want to respond? It was just thrown out there.

Chairman HALL. Oh.

Mr. FITCH. I could say a few words to that, I guess. I am not sure exactly the details behind that Pennsylvania blowout, but I think I can safely say it was not a fracturing issue, per se. It was a well control issue. You can have that with any kind of well, whether it is fractured or not. To echo Texas, the states do have safeguards. We require casing programs, blowout preventer programs to counteract those kinds of things. However, nothing is ever going to be totally risk free.

Dr. ECONOMIDES. Let me, if I might, add a couple of comments here. First of all, fracking and drilling are not the same thing. People bunch them together. We drill wells, then we frack them. They are not connected as processes.

There is no such thing as risk free. If you are familiar with the rule of nines, in other words, nine, nine, nine, nine, there is always one probability out there for something horrible to happen.

In this respect, the oil and gas industry is one of the safest industries in the world, in spite of sensational accidents. You don't stop flying because an airplane crashes, and the same thing, we don't stop drilling for this very vital commodity, oil and gas, just because one errant well had an accident.

Chairman HALL. Does the gentlelady yield back?

Ms. WILSON. Mr. Chair, I don't want to assume or give you the impression that we should stop because of one accident. However, my question was, what safeguards do you have in place to prevent accidents.

Dr. ECONOMIDES. Well, there are plenty of them. We are computer monitored in everything we do. We take great lengths to do measurements before and after any action we do. We take into account integrity of the well. We do everything in our power to prevent spills. We do everything in our power to prevent zonal communication with adjoining geological structures, let alone some things that are thousands of feet away.

So in other words, the industry has no economic interest to be careless. The industry, on the contrary, environmental sensibilities notwithstanding, has a financial interest to do things right, and they do it right.

Chairman HALL. The gentlelady's time has expired.

Ms. WILSON. Thank you, Mr. Chair.

Chairman HALL. Thank you. Before we recognize the gentleman from Michigan, Mr. Benishek, I want to recognize our astronauts on the back stage there. I would like for you all to stand up and let us honor you from STS 133, you just landed when, yesterday or the day before?

VOICE. We got back Saturday morning.

Chairman HALL. Well, that is about how up to date I am. But we appreciate you very, very much. And you are the Columbuses and Magellans of space. We are proud of you. Thank you. And don't

any of you come back and run against any of us in our district because you would get elected.

Okay. The gentleman from Michigan, Mr. Benishek, is recognized.

Mr. BENISHEK. Thank you, Mr. Chairman. Mr. Fitch is here from Michigan, and I think I will address this question to you. There have been numerous comments filed with the EPA including the Administration's Department of Energy. They have pointed out that the EPA draft study does not objectively characterize the risk of this drinking water fracking in part because they selectively focused on cases that have had negative outcomes reported, although not necessarily confirmed. Do you agree with the concern that there is no quantitative analysis of the risk that may skew the results?

Mr. FITCH. I do agree with that. I think any activity you look at out there you can find potential problems or actual problems, and by not putting it in context, I think it at least certainly lends itself to being misused by people who are opposed to energy development, and that would be our concern. I think it needs to be put in perspective.

Mr. BENISHEK. Thank you. Does anyone else on the panel have any other comments on sort of that line of thinking?

Dr. COOPER. I think we are asked to quantify risk all the time, and I think it is a big glaring hole that EPA doesn't seem to think that they need to quantify risk.

Mr. BENISHEK. Thank you very much, gentlemen. I yield back the remainder of my time.

Chairman HALL. The gentleman yields back. Dr. Broun, do you have questions? The gentlelady from California, Ms. Woolsey, is recognized for five minutes.

Ms. WOOLSEY. Congresswoman Woolsey does not have a question. Thank you.

Chairman HALL. Congresswoman Woolsey is recognized for six minutes. It doesn't take her long to use up her six minutes.

All right. I thank the witnesses for your very valuable testimony, and I thank the Members for their questions. We are going to now move to the second panel, and if Dr. Anastas takes his seat at the table—somebody call Dr. Anastas and tell him he is on.

Dr. BROUN. Mr. Chairman?

Chairman HALL. The Chair recognizes—

Dr. BROUN. Before this panel leaves, I would like to ask a quick question, if I may.

Chairman HALL. All right. You may.

Dr. BROUN. I apologize for throwing the wrench in the works here while we are waiting for the next panel to come.

I wanted to follow up on what Mr. Luján was saying. I believe in the Constitution as our Founding Fathers meant for it to be, and Mr. Luján is going down a track, talking about we needed to see up some federal minimum standards. And frankly, I think the states personally can set whatever standards are necessary to make improvements or protect the environment within their own states. Do any of the five of you see any necessity to having a federal standard or can you, within your own state, within your own purview, set up standards that are necessary to protect your own

state's drinking waters and make sure that your citizens continue to be safe? Very quickly.

Dr. SUMMERS. I believe we do need to have minimum standards and specifically in my testimony I mentioned the fact that we have interstate waters, and we need to make sure that all the states are doing at least minimal level of protection.

Dr. BROUN. Can we do that through interstate cooperation instead of having some federal nexus here?

Dr. SUMMERS. In fact we have the Susquehanna River Basin Commission which I mentioned that has representatives from all the states that share that watershed, and I believe that that works extremely well. But we don't have that across the entire set of watersheds that impact Maryland. So in Maryland, I think that would work with the Environmental Protection Agency, Region III and the Chesapeake Bay Restoration has been a good example of how that federal work with the states can be very effective and productive.

Dr. BROUN. Anybody else, very quickly? Mrs. Jones? Go ahead.

Mrs. JONES. I would say no, that we can, the State of Texas, can certainly and has already developed minimum and they are quite stringent minimum standards. And thank you, Congressman, because I don't see anywhere in the Constitution where the authority to do this was delegated to the Federal Government. And I think that the states can regulate their own energy patch just fine—we have also worked with the EPA, and I think that Maryland, I look forward to helping to craft a compact where they can regulate their energy resources, too. We can share knowledge and certainly are just a phone call away.

Dr. BROUN. Anybody else want to comment?

Mr. FITCH. I would say from my perspective, each state is fully capable and has the necessary authority to properly regulate oil and gas, all aspects, including hydraulic fracturing. We do cooperate among the states. The Interstate Oil and Gas Compact Commission is one very good vehicle for that, and we would welcome Maryland's stronger involvement in IOGCC, and we would be glad to help share some of our expertise in that area.

I mentioned I am a member of the board of Stronger, Incorporated. We review states on a voluntary basis for their regulatory programs against a set of guidelines, and as I said, we just completed this year review of four states' hydraulic fracturing programs to, you know, give some assurance that they meet minimum standards.

Dr. BROUN. Anybody else want to comment? I thank you all for the quick answers, and thank you for coming back on the panel. But I want to say this. Our Federal Government has gotten too large. We are spending too much money. We are interfering with state business too much. We need to go back to the original intent of the Constitution which means very limited government. The Constitution only authorizes the Federal Government to be involved in national defense, national security and foreign affairs predominantly. There are a few other things constitutionally that we have authority to do, and it is not in our purview to interfere with what the states are doing. There is a state DEP in every state of this country that is engaged in trying to protect the citizens of

that state, and I applaud what you all are doing, and I encourage you to continue to do so and thank you for your testimony. Thank you, Mr. Chairman. I yield back.

Mr. ROHRABACHER. Would the gentleman yield?

Dr. BROUN. Certainly to you. I will always yield.

Mr. ROHRABACHER. Well, while we were going through the hearing here, I went out and had to get a hamburger. Now, what I need to know is if we keep obstructing the development of energy, and especially this new opportunity we have through fracking, do you think the price of these hamburgers are going to go up for ordinary people? Is that what it is all about? I think it is. If we are going to be sucking wealth out of our country and having to send it overseas, eventually we are going to have to spend more money for what we get here.

So Mr. Chairman, I really took to heart what our colleague from Michigan was talking about when he said he was talking about the poor people who live in his area and how they are severely impacted by various uses of energy. Let me just note. We have more and more poor people and fewer and fewer hamburgers for us to eat if we don't develop our own energy resources. There is a direct relationship. Yes, no fracking, no gas. No gas, no prosperity. No prosperity, no jobs, no good life for the American people.

So thank you all for your testimony. Thank you, Mr. Chairman for leading this effort.

Chairman HALL. Are you going to eat all that hamburger and not even offer us a bite?

Mr. ROHRABACHER. These are my carbs. It has something to do with sunshine and gas——

Dr. BROUN. All right. I will reclaim my time, Mr. Chairman, and I yield it back.

Chairman HALL. I once again thank the panel and the Members for their questions, and we have our second panel now. Dr. Anastas, please take your seat at the table.

You folks are welcome to stay, and the seats are set aside for you back there.

Before getting settled, I would like to recognize a couple of people that I am honored to have in presence here. Mr. Howard Zelkiv, Rock Wall and Dallas Area Chamber of Commerce and Association of Realtors and have Mrs. Pat Bell who is a leader in the field of education in Paris, Texas, in that area. Glad to have both of you there. Thank you.

Dr. Anastas, are you ready to roll?

Mr. ANASTAS. Yes.

Chairman HALL. All right. A reminder to you that your testimony is limited to five minutes after which Members will have five minutes each to ask questions. I now recognize our first and only witness for this panel, Dr. Paul Anastas, Assistant Administrator for the EPA, Office of Research and Development and science advisor to EPA, for five minutes, sir.

STATEMENT OF DR. PAUL ANASTAS, ASSISTANT ADMINISTRATOR, OFFICE OF RESEARCH AND DEVELOPMENT, U.S. ENVIRONMENTAL PROTECTION AGENCY

Dr. ANASTAS. Good morning, Chairman Hall, and Members of the Committee. My name is Paul Anastas, and I am the Assistant Administrator for the Office of Research and Development of the U.S. Environmental Protection Agency.

I want to say on a personal level how happy I am to be here before this Committee. I have appeared before this Committee on numerous occasions, and I believe you know, Mr. Chairman, that they have always been useful and productive. And so I appreciate the opportunity to be here today.

Let me begin by saying that natural gas is an abundant source of domestic energy. However, as everyone can agree, we must ensure that its extraction is done in a way that does not contaminate the Nation's drinking water supplies.

Last year, in response to Congress and citizens across the country, EPA began designing a scientifically rigorous study on potential linkages between natural gas extraction through hydraulic fracturing and drinking water contamination. Consistent with advice provided by the Science Advisory Board at the U.S. EPA, in June of 2010 the scope of EPA's proposed research plan spans the full life cycle of water used in hydraulic fracturing activities from its acquisition to chemical mixing, fracturing and post-fracturing and its ultimate treatment and disposal. This full life-cycle approach is necessary to identifying and understanding all of the factors that may impact the water quality of drinking water supplies across the United States.

As we move ahead with the scientific process, we will adhere to two basic principles. First, our work will be driven by sound science. EPA has never and will never presuppose the outcome of any research effort. As this study progresses, we will rely only on sound scientific data and results to draw conclusions. Additionally, the draft study plan includes EPA's rigorous quality assurance requirements and upholds the highest standard of scientific integrity, a principle that is central to all of this agency's scientific work.

[The EPA Draft Plan can be accessed at EPA/600/D-11/001/February2011/www.eps.gov/research.]

Let me also be very clear. The new pertinent science from any and all scientific sources will be considered by EPA if it is independent and peer-reviewed.

Second, it is my firm belief that when citizens voice their concerns through their elected officials, it is the duty of public servants to address them in an open and transparent way. To this end, EPA is directly engaging stakeholders and technical experts throughout the course of the design of this study and the implementation of this study. For example, we have held a series of webinars for state, federal and tribal stakeholders which have drawn representatives from 21 states as well as the Association of State Drinking Water Administrators, the Association of State and Interstate Water Pollution Control Administrators, the Groundwater Protection Council and the Interstate Oil and Gas Compact Commission.

We also held webinars with representatives from industry and non-governmental organizations to discuss public engagement process, the research study scope, data sharing and other issues of interest. In total, 64 individuals from NGOs and 176 individuals from natural gas production and service companies and industry association have participated in these webinars.

In the summer of 2010, EPA also held four public information sessions in Ft. Worth, Texas; Denver, Colorado; Canonsburg, Pennsylvania; and Binghamton, New York. More than 3,500 individuals attended these sessions, provided more than 700 verbal comments and over 5,000 electronic and written comments. In addition, between February and March of 2011, EPA held a series of technical workshops with experts from industry and academia to discuss chemical and analytical methods, well construction and operations, fate and transport, and water resources management. More than 160 experts participated in these workshops, and all of these associated, meeting agendas, presentations, and proceedings can be found on the EPA web site.

As the fracturing study progresses and results become available, we will continue to provide updates and invite stakeholder input on technical issues of concern. Their feedback is always welcome.

Mr. Chairman, this study is, first and foremost, about obtaining the knowledge to protect the American people and their environment. We are pursuing this work with the best available science and the highest level of transparency. As is our duty, we will conduct and present this study to the American people in the same, unbiased scientifically rigorous manner which we carry out all of our work.

I look forward to keeping this Committee updated on all of our progress, and thank you for the opportunity to appear before you today.

[The prepared statement of Dr. Anastas follows:]

PREPARED STATEMENT OF DR. PAUL ANASTAS, ASSISTANT ADMINISTRATOR, OFFICE OF RESEARCH AND DEVELOPMENT, U.S. ENVIRONMENTAL PROTECTION AGENCY

Good morning Chairman Hall, Ranking Member Johnson, and other members of the Committee. My name is Paul Anastas. I am the Assistant Administrator for Research and Development (ORD). It is a pleasure to be here with you this morning to discuss the EPA Office of Research and Development's Research Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources.

In its FY2010 Appropriations Committee Conference Report, Congress directed EPA to study the relationship between hydraulic fracturing and drinking water. In response to this request, and interest by stakeholders, EPA is undertaking a study to understand the potential impacts of hydraulic fracturing on drinking water resources. As Congress requested, the study will use the best available science and independent sources of information. We will undertake the study using a transparent, peer-reviewed process and will consult with stakeholders throughout the study. Produced responsibly, natural gas has the potential to reduce green house gas emissions, stabilize energy prices, and provide greater certainty about the future energy reserves.

The study is designed to examine the conditions that may be associated with the potential contamination of drinking water resources, and to identify the factors that may lead to human exposure and risks. The scope of the proposed research includes the full lifespan of water in hydraulic fracturing, from acquisition of the water, through the mixing of chemicals and actual fracturing, to the post-fracturing stage, including the management of flowback and produced water and its ultimate treatment and disposal, an approach EPA's Science Advisory Board (SAB) agreed was appropriate in their June 2010 review.

EPA recognizes that there are important potential research areas related to hydraulic fracturing other than those involving drinking water resources, including effects on air quality, aquatic and terrestrial ecosystem impacts, seismic risks, occupational risks, and public safety concerns.

The SAB reviewed the draft plan on March 7–8, 2011. Consistent with the operating procedures of the SAB, an opportunity was provided for the public, including affected stakeholders, to provide comments for the SAB to take into account during their review. The Agency will consider all of the public comments, revise the study plan in response to the SAB's report and begin full implementation of the plan. A first report of research results is expected by the end of 2012. Certain portions of the work will be longer-term projects that are not likely to be finished at that time. An additional report of study findings will be published in 2014 after these longer-term projects are completed.

We are now in the final stages of evaluating and selecting candidate field locations for retrospective and prospective case studies. Retrospective case studies provide an opportunity to investigate instances where concerns about drinking water have been reported, and to determine whether and to what extent any impacts may be associated with hydraulic fracturing. Prospective case studies will allow us to observe modern hydraulic fracturing practices and gather data uniquely available during this process, such as samples of flowback and produced water.

In addition to case studies, our research will include analysis of data from many sources, including industry and the states, along with laboratory studies and modeling to assess a range of conditions under which hydraulic fracturing takes place.

Stakeholder Input

Stakeholder input has played, and will continue to play, an important role in the hydraulic fracturing study. We have implemented a strategy that engages stakeholders and technical experts in dialogue and provides opportunities for input on the study scope and case study locations. We have held webinars with stakeholders, including representatives from 21 states as well as the Association of State Drinking Water Administrators, the Association of State and Interstate Water Pollution Control Administrators, the Ground Water Protection Council, and the Interstate Oil and Gas Compact Commission. In addition, we have held webinars with representatives from industry and from non-governmental organizations (NGOs) to discuss the public engagement process, the scope of the study, coordination of data sharing, and other key issues. Overall, webinar participants have included 176 individuals from various natural gas production and service companies and industry associations, as well as 64 individuals from NGOs.

EPA held public information meetings between July and September, 2010, in Fort Worth, Texas; Denver, Colorado; Canonsburg, Pennsylvania; and Binghamton, New York. At these meetings, EPA presented information on the Agency's reasons for studying hydraulic fracturing, an overview of what the study might include, and how stakeholders could be involved. Opportunities to present oral and written comments were provided. Total attendance for all of the information public meetings exceeded 3,500, and more than 700 oral comments were heard. EPA also provided stakeholders with opportunities to submit electronic or written comments on the hydraulic fracturing study and received over 5,000 comments.

In February and March 2011, EPA held a series of four technical workshops with experts from industry, academia and others to discuss chemical and analytical methods, well construction and operations, fate and transport, and water resource management. More than 160 experts from industry and academia participated in these workshops. The information shared during these workshops will be very useful to EPA in the conduct of the study. In the interest of transparency, the agendas, presentations, and proceedings will be posted on EPA's web site.

As the research progresses and results become available, we will engage stakeholders by providing updates and receiving input on technical issues of concern.

Coordination with Other Federal Agencies

EPA has been actively consulting with several key federal agencies regarding research related to hydraulic fracturing. We have met with representatives from the Department of Energy (DOE), including DOE's National Energy Technology Laboratory; the US Geological Survey; the US Army Corps of Engineers; and other agencies to identify opportunities for collaboration and leveraging of resources. Federal agencies have also commented on the draft study plan through an interagency review process.

