Statement of Robert W. Howarth, Ph.D.

before the Subcommittee on Technology, Information Policy, Intergovernmental Relations and Procurement Reform,
Committee on Oversight and Government Reform,
Congress of the United States, House of Representatives

May 31, 2012

My name is Robert Howarth. I have been a tenured faculty member at Cornell University in Ithaca, NY, since 1985, and have held an endowed faculty position, the "*David R. Atkinson Professor of Ecology & Environmental Biology,*" since 1993. I am also the Founding Editor of the journal *Biogeochemistry* and an adjunct senior research scientist at the Marine Biological Laboratory in Woods Hole, MA. I have performed research and published scientific papers on environmental risk assessment and the consequences of pollution, including the effects of oil and gas development, since the mid 1970s.

I was invited to present information in this hearing on the environmental and public health consequences of hydraulic fracturing. Hydraulic fracturing is not new. The process has existed for many decades, using relatively small volumes of water, to stimulate gas and oil wells to increase production. What is new is the combination of high-precision, directional drilling with high-volume hydraulic fracturing. This new combination uses many times more water and chemical additives for the fracturing, often 5 million gallons or more per well. This is 50 to 100 times more fracturing fluid than used to stimulate conventional gas wells. The high-volume hydraulic fracturing combined with directional drilling has allowed the exploitation of gas resources not previously available, such as shale gas. This combination of technologies to obtain shale gas is very new, first used in Texas just over a decade ago. And over half of all the shale gas that has ever been developed in the world has been produced in the last 3 years.

Because the development of shale gas is so new, the science on this process and its environmental consequences is also very new. Almost all peer-reviewed scientific publications on the environmental and public health consequences of shale gas have been published in the past 14 months, since April 2011. A list of these papers and their abstracts can be found on the web site of Physicians, Scientists, and Engineers for Healthy Energy (http://www.psehealthyenergy.org/site/show_list/id/35). Today, I will briefly summarize the findings of this new, developing science.

Surface water pollution: Shale gas development has already caused significant surface water pollution. The additives used in hydraulic fracturing include toxic and carcinogenic substances, such as formaldehyde, benzene, xylene, and monoethanolamine. As importantly, frac fluids extract chemical substances from shales, including toxic and carcinogenic aromatic hydrocarbons, toxic metals, and radioactive materials such as uranium, thorium, and radium. Some of these materials are released to the environment when blowouts and other accidents occur. A greater route of release and exposure comes from disposal of frac-return fluids. Approximately 20%, or 1 million gallons or so, of the material used in hydraulic fracturing flows back to the surface in the first few weeks after fracturing, with all of the added and extracted chemical substances. In Texas, where most high-volume hydraulic fracturing has occurred so far, these wastes are disposed of by injection into old, abandoned conventional gas wells. In the Marcellus formation in Pennsylvania, some waste has been injected in such disposal wells, but suitable disposal wells are rare in the northeast, and much more has been disposed of in municipal sewage treatment plants. Such treatment plants simply are not designed to handle these toxic wastes. A significant amount of the wastes flow through the plants and are released into rivers. Public drinking water supplies in the Pittsburg area have already been affected, with elevated bromides from the waste interacting with chlorination in public drinking water systems to produce highly dangerous brominated organic compounds. As a result, the PA DEP and US EPA have put a stop to using sewage plants to dispose of frac wastes, as of the summer of 2011. But suitable alternative disposal methods have yet to be developed.

Groundwater contamination: There are several reports of contamination of drinking water wells and surface aquifers by fracking fluids, particularly in Pennsylvania and in Colorado. The extent of such contamination, and the mechanisms which might lead to such contamination, remain poorly studied. Most scientists familiar with the existing, public data (note that a lot of information is not publicly available) believe the contamination is likely caused by well and cementing failures. A recently published model suggests there may also be a threat of migration of contaminated fracking fluids from depth to surface drinking water aquifers over time through fissures and cracks. The US EPA is currently pursuing a comprehensive study of groundwater contamination from hydraulