

The Public Health Implications of Unconventional Gas Drilling

**For presentation to the
Energy and Environment Subcommittee,
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My name is Bernard Goldstein. I am a physician, board certified in Internal Medicine and in the subspecialty of Hematology. I am also board certified in Toxicology. My background includes appointment by President Ronald Reagan as Assistant Administrator for Research and Development of the US Environmental Protection Agency. I am an elected member of the American Society for Clinical Investigation and of the National Academies of Sciences Institute of Medicine for whom I have been a member or chair of over twenty committees involved with environmental health. Since serving in the US Public Health Service Division of Air Pollution over 40 years ago, I have written more than 200 papers or chapters on environmental health issues, including in the past year an invited review in the New England Journal of Medicine of the health implications of the Gulf Oil Spill. My current position is professor emeritus of environmental and occupational health and dean emeritus of the University of Pittsburgh Graduate School of Public Health. Our school was founded in 1948 with a commitment to be responsive to environmental pollution issues for which Pittsburgh was then infamous, and we maintain this commitment in addressing the threats posed by the very rapid development of unconventional gas drilling in our state. My testimony, of course, represents my own views and are not necessarily those of the University of Pittsburgh. I will speak to the issue of the public health impact of unconventional natural gas drilling.

My testimony today is largely based upon my experience as a physician, as a toxicologist, and as a government official who has worked in the field of environmental health for over 40 years. But, I must stress that it is also based upon personal discussion with community groups and individuals who are very concerned that their or their family's health has been or will be affected; and with physicians who are puzzled about the appropriate answer to the questions their patients are asking.

My overall theme is that it is in the nation's and in industry's best interests to maximize the yield of natural gas while minimizing the short-term and long-term environmental and public health costs, and that to do so we must seriously address the possibility of adverse public health impacts. I believe that that we are ignoring many of the lessons about how to approach potential environmental health issues that we have so painfully learned over the past forty years.

My three major points are that:

- 1) the public is concerned about the potential health impacts of unconventional shale gas development;
- 2) there is genuine cause for this concern, and

3) the current lack of almost any support for research directly related to the health effects of unconventional gas drilling is shortsighted and counterproductive.

Before presenting these three points in more detail, I believe it important that the context of this concern be addressed.

The public is confused, and in some cases rightfully angry, concerning the conflicting information they are receiving about two important aspects of unconventional shale gas drilling. The nation is hearing from industry, and from the government, that exciting new technology permits obtaining gas from deep underground shale formations; but we are also told that this has been done for decades so there is nothing to worry about. It can't be both. It is true that hydrofracking is a decades-old technology, but where previously perhaps 50,000 gallons of water was used in a relatively shallow vertical well, current technology uses 5 million or more gallons of water, goes much deeper and turns horizontally underground. Implying that they are the same is like saying that a two-ton bomb represents no greater risk than a hand grenade because they both are explosives. Further, although there is far too much secrecy about the issue, it appears that there have been substantial changes over the years in the components of the fracking mixtures which makes it very difficult to predict present outcomes from past experience

A second contradictory issue concerns the subject of what is meant by hydrofracking. This committee is considering the controversial evidence from Pavilion, Wyoming concerning whether fracking chemicals released deep underground ever make their way to groundwater wells. To the public, however, hydrofracking is a general term that encompasses what the public is truly interested in – which is any problems beginning with the time the land is leveled for a drill pad, until decades from now when the land, hopefully, is restored. Public concern includes what happens to the flowback water, the impact of the trucks and the often noisy compressors, public safety and all of the other potential problems caused by unconventional gas drilling activity. To the public, reading about residents losing use of their wells, or drilling companies being fined for groundwater contamination, a focus that is solely on the issue presented by the Pavilion study seems like a subterfuge designed to avoid answering their questions about the overall impact of unconventional shale gas drilling on their environment and on their health.

Evidence that the public is concerned about the human health impacts of unconventional gas drilling is easy to obtain. Our own study of those who testified against drilling to the Natural Gas Subcommittee of the Secretary of Energy's Scientific Advisory Board shows that about two-thirds cited health concerns. Contributing to this concern is the level of secrecy about the specific chemicals being used. In the Gulf of Mexico, the secret ingredient in the dispersant, whose secrecy contributed to the stress experienced by Gulf residents, turns out to have been a commonly used over-the-counter stool softener of no toxicological significance – at least to humans.