Scientific Integrity

As noted in EPA's draft study plan, all EPA-funded research projects, whether conducted by EPA scientists or extramural cooperators, will comply with the most

rigorous level of the Agency's Quality Assurance (QA) requirements. This will include, for example, technical system audits, audits of data quality, and data quality assessments; performance evaluations of measurement systems; and QA review of products. The scientific integrity of our research will be further ensured through the peer review of our research results.

Conclusion

In conclusion, I want to assure the members of this committee and others that this study will be conducted through a transparent, peer-reviewed process in consultation with other Federal agencies as well as appropriate State and interstate regulatory agencies.

I look forward to working with the Committee to address current and emerging environmental problems that will help our Agency protect the environment and human health. Thank you for the opportunity to appear before you today.

Chairman HALL. I thank you, sir, and I remind Members again, Committee rules limit questioning to five minutes. At this point I will open a round of questions by recognizing myself for five minutes.

Dr. Anastas, you know that I don't agree with you about 90 percent of the time, don't you? You understand that? And you are willing to come and testify here, and I thank you for that.

Dr. ANASTAS. I certainly am. Thank you, Chairman.

Chairman HALL. I find it interesting that the Department of Energy has filed comments with EPA that were clearly critical of the draft plan. You are aware of that, aren't you?

Dr. ANASTAS. I am.

Chairman HALL. Specifically DoE said EPA's scope will not objectively characterize risk "given that the retrospective case study methodology will selectively focus on cases for which there have been negative outcomes. There is concern that the study may not adequately represent the overall risk presented by hydraulic fracturing" the comment says.

So Doctor, I guess I ask you, what is your response to these comments from DoE?

Dr. ANASTAS. I think it is important to recognize what this study is intended to do. This study is intended to understand the factors that potentially could result in impact to drinking water from hydraulic fracturing operations. When we are saying that we want to understand the factors, that is, trying to understand the factors that are the basis of whether or not a risk exists. This study is not intended to be a risk assessment. This study is not intended to assume that there is a risk. This study is intended to understand whether or not the factors are present that would result in a potential impact to drinking water.

Perhaps I could explain even further.

Chairman HALL. All right.

Dr. ANASTAS. In order for there to be a risk——

Chairman HALL. You have not made me understand it yet but go ahead.

Dr. ANASTAS. In order for there to be a risk, there needs to be the elements of both hazard and exposure. Those are the factors that we are seeking to understand. Are there hazards that could impact the drinking water and is there exposure? The results of those two elements are what would cause a risk, and we are not presupposing the outcome of this study in order to do a risk determination.

Chairman HALL. Do you agree or disagree with the DoE comments? I can't tell.

Mr. ANASTAS. Let me be clear. The DoE comments are saying that this study does not conduct a risk assessment. I am saying that this study is not a risk assessment.

Chairman HALL. You disagree with them?

Dr. ANASTAS. Yes.

Chairman HALL. Okay. That is what I wanted to hear you say. Your EPA research office is responsible, are they not, for carrying out this study, your office?

Dr. ANASTAS. That is correct.

Chairman HALL. And it seems strange that all of the online materials and information related to this study are located on EPA's Office of Water website. Why is that? They are responsible for water-related regulations.

Mr. ANASTAS. We want to make the information available and easy to find. We can certainly have a mirror website say where people could go to either, but I think the most important thing is to make sure that the information is available to the American people.

Chairman HALL. Who carries out the study? I would expect this study to be carried out by scientists whose job it is to focus on research, which are a research.

Dr. ANASTAS. That is correct. The study will be carried out——

Chairman HALL. Not by people whose job it is to regulate, and I don't really consider you regulators.

Dr. ANASTAS. That is correct. This study will be carried out by scientists.

Chairman HALL. With that in mind, please describe the division of labor between your office and the Office of Water. I would like to know who makes these decisions.

Dr. ANASTAS. These decisions and this study is being carried out by the Office of Research and Development.

Chairman HALL. Approximately how many staff within each office will be dedicated to that effort?

Dr. ANASTAS. I will have to get back to you on the exact number of staff because that is not a number that I have at my fingertips, sir.

Chairman HALL. All right, sir. In question, two, of the invitation letter which I have here, I ask you if you would allow for public comment on the revised study plan so after the Science Advisory Board provides comments and recommendations, EPA is going to revise the study plan. At that time, will you allow for public comment at that point, the revised plan?

Dr. ANASTAS. We are certainly going to have continued engagement on the plan and will be responsive to the public comments that were accepted by the Science Advisory Board.

Chairman HALL. You will have engagement. That is not what I asked you. Will you allow for public comment?

Dr. ANASTAS. We will accept public comment in the meetings that we have with stakeholders and the dialog and the updates that we provide to stakeholders, certainly.

Chairman HALL. Okay. That is a yes.

Dr. ANASTAS. Public comment in the framework of a Scientific Advisory Board meeting is a very formal mechanism. What I am saying is that we certainly will accept comment in the interactions that we have on the updates and the ongoing updates, informing the American public of the progress.

Chairman HALL. Would that be formal public comment in the Federal Register?

Dr. ANASTAS. No, there will not be a Federal Register. Those will be direct interactions.

Chairman HALL. I am told my time is up. The Chair recognizes Mr. Wu, Ranking Member Mr. Wu, from Oregon.

Mr. WU. Yes, sir.

Chairman HALL. I zigged pretty good, didn't I? I almost said you were from Washington. You are recognized for five minutes.

Mr. WU. You did fantastic, sir. Thank you very much. Appreciate it.

Chairman HALL. I am doing better.

Mr. WU. Well, this Administration recognizes the need to obtain energy from all sources, including natural gas, and it has established the Secretary of Energy Advisory Board to also establish a Subcommittee to examine more closely the set of hydraulic fracturing issues.

First of all, is EPA supportive of this initiative and secondly, how does EPA intend to put together its work and recommendations with the work of that body?

Dr. ANASTAS. This study plan is being carried out by the Environmental Protection Agency, but we recognize that other agencies have important roles to play, important interests, and certainly the Advisory Board put together by DoE to inform best practices is something that we do support. And we always seek to work very closely with our other agency partners across the Federal Government.

Mr. WU. Dr. Anastas, can you describe to me the process that you have gone through and also the extent to which you have sought stakeholder input from all sources?

Dr. ANASTAS. Yes, one of the things that was a hallmark of putting together this study plan was in order to engage technical experts from industry, from academia, certainly in coordination with other governmental, other federal agencies. We also wanted to make sure that we allowed for input from the public. That is why these workshops that were held around the country where we had thousands of people come in in order to provide input and provide their perspectives on the study design, that is why we went to the Science Advisory Board in order to seek their input, both on the initial structure of the study as well as the current review that is currently taking place on this study. So we went through a very rigorous process in order to seek out input from all quarters.

Mr. WU. Okay. Very good. One final, more focused, narrowing to one area, an investigation of the Commerce Committee found that potentially millions of gallons of diesel fuel are used in fracking wells. Does EPA know how much diesel is currently being used, where it is being used and where it goes? And do you think that those doing the fracking are doing what they need to properly take care of this downstream from the actual useful use of diesel?

Dr. ANASTAS. Thank you for asking that question. It is a very important question of regulatory concern. I know that this is one that the EPA is actively engaged in. As you know, I am in the Office of Research and Development, so I will be happy to get more information on that regulatory question back to you, Congressman.

Mr. WU. Thank you very much, Dr. Anastas. Mr. Chairman, I have no further questions at this point.

Chairman HALL. The gentleman yields back. The Chair recognizes the gentleman from California, Mr. Rohrabacher.

Mr. ROHRABACHER. Thank you very much, Mr. Chairman. I am done with my cheeseburger, so I am ready. What we are talking about here is not just a scientific study by the EPA. What most of us are worried about is a centralization of power being justified by unelected and unattached decision-makers in the EPA and throughout the bureaucracy.

Again, in your testimony as in the testimony of one of the witnesses before, you mentioned the word drinking water numerous times.

Dr. ANASTAS. Correct.

Mr. ROHRABACHER. Numerous times.

Dr. ANASTAS. Correct.

Mr. ROHRABACHER. The other witness was unable to give us an example of one. Maybe you have several examples of where the drinking water has been compromised due to fracking.

Dr. ANASTAS. The way that we are able to answer questions like that is by asking the tough question scientifically in making these determinations.

The reason that we carry out these studies is to be able to give you a reliable and certain answer. In the absence of these studies, in the absence of these measurements and monitoring, the confidence that anyone has in giving you an answer to that question is compromised. And so we ask the scientific questions in order to give solid answers, rather than——

Mr. ROHRABACHER. You just rush forward without any examples and you think that we have unlimited resources and we are just going to go out there until every question is answered? Doesn't there have to be some reason behind it, some malady, some group of deaths or something? Aren't there enough things to study in the United States where we can pinpoint that there is a threat because there have been incidents where people have been hurt without having to go to things that you can't even give us one example of where there has been harm cased by human beings in their drinking water due to fracking?

Dr. ANASTAS. I appreciate the question, but when the American people, through their elected representatives in Congress, direct the U.S. EPA to address concerns and to undertake a scientific study and direct us to investigate if there is any link between hydraulic fracturing operations and drinking water, we take that charge very seriously.

Mr. ROHRABACHER. The American people didn't mandate this. You have got a bunch of bureaucrats and left-wingers from universities who make their living trying to scare the American people into thinking there are problems. At least you would have some

kind of evidence, something that has happened that would indicate there is a major threat. How much is that study going to cost?

Dr. ANASTAS. When the American people and when the Congress directs us to undertake a study——

Chairman HALL. Just answer his question. How much does it cost?

Dr. ANASTAS. In fiscal year 2010, we had $1.9 million budgeted and fiscal year 2011, it was $4.3 million, in the President's budget request.

Mr. ROHRABACHER. Okay. And how long will it take and how much is it expected to cost?

Dr. ANASTAS. The initial results of the study are expected by the end of 2012.

Mr. ROHRABACHER. Okay, and how much is the end result going to cost?

Dr. ANASTAS. The end result at the end of the entirety of the study will be approximately $12 million.

Mr. ROHRABACHER. Okay. So you have focused in, you have committed time of your scientists and $12 million of money without having one example that indicates that we are at risk.

Dr. ANASTAS. The Environmental Protection Agency has followed the direction of Congress to investigate——

Mr. ROHRABACHER. Well, the answer is yes, okay? Fine. Thank you. If you can't give us an example of where fracturing is actually in some way compromised the drinking water, can you give us an example of where the states that are regulating this have failed in their responsibility to their people and thus this centralizing of power in the Federal Government and yes, non-elected officials in Washington would be justified?

Dr. ANASTAS. The study that we are undertaking is not a regulatory study. This is not a——

Mr. ROHRABACHER. Okay, so you don't have any examples where the regulation of—yeah, it is not a study, but you as an individual, you are a decision-maker. You are talking to the decision-makers here. You should certainly know the history of what is going on around the country and/or give us some examples of where there is a threat in order to justify committing a large amount of your personnel and $12 million over a five-year period. And there are just no examples of failure at the state level and no examples of even where there has been a compromise of the drinking water.

Mr. Chairman, there is something motivating this going forward in this area. What is motivating this? Aren't there other areas that you have to choose from that, you know, people are actually out there being threatened by chemicals? There are a lot of chemical problems in urban America that you can focus on. And by the way, they are very easy to prove. I mean, it is very easy to prove that chemicals are a problem to our health in Southern California, what we breathe in, okay? There is instance of that. But yet you have committed yourself to spending the money on something that we don't have any examples of where it has actually affected anyone's health.

Dr. ANASTAS. The Environmental Protection Agency is taking on, as you are well aware, a wide-range of issues to protect human health and the environment, including some of the air-quality

issues. What this study, at the direction of Congress, has undertaken is to determine if there are factors that could cause potential harm to humans or the environment.

Mr. ROHRABACHER. Yes, if there are——

Dr. ANASTAS. Specifically, our drinking water.

Mr. ROHRABACHER. And there are probably thousands of other things that we could say, what is there potential harm in, mountain climbing? Is there a potential harm in manufacturing baby clothing? But yet you have chosen——

Chairman HALL. Surfing.

Mr. ROHRABACHER. One last note and that is our country is being strangled. The reason why our people are living worse off now than they were ten years ago, and people can't get good jobs, is we are sending wealth out of our country, a trillion dollars a year. Industry is being strangled. Our way of life is being strangled because we are not being permitted the energy we need to have prosperity in this country, and the frivolous nature of just giving scientists, go out and see if you can find something that will permit us to stop energy production, because that is what this is all about, and I am happy to see that Congressman Hall is having this hearing so we can express that. Thank you.

Chairman HALL. The gentleman's time has expired. The Chair recognizes Mrs. Woolsey of California for five minutes.

Ms. WOOLSEY. Pronounced Wool-sey, Mr. Chairman. Thank you, Doctor, for being here. You are doing great. I think you are aware and you knew before you even got here that good science isn't always the basis of our decisions on the Science Committee. I think that is weird, but it is true.

So you know, motivation, okay? The motivation for this study is a bunch of citizens, scientists concerned about a process that we don't know enough about in this country. So maybe could you outline a little bit about what those concerns were from your perspective that led the Congress to direct this study, and why the 2004 report of little or no threat to water supplies really wasn't enough.

Dr. ANASTAS. Okay. The 2004 report really did focus on coal bed methane extraction. It was significantly different in terms of the type of operations, the depths of the operations, the nature of the drilling. And it was, rather than a field and laboratory study, far more of a survey of the existing knowledge, not as in depth as certainly what is being planned with this focus study.

The nature of the concerns and the questions that are raised both by people to the Congress and what they expressed as well as in the workshops and meetings that the EPA conducted over the months were questions whether or not there was contamination of drinking water due to fracturing operations, that contamination could take the form of methane in the drinking water, could take the form of hydraulic fracturing fluids in the water and those concerns are what have been raised, and I think that is why we asked the questions in order to answer those and assure the American public of the safety of their drinking water while we pursue the extraction of domestic energy resources.

Ms. WOOLSEY. Well, you probably already have your opinions, but the science of the study is what is going to drive the results

in your report. It is not your opinion as a scientist or the Committee's opinion?

Dr. ANASTAS. Absolutely, and I think that is an important point to emphasize. It would be antithetical to a scientific approach to presuppose, predetermine or in any way bias the outcome of this study. In order to assure the American public that the results of this study is credible, we need to ensure that this maintains scientific integrity throughout all of the conduct, the design and the conduct of this study.

Ms. WOOLSEY. So the American public, the American public, you know, I mean, not the people sitting up here that still don't have enough information to make these decisions without good base study behind it, but the American public, they aren't worried about this yet, but they will certainly be worried about it if they start having traces of poisons and problems in their drinking water. And is not this study to prevent something from happening, then the American public will stand up and roar and what is the matter with you idiots on the Science Committee? You don't protect us. So isn't that what EPA is about?

Dr. ANASTAS. I believe that certainly there is every opportunity for this study to clarify and give knowledge and insight about the operations so that the American people can be confident that their drinking water is pure and uncontaminated, and I think that it is studies like this that give the American people that confidence.

Ms. WOOLSEY. Well, I thank you very much. I yield back.

Chairman HALL. Thank you. The gentlelady yields back. The gentleman from Maryland, Dr. Harris is recognized for five minutes.

Mr. HARRIS. Thank you very much. Thank you, Dr. Anastas, for coming to testify. I have got a question. I guess the background is that back in the fiscal year 2010 budget I guess there was some kind of language suggesting the EPA study, but it left the scope of the study or I guess the need for an in-depth study totally up to the EPA. Is that right, given the language? I don't have the exact language in front of me.

Dr. ANASTAS. The report language did talk about the connection between hydraulic fracturing operation and——

Mr. HARRIS. And drinking water. Correct. So the EPA could have come back and just said, you know, we have investigated and there has been no case ever of known contamination of drinking water from hydraulic fracturing which has gone on for years and years and years. I mean, that is one possible outcome of the EPA evaluation. They could have done a retrospective review of all the reported cases and said actually, it has never been proven that any drinking water has been contaminated by it. Is that——

Dr. ANASTAS. I believe to have that kind of unilateral determination without tapping into the type of expertise we did without review by the Science Advisory Board may have been highly questioned.

Mr. HARRIS. Well, the Science Board could have done it that way. And the reason is because, you know, in medicine, and I have done medical research, I mean there is this thing called the index case. It is usually what brings something to people's attention. In the absence of an index case, it is a shotgun approach for anything, and

I will give you an example. I mean, you know, I could say, you know, there is a group of people, you know, very concerned about aspirin. I mean, my gosh, and maybe I should write a letter to the EPA or maybe we should stick in some budget language, the FDA ought to study aspirin. And I would come back and say, let me tell you something. It has been around for a long time, and sure, there are possible potential—in fact, aspirin is a bad example because there are kind of bad things that can happen with aspirin, but you know, the lack of an index case is very puzzling to me. And it begs the question, was the question framed in such a way that you have to go after potential impacts or was the question framed in such a way you could say, you know what we are going to do? We are going to look for an index case, and in the absence of an index case, we are going to say that we really should defer the expenditure of $12 million, money we don't have, money we have to borrow from the Chinese to fund this study.

So was that one possible outcome? I mean, the Science Advisory Board could have said, you know, we are going to search for an index case, but in the absence of an index case, what are we looking for?