Are public health concerns legitimate? Certainly. Let me begin with toxicology. There are many agents of toxicological concern in the fracking mixture, and many other agents about which we know too little. It is very hard to find a health complaint that has not been associated in the literature with at least one of these compounds. Let me at this point respectfully comment on the issue of waiting for an index case

to appear. The index case is a very valuable concept in medicine, particularly in infectious diseases – but in my experience is of very little value in environmental medicine. In a cholera outbreak, the original person with diarrheal disease from whose body fluids we identify *Cholera vibrio*, the bacterial cause of cholera, is truly an index case; and in retrospect we can identify the flight attendant who was the index case for HIV/AIDS in the United States. But the chemicals on the fracking list are those that can be expected to add to the burden of existing diseases or symptoms. They might cause leukemia or asthma, headaches or rashes, all of which have a background incidence. Let's imagine a community whose childhood asthma rate increases by 20% due to an environmental cause. None of us would want that to happen in our community, but, statistically, 5 out of 6 of the children would have had an asthma attack without the new environmental cause. There would be no index case as such, and we might not even notice unless a thorough study was done of the asthma incidence in relation to the environmental exposure. As far as I can tell, there is no study underway which thoroughly explores exposures and outcomes related to unconventional shale gas drilling activities - no study which takes advantage of the valuable advances in environmental health sciences which this committee has overseen.

The index case approach can be useful in environmental medicine when there are truly unusual outcomes, such as mesothelioma due to asbestos, or blue babies due to high levels of nitrite in groundwater. It is possible that unconventional gas drilling will cause index cases of unusual diseases over time given how little we know about the health implications of the fracking mixtures.

Two types of mixtures associated with unconventional gas development are of concern. The first is the mixture of fracking compounds themselves. Twelve different goals for these agents are shown. The website of the Interstate Oil and Gas Compact Commission states that there are dozens to hundreds of compounds that can be used in fracking. An even more worrisome mixture of agents is present in the flowback fluids which contain not only fracking compounds, but hydrocarbons associated with the natural gas plus dissolved minerals, brine constituents, and naturally occurring radioactive materials. (And the eventual disposal of these ever larger volumes of flowback water is still unclear). As a physician and a toxicologist, I am least worried about mixtures whose composition is reasonably predictable and whose effects have been well studied – just think of gasoline, or of coffee. Major advances in the toxicological understanding of mixtures in the past resulted from studies by NIEHS, ATSDR and EPA, that were funded due to public concern about mixtures of hazardous wastes at Superfund sites - and the number of hydraulic fracturing sites is now beginning to rival the number of Superfund sites. I urge congress to update these mixture studies by providing funding to apply modern toxicological advances to the chemical mixtures that are being used in, or result from, hydraulic fracturing.

There are many other health issues - too many to discuss in a brief time. There are legitimate concerns about air pollution levels, particularly during the intense fracking period when neighbors often perceive noxious odors. Ozone formation occurring many miles downwind is a possibility. The aggregate releases of ozone precursors from multiple wells may tip areas into non-attainment with the ozone standard - which is particularly ironic as the federally-required response to non-attainment may include limiting the industrial development that is perceived to be the benefit of shale gas drilling.

An additional reason for public concern is the mixed performance of industries engaged in unconventional natural gas drilling. The next slide in my handout is taken from the fractracker web site (www.fractracker.org). It shows the distribution of Pennsylvania Department of Environmental Protection violations for companies that have at least ten well starts. The names of the companies are on the web site. I have left them out of this presentation so as not to lose sight of the important issue – which is the wide range of performance of the different companies. To protect the public we need to better understand what factors are driving this wide disparity in performance and to ensure that best practices are enforced across the entire industry. Parenthetically, if the drilling industry wants to be judged as caring about the environmental and public health consequences of its activities, a good test will be whether it supports, or stonewalls, EPA's forthcoming delineation of best practices.