Dr. ANASTAS. It is an excellent question, Congressman. I have to say that the reason that we ask the hardest questions and seek this knowledge is to give the American people confidence in the——

Mr. HARRIS. Okay. I hate to stop you there, but I only have two more minutes. Wouldn't the American people have confidence if the EPA came out and said, you know what? We have looked into every reported potential case, and there is no case of drinking water contamination because that is striking to me, that one result of this hearing is that we have confirmed and you are kind of confirming and you know, the head of the Maryland Department of Environment who, in fact, you know, went to the Maryland legislature to attempt to also promote a study has confirmed no one knows of a case of documented drinking water contamination. Is that an accurate summary? And wouldn't the American people better be served by saying, you know what? There is no known danger right now, but as soon as something comes to our attention that could be a known danger, a known risk where contamination has occurred, we are right on it? I mean, this is kind of the way we look for it. You know, when we have new drugs, we look for side effects and then we study why those side effects could occur and minimize them. And we don't just say, well, you know, we are not going to approve any new drug because there could be potentially some side effects, even though none has ever been reported. I mean, that is a very clear way we handle medical research with regards to new substances, and I will proffer this isn't a new substance. I mean, fracturing has been around a while. It is a long, lengthy question. But I guess to finalize, has there been a case as far as you know and wouldn't the American people be served better by in fact turning down the what I will refer to as hysteria? And believe me, I have seen it in the medical field plenty of times, hysteria that you know, knowledgeable, qualified people, their best approach might be to say instead of writing something about all the potential impacts, saying—you know, because I looked here. I looked through the study, and I don't see it emphasized that no case has ever been de-

termined to have occurred. Am I missing it or is it in here somewhere?

Dr. ANASTAS. What I believe you may be missing, Congressman, is that when we see studies such as the one that even recently came out of Duke University, that appearing in the proceedings in the National Academy of Sciences, we need to take those studies seriously. When we see such reputable groups such as the University of Texas announcing today their comprehensive review of hydraulic fracturing, the leader of that group, Dr. Ray Orbach, who is tremendously respected, was a tremendously respected Undersecretary of Energy in the Bush Administration, to think that we could unilaterally declare that there is no problem here and we are going to move on with these kinds of lingering concerns, I think the American people expect us to ask the tough questions and answer those tough questions in a process that preserves scientific integrity.

Mr. HARRIS. I am going to yield back, Mr. Chairman. I would just say, you know, once to emphasize again, there is no index case here. Thank you.

Chairman HALL. Would you, before you yield back, yield to me to ask one question of the gentleman?

Mr. HARRIS. I certainly would, Mr. Chairman. Always.

Chairman HALL. You mentioned the Duke study. I presume you have read the Duke study?

Mr. ANASTAS. Yes, I have.

Chairman HALL. And you use that to substantiate some of the things that you have said, do you not?

Dr. ANASTAS. I use that study to show that there are concerns.

Chairman HALL. Well, did you really read the study?

Dr. ANASTAS. I read every word of that study.

Chairman HALL. Did you read where they said our results show evidence for methane contamination for shallow drinking water systems in at least three areas of the region and suggest important environmental risk accompanying shale gas exploration worldwide?

Dr. ANASTAS. Yes, I have.

Chairman HALL. Did you stop there?

Dr. ANASTAS. No, I did not, sir.

Chairman HALL. Did you read on page 4 where they said based on our data, we found no evidence for contamination of the shallow wells near active drilling sites from deep brines and/or fracturing fluids? Did you read that on page 4? Do you have page 4?

Dr. ANASTAS. I have read every word of the study, and I have read that they——

Chairman HALL. Well, they are saying that what they said is just absolutely not so, and now are you going to use that like you have done before when you bolstered your testimony with false science? Is that what you are sitting here doing?

Dr. ANASTAS. This is far from false science. What they have concluded and what you have just read shows that what they have determined is contamination of drinking water by methane and that they found no evidence of fracturing fluid contamination. This study that we are proposing and pursing is looking at both of those questions.

Chairman HALL. Let me read further to, just a little on down on page 4. "In sum, the geochemical and isotopic features for water we measured in the shallow wells from both active and non-active areas are consistent with historical data and inconsistent with contamination from mixed Marcellus shale formation water or saline fracturing fluid." How are you going to get around that?

Dr. ANASTAS. I am not going to get around it. I agree with their findings. What they are saying is they have seen no contamination from fracturing fluids. What they are saying is that they have determined that the methane that is being seen is not biogenic in nature but rather thermogenic in nature.

Chairman HALL. I recognize the gentleman from Michigan, Dr. Benishek, for five minutes.

Mr. BENISHEK. Thank you, Doctor, for being here. Let me just quote from the language, I believe from the appropriation for your study, that they urge the agency to carry out a study on the relationship between hydraulic fracturing and drinking water using a credible approach that relies on the best available science.

So as I understand it from this language that the Congress asked you to carry out a study on the relationship between fracking and drinking water. And I don't see how a study, which specifically says that it is not going to address the risk, complies with this order to study the relationship.

Dr. ANASTAS. Let me be clear. I apologize if I didn't make it clear previously. In order to do a risk assessment, we need to understand those relationships, whether or not there is a hazard to people from contamination to the drinking water and whether or not there is exposure and——

Mr. BENISHEK. No, any time there is contamination of drinking water, there is a risk. But the relationship between fracking and drinking water to me implies defining the risk, and apparently you disagree.

Dr. ANASTAS. What I am saying is you can't do a risk assessment, you can't do a risk analysis, a quantitative risk analysis, without understanding the elements of hazard and exposure. We have to first understand the elements of the hazard and the exposure in order to do that kind of risk analysis.

Mr. BENISHEK. I guess I just disagree with you because it seems to me that, you know, with thousands upon thousands of wells and that is the whole purpose of the study, is to determine if there is a significant risk. I just don't get it.

The other question I have is relying on best available science. So how many people on the Science Advisory Board have direct experience doing hydraulic fracturing?

Dr. ANASTAS. You mean the panel that has been put together specifically on this?

Mr. BENISHEK. Right.

Dr. ANASTAS. I would have to get the exact numbers, but we certainly do have people who are experts in all of the disciplines related to hydraulic fracturing.

Mr. BENISHEK. Does anybody have any direct fracking experience on this Science Advisory Board?

Dr. ANASTAS. The short answer is yes, and I will be happy to get those biographies to you, sir.

Mr. BENISHEK. All right. Thank you. I yield back my time.

Chairman HALL. The gentleman yields back. The Chair recognizes Dr. Broun.

Dr. BROUN. Thank you, Mr. Chairman. Before I begin asking this panel my questions, I want to express my extreme displeasure at what appears to be a pattern of a lack of respect and a complete disregard of the House of Representatives Committee process and our Constitutional authority to oversee the executive branch of government. Regardless of which party is in control of the White House or Congress, we as Members of Congress must be vigilant in our oversight responsibilities.

Today's hearing includes two panels which is not the preferred practice of our Committee but was necessitated by the unprecedented recalcitrant behavior of the EPA in response to the Committee's invitation to testify at this hearing. It is also important to note that EPA has testified before this Committee on a single panel with other witnesses before. Beyond the convenience to Members and witnesses, especially to those of us who serve on multiple Committees, a single panel provides an opportunity for an open discussion and free flow of ideas that this Committee has always encouraged.

However, it is not the inconvenience of having multiple panels that alarms me the most. I am alarmed at the level of arrogance, arrogance that this Administration continues to demonstrate by presuming that they can actually dictate how a House Committee may conduct its hearing and business. Today's latest example is not the first instance of the Administration going back on its stated goal in a cooperative fashion with the 112th Congress. Investigations and Oversight Subcommittee, which I am Chairman, experienced this same behavior with our first hearing when the TSA actually thought they could dictate what issues and topics fall under this Committee's jurisdiction and refused to testify. I see the same thing from the EPA, and I am extremely disappointed in the behavior of this Administration.

Mr. Chairman, I appreciate the Committee's indulgence in letting me air my frustration and hope this situation can be rectified and the Committee can continue its important duties.

Dr. ANASTAS. May I address your comment?

Dr. BROUN. No, Doctor, I don't have but just a few minutes, and I have got a question or two I want to ask you. Did you write your testimony?

Dr. ANASTAS. I did.

Dr. BROUN. Doctor, I am a physician. I am a scientist, applied scientist, not a research scientist. I know very well as a policymaker that science cannot dictate policy. Policy can be based on good science. Saying it another way, science describes, it cannot prescribe.

In your testimony you made a statement that I think is blatantly false. You stated that the EPA utilizes good science, peer review science and takes into consideration opposing views. I don't think that is factual, and the endangerment finding is a good example because I believe in my heart that EPA had a policy that they wanted to put in place that this Administration wanted to follow and that they utilized one set of scientific data to try to justify the policy dic-

tated. And I see the same thing with this frack policy that you guys are trying to promote and trying to stop fracking. I believe this Administration wants to stop oil and gas development in this country, and I think they are utilizing EPA and what you are doing in that process.

Now EPA published a study Ms. Woolsey asked you about in 2004, Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coal Bed Methane Reservoirs. Do you all stand by the conclusions that you all issued in the report that it poses little or no threat to drinking water?

Dr. ANASTAS. Coal bed methane reservoirs are not the subject of this study. So if you are asking whether or not that study is relevant to the study that we are undertaking, the answer would be no, only partially relevant because those are at much different strata of the geologic formations and different processes being used.

Dr. BROUN. Well, given President Obama's executive order memoranda, highlighting the importance of interagency coordination regarding regulatory activity, please explain how the EPA is syncing its study with those with the Department of Energy and the Department of Interior? In general, how is EPA implementing the executive order with reference to potential fracking regulation?

Dr. ANASTAS. This study is not a regulatory study. This study is a scientific study that we worked closely with our partners at other agencies in informing the nature of this study, but this study is not a study that is based on regulations. This is not a regulatory action.

Dr. BROUN. Well, we have no index study, as Dr. Harris was just talking about. You are just going out and doing a study. It seems to me that you are trying to stop the fracking process, and I am extremely disappointed with EPA. I am extremely disappointed with this Administration. And I think it just needs to change. Mr. Chairman, I yield back.

Chairman HALL. The gentleman yields back. Dr. Anastas, I thank you for your testimony, and I thank the Members for their questions.

At this time, Dr. Anastas, you are welcome to stay seated at the table if you want to or you can take a seat there or you can leave or do whatever you want to, but I am going to ask our first panel of witnesses to join us again by retaking their seats at the table for a chance to summarize our comments.

Mr. ROHRABACHER. Mr. Chairman, as our new panel is being seated, if I could just mention that I would like to thank Dr. Anastas for coming forward today. This was a rough hearing, and we were rough on you but we are trying to get to the truth, and I appreciate the fact that in some of the questions, you know, on almost all the questions, you were being straightforward with us. And at times we had to cut you off because we have limited time that we can ask, and I just wanted to express my appreciation to your forthrightness today in answering these questions.

Dr. ANASTAS. Thank you, sir.

Chairman HALL. We are not done, Dr. Anastas, he has to leave. He is perfectly welcome to stay. We are going to ask for a comment from each of these people, just a 1-minute comment from you or 2-minute comment.

On the testimony you have heard, Dr. Anastas had a chance to listen to your testimony, and you had a chance to listen to his. So I think instead of having another round of questions, that wouldn't be fair to the Democrats that are not here. This will go for the record now. This will be in the record, and Democrat and Republicans can read those records.

So I will start out when you get your things together there, whatever you are getting ready to do. What is going on at the table there? Is it something I am not supposed to see or I couldn't stand to see? Now, you got Mrs. Jones blocked off. All right. I thank you. That is the good staff we have, and I appreciate them.

You have heard the testimony of the EPA witness. Do you have comments on it?

Mrs. JONES. I do, Chairman, and I would like to say that in fact I probably am the only person in this room who actually attended one of the meetings across the country that the EPA held in Ft. Worth, Texas, last year, and I want to tell you it was the least scientific-based meeting I have ever attended. I didn't have time to speak to it, and people were lined up. The conversation really did not even address hydraulic fracturing. It was a large crowd of anti-drilling activists who in fact were trying to use every applied application technology in the drilling industry as an excuse or to suspect it, disparage it. I have never been in such an activist crowd that is so opposed to drilling.

And there is a group in Texas who doesn't understand how strong the oil and gas exploration and production and severance taxes of it make this State. They are a very vocal minority I might add, and that study, if it is to be based upon the information gathered at the hearing that I was at will be extremely flawed when it is finally done.

I would suggest to you that there are more studies here than we can shake a stick at. In fact, it sounds to me like the EPA has a $12 million solution to a problem that doesn't even exist. I don't understand why my word, and my word is my bond, and if I can save the taxpayers some dollars, I am here to do that. And I am telling you, there has never been an indication of groundwater contamination from hydraulic fracturing that I know of in the State of Texas and nationally. And if that is not good enough for somebody who is employed up here in Washington, I don't know how we are ever going to get to the truth if people will not start listening to people like me who are out there in the field, in the trenches, elected by the people to do the people's business. And it burns me up what I am hearing about this scientific-based study when I was at a hearing, a town hall meeting that was anything but scientific based.

Chairman HALL. I thank you, and I might say this hearing is not for the Congress particularly. It is probably for generations, this generation that is being hurt by lack of energy and the Administration's offense against energy and against energy states and against other states that didn't vote for him. I think something that Congress has an interest in and I am interested in it. I am interested in my children and my children's children because other than prayer, energy is probably the most important word in the dictionary for those youngsters that are 15 years old and up.

We will go on. You commented. Thank you for your comment. We recognize Dr. Summers for his comment. Hold it as near to a couple of minutes as you can.

Dr. SUMMERS. Thank you, Chairman Hall. Well, I have heard a lot of information today regarding the safety of these practices from my colleagues. As I said in my testimony, we have seen problems in the Marcellus shale in Pennsylvania. I have learned that Mrs. Jones and her experience in Texas, which is very extensive, indicated that one size doesn't fit all. I want to make sure that we get the right size here in Maryland. We have a very important group of watersheds that millions of people depend upon for many purposes, and I think it is absolutely critical that we get the best information on all the various issues that I raised in my testimony. And we obviously have the opportunity to gather that information, specifically with respect to the EPA study. As I said, one of the big concerns or issue that has been raised is the potential for impacts on drinking water. I have been to public meetings in Maryland where a lot of folks have raised a lot of concerns about the drinking water impacts, probably very similar to what was just described, and I want to make sure we have the best scientific answers possible. And I believe that the EPA's study is another piece of information that we need to pull that information together.

Chairman HALL. And I believe you want all the information you can get, and I think you would be one that would frown on the EPA and on the testimony we just heard from the EPA when it was said clearly that he supports the Duke study and he thinks that upholds some of his testimony. When we just read to him there where it said we found no evidence for contamination of the shallow wells near active drilling sites from deep brines. That is just about as clear as you can make it.

Mr. Fitch?

Mr. FITCH. Yes, thank you, Mr. Chairman. First of all, we have to acknowledge there is a Congressional directive there for the EPA to conduct a study. However, the language in that directive is quite general. It allows for quite a bit of flexibility, and we would just reiterate that we believe the design of the study is overly broad. There has been a lot of totally unscientific information brought to bear on this, and that does not warrant a scientific investigation of some of those things, some of those allegations. We believe that the study should focus on one area where there have been some legitimate concerns, and that is the management of wastewater, management of flow back water. Also I think this study should engage on the issue of identification of the degree of risk and not just whether there is some risk or not, because otherwise, you lose perspective. And we see a great potential there for a study to be misused if it doesn't address the degree of risk.

Chairman HALL. Thank you, sir. Dr. Cooper?

Dr. COOPER. Thank you. I think as a scientific study, what we have mostly seen in all of the EPA activity to discuss this publicly is it seems to be more political than scientific. And that disturbs me a lot. I am not opposed to a study that we are trying to address a question that we are trying to solve. I am not sure that we have got that question on the table, and I am really sorry that EPA today did not really engage with the rest of us in a discussion

about what might be done, what we really need to think about, if anything. Thank you.

Chairman HALL. Dr. Economides. Did I pronounce it right then?

Dr. ECONOMIDES. You are improving.

Chairman HALL. All right.

Dr. ECONOMIDES. It is great. Just two quick points. I, too, have this vision that a more balanced EPA would have actually blasted this Duke paper today. They will actually take it upon themselves to critique it and tear it for what it is. This is shabby science, Mr. Chairman, including the conclusions, by the way. After they reached what you read, the conclusion is letting us just outlaw hydraulic fracturing, essentially, after they said they found no evidence of contamination.

Regarding the Scientific Advisory Board, I took it upon myself to Google every Member on that Committee about three weeks ago. There are three people that I would think have some experience in hydraulic fracturing, and one is a lady professor at the University of Missouri, D'Aleo. She and I wrote a book, by the way, a few years ago. But she doesn't have direct experience in hydraulic fracturing. There is a researcher from Texas A&M who is a chemist. I don't think he has ever been on a well site for hydraulic fracturing, and there is a geophysicist, everybody else, they are experts in their field, but I don't think any one of them has ever been on a well site for hydraulic fracturing. So it really mystifies me how a Scientific Advisory Board consisting of people like this, they are, Congressman, on a wild goose chase, by the way, in my view. That is all there is. It is a shortcut approach, and the only obvious conclusion would be if they find something negative, then they will condemn the entire industry. And that is the danger.

Chairman HALL. All right. Gentlemen, and lady, we thank you for your time, and I thank every one of you. I think this hearing ought to clear up the hard, cold facts that the hearing was set for, if the liberal press will print it properly.

With that, I will remain. I thank all the witnesses on both panels for their valuable testimony, for Members for their questions. And Members of the Committee may have an additional question for any one of you, and we will ask you to respond to those in writing. The record will remain open for two weeks for additional comments from Members, and the witnesses are excused. And this hearing is, thank goodness, adjourned.

[Whereupon, at 1:05 p.m., the Committee was adjourned.]

Appendix I

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Mrs. Elizabeth Ames Jones, Commissioner, Texas Railroad Commission

Questions submitted by Chairman Ralph Hall

Q1. How would you compare the thoroughness of Texas regulations to those of other States? How does your State's participation in the STRONGER process (State Review of Oil and Natural Gas Environmental Regulations) create better regulations? Are you aware of any States that have emulated Texas' regulatory framework?

A1. **Texas Regulations.** Texas is typical of the oil and gas producing states in taking a proactive approach to address large-scale hydraulic fracturing as well as other issues associated with deep shale gas development. The laws and rules in Texas effectively protect water and other natural resources as well as public health and safety from potential adverse effects of hydraulic fracturing. The Ground Water Protection Council's State Oil and Gas Regulations Designed to Protect Water Resources is a comprehensive state-by-state evaluation of state oil and gas regulations. It concludes that state oil and gas regulations are in general adequately designed to directly protect water resources.

Texas, like most states with mature production, has a long history of successful regulation of well drilling, completion, and production. The practice of hydraulic fracturing has been developed over 60 years. The Railroad Commission developed and oversees a comprehensive regulatory framework encompassing all oil and gas activities. Under this framework, the actual practice of hydraulic fracturing has never been identified as a contributor to groundwater contamination. The Texas regulatory framework emphasizes well construction with multiple layers of protection for groundwater and thousands of inspections each year to ensure compliance with regulations.

The Railroad Commission has authority to regulate pollution of any type from oil and gas exploration and production activity whether it is hydrocarbon, produced water or hydraulic fracturing fluid contamination. The Commission has regulations regarding construction requirements for wells to ensure that each well is protective of natural resources, including groundwater. Railroad Commission regulations specifically prohibit contamination of water resources. There have been no contamination incidents resulting from hydraulic fracturing in Texas.

State Review Process. A STRONGER review provides Significant benefits to states by demonstrating the effectiveness of a state regulatory program to the public and to the state legislatures that fund the programs. The STRONGER state review process demonstrates in a clear and public process that state programs are sound and effective. The review process also identifies areas that could be improved.

The STRONGER guidelines are updated as necessary to address new issues. STRONGER expanded its reviews in 2010 to address hydraulic fracturing regulations in response to public concerns. The Commission chaired the workgroup that developed the STRONGER guidelines for hydraulic fracturing. This expansion resulted from increased interest in the practice of hydraulic fracturing and from interest by the state regulators to provide reviews of their fracturing regulations.

This month, the Commission initiated the process of rulemaking to require disclosure of chemicals used in hydraulic fracturing.

The Commission frequently reviews its regulatory programs to determine effectiveness, particularly in light of new technological or geological developments. The STRONGER guidelines are helpful during these internal reviews.

Texas was initially reviewed in 1993. There was a follow-up review in 2002. Several program improvements were noted in the follow-up report.

Following the initial review, the Railroad Commission began to consider the compliance history of the operator when making permit decisions. The Oil Field Cleanup Fund Advisory Committee was established to provide advice to the Commission. A bonding program was established to ensure closure of reclamation plants and commercial disposal facilities and rules were updated to ensure proper plugging of wells. The data management system was expanded and upgraded. A Field Inspection Manual was developed, as was a Memorandum of Understanding between the Commission and the Texas Commission on Environmental Quality to coordinate exploration and production waste management activities.

Since the 2002 follow-up review, the Commission made additional improvements, and has begun other improvements, to the Commission's regulatory program. For example, the Commission is working with the Department of State Health Services to develop a memorandum of understanding relating to radiation issues.

Q2. Summarize Texas Railroad Commission (TRC) oversight authorities and activities related to hydraulic fracturing, as well as TRC coordination efforts with other State-level oversight bodies.

A2. The Railroad Commission's regulatory framework for oil and gas activities, including the practice of hydraulic fracturing, effectively protect surface and ground water. The, Texas framework emphasizes well construction with multiple layers of protection for groundwater, and inspectors conduct thousands of inspections to ensure compliance with the Commission's regulations.

The Commission does not permit a well on which hydraulic fracturing will be performed without certification that identifies the depth to which groundwater must be protected by cement and steel casing. Geologists and hydrologists evaluate the area well logs around any proposed well to determine the required depth of the surface casing to protect fresh water formations. An operator proposing to drill a well must submit that determination before the Commission will consider issuing a drilling permit.

In every new well, Commission regulations require that heavy steel surface casing extend below the base of the deepest fresh water formation and that the surface casing be cemented in place throughout the annulus between the drill hole and the surface casing. As an additional safeguard, Commission rules require that the surface casing be pressure tested for leakage before re-commencing drilling.

Coordination with Other State-Level OverSight Bodies. The Commission actively works with other states through participation in the Interstate Oil and Gas Compact Commission, the national Groundwater Protection Council (GWPC), and STRONGER, Inco activities.

One example of such participation is the new hydraulic fracturing chemical disclosure website FracFocus.org. Responding to the concerns about the nature of chemicals used in fracturing, the Ground Water Protection Council (GWPC) and the Interstate Oil and Gas Compact Commission (lOGCC) initiated a national registry to display the chemicals used in individual fracturing jobs, building off of well completion reports. GWPC and IOGCC worked closely with producers, service companies, and state regulatory bodies to develop a format that will allow for the submission of well data. The Commission has been heavily involved in this effort. Many of the active shale gas producers already have begun to populate the website with well data. Numerous regional and national oil and gas industry associations have endorsed the project.

While initially directed at reviewing state drilling fluids and produced water management regulations, STRONGER expanded its reviews in 2010 to address hydraulic fracturing regulations in response to public concerns. The Commission chaired the workgroup that developed the STRONGER guidelines for hydraulic fracturing. Since adding fracturing to the review process, STRONGER has conducted reviews in Pennsylvania, Ohio, Louisiana and Oklahoma. A STRONGER review provides significant benefits to states by demonstrating the effectiveness of a state regulatory program to the public and to the state legislatures that fund the programs. By bringing experts from other state programs, it can identify issues that need to be improved. The STRONGER state review process demonstrates in a clear and public process that state programs are sound and effective.

Texas also works with individual states on issues of shared interest. In 2004, the Railroad Commission and the Louisiana Department of Natural Resources entered into a Memorandum of Understanding (MOU) agreeing to provide written notice to each other when certain oil and gas activities will occur near each side of the state line. By working together as good neighbors and notifying one another of proposed projects or subsurface injection operations within at least a one-mile distance from the common border, the potential for problems affecting the land and water supplies can be diminished.

Q3. How are complaints of water contamination usually handled? How extensive is the investigatory process? Is this process mandated by law, or has it evolved over time from experience? In your testimony, you spoke about how the Railroad Commission conducted a thorough research and legal investigation of the incident involving Range Resources. However, EPA still stepped in and halted operations. Did EPA's interference come after your investigation?

A3. A critical function of the Railroad Commission's Field Operations section is to address complaints. These complaints are received from both industry and the public. The Commission's process for handling complaints of groundwater contamination has evolved over time from experience.

Commission staff must contact the complaining party to schedule a joint inspection within 24 hours of receipt of complaint. Response is immediate in cases where there is imminent danger of pollution or threat to the public. Field personnel gather information in order to:

a. Confirm that a contamination problem exists

b. Determine whether or not the cause is under the Commission's jurisdiction.

c. Determine possible sources of contamination

d. Determine possible ways to eliminate the source of contamination and initiate clean up if the problem is found to be the result of activities under the Commission's jurisdiction.

e. Determine the manner of completion, age, fluid level, pump-off time, etc. of the water well, the problem with the water (salty taste, odor, oil film, etc), when the problem was first noticed, whether the water gets better or worse after pumping the well for a while (could be an indication of aquifer contamination versus wellbore contamination), whether the well has a filtering system or water softener, whether the complainant has a septic system.

Field personnel then collect samples from the affected water well immediately and again after the pump has been allowed to run for approximately 10 minutes. Samples are taken as near as possible to the wellbore and before the water passes through any filters, water heaters, softeners, settling tanks, or other vessels. Staff collects samples from other water wells in the area for comparison and notes the depth, completion and any other pertinent characteristics of these water wells. Bacteriological samples are taken and forwarded to local health department. Staff then collects samples of produced water from oil and or gas wells within)I. mile of the subject water well.

Staff also inspects the surrounding area approximately 1/4-mile from subject water well. Staff notes the location, status and current condition of oil and or gas wells within the area and inspects disposal or injection wells for operable observation valves and annular pressures that may indicate a mechanical integrity problem, oil and gas storage and treatment facilities, pits (current and abandoned), flowlines, evidence of past leaks or spills, creeks or streams and any other situation that may have contributed to the problem. Complainant receives copies of all correspondence related to the complaint.

If water contamination is verified, the case is forwarded to the Commission's Site Remediation division to address remediation. The case also may be forwarded to the Commission's Office of General Counsel for enforcement action if the source of the contamination is found to be a result of violations of Commission rules, permits, or orders.

Range Resources Complaint. In 2010, the Commission received a complaint involving natural gas in a 200-foot deep domestic water well in Parker County located near two natural gas wells operated by Range Resources. Throughout its investigation, Commission staff has shared data cooperatively with EPA staff. After a hearing, the Commission issued a final order finding that, based on the evidence, the Range Resources wells did not contribute and are not contributing to contamination of domestic water wells.

Range Resources cooperated with the Commission as part of the investigation. On December 3, 2010, Range Resources agreed to take additional actions including performing further testing. of its wells, performing soil gas surveys, monitoring gas concentrations, and offering a water supply to the residence. However, on December 7, 2010, EPA asserted its authority under Section 1431 (a) of the Safe Drinking Water Act ("SDWA "), 42 U.S.C. §300i(a) and issued an emergency endangerment order against Range Resource, related to the occurrence of natural gas in the domestic water well in Parker County. EPA Region 6's letter declared an *imminent and substantial endangerment to a public drinking water aquifer has occurred (or may occur) through methane contamination which is directly related to oil and gas production facilities under your operation.*

EPA acted prematurely. Before EPA issued its order, Commission staff advised EPA that a specific source of contamination was unknown and still under investigation. Commission staff also advised EPA that the Commission had secured voluntary cooperation from the operator, including measures to assure safety in the affected household. All parties agreed natural gas was present in the Lipsky and Hayley water wells; however, the Commission advised EPA that evidence suggested that the gas was present in the aquifer prior to Range's activities.

EPA acted incorrectly. It is fair to question whether or not the presence of the gas in the water wells was an imminent and substantial danger to human health because one water well owner had disconnected his water well from the residence. Air monitoring of the residence never indicated a threat of explosion. The other water well owner never filed a complaint with the Commission.

Reportedly, he was aware of natural gas and was managing it with an open holding tank that vented any gas before the water was used.

In addition, State and local authorities had been actively investigating the matter since August, and had not determined whether or not there was a connection between the Range activities and the gas in the water wells. State authorities had secured commitments from Range to expand the investigation. The Commission's investigation is actively ongoing, and, at that time, Commission staff had made no conclusions about possible sources of natural gas and hydrocarbons found in the water well. Additionally, no pathways from a deep hydrocarbon source to the water well had been identified. The Commission advised EPA of the commitment from Range to expand the investigation before EPA issued the emergency order.

EPA relied on incorrect science. Based on the evidence presented at hearing, Commission examiners concluded, and the Railroad Commission agreed, that gas in the water wells is from the Strawn Formation, which is in direct communication with the Cretaceous aquifer in which the water wells are completed. There was no evidence to indicate that either natural gas production well was the source of the gas in the water wells. The appropriate geochemical parameters for fingerprinting to distinguish Strawn gas of Pennsylvania age from Barnett Shale gas of Mississippian age, are nitrogen and carbon dioxide, not carbon. Gas from Pennsylvanian age rock, including Strawn, has higher nitrogen concentration and lower carbon dioxide concentration than Barnett Shale gas. Gas found in the water wells does not match the nitrogen isotopic fingerprint of Barnett Shale gas. Bradenhead gas samples from both production wells did not match Barnett Shale gas, confirming that gas is not migrating up the wellbores and that the Barnett Shale producing interval in the wells is properly isolated. Three dimensional seismic data indicates no evidence of faulting in the area of the water wells and microseismic data available for more than 320 fracture stimulations in Parker County indicated a maximum fracture height of approximately 400 feet, meaning that almost one mile of rock exists between the highest fracture and the shallow groundwater aquifer.

The Commission continues to investigate the presence of gas in water wells in the area to determine source and conduits and what, if any, actions the Commission should take. If an investigation indicates oil field activities are responsible, the Commission would require assessment and cleanup, and evaluate what fines or penalties may be assessed as necessary.

Q4. How useful is the current scope and breadth of the EPA study to State regulators and risk managers? What would be needed in order to make the study more worthwhile?

A4. The states, including Texas, have adequate programs and authority for regulating hydraulic fracturing and a very good understanding of the technology and its potential for impacts. However, we recognize that there has been substantial public concern and much controversy over the use of hydraulic fracturing. While we support the study plan in principle, we hope that the study will be an objective assessment that takes in account current state regulatory programs and regional differences.

We appreciate EPA's pledge to work with the states, state organizations, and other stakeholders in conducting the study. In particular, the study should adhere to the directive of Congress that the study use the best available science; rely on independent sources of information; be a transparent, peer-reviewed process; and incorporate consultation with stakeholders.

We do have some concern with the scope and timing of the study. EPA's original scoping document proposed to study the "Full Life Cycle' of an oil and gas well. In other words, the scope included all areas of oil and gas exploration and production activity, such as site selection and development, as well as production, storage and transportation, which are unrelated to hydraulic fracturing. EPA's Science Advisory Board rightfully concluded that initial, short-term research be directed to study sources and pathways of potential impacts of hydraulic fracturing on water resources, especially potential drinking water sources considering the Congressional request and a desire by EPA to complete initial research products by the end of calendar year 2012. We believe that the scope of the Draft Study, however, remains broader than Congress may have intended.

EPA proposes to delve into areas beyond the reach of federal law. EPA did limit the Draft Study to drinking water resources by replacing the "lifecycle" approach with the concept of "water lifecycle." However, the Draft Study includes a study of how water withdrawals might impact water availability in the source area, and the water quality of source waterbodies. Water availability and water withdrawal has historically been the prerogative of the states and, we believe, is beyond the reach of federal law.

EPA proposes to study areas beyond the specific practice of hydraulic fracturing. In addition to proposing to study water withdrawals, EPA proposes to study the potential impacts of spills, containment, treatment, and disposal of wastewaters re-

sulting from hydraulic fracturing, as well as produced water from wells that have been fractured. Contrary to what some believe, there are existing controls on oil and gas activities in federal law and regulations, including the Safe Drinking Water Act, Clean Water Act, Clean Air Act, Resource Conservation and Recovery Act, not to mention state laws and regulations actively being enforced by state regulators.

EPA should refocus and narrow the scope of the study to that directed by Congress -to practices directly associated with actual hydraulic fracturing and drinking water resources. Expansion of the study to other areas will only dilute EPA's ability to focus on the actual practice of hydraulic fracturing.

In addition, we have encouraged EPA to include in any working groups professional geoscientists and engineers with field experience and to actively seek participation from experts from the state regulatory agencies and base the study on sound science, valid data, and accurate information from credible sources.

Q5. In the last few years, some companies have significantly increased wastewater recycling to move toward 100 percent recycling with zero discharge. What is the role of recycling and reuse of hydraulic fracturing fluids?

A5. Wastewater in the northeast Marcellus Shale area has been discharged under the Clean Water Act to publicly owned treatment works (POTWs), thence to surface water because the geology is such that deep well underground injection was not an option. Evidently, the POTWs were not prepared to accept the volumes of wastewater generated in association with shale gas and recycling is becoming the norm. In Texas, wastewater from gas shale is generally injected into permitted deep disposal wells. However, water availability may drive the push towards more recycling in Texas.

Texas is understandably concerned about water resources, particularly with the extraordinary drought conditions Texas currently faces. The Railroad Commission encourages use or reuse of oil and gas wastes for beneficial purposes and adopted recycling regulations in 2006 to ensure that the storage, handling, treatment, and recycling of oil and gas wastes and recyclable product do not threaten or impair the environment or public health and safety.

The Commission has issued one mobile recycling permit in the Bamett Shale area, which authorizes treatment of hydraulic fracturing flowback water using on-site distillation units. The process allows reuse of approximately 80 percent of the returned fluids.

The Commission also has issued one Stationary Recycling Permit for a facility located in Parker County in the Bamett Shale area. This stationary facility uses the same technology.

The Commission has one pending permit application for a pilot project in Webb County -in the Eagle Ford Shale area. The applicant proposes to test a process for removal of extraneous materials (other than salts) from hydraulic fracturing flowback water.

Q6. This past April there was an incident in Pennsylvania where there was a blowout of a well that caused fracking fluid to spill.

a. As part of permitting hydraulic fracturing, what kind of response planning are companies required to submit?

b. What other information do companies have to disclose to regulators in the event of a blowout?

c. How does this differ from the information companies are required to provide to regulators in order to obtain the permit in the first place?

A6. The Railroad Commission requires that each permitted well, including those that use hydraulic fracturing techniques, install a blowout preventer or control head and other connections to keep the well under control at all times as soon as surface casing is set.

In the event of a blowout, companies are required to disclose to the Commission a full description of the event, including the volume of crude oil or gas lost. The location of the well must be provided to the Commission including county, survey, and property data, so that the exact location can be readily located on the ground. The company must specify what steps have been taken or are in progress to remedy the situation.

A company must comply with Railroad Commission rules, including Statewide Rule 13, which requires a blowout preventer and Statewide Rule 20, which mandates reporting requirements in the event of a blowout or other releases of oil and gas waste. In addition, Commission regulations require construction of dikes or fire walls around all permanent oil tanks or tank batteries that are deemed by state to be an objectionable hazard.

Question submitted by Representative Chip Cravaack

Q1. In your prior experiences with EPA, how would you describe their work as a regulatory partner? Do you see any areas where EPA could improve their dealings with state agencies? Do you have any suggestions for Congress on how we could encourage EPA to be a better partner with state government?

A1. The Texas experience with EPA most recently has been one of heavy-handed overreach. The following are just a few examples.