My third point concerns the current shortsighted and counterproductive lack of almost any support for research directly related to the health effects of unconventional gas drilling . It begins with the apparent failure of government to even want to hear from the expert environmental public health community. That is a strong statement, but it is backed up by our attached peer-reviewed analysis, accepted for publication in *Environmental Health Perspectives*, of the membership of three advisory committees established in the past year: by President Obama in his Blueprint for a Secure Energy Future; and by the Governors of Pennsylvania and Maryland. Of the 52 members of these three commissions we could identify none with any background in any health field. There are no physicians, nurses, pharmacists, public health practitioners, toxicologists or professional risk assessors. Similarly, neither state included its Department of Health among the total of eight state agencies from whom members were drawn in the two state advisory processes; and the Department of Health and Human Services was not among the three federal agencies specified to be involved in the ongoing federal effort. While health concerns were certainly prominent in the executive orders establishing these three advisory committees, and the two that have reported so far do have health recommendations, it is not surprising that research on public health issues is far behind where it needs to be. EPA, the subject of your hearings, has focused primarily on hydrogeological issues but commendably has begun to look at identifying the health and environmental hazards of the fracking compounds. Understanding exposure pathways for humans is important, but is not accomplished by looking at just one potential pathway of exposure, such as is being evaluated in the Pavilion study. Understanding exposure pathways so as to predict environmental and public health effects requires a broad evaluation of all activities, not only at the site, but including such issues as the impact of trucking and the disposition of the contaminated flowback fluid. Worker health and safety is also important. The whole panoply of exposure assessment technologies needs to be employed, including the study of air, water and soil, and of biological markers of exposure and effect in ecosystems and in humans. Further, studies of exposure and of effect require listening to the community. An initial attempt at a broad health impact assessment in Colorado was aborted by lack of ongoing support. Governor Corbett of Pennsylvania has indicated his support of funding the state Department of Health to begin health-related studies, and I hope this will occur.

Ignoring the public health implications of unconventional natural gas extraction is not going to work. This is not a one-time event in a single location whose health effects could be hidden by simply not looking for them. Let us not, five or ten years from now, find conclusive evidence that we are hurting

people or the environment. Such an impact, and the cost of the necessary but belated response, would severely detract from the promise to our nation of unconventional shale gas drilling.

I believe that in the coming decades we will extract the natural gas in the Marcellus shale and in other accessible shale beds in the United States. It is in the best interests of the nation to invest in understanding the potential adverse human health consequences of this activity. The most cost-effective time, and in fact the only cost-effective time, to make this investment is now rather than to wait until the inevitable clamor for such research when diseases begin to appear that are associated with natural gas drilling activities. Determining if such an association is truly causal or occurs solely by chance is always far more difficult to do in retrospect, particularly in the setting of media publicity, fear for the health of one's family, the inevitable litigation, and lost property values. We need a longer term view of how to most optimally and sustainably develop these resources.

I can summarize my testimony as stating that there are three virtual certainties.

- 1) The complex and evolving process of unconventional gas drilling will lead to unwanted surprises;
- 2) industry, given time and rigorous oversight, will do a better job of recycling the fracking chemicals, which they buy, and decreasing the release of hydrocarbons, which they sell; and,
- 3) Adverse health effects will be statistically associated with unconventional gas development activities

Finally, what is the rush. The National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling called for careful renewal of deepwater drilling in part because it is in our national interest to get this oil before the Cubans or the Venezuelans or the Chinese do so. But unless the Canadians can horizontally drill under Lake Erie to get to the Marcellus shale, that gas is not going to anyone but us.

Thank you for your attention. I welcome your questions.

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Three Major Points

- The public is concerned about the potential health impacts of unconventional shale gas development
- There is genuine reason for this concern
- The current lack of almost any support for research directly related to the health effects of unconventional gas drilling is shortsighted and counterproductive

Public Confusion

Depending on the definition of hydrofracking, all of the following answers are true

Is hydrofracking old or new?

- 1) New hydrofracking technology now permits extraction of gas trapped in the Marcellus shale
- 2) Hydrofracking has been around for decades

Does hydrofracking cause groundwater contamination?

- 1) There is no proof that hydrofracking in the Marcellus shale has caused groundwater contamination
- 2) Major water contamination has occurred as a result of Marcellus shale gas drilling activities

Reasons given by those not in favor of Marcellus Shale drilling

Washington, PA public meeting with Natural Gas Subcommittee of the Secretary of Energy Advisory Board, N=59

Reason	Percent (%)
Environmental concerns	78.0%
Negative effects on water	66.1%
Negative effects on air	39.0%
Chemicals in water	37.3%
General health concerns	62.7%
Health problem in family member attributed to drilling	20.3%
Personal legal rights have been infringed upon by companies	13.6%
Concern about safety and/or regulation of industry	69.5%
Bias, conflict of interest, or lack of expertise in desired subject area by members of the committee	23.7%
Export of domestic natural gas resources	10.2%
Depreciation in property values	6.8%