EPA asserts its authority under certain laws prematurely and. in many cases. incorrectly. One example is EPA's assertion of its authority under Section 1431 (a) of the Safe Drinking Water Act ("SDWA "), 42 U.S.C. §300i(a), when it issued an emergency endangerment order against Range Resource, related to the occurrence of natural gas in the domestic water well in Parker County. EPA Region 6's letter declared that an *"imminent and substantial endangerment to a public drinking water aquifer has occurred (or may occur) through methane contamination which is directly related to oil and gas production facilities under your operation."* EPA stated that it issued the order because the methane could cause an explosion and that the state had failed to act. In fact, the water wells had been disconnected from the houses, eliminating the chance that the houses would explode, and the' Railroad Commission had been efficiently and effectively investigating the incident in concert with EPA since the initial complaint.

Another example of EPA overreach is EPA's Spill Prevention, Control, and Countermeasures (SPCC) regulations. The SPCC rules adopted by EPA, which recently became effective, do not allow the oil and gas sector to use the SPCC rule's wastewater exemption for produced water, although other sectors were allowed to use the exemption. Thus, the SPCC regulations cover not only vessels storing oil, but also produced water storage tanks that contain de minimis quantities of oil. EPA singled out oil and gas water separation facilities for increased level of regulation relative to other sectors using similar or nearly identical technologies and treatment goals. The rule subjects hundreds of thousands of produced water vessels to additional requirements that are unnecessary given the incidental amounts of oil they contain and the small environmental risks they represent.

EPA is using "guidance documents" to avoid rulemaking. In several instances, EPA has adopted or amended guidance documents when rulemaking would be more appropriate. The problem with adoption of requirements as guidelines rather than rules, is that the guidelines are not required to be as fully and formally vetted as rules.

One instance is EPA's current effort to draft a guidance document for permitting of hydraulic fracturing that includes the use of diesel fuel. Section 322 of the Energy Policy Act of 2005 amended the Safe Drinking Water Act (SDWA) by modifying the definition of "underground injection" to exclude " . . .. the underground injection of fluids or propping agents (other than diesel fuels) pursuant to hydraulic fracturing operations related to oil, gas, or geothermal production activities." Rather than pursue rulemaking with the attendant formal review and comment period, EPA has decided to draft guidance for permitting hydraulic fracturing that includes the use of diesel fuel as a Class II underground injection activity. The permitting program for Class II injection wells was developed under the assumption that injection would be continuous over a relatively long period of time, and thus, includes requirements that are not appropriate for short-term hydraulic fracturing activities.

In another instance is EPA's expansion of the definition of "waters of the United States" and "navigable water" under the Clean Water Act. Most recently, EPA and the U.S. Army Corps of Engineers released a draft proposed "Clean Water Protection Guidance" in April of this year that describes their view of the Federal Government's authority to regulate wetlands. If adopted, this guidance will significantly expand federal Clean Water Act jurisdiction.

Questions submitted by Representative Paul Tonko

Q1. 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?

A1. The technology has developed over a 60-year period. The use of hydraulic fracturing has changed dramatically since its introduction 60 years ago, and according to industry it is now used in about 90% of operational wells today. Hydraulic fracturing is a process of injecting a mixture of water, chemicals and particles underground to create fractures through which gas can flow for collection. The difference

in the activity of 60 years ago and today is that larger volumes of water are used in more technologically sound fracturing operations in conjunction with horizontal drilling technology. Today's technology has developed to a point that operators can determine the size, direction, and efficiency of the fractures.

Q2. What is the industry doing to continue this technological evolution to cleaner technologies?

A2. Industry and other stakeholders, including state regulators, have been very active in efforts to develop and encourage cleaner technologies, as well as technologies that have less impact. Just a few examples follow:

Reduced "Footprint." The ability of an operator to drill numerous wells from one well pad has reduced the overall footprint of natural gas exploration and extraction in the form of fewer access roads and pipeline and production infrastructure. It also has resulted in less truck traffic, which further results in reduced emissions, dust, noise, erosion, wear and tear on roads, less disturbance to people and wildlife, and the potential for vehicular injuries, spills and property damage. Industry also has developed low-impact rigs, which adapt to the environment with a minimum of disturbance.

Use of Coiled Tubing Drilling. Coiled tubing drilling is a high-potential solution for reducing environmental impact while also improving drilling efficiency and cost. Drilling with coiled tubing is not applicable in all situations.

Use of Closed-Loop Drilling Mud Management. Many operators, particularly in urban/suburban areas, are moving away from lined reserve pits and are using closed-loop drilling mud management systems.

Chemical Substitution. The "single biggest move" the industry has made to reduce the toxicity of its fluids, according to BJ Services, is phasing out diesel fuel, a solvent that contains the potent carcinogen benzene. Diesel fuel was once commonly used in hydraulic fracturing. Today, many companies have replaced diesel fuel with much less toxic mineral oil in most of their fracturing solutions. The shift began in 2003, after EPA pressed the nation's dominant hydraulic fracturing companies to voluntarily eliminate diesel fuel from some of their fluids. The Railroad Commission has encouraged this action.

Green Completions. Also becoming prevalent, particularly in urban/suburban areas, is a process known as green completion. Green completions capture gas produced during well completions and well workovers following hydraulic fracturing. Generally, an operator will use portable equipment to separate gas from the solids and liquids produced during flowback of the well. The gas then can be delivered into the sales pipeline. Green completions reduce emissions of methane, volatile organic carbons, and hazardous air pollutants during well cleanup and can eliminate or significantly reduce the need for flaring.

Some operators also are reducing their methane emissions by replacing retrofit continuous-bleed pneumatic pilot valves on field separators and controllers with low-bleed valves. Gas is bled off continuously from separators using high bleed pilot valves. Replacing or retrofitting high-bleed valves reduced emissions and has resulted in the ability to capture and sell gas that previously escaped.

Recycling. The Railroad Commission encourages use or reuse of oil and gas wastes for beneficial purposes and adopted recycling regulations in 2006 to ensure that the storage, handling, treatment, and recycling of oil and gas wastes and recyclable product do not threaten or impair the environment or public health and safety.

The Commission has issued a mobile recycling permit in the Barnett Shale area treats hydraulic fracturing flowback water using on-site distillation units. The process allows reuse of approximately 80 percent of the returned fluids.

The Commission also has issued a stationary recycling permit for a facility located in Parker County in the Barnett Shale area, which also uses distillation.

The Commission has one pending permit application for a pilot project in Webb County -in the Eagle Ford Shale area, in which the applicant proposes to test a process for removal of extraneous materials (other than salts) from hydraulic fracturing flowback water.

One company that received authority in 2006 from the Commission has process over 12.7 million barrels of hydraulic fracturing fluid to recover over 9.9 million barrels—or 77%—of reusable distilled water.

Ongoing Efforts. The Houston Advanced Research Center and Texas A&M University, along with industry sponsors and other stakeholders, including NGOs, government agencies, and others, operate the operate the Environmentally Friendly Drilling Systems Program integrating advanced technologies into systems that Significantly reduce the impact of petroleum drilling and production in environmentally sensitive areas. (See http://www.efdsystems.org/)

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Robert M. Summers, Secretary, Maryland Department of the Environment

Questions submitted by Chairman Ralph Hall

Q1. States regulate many aspects of oil and natural gas activities. How robust is this regulation? How often are wells inspected? What are the qualifications of the regulators?

A1. Maryland statutory law assigns the responsibility for permitting oil and gas wells to the Maryland Department of the Environment. The Department adopted implementing regulations that were last revised in 1993. MDE's Minerals, Oil and Gas Division currently has four professional employees, of whom three are geologists and one a regulatory and compliance engineer, in addition to an administrative specialist. There are currently about 10 gas production wells in Maryland and a natural gas compressor station associated with about 85 gas storage wells. The production wells are scheduled for inspection once a year. The compressor station is inspected annually and the storage wells once every five years.

Q2. Do you believe states are incapable of effectively regulating hydraulic fracturing without direction from EPA?

A2. At this time, Maryland lacks sufficient information to effectively regulate hydraulic fracturing. As I said in my testimony, guidance from EPA is needed and has been requested by Maryland. The availability of recommendations regarding best practices, such as those that the Department of Energy has said they will be providing in the next 6 months, would be extremely helpful and would allow States like Maryland to proceed more quickly to achieve our objective of ensuring that any permits issued that would utilize hydraulic fracturing are fully protective.

Q3. Have you reviewed Texas' regulations overseeing hydraulic fracturing? Have you reviewed the regulations of other oil and gas producing States? If so, what type of review have you performed?

A3. Staff at MDE has reviewed Texas' regulations and the regulations, adopted and proposed, of other States and interstate agencies such as the Susquehanna River Basin Commission. A variety of different requirements have been put in place across the Country and many states are currently making improvements to their regulatory programs. We need to ensure that Maryland is using the most up-to-date protective measures. During the course of the study mandated under Governor O'Malley's Executive Order, in conjunction with an Advisory Committee, the Department will examine these regulations, and the EPA and DOE guidance being developed now, to establish permit requirements for best practices that are sufficiently protective.

Q4. How useful is the current scope and breadth of the EPA study to State regulators and risk managers? What would be needed in order to make the study more worthwhile?

A4. EPA summarizes the study on their web page as follows: "the overall purpose of the study is to understand the relationship between hydraulic fracturing and drinking water resources. The scope of the proposed research includes the full lifespan of water in hydraulic fracturing, from acquisition of the water, through the mixing of chemicals and actual fracturing, to the post-fracturing stage, including the management of flowback and produced water and its ultimate treatment and disposal." The scope and breadth of the EPA study plan will assure that State regulators get useful data on the toxicity of chemicals used in or released by hydraulic fracturing and the potential for impacts to drinking water resources. This is a topic that would be of interest to all states, and we look forward to EPA's summary. The study would be more worthwhile if it addressed additional topics, such as re-fracturing, and impacts to air quality and terrestrial and aquatic ecosystems.

Q5. It seems many of the alleged environmental concerns associated with fracking-such as wastewater discharge-are not actually associated with the hydraulic fracking process and indeed exist at all oil and gas production activities regardless of whether fracking occurs. Does EPA properly distinguish between these categories in its study plan? How can this distinction be improved?

A5. Hydraulic fracturing wastewater is different in volume and characteristics from wastewater generated in conventional oil and gas operations because of the additives used in the fracking fluid and the potential release from the fracked shale of metals, organics and other contaminants. The EPA study plan appropriately focuses on wastes associated with hydraulic fracturing.

Question submitted by Representative Chip Cravaak

Q1. Many people are concerned about the waste water that is created as part of the fracturing process. Can you please describe the current technologies that are available to help recycle these fluids?

A1. The fracking flowback can contain not only the returning fracking fluid with its additives, but also radioactivity, metals, and organic chemicals that were in the target formation before fracking. Different treatment may be needed for different contaminants. Maryland is currently investigating the available treatment methodologies. This is one of the key questions that Maryland will be evaluating as part of its study over the next year.

Questions submitted by Representative Eddie Bernice Johnson

Q1. Dr. Summers during the hearing Mr. Luján asked all of the witnesses if they would agree that the country needs a minimum standard for hydraulic fracturing. You were not given a chance to answer this question. Do you believe the country should adopt some kind of minimum best practices or standards? If yes, why?

A1. Yes. Federal minimum best practices for hydraulic fracturing would be very helpful to Maryland as it refines its own regulatory program. Such practices would also ensure that upstream States are requiring appropriate practices to protect Maryland's rivers and streams from the potential adverse impacts of hydraulic fracturing that occurs in those States. Similarly, federal standards for wastewater treatment of fracking flowback would ensure that treatment levels are sufficiently protective prior to issuance of discharge permits regardless of which state has issued the permit.

Q2. After reviewing much of the EPA study plan, I recognize that there is a considerable amount of evaluation that is conducted to determine if a site can be safely leased for drilling. Analyses related to the use of chemicals, drinking water evaluations, and geological and surface evaluations all take considerable time and funds.

- *How are States able to conduct these evaluations?*
- *How much do States depend on the industry for these kinds of evaluations?*

A2. Information about geology and drinking water resources are generally available on a regional scale. Maryland has geologists and engineers on staff who are able to review and interpret this information as part of the permitting process, however, for site-specific information, Maryland must rely heavily on information provided by the applicant for a drilling permit. Maryland law and regulations require applicants to perform an Environmental Assessment that provides the information needed to evaluate the application. Maryland is currently updating these requirements to ensure that appropriate evaluations are conducted for all future applicants.

As for the chemicals, MDE requires the disclosure of all the chemicals used onsite. We rely heavily on Material Safety Data Sheets and published studies to evaluate the toxicity of the chemicals. The fate and transport of these chemicals is seldom known with any degree of detail or certainty and Maryland intends to require site-specific water quality monitoring of surface and groundwater to ensure that best management practices are protective of water quality. In addition, the fracking fluid can react with the target formation, producing different chemicals in the wastewater that must be evaluated and properly treated. Maryland is depending on accurate information from the applicants and would benefit greatly from additional federal guidance and oversight to assist in the evaluations.

Question submitted by Representative Ben Luján

Q1. Dr. Summers, in your testimony during the hearing you discuss the need for the Federal Government to provide guidance and technical support to the States on what steps need to be taken to ensure the safety and environmental performance of fracking. Can you elaborate on how a federal-state partnership could promote natural gas production and ensure the health of our public?

A1. Because of its national scope, EPA receives information about operations in all the States that are experiencing hydraulic fracturing of deep deposits. The EPA is in a better position than any individual State to collect, analyze, and make available information on best practices across the country. To cite one example, the EPA has knowledge about best practices for reducing the escape of methane gas to the atmosphere during drilling and hydrofracking. Sharing this information would allow States to avoid "reinventing the wheel." As another example, EPA Region III, which

includes several Marcellus Shale states, has provided useful guidance on the treatment and disposal of fracking wastewater.

Questions submitted by Representative Paul Tonko

Q1. 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?

A1. Hydraulic fracturing has been known and used for a significant period of time. Applying the technology to deep, horizontally-drilled wells is relatively new. It has only been used in the Eastern United States for a few years. The industry continues to innovate and add new technology and chemicals. We have observed that Pennsylvania has found it necessary to continually update its requirements and regulations over the past few years to address issues that have arisen due to the rapid development of Marcellus Shale gas wells. Many citizens are quite concerned about the impacts they have observed and the potential for additional cumulative impacts as many more wells and associated gathering lines and other infrastructure are developed. Maryland has not received the volume of applications that Pennsylvania has, however, in reviewing its experience and some of the ongoing problems encountered, it is clear to us that the technology is evolving and will continue to evolve. States need the assistance and expertise of the federal agencies to ensure that we are requiring the best available practices so that our citizens' health and safety are protected and we are not left with a legacy of environmental contamination and degradation of our natural resources.

Q2. What is the industry doing to continue this technological evolution to cleaner technologies?

A2. Many companies are working to develop cleaner, safer practices and it was Maryland's hope that those industries would support legislation that was introduced in the Maryland legislature this past session to help Maryland ensure that the best practices were being employed in the development of the Marcellus Shale in our State. Unfortunately, the industry in Maryland did not support that legislation because they believed that it placed requirements that would prevent us from moving forward with production of gas as quickly as they would have liked.

Many different practices and regulatory standards are being required in the various States whose programs we have reviewed. It is extremely difficult and time consuming for staff from a single State to ensure that industry is using the best practices and is taking advantage of available technological advances. This is complicated by the fact that not all the technological innovations result in cleaner operations; some are used to tap previously unreachable or unrecoverable gas and may have additional unanticipated environmental impacts that must be evaluated. Maryland will take the time needed to ensure that any permits we issue are fully protective. With Governor O'Malley's Executive Order, we are establishing an advisory committee and we are encouraging industry representatives to participate and assist us in appropriately addressing the issues so that Maryland's permits are reasonable and fully protective.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Mr. Harold Fitch, Michigan State Geologist; Director, Office of Geological Survey, Michigan Department of Environmental Quality; and Board Member, Ground Water Protection Council

Questions submitted by Chairman Ralph Hall

Q1a. FracFocus is a voluntary website that discloses the additives used in fracking fluids. Some people have advocated that this disclosure should be mandatory.
a Is this necessary, or are the voluntary measures enough?

A1a. Circumstances vary among states, and the issue should be left to each state to address. Michigan has implemented mandatory disclosure of Material Safety Data Sheets (MSDSs) for high-volume hydraulic fracturing operations in response to public interest. We are posting the MSDSs on our website. To address the question in a regional or national context, the voluntary disclosure under FracFocus provides adequate information to characterize hydraulic fracturing fluids in general.

b. How does the information disclosed on this website compare with the information companiesprovide to State regulators?

A1b. The information on the FracFocus website closely parallels that for Michigan.

Q2. States regulate many aspects of oil and natural gas activities. How robust is this regulation? How often are wells inspected? What are the qualifications of the regulators?

A2. Michigan has a comprehensive and thorough system for regulation of all aspects of oil and gas wells and associated pipelines and facilities, from initial siting to closure and restoration. Wells are inspected once every two to four days during drilling, completion (including hydraulic fracturing), and plugging; and several times annually during production. While states vary somewhat in this respect, I believe Michigan is fairly typical. Michigan inspectors are degreed geologists and have significant on-the-job training before qualifying for independent field inspection activities.

Q3. How useful is the current scope and breadth of the EPA study to State regulators and risk managers? What would be needed in order to make the study more worthwhile?

A3. The EPA plans for the study are quite broad. Michigan does not object to a broad study; we believe that the results will confirm what the states already know to be the case. However, we are concerned that the breadth of the study means the results will not be available in a timely manner. We are also concerned that the study does not incorporate risk assessment. While the study may point out a few risks to the environment, it is important to weigh the degree of risk, not just the possibility of a problem (which may be very remote).

Q4. At what depths do we find functional groundwater wells? At what depths is hydraulic fracturing taking place? What is the potential relationship between these wells and hydraulic fracturing activities both on the surface and below ground? How does this vary across local geology?

A4. The depth of water supply wells varies greatly from state to state and within each state. In Michigan, it ranges from tens of feet to hundreds of feet. Likewise, the depth and characteristics of hydraulic fracturing varies greatly-more reasons for state-based regulation. In Michigan the vertical separation between the deepest fresh groundwater and the zones that are hydraulically fractured ranges from 200 feet to thousands of feet. The separation distance is smallest at shallow depths. In shallow wells the volume of hydraulic fracturing fluid is small and fractures propagate horizontally; as a result, the fractures do not extend upward into the fresh water aquifer. In deeper wells, the great isolation distance and nature of intervening formations prevents propagation of fractures into fresh water zones.

Q5. In the last few years, some companies have significantly increased wastewater recycling to move toward 100 percent recycling with zero discharge. What is the role of recycling and reuse of hydraulic fracturing fluids?

A5. The states encourage recycling and reuse of hydraulic fracturing water. It may not be practical in some cases due to unfavorable characteristics of the flow back or produced water.

Q6. Could you differentiate flowback and produced water, and any other water used during the hydraulic fracturing process? How does the composition of the flowback and produced water vary as a function of management practices and local geology?

A6. In some cases flow back, produced water, and drilling fluids can be distinguished by their chemical signatures. In general, water recovered from a well may be a mixture of all three. The recovery of hydraulic fracturing water tends to be high at first then decline over time; it may take an extended period to recover the hydraulic fracturing fluid, and some portion will likely remain in the producing formation indefinitely. The recovery of flowback water depends on the nature of the target formation and the hydraulic fracturing pressures and volumes.

Q7. What existing treatment technologies are currently being used to treat hydraulic fracturing wastewater?

A7. There are proprietary equipment and processes for treating hydraulic fracturing wastewater on-site. In some states the wastewater has been transported to public wastewater treatment plants. In Michigan all hydraulic fracturing wastewater must be recycled or disposed of in deep disposal wells.

a. How do the form and potential impacts of wastewater treatment and disposal vary across the country and across geological formations where hydraulic fracturing is practiced?

A7a. Appropriate treatment and disposal techniques vary depending primarily on dissolved salt content. In Michigan the dissolved salt content is typically relatively high, so treatment and discharge or reuse for other purposes is generally not practical.

b. What states regulate hydraulic fracturing under the Underground Injection Control program of the Safe Drinking Water Act?

A7b. To my knowledge only Alabama regulates hydraulic fracturing under the Underground Injection Control program. The Alabama regulations were necessitated by a federal court ruling in a lawsuit brought by an environmental interest group. The regulations are limited and apply only to hydraulic fracturing of shallow coal beds.

Questions submitted by Representative Paul Tonko

Q1. 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?

A1. The primary other technology that may be used in conjunction with hydraulic fracturing is horizontal drilling, which has been used commercially since the 1980s.

Q2. What is the industry doing to continue this technological evolution to cleaner technologies?

A2. The service companies that carry out hydraulic fracturing operations are developingnew ″greener″ chemical additives as well as ways to reduce the volume of water needed.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Cal Cooper, Manager, Worldwide Environmental Technologies, Greenhouse Gas, and Hydraulic Fracturing, Apache Corporation

Questions submitted by Chairman Ralph Hall

Q1. FracFocus is a voluntary website that discloses the additives used in fracking fluids. Some people have advocated that this disclosure should be mandatory.

a.Is this necessary, or are the voluntary measures enough?

A1a. Apache encourages States to require mandatory reporting of the additives used in frac fluids to the FracFocus website. In Texas this was recently enabled by a legislative bill, but generally State Regulators have the power to require disclosure by Rule without new legislation. In Louisiana rules have been proposed by LOC that would require disclosure like FracFocus to a public website.

Apache does not see the need for a Federal mandate.

b. How does the information disclosed on this website compare with the information companies provide to State regulators?

A1b. The FracFocus site consolidates essential information; it allows for geographical searching of well locations and also provides separate technical and statutory explanations that are generally not part of state records. FracFocus is designed to be user friendly and current. It is substantially more efficient than freedom of information records release. Furthermore the website minimizes the costs to state government agencies of making this information available to the public. The final well reports filed by operators with state regulators contain proscribed technical information including copies of well logs. This includes mostly standard details not directly related to HF completions, but also includes information about the completions including pressures and injected volumes. Only a few states require disclosure of additive composition. All reported information is eventually available to the public but the information is not designed to be user friendly or understood by non-specialists. Some States make public, and allow commercial entities to reproduce, publish and sell well logs and well reports, usually one year after completion.

Q2. In your written, testimony you note that the success of any scientific evaluation hinges, in large part, on the clarity and focus involved in the prioritization of testing.

a.Could you please articulate the specific flaws in the EPA Draft Plan's prioritization?

A2a. The essential flaw is that EPA categorically avoids any meaningful prioritization whatsoever in a scientific sense. Referring to the Draft Plan, page 4 under section: *2.3 Research Prioritization* the text suggests that the (only) priority is to study hydraulic fracturing in shale formations based on stakeholder input. That would be the public outcry perceived from EPA public hearings, as opposed to any scientific reasoning evident in the EPA plan. The white-wash goes on to boldly claim that" EPA used a risk-based prioritization approach to identify research that addresses the most significant risks." but the Draft Plan offers absolutely no information on how this was done, or what criteria was included a technical risk matrix. It does not rank any particular scientific question more worthy of investigation than another. It does not even pretend to focus on any areas considered as the greatest risk to water resources. Instead it refers to itself as a "comprehensive study." The unfocused, unrisked "comprehensive" EPA plan covers almost every imaginable base will easily cost 100's of millions of dollars and take probably a decade or more to complete.

In his testimony before this committee Mr. Anastas flatly contradicts the written words in the EPA Draft Plan and declares that *" This study is intended to understand the factors that potentially could result in impact to drinking water from HF. the factors that are the basis of whether or not a risk exists . . .This study is not intended to be a risk assessment."* He goes on to recognize that *"for there to be a risk there needs to be the elements of both hazard and exposure."* Clearly in the study plan the focus in on identifying hazards of every imaginable type without any indication that they will quantify exposure. Risk analysis (see below) is not contemplated.

For it to be a scientific study, it must start by asking questions like a scientist, test concepts, and start where you expect to get the most impact based on analysis. The current approach appears to invent problems in order to fund everyone who wants funding. It also gives the EPA total flexibility to do whatever it wants with the funding it gets, effectively neutering any oversight guidance. Is this what Congress intends?

b. What specific areas of existing knowledge have been ignored or under-represented?

A2b. The biggest omission is the whole area of quantitative risk analysis (different from relative scientific risk). HF is a moderately complex industrial process with considerable variation in its application. The process and its applications lend themselves to an analysis of the risk of occurrence that other regulatory agencies now demand. Without understanding a risk of occurrence or a risk of magnitude of a potential problem, the EPA cannot legitimately propose or promulgate science based rules for HF.

Generally there is a complete aversion to addressing concentrations of concern for chemicals and any acknowledgement about the impact that expected dilution will have on concentration effect. In other words, all "bad chemicals" and "feared constituents" have equal standing. There is little or no proposed investigation linking pathways for contamination and how these change with time.

In spite of its broad scope, the study almost fails to address subsurface context, which is essential to test many scientific ideas. Sometimes one wonders if EPA intends to appreciate Darcy's law and the difficulty of circulating fluids across 1000's of m of rock (or not).

c. What impact might this have on the effectiveness of the study as whole, and subsequently on its impact on improving the safety and risk management of hydraulic fracturing operations?

A2c. All of the responses in part "b" above will result in a significantly less effective study and handicap any interpretation that hopes to positively improve safety and risk management.

Q3. In your testimony you state that it would be helpful for EPA to collaborate with industry to identify and prioritize the chemical additives of greatest concern, based on regionally "specific information for different shale gas formations, analysis of their true presence in produced waters, and the actual risks to the public.

a. In your opinion, has the EPA made a significant effort to accomplish this goal—either in this specific study or in separate endeavors?

A3a. Following my testimony before this committee, Mr. Anastas suggested to me that EPA might like to explore such an opportunity. One month later, no one from EPA has suggested any follow-up. I remain hopeful that this only reflects other pressing priorities.

As Mr. Anastas explained to me, EPA lawyers limit his ability to communicate, even to a Congressional committee. So before this committee, EPA uses legal posturing to inhibit and frame scientific discussion. Industry sees this and concludes that EPA seems more mindful of positioning for consent decree negotiations than seeking scientific truth. I believe that many in industry would welcome an honestly brokered joint scientific effort to address the effective mitigation of risks associated with HF chemicals.

In the past week, Mr. Anastas publicly announced that EPA has released toxicology studies on some 500 chemicals. So applying the concept to HF chemicals would align with current EPA technical strengths.

b. Is this collaborative activity necessary to developing alternative additives?

A3b. It is not absolutely necessarily in the sense that industry is migrating in that direction on its own, albeit not with the clarity of purpose and confidence that a positive engagement from the EPA would provide. It scares me a bit that EPA might be afraid to engage because they are constrained by technical capacity to definitively impact the outcome in a scientific sense. In other words, in a scientific sense we may be all charting new ground, and EPA may not have the bench strength required to provide guidance.

c. Is collaboration fundamental to developing the best practices to protect the environment and the public, while ensuring the success and safety of unlocking vital energy resources through hydraulic fracturing?

A3c. Collaboration between industry, state regulators and EPA will be the most effective and credible way to develop the best practices for environmental protection. In many cases industry can develop and validate best practices for operations without any external input, however there are unusual distinctions in competencies in the case of chemicals and public protection. The industry is not an authority on the relative chemical risk to public health and bioaccumulation. EPA, with the support of other national institutes should be better equipped to provide scientifically sound input if it chooses to engage constructively instead of in an adversarial way. EPA needs to remember that science is not law and is not tested using legal constructs.

Q4. It seems many of the alleged environmental concerns associated with fracking—such as wastewater discharge—are not actually associated with the hydraulic fracking process and indeed exist at all oil and gas production, activities regardless of whether fracking occurs. Does EPA properly distinguish between these categories in-its study plan? How can this distinction be improved?

A4. Dealing with produced water discharge is an essential part of oil and gas production everywhere. All states have regulations regarding water standards for discharge, and most oil and gas producing states prefer for produced water to be re-injected unless it meets specific high quality standards by treatment. So to frame the concerns properly, EPA must identify where waste water disposal is an issue, and why, and then put the scientific information in context as opposed to making sweeping generalizations about exceptional cases.

EPA in its study proposal tends to emphasize disposal concerns that are particular to the Appalachian basin and the Marcellus due to the fact that subsurface disposal of water is not currently a viable option, especially in Pennsylvania. Straight re-injection is the safest technique. When re-injection is not possible, most industry operators consider it a best practice to clean-up and re-use produced waters in subsequent frac jobs effectively re-injecting it instead of disposing it on the surface. In the draft plan, EPA seems to ignore this option or exaggerate the risk of frac fluid re-injection without any scientific support. Pennsylvania recently asked operators to voluntarily recycle frac fluids in subsequent frac jobs.

EPA would benefit from recognition that fracing in an important technique in nearly every hydrocarbon producing basin and that the New York Times is not a good source for explanation of industry practice in a general sense.

Questions submitted by Representative Chip Cravaack

Q1. Hydraulic fracturing has been in use since the 1950s and according your testimony, over 1 million wells in the United States have been fracked. However, there have been very few incidents and according to Mrs. Jones, there are states' such as Texas that currently effectively regulate the practice. How we put the risks of hydraulic fracturing into perspective, when there are so many economic and societal benefits?

A1. HF like any significant industrial process is not without risk, and it is almost inevitable that some unfortunate accidents will occur. Acknowledging and managing risk is the only path forward. This also means separating hyperbole and false accusations from the facts.

I'm writing this on an airplane thinking that there are many risks associated with flying, but it seems many people readily accept those risks, and statistics show that driving is a greater risk. We as a nation need dependable, low cost clean energy delivered to our doorsteps and the opportunity to build our economy and create jobs cannot be ignored. We must learn to manage risk, and we certainly have the intellectual capacity and the organizational ability to manage risk effectively if we accept the challenge.

Q2. Many people are concerned about the waste water that is created as part of the fracturing process. Can you please describe the current technologies that are available to help recycle these fluids?

A2. Recycling waste water benefits from both low tech and high tech applications. It normally starts with some pretty simple gravitational separation process, and sometimes agents are added to precipitate suspended solids or neutralize pH. Pressure and temperature changes are leveraged to remove dissolved gasses especially natural gas. Some companies use advanced filtration or membrane separation techniques, and others use what are "flash" water distillation techniques. Much technical development is focused on high volume, high-energy efficient purification techniques at affordable costs.

As described in responses to Mr. Hall above, re-injection of frac fluids and produced water or "recycling" partially treated fluids in subsequent frac jobs seems like a very viable, low tech solution, where it is practical and possible.

Questions submitted by Representative Honorable Paul Tonko

Q1. 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?

A1. Industry first developed hydraulic fracturing techniques for hydrocarbon reservoirs in the late 1940's and the techniques have been constantly improving since then. The first HF applications in shales began in the early 1980's and gained momentum in the 1990's, and have consistently become both more effective and more economic every year. Certainly there has been considerable technological innovation. Aviation enthusiasts attribute the first flight to the Wright brothers, but modern aviation has come a long way since then. Extending the analogy to hydraulic frac-

turing of shales, the 1990's ended with a DC–3. Today we are doing jumbo jets and testing the Dreamliner for commercialization. Most people are a lot more comfortable with the safety record and performance of jumbo jets than the earlier models.

Q2. What is the industry doing to continue this technological evolution to cleaner technologies?

There is a lot of focus on alternative chemicals, clean-up and recycling water, and especially looking performance associated with using saline brine water instead of fresh water and re-injecting it into saline aquifers.

Some other promising areas include concentration of facilities onto single pads with longer offset horizontal wells to reduce surface footprint, the substitution of dry chemicals instead of liquid chemicals for delivery, and switching engines to use natural gas power instead of diesel that will reduce GHG emissions by 25%. The oil and gas industry has a long history of innovation and much intellectual energy is directed toward improving the process and minimizing the environmental impact of hydraulic fracturing.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Michael Economides, Professor of Chemical and Biomolecular Engineering, University of Houston

Questions submitted by Representative Ralph Hall

Q1. How useful is the current scope and breadth of the EPA study to State regulators and risk managers? What would be needed in order to make the study more worthwhile?

A1. I think the EPA study is flawed on its premise in the first place. It is a blind attempt to castigate fracturing in a thinly disguised anti-natural gas attempt. Certain environmental groups have tried to link this widespread oil and gas well completion technique with a variety of ills, the most insidious of them all that drinking water aquifers might be contaminated. Others include spreading radioactivity and, of course, attacking the very rationale for doing it in the first place. Shale gas, the target of the recently enormous enhancement in industry activity may not be what is cracked out to be.

Last year more than 35,000 wells were drilled in the United States and 120,000 hydraulic fracturing treatments were executed, more than three stages per well on average. Not one case of drinking water contamination was reported. Case closed one would think. The refrain is even more impressionable: Sixty years of fracturing, covering more than 1.2 million wells and the only "news story"—in the latest NYT piece is one from 1984 in West Virginia? Case closed again, one would reasonably think even further.

Q2. In your written testimony you note that EPA expects to draw conclusions in its final report from a single year of research. You also mention that in most funded projects you rarely see any that can even get started in a year's time.

a. In your opinion, what circumstances, influences or objectives lead the EPA to use only one year of research to inform their overall findings?

b. How does this time frame tangibly impact the value and applicabilty of the EPA study? What flaws, misrepresentations, or information gaps might be present as a result of such a time frame?

A2a and b. This is an amusing situation. On the one hand I think the whole study is an exercise in futility. If what they will do is just study 4 "suspect wells" then this may be sufficient time but this is precisely the problem that I see from a biased approach. One year is a very short period of time for any substantive research and evaluation of the literally hundreds to thousands of jobs that one should study to reach conclusions that are not biased. In my view in such case there will be an almost foregone verdict: The EPA quest is a non-issue. Fracturing is clearly safe.

Q3. In your testimony you note that the EPA studyspecifically excludes the State agencies' experiences in hydraulic fracturing oversight and research from the Study plan.

a. In your opinion what is the implication of this omission, what direction does it indicate for the EPA's focus and intended impact of the Study plan?

b. What lessons could have been learned or what valuable information could have been included with an incorporation of the State agencies' experiences into the EPA Study plan?

A3a and b. The States such as the state of Texas and Pennsylvania have had a lengthy and substantive experience for the regulation and smooth operation of hydraulic fracturing. EPA oversight would mean only an additional layer of bureaucracy without any benefit to the environment but certainly a yet another obstacle for the industry, based on a totally unproven premise and innuendo.

Q4. The movie Gasland *dramatically depicts scenes of alleged water contamination caused by hydraulic fracking.The movie was nominated for an Oscar, yet much of the substance and detail of the movie appears to have been discredited as false and misleading. What are some examples of the most common misconceptions or misleading information about hydraulic fracturing that are advanced in the media and by anti-energy activists?*

A4. (This from my work with Peter Glover, published in my *Energy Tribune*.) *Gasland* treads the same fear-inducing path of Al Gore's Oscar-winning *An Inconvenient Truth*. It presents a simplistically stark contrast between the pristine wilderness (where our intrepid self-proclaimed hippie film-maker lives) and the dark mutilated moonscape (where 'evil' Big Gas is slowly poisoning natural water resources). As with Gore's power-point 'epic'—later ripped apart in the factual stakes by a British high court judge—*Gasland* loses credibility from the start, as *Debunk-*

ing Gasland, a rebuttal report from Energy in Depth, on behalf of the nation's gas and oil producers, revealed last summer.