Source: Goldstein, Kriesky, and Pavliakova. (2012). *Missing from the Table: Role of the Environmental Public Health Community in Governmental Advisory Commissions Related to Marcellus Shale Drilling*. *Environ Health Perspect.* (in press)

COREXIT 9500 MSDS: NALCO

(edited)

2. COMPOSITION/INFORMATION ON INGREDIENTS

Our hazard evaluation has identified the following chemical substance(s) as hazardous:

Hazardous Substance(s)	(w/w)
- Distillates, petroleum, hydrotreated light	10.0 - 30.0%
- Propylene Glycol	1.0 - 5.0%
- Organic sulfonic acid salt (Proprietary)	10.0 - 30.0%

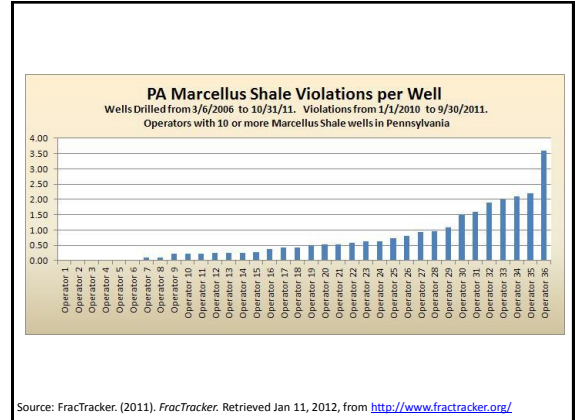
12 Types of Additives for Fracking (0.5% of fluid)

Additive	Example Chemical	Purpose
Acid	Hydrochloric acid or muriatic acid	Helps dissolve minerals and initiate cracks in the rock
Antibacterial agent	Glutaraldehyde	Eliminates bacteria in the water that produces corrosive by-products
Iron control	Citric acid	Prevents precipitation of metal oxides
Breaker	Ammonium persulfate	Allows a delayed break down of the frac gel
Corrosion inhibitor	n,n-dibethyl formamide	Prevents corrosion of pipe
Crosslinker	Borate salts	Maintains fluid viscosity
Surfactant	Isopropanol	Increases viscosity of the frac fluid
Friction reducer	Petroleum distillate	Minimizes friction
Gel Guar gum	Hydroxyethyl cellulose	Helps suspend the sand in water
Clay stabilizer	Potassium chloride	Brine carrier fluid
pH adjusting agent	Sodium or potassium carbonate	Adjusts and controls pH of the fluid
Scale Inhibitor	Ethylene glycol	Reduces scale deposits in pipe

Sources: Earthworks. (2011). *Hydraulic Fracturing 101*. Retrieved Jan 11, 2012, from http://www.earthworkaction.org/issues/detail/hydraulic_fracturing_101#CHEMICALS.
 EnergyIndustryPhotos. (2008). *What is Hydraulic Fracturing and What is it Used for?* Retrieved Jan 11, 2012, from http://www.energyindustryphotos.com/what_is_hydraulic_fracturing.htm

Pathways to Adverse Health Impacts of Marcellus Shale Operations

- Worker health and safety
- Air pollution
- Water pollution
- Soil pollution
- Noise pollution
- Community safety: traffic, explosions, fires; crimes
- Psychosocial disruption
- Sustainability
- Global climate change



Language of the Executive Orders Creating Unconventional Natural Gas Drilling Advisory Committees

"...task the Secretary of Energy Advisory Board (SEAB) with establishing a subcommittee...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**" (emphasis added)

-President Barak Obama in
Blueprint for a Secure Energy Future (March 2011)

The Marcellus Shale Safe Drilling Initiative will assist State policymakers and regulators in determining how gas production from the Marcellus shale in Maryland can be accomplished **without unacceptable risks of adverse impacts to public health, safety, the environment and natural resources**" (emphasis added)

-Maryland Governor Martin O'Malley in
Executive Order 01.01.2011.11: The Marcellus Shale Safe Drilling Initiative (June 2011)

"WHEREAS, the Commonwealth takes seriously its responsibility to ensure the development of natural gas in a manner that protects the environment and **safeguards the health and welfare of its citizens**" (emphasis added)

-Pennsylvania Governor Tom Corbett in
Executive Order 2011-011: Creation of Governor's Marcellus Shale Advisory Commission (March 2011)

Three Certainties

- 1) Surprises
- 2) Improved technology
- 3) Association with adverse health impacts