This review will follow an outline similar to *Debunking Gasland* which falls into a handful of key areas: mis-statements on the law, mis-representation of the rules, mis-characterization of the process and "flat-out making stuff up", including the recycling of discredited claims.

Within seconds of the film opening we glimpse (just glimpse) a shot of George W's 'evil' sidekick and former Halliburton CEO and Chairman—and thus an 'energy shill'—Dick Cheney. This movie technique sets us up for what's to come, when Fox informs us: "What I didn't know was that in 2005 the energy bill pushed through Congress by Dick Cheney exempts the oil and natural gas industries from the Clean Water Act, the Clean Air Act, the Safe Drinking Water Act (SDWA), the Superfund Law, and about a dozen other environmental and democratic regulations." Frightening. Or it would be, if the alleged "Halliburton Loophole" (in fact created by a cross-party alliance including the vote of one Barack Obama) were actually true. As an *Energy in Depth* factsheet points out, the oil and gas industry is regulated under every single one of these laws; in the case of the SDWA, being aggressively regulated at state level. But hey, this is Hollywood, right? "Print the legend" and all that...?

Gasland goes on to cite the passing of the 2005 energy bill as declaring a "wild west" open season for domestic gas drilling, not least in Fox's home state, Pennsylvania, on the Marcellus Shale. Fox fails to mention, however, that hydraulic fracturing has a 60 year history after Halliburton pioneered the process in 1949. Nor does he mention that the fracking process has been used in over 1.2 million treatments in 90 percent of *all* US gas (and many oil) extraction wells, conventional and unconventional, *without a single documented instance of the process leading to the pollution of a water aquifer.* Undaunted by facts, Fox goes on to assert that the law "authorizes oil and gas drillers to inject hazardous materials, unchecked, directly into or adjacent to underground water supplies." As *Debunking Gasland* states, "if such an outrageous thing were actually true, one assumes it wouldn't have taken five years and a purveyor of the avant-garde to bring it to light".

An hour in and Fox states: "the only reason we know about fracking chemicals is because of the work of Theo Colborn...by chasing down trucks..." Naughty, Josh. Even Fox's home state of Pennsylvania requires that, "Drilling companies must disclose the name of all chemicals to be stored and used at a drilling site..." In fact, the safety sheets for all chemicals used in fracking are a matter of public record, though the actual mix may remain a proprietary issue.

By now, the movie's hype is in full flow: "in order to frack ... you need some fracking fluid—a mix of over 596 chemicals". To underline the point the figure appears full screen. Now the unsuspecting could only conclude that Big Gas is indeed pouring massive cocktails of chemicals into the ground. In reality, over 99.5 percent of the fracking fluid is water and sand. The rest are largely components used around the house, including gums and emulsifiers. As the US Department of Energy/Ground Water Protection Council (GWPC) report states: "Although the hydraulic fracturing industry may have a number of compounds that can be used in a hydraulic fracturing fluid, any single fracturing job *would only use a few of the available additives*" (italics mine).

The film-maker goes on to make a raft of assertions not based in fact. At one point he claims that the "Pinedale Anticline and Jonah gas fields [of Wyoming] are directly in the path of the thousand year old migration corridor of pronghorn antelope, mule deer and sage grouse." As *Debunking Gasland's* investigations revealed, however, only three species of pronghorn antelope are on the endangered list, and none are anywhere near Pinedale Anticline. Equally, so large are the numbers of Wyoming's mule deer that the state now has an official mule deer hunting season.

An EPA investigation into water contamination "due to hydraulic fracturing in Alabama" in 2004 elicits "no recollection" at all from the Alabama State Oil and Gas Board official responsible for oversight of fracking in the state at the time. An allegation that shortly after Fox interviewed a Pennsylvania Department of Environmental Protection official, the department "suffered the worst budget cuts in its history, amounting to over 700 staff either being fired or having reduced hours" is shown to be blatantly untrue when a DEP press release is adduced revealing the DEP actually begun hiring "68 new personnel" in January 2010 specifically "to protect Pennsylvania's residents and environment from the impact of increased natural gas exploration across the state".

Next up, Fox presents us with a local resident from Dunkard Creek, Washington, Pa., who runs us through the unpleasant story of a 35-mile stretch of Creek full of dead fish in 2009. While Fox lays the blame at the feet of local natural gas development, nobody seems to have informed him that a pre-*Gasland* EPA report con-

cluded the water pollution was attributable to a build up of toxic "algal bloom" the result of discharges from coal mines. Even the local newspaper chipped in to describe this *Gasland* gaffe as a "glaring error"

Can You Light Your Water on Fire?

Finally, and most iconic of all, there's the much-vaunted and disturbing image of flammable running water from faucets. *Gasland's* publicity posters and DVD cover asks: "Can You Light Your Water on Fire?" Well yes, apparently *many* can—but sadly for *Gasland*, for reasons *au naturelle*. Fox highlights the instance of a flammable faucet in Fort Lupton, Colorado pinning the blame on gas development. The Colorado Oil and Gas Conservation Commission however disagree, maintaining, "Dissolved methane in well water appears to be biogenic [natural occurring] in origin" and they found "no indications of oil and gas related impacts to the water well."

And it's not just the various EPA departments, including Fox's own, whose studies have found hydraulic fracking to be a safe process. In September 2010, STRONGER (State review of Oil and Natural Gas Environmental Regulations), an independent panel of national environmental, industry and EPA experts, not only pronounced Pennsylvania's fracking process "safe in respect" to shale gas development, it went on to claim the state's regulation process "merits special recognition".

While some contaminated groundwater has been found in the proximity of fracked wells and where wells have not been properly completed, it is hard to detract from the success of an industry and procedure that offers an enormous boost to the economy, provides real jobs, and keeps domestic gas prices low, creates real jobs and drives the economy. These are aspects of public service provision that seem entirely alien to some backwoods-living, self-proclaimed, finger-picking hippies, however.

Fox once told New York's *Time Out*, "Art is more important than politics. Politics is people lying to you and simplifying everything: art is about contradictions". By Fox's own subjective understanding, being entirely bereft of "contradictions" (or nuance), *Gasland* qualifies as 'politics'.

Made by 'Docurama Films' the logo on the DVD states: "Everything else is pure fiction". Removing the "else" and changing to "pure Hollywood" would be more on the money.

Q5. It seems many of the alleged environmental concerns associated with fracking—such as wastewater discharge—are not actually associated with the hydraulic fracking process and indeed exist at all oil and gas production activities regardless of whether fracking occurs. Does EPA properly distinguish between these categories in its study plan?

A5. The anti-fracking crusaders, have never bothered to distinguish or explain, that leaking from the very rare, badly cemented or cased well, even if the well was fractured (almost all are) does not make fracking the culprit. There is no physics to support connectivity between the induced fracture, done thousands of feet underground, that would contaminate drinking water aquifers, found at a few hundred feet depth. An occasional "scientist" may be enlisted to offer a fanciful connecting theory whose possibility is just south of being hit by lightning. Communicating through the well itself, undesirable as it may be, has nothing to do with fracking.

Question submitted by Representative Chip Cravaak

Q1. Hydraulic fracturing has been in use since the 1950s and according to Dr. Cooper's testimony, over 1 million wells in the United States have been fracked. However, there have been very full incidents and according to Mrs. Jones, there are states such as Texas that currently effectively regulate the practice. How do we put the risks of hydraulic fracturing into perspective, when there are so many economic and societal benefits?

A1. Mr. Cravaack. This is a self-explanatory issue in my view. Much of the opposition is a made up issue. Please see my answers above to Mr. Hall's questions.

Question submitted by Representative Eddie Bernice Johnson

Q1. Dr. Economides, during the hearing you were asked by Ms. Wilson (D-FL) to discuss how natural gas wells are monitored, You stated that the industry is "computer monitored in everything we do." Please describe in detail what kinds of technologies are used to monitor gas wells, what properties are monitored at each well, and how these technologies could be improved through additional research. Additionally, please discuss what best practices could be shared with other states for monitoring gas wells.

A1. The industry monitors wells with electronic devices, measuring rates, fraction of water, gas, pressure and other variables. Often large, SCADA based systems

monitor production and any irregularities, trigger alarms or cautions. The degree of sophistication ranges from manual recording (becoming rare) to satellite transmission to centralized control and monitoring centers. These systems are constantly improved and it is an active area of research by both the production and service indsutries.

Questions submitted by Representative Paul Tonko

Q1. For the record, it is my understanding that the practice of hydraulic fracturing includes fracturiing 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?

A1. Some shale gas has been produced for 60 years but the process has accelerated in the last ten and at a far faster pace the last five years. Fracturing of all other types of reservoirs (oil, tight gas, coal-bed methane) has been going on for 60 years.

Q2. What is the industry doing to coontinue this technological evolution to cleaner technologies?

A2. I am not sure I understand this question. Do you mean to energy other than natural gas? You would be hard-pressed to find anything cleaner than natural gas.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Paul Anastas, Administrator, Office of Research and Development, U.S. Environmental Protection Agency

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."?

Answer: 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 (USDW). 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.

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.

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?

Answer: (a-b) It would be correct to say that some, not all, coalbed methane formations can be located either near or within potential USDWs. The 2004 study focused on coalbed methane

formations that were either in or close to USDWs, but did include information pertaining to basins where the coalbed methane formations were not USDWs. This was largely a paper study relying on secondary 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. This information was collected through stakeholder outreach conducted as part of EPA's draft study plan. The draft study plan case studies will provide independent analysis of the issues identified by stakeholders. A variety of geological settings will be evaluated, with an emphasis on shale. While the shale target zone can be several thousand feet below the surface, there may be other pathways of potential exposure to drinking water resources beside movement from the hydraulically fractured zone to overlying underground sources of drinking water, such as other nearby wells, fractures or faults. This study will evaluate existing data as well as collect new data from actual sites across the country, and will cover the entire water cycle in the hydraulic fracturing process.

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?

Answer: (a-c) It is commonly accepted that improper well drilling and cementing practices can be a pathway for contamination to underground sources of drinking water. One site (Dimock, PA) where this was reported by the Pennsylvania Department of Environmental Protection is included as a case study in the draft study plan. 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, have 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?

Answer: (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 and the Bureau of Land Management; 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 experience. 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?

Answer: 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.

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. The seven sites selected best met the criteria for selection and represent a wide range of conditions and impacts that may result from hydraulic fracturing activities. These criteria included proximity of population and drinking water supplies, evidence of impaired water quality (retrospective only), health and environmental concerns (retrospective only), and knowledge gaps that could be filled by the case study. Sites were prioritized based on geographic and geologic diversity, population at risk, site status (planned, active or completed), unique geological or hydrological features, characteristics of water resources, and land use.

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 Benishek.

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?

Answer:
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?

Answer:
a. Yes, EPA's Office of Research and Development (ORD) is responsible for final decisions associated with the study design, implementation, and reporting of results.

b. Over 30 people in ORD 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 strives to present information on the web site in a way that best meets the public's needs. Therefore, ORD posted material on the existing established website rather than forcing the public to seek the information on a page run by a different 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?

Answer: 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.

Answer: In the draft study plan, EPA refers to data from a variety of sources to highlight the potential impacts to drinking water resources from hydraulic fracturing. However, the research identified in both the draft and final plans makes no assumptions about the presence of impacts from hydraulic fracturing. The research approach outlined in the study plan uses multiple sources of data – including peer reviewed literature, assessment of data and information from industry and states, case studies, laboratory work, and computer modeling – to provide a thorough, unbiased assessment of the potential impacts of hydraulic fracturing on drinking water resources. EPA will collect data from prospective and retrospective case studies to determine potential impacts at specific locations where hydraulic fracturing occurs. Additionally, EPA will analyze well files from randomly selected oil and gas production wells that have been hydraulically fractured between 2009 and 2010. Together, these data will provide us with information on potential impacts to drinking water resources under current industry practices.

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. Furthermore, EPA will ensure that the data used in this study are not biased by following the Agency's quality assurance (QA) guidelines (please see part c of this question for more detail on the QA process). Finally, to ensure an unbiased study, the results will undergo several thorough peer review processes, including an internal Agency review, a QA review, and an external peer review by the Science Advisory Board.

   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?

Answer: Yes, EPA will ensure that the data used in this study are not biased by following the Agency's QA guidelines. This study will be conducted following the Agency's most graded approach for the application of QA requirements to research projects according to the intended use of the results and the degree of confidence needed in the quality of the results. By implementing the study at the highest category, QA Category I, a rigorous QA approach is

applied. This includes technical systems audits (both field and laboratory audits), performance evaluations of measurement systems, audits of data quality and data quality assessments. The study will have its own defined quality system, which will be documented in a Quality Management Plan that presents the various roles and responsibilities of the study participants, as well as the various processes to be implemented. Laboratories used to analyze samples for critical analytes must have demonstrated competency through appropriate accreditation or other means approved by the EPA. Each EPA-funded research project will have an associated Quality Assurance Project Plan (QAPP) which has been QA reviewed and approved prior to start of data collection. The QAPP will outline the criteria used to determine the quality of data collected or generated for the research project and will also address uncertainties associated with the data. This will ensure that all data used in EPA-funded research projects will be of the quality appropriate for the study.

All reports produced from EPA-funded research projects will include a readily identifiable QA section in which audit findings, data sources, data quality assessments, and uncertainties 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?

Answer: 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, and 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 QA review, and an external peer review by the Science Advisory Board. The QA section described in 9b will be included in these reports to ensure the quality of the data.

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

Answer: The study will be conducted following the Agency's most rigorous QA 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?

Answer: 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 QA 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?

Answer: 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?

Answer: (a-e) 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 and surface waters. Our study looks at drinking water resources as they are currently defined by the EPA.

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?

Answer:
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/MCLGs as a primary measure when available, along with health advisories, and Provisional Peer Reviewed Toxicity Values (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. 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.]. 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.

e. EPA will not 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 draft 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 draft 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 draft study plan.

12. As you know, the Department of Energy filed comments with EPA that were clearly critical of the draft plan. Specifically, DOE said EPA's scope may not objectively characterize risk: "Given that the retrospective case study methodology will selectively focus on cases for which there have been negative outcomes reported, there is concern that the study may not adequately represent the overall risk presented by hydraulic fracturing," the comments say.

    a. Do you agree with DOE that it is important to objectively assess the overall risks of hydraulic fracturing?
    b. If EPA attempts to take regulatory action in the future, do you agree that such a risk assessment of hydraulic fracturing is a necessary pre-requisite?
    c. If so, would you characterize this study as fulfilling that requirement?

Answer:
a. We agree that understanding the risks associated with hydraulic fracturing is important to inform decision making. To that end, the research described in the EPA study plan involves the collection and analysis of multiple sources of data that will provide decision makers with a thorough, unbiased assessment of the potential impacts of hydraulic fracturing. The retrospective case studies referred to in your question represent only one of several research approaches that will be used by EPA for this purpose.

b. 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 appropriate, and promoting consistency in environmental protection across the country. Understanding the factors that may contribute to potential risks is a necessary pre-requisite to any regulatory action that may be taken by the Agency in the future.

c. EPA was charged with a specific task by Congress – to study the relationship between hydraulic fracturing and drinking water resources. The study is designed to address the specific direction from Congress, and EPA believes that it will.

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?

Answer:

1. 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 to aid in the implementation of current regulations.

   EPA will continue to use its legal authorities to address any threats to human health and the environment that may be 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.

   In some cases, the state regulatory framework was 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 in light 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 underground sources of drinking water 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 examine 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.

Answer: EPA believes the Hydraulic Fracturing Study Plan Review Panel possesses the appropriate depth and breadth of technical experience needed for a sound scientific review of the study plan. Biographies of all members of the Hydraulic Fracturing Study Plan Review Panel are provided below. The attached CVs for the following seven panel members in particular highlight the panel's specific technical experience related to hydraulic fracturing.

- Dr. Thomas P. Ballestero, University of New Hampshire (NH)
- Dr. David B. Burnett, Texas A&M University (TX)
- Dr. Thomas L. Davis, Colorado School of Mines (CO)

- Dr. Shari Dunn-Norman, Missouri University of Science and Technology (MO)
- Dr. Geoffrey D. Thyne, University of Wyoming (WY)
- Dr. Jeanne M. VanBriesen, Carnegie Mellon University (PA)
- Dr. Radisav D. Vidic, University of Pittsburgh (PA)

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 33 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?

Answer:

1. 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 and with the receptor. 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. [References: Pennsylvania Department of Environmental Protection's finding of contamination of the Kemble water supply; Bainbridge Township, OH. (See attached reports)]

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?

Answer: 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://epa.gov/airquality/oilandgas/actions.html. 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. When developing the proposed rulemaking, EPA relied on information generated in partnership with industry through the Natural Gas STAR program (http://www.epa.gov/gasstar/). Through the Natural Gas STAR program, EPA and partner companies have identified technologies and practices that can cost-effectively reduce methane emissions from the oil and natural gas sector in the U.S. and abroad.

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?

Answer:

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. Current hydraulic fracturing also involves large volumes of water and increased pressures used for injection. 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" 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?

Answer: 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 are considered proprietary information, EPA is not legally able to view the information in order to verify it.

Appendix I

Additional Material for the Record

ADDITIONAL MATERIAL FOR THE RECORD

Report Submitted by Dr. Michael J. Economides, Professor of Chemical and Biomolecular Engineering, University of Houston

Hydraulic Fracturing – the State of the Art

(And the Market and the Technology and the Environment)

Michael J. Economides

University of Houston

Introduction

Arguably, one of the most important well completion technologies in the entire oil and gas history is the use of hydraulic fracturing for well performance enhancement. Fundamentally, the process is used to make oil and gas wells produce oil and gas faster. It does not create hydrocarbons or increase formation permeability – it simply makes wells produce existing reserves more quickly. In almost all cases in North America and many other parts of the world with long history of oil and gas production, hydraulic fracturing means the difference between an economic and a sub-economic well. For gas wells I particular it is certain that "no frac- no gas."

It took many years for the industry to realize that, by pumping hydraulic pressure into a subsurface hydrocarbon filled rock, one could create a crack that would make it much easier for oil, or gas, to flow out of the rock. Today virtually all wells require this process to produce commercial quantities of gas (or oil). It has taken the industry the last 20 years to figure out that horizontal wellbores combined with hydraulic fracturing are the key to producing commercial quantities of natural gas from shale formations.

This realization, combined with advancements in the ability to pump multiple fracture treatments in tight rock and shale formations has led to a huge boom in gas production. Shale and tight gas now account for over 2/3 of the daily gas produced in the United States, and this has led to 87% of US natural gas supply to be produced domestically. It is important to realize that this gas production wouldn't be possible without hydraulic fracturing. Many other countries, prominent among which are China, Australia and, in Europe, Poland and several other Eastern European nations are on the verge of massive new developments in which hydraulic fracturing will be an essential element.

If we assume that it costs about the same amount of money to drill a well of similar deviation, architecture, size and location, regardless of hydrocarbon type, pay thickness or reservoir permeability, then we can also safely assume that the well will need to have similar productivity (in terms of revenue per day) in order to be economic, regardless of fluid type or reservoir permeability. This creates a problem, as it is obviously much easier to get an economic well in a 100 millidarcy, md oil reservoir than it is in a 0.01 md gas reservoir.

So let's stimulate the 0.01 md gas reservoir and make it produce the gas faster. This can be easily done and indeed this type of situation was the very backbone of the fracturing industry until quite recently. How productive this type of well can be comes down to reservoir contact, or to put it another way, inflow area. This is the area of contact between the wellbore and the reservoir, through which the hydrocarbons flow into the wellbore. Quite obviously, the larger the inflow area, the greater the productivity – larger diameter wellbores produce more than smaller diameter wellbores, for instance.

One way of increasing reservoir contact is to drill horizontal wellbore rather than vertical. Another way is to drill multilaterals. Yet another way is to create a hydraulic fracture. The relative inflow areas of common wellbore configurations are given in Table 1. As one can see from this table, even some quite complex wellbore configurations still only have a fraction of the inflow area of a very small hydraulic fracture.

Configuration	Inflow area ft²
Vertical, cased, 8 ½" diameter, perforated with 2 spf, 8" penetration, 100 ft net height	111
Vertical, open hole, 8 ½" diameter, 100 ft net height	223
2000 ft horizontal openhole wellbore, 8 ½" diameter	4,450
6 x 500 ft 6 ¼" openhole multilaterals	4,909
50 ft half-length radial hydraulic fracture	15,708

Table 1: Surface area for different well geometries

For a given hydrocarbon production rate, there is an approximate inverse relationship between permeability and inflow area – as the permeability goes down by an order of magnitude, so the inflow area has to increase by an order of magnitude. Consequently, there is a progression to larger and larger fractures as permeability decreases:-

- For high permeability conventional gas (above 1 md), economic wells can be made (in most circumstances) without having to fracture. However, this does not mean that fracturing is not beneficial – it can turn a *good* well into a *great* well – but it is not essential.
- For low permeability conventional gas and "good" tight gas (0.01 to 1 md), a well can be made economic with a relatively small and cheap hydraulic fracture.
- As the formations get really tight (0.1 μd to 0.01 md), very large hydraulic fractures have to be placed, often with two or more on a wellbore, if the net pay is sufficient. At the lower end of this range, it may be necessary to drill horizontal wellbores in order to place several fractures in the net pay.
- As the permeability decreases even further, into the range of shale gas formations (1 to 100 nd), even placing multiple fractures along a horizontal wellbore becomes insufficient. In these cases, the only way to get sufficient inflow area is to deliberately target extensive areas of natural fractures, into which the hydraulic fracture can propagate and also to place anywhere up to 40 of these treatments along a horizontal wellbore.
- This relationship between permeability and fracturing strategy is also true for oil, except that the permeability ranges are two orders of magnitude greater.

The issue of inflow area or reservoir contact is the fundamental reason why fracturing has become the only viable completion method in tight gas, shale gas and shale oil formations. It is also the reason why as the industry has moved from conventional to unconventional and on to shale, "frac jobs" have become bigger, more complex and more common. Indeed, probably more than 75% of North America's gas industry only exists because of the success of hydraulic fracturing.

The massive growth of the hydraulic fracturing industry, especially in the USA and Canada, is illustrated in Figures 1 and 2.

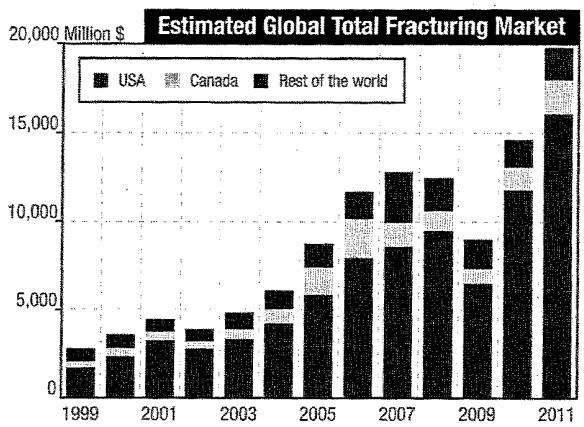


Figure 1: Global market size for hydraulic fracturing in oil and gas fields

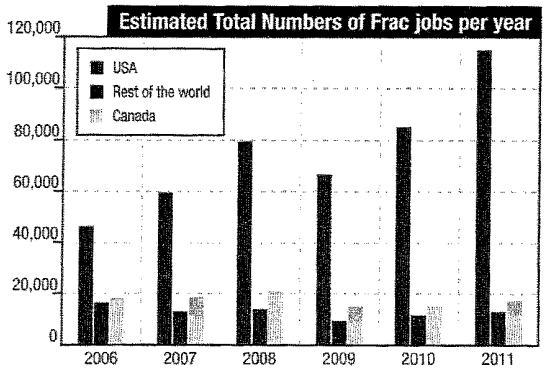


Figure 2: Number of fracturing treatments per year

Recent Trends in Fracturing Activity

North America - Land

The downturn in the global oil and gas industry that started in late 2008 and went through all of 2009 has now completely worked its way through the system, as illustrated in Figures 1 and 2. Activity is once

again threatening record levels and once again independent operators are being forced to wait several months for hydraulic fracture treatments. Pricing has also increased, as illustrated in Figure 3. In early 2008 the average price of a frac job was between $110k and $120k. In mid-2009, this dipped to as low as $80k, but is expected to be as high as $150k by the end of the year. However, this measure of the buoyancy of the market is a somewhat blunt instrument, as treatments have changed significant since 2008.

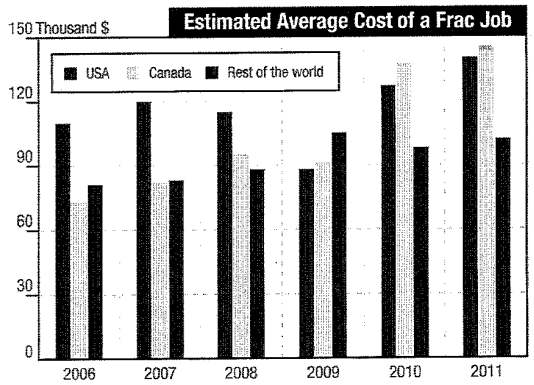


Figure 3: Average cost per fracturing treatment

Up until 2008, the boom in the fracturing industry was driven by the gas price and the development of techniques that allowed the economic exploitation of shale gas reservoirs. However, the gas price has remained fairly stagnant since 2009 and the current boom is driven by the steady rise in the price of oil. Consequently the major boom areas are no longer the Barnett shale and the tight gas fields of the Rocky Mountains. This time, the boom areas are conventional oil plays like the Permian basin, oil shales like the Bakken and liquids-rich gas shales such as the Eagle Ford and the Granite Wash. As a result, the drilling and service sectors have moved considerable resources towards these areas and away from the boom areas of as little as 4 years ago.

The market is once again capacity limited, and although the service companies are adding capacity as fast as they are able, this is tempered by the knowledge that a sudden collapse in oil price could leave them high and dry with enormous CAPEX exposures. Although estimates vary, there is around 12,000,000 HHP currently in the North American market, up around 25% from last year and about 6 times the total available in 2004. Approximately 50% of this belongs to the three big fracturing service providers (Halliburton, Schlumberger and Baker Hughes), another 20% to the next three "up-and-coming" independent service providers (Frac Tech, Trican and Weatherford) with the remaining 30% split amongst a couple of dozen minor companies. For a while it looked as if the 2009 downturn would drive a number of the independent service providers under, but the rise in oil-related activity came just in time to turn things around. The global market share trend over the last few years (which is heavily dominated by North America) is illustrated in Figure 4.

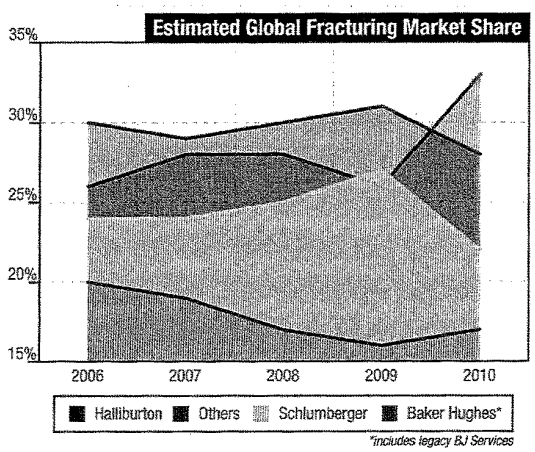


Figure 4: Market share in hydraulic fracturing

The trend in market share that saw the independents gaining at the expense of the big three fracturing companies throughout 2006, 2007 and 2008 has largely been halted, as the commodity-style fracturing of the shallower shales such as the Barnett has been replaced by the more technology-intensive, deeper and hotter liquids-rich gas shales and also the Bakken oil shale.

Whilst under-capacity in the market is good for the service providers, it is bad for the operating companies as they have increasing numbers of wells waiting to be fractured. This time, however, it is not just the availability of fracturing equipment that is holding back the industry:-

- **Proppant**. The granular material used to keep the hydraulic fractures propped open is in very short supply. Although the majority of treatments are still performed using specially-selected natural sand, an increasing proportion of treatments are performed using the much stronger – but also much more expensive – artificial proppants. This is necessary as formations such as the Hainesville, Eagle Ford and Granite Wash are considerably deeper than the standard-setting Barnett shale, requiring correspondingly stronger formations. Sales of frac sand and resin-coated frac sand have risen threefold since 2006, whilst sales of artificial proppants have doubled. Currently, the industry faces severe shortages of all these products and the ability to fracture a well is as often determined by availability of proppant as it is by availability of equipment
- **Guar polymer**. A shortage of guar polymer is a new phenomenon. The polymer is widely used as a viscosifying agent for the fluids used frac treatments and has the advantages of being cheap, easy to use and environmentally-friendly. It extracted from the guar bean, the vast majority of which are grown in India. With supply unable to keep pace with demand – and a supply sector unused to responding to the rapid swings in demand associated with the North American oil and gas industry – many service providers are developing artificial alternatives. However, it is unlikely

that these will be as cheap as guar and making them as environmentally-friendly will be a major challenge.

North America – Offshore

In the Gulf of Mexico, activity continues to be affected by the Macondo incident. Before this event, the three major fracturing service providers maintained 9 fracturing vessels in this market. Since Macondo, whilst Superior have entered this market with two vessels acquired as part of the Department of Justice's conditions for the Baker Hughes acquisition of BJ Services, two of the older vessels have been decommissioned and Schlumberger have withdrawn both of their vessels and placed them elsewhere around the world. This leaves a total of only six vessels. Whilst the shallow water sector of the market has begun to see an increase in activity, the far more lucrative deep water market is still largely shut down.

Nevertheless, the offshore segment remains relatively small. Globally, the offshore fracturing market accounts for about 5% of total activity, with the Gulf of Mexico accounting for about 20% of that, The other big offshore fracturing markets being Brazil, Mexico, the North Sea, West Africa and the Arabian Gulf.

The Rest of the World

Outside of North America, the fracturing industry continues much as has over the last few years. The sector of the industry has always accounted for around 10% of global activity and has always been far more influenced by oil prices than by gas prices, as illustrated by the relative proportions of oil and gas formations treated given in Figure 5.

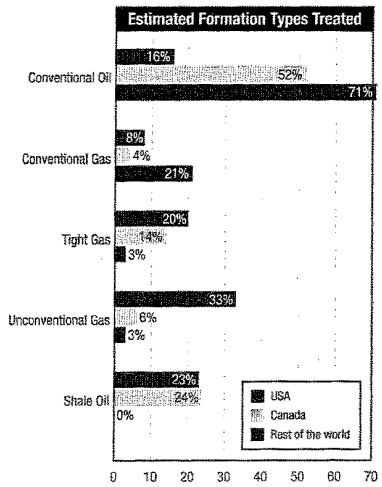


Figure 5: Formation treated with hydraulic fracturing in different regions

International fracturing activity continues to be heavily dominated by oil well stimulation for two main reasons. First, the world's third largest fracturing market is Russia, which accounts for about one-third of non-North American activity. This market is almost exclusively oil and this is reflected in the overall numbers contained in Figure 5. Second, outside of North America, natural gas is still very abundant and easy to extract. While there may be considerable technical advantages to fracturing these high permeability formations, there is no economic necessity to do so. This, combined with the ever-increasing mobility of gas from places such as Qatar, Algeria, Russia, Saudi Arabia, Norway, Australia, Indonesia and Nigeria due to the world expanding LNG carrier fleet, means that there has been little need to extract gas from tight and shale gas reservoirs.

While there has been considerable speculation on the advent of shale gas exploitation in places like North Africa, Eastern Europe, China and Argentina, so far words have failed to translate into action.

However, one sector of the market that is increasing and is expected to increase is fracturing of carbonate formations, especially offshore in areas such as the North Sea (Central Graben), Mexico (Bay of Campeche), Brazil (pre-salt formations in the Espirito Santos basin) and the Arabian Gulf.

The Environmentalist Onslaught

Despite the fact that the US Environmental Protection Agency, EPA having conducted several historical reviews of hydraulic fracturing, and clearing the process as recently as 2004, cap-and-trade proponents in Congress directed a new study in 2010. However, this time the internet tools of Facebook, privately funded documentaries such as *Gasland*, and the national media have fueled a frenzy of anti-fracturing sentiment previously unknown. There has been a concerted effort, including articles in the NYTimes to associate "fracking" with a variety of ills, the most insidious of them all that drinking water aquifers might be contaminated. Others include spreading radioactivity and, of course, attacking the very rationale for doing it in the first place. Shale gas, the target of the recently enormous enhancement in industry activity may not be what is cracked out to be.

The latter is easy to dispel. There has never been an energy resource that escalated its market share from essentially zero to 25 percent in just five years. This is what shale gas has done in the United States natural gas supply. Outside of North America, the regulatory authorities have reacted to media speculation with widely differing courses of action. Almost simultaneously, whilst the UK Government endorsed hydraulic fracturing, the French Government made it illegal.

A composite schematic of fracture treatments mapped by Pinnacle in the Marcellus Shale (Figure 6) shows the fracture heights and the depth of groundwater aquifers. Each stage of fracture treatment is plotted with the red line representing the mid depth where the fractures originate. The shallowest point and deepest points are plotted. At the top, the blue is a plot of the deepest groundwater. As can be seen readily, the fracture treatments are well confined heights, at least a mile below the deepest groundwater. The chance of propagating a fracture upward into groundwater is nil.

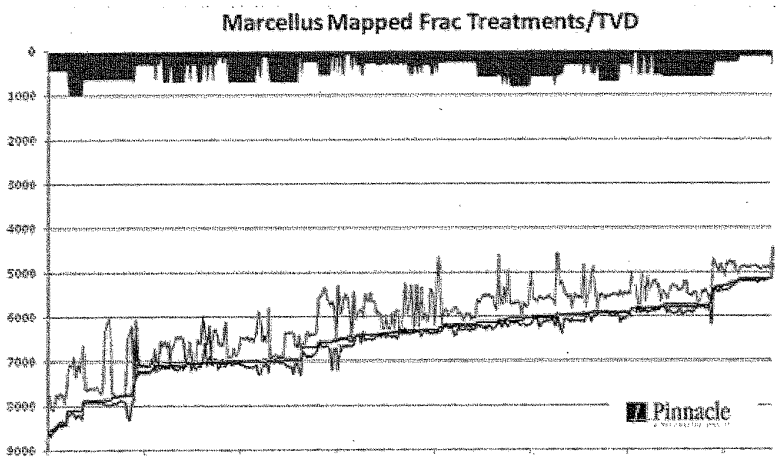


Figure 6: Fracture height and groundwater aquifers, mapped in the Marcellus shale region

Ultimately, the frenzy of arguments over hydraulic fracturing distill to this single fact: Either the world wishes to utilize its natural gas resources, or it doesn't. For development of shale or tight gas goes hand-in-hand with hydraulic fracturing. Saying "no' to hydraulic fracturing really means you are saying "no" to natural gas production.

For further study on hydraulic fracturing and, especially all its technical nuances the following textbooks are recommended:

Economides, M. J. and Martin, T.: *Modern Fracturing, Enhancing Natural Gas Production,* (hardbound) Energy Tribune Publishing, Houston, 2007

Economides, M. J., Oligney, R.E. and Valkó, P.P.: *Unified Fracture Design,* (hardbound) Orsa Press, Houston, May 2002.

Russian Edition, Biblioteka, Moscow, 2007

Economides, M.J. and **Nolte, K.G.:** *Reservoir Stimulation, Third Edition,* 750 p. (hardbound) Wiley, NY and Chichester, March 2000

Chinese Edition, Petroleum Industry Press, Beijing, 2002

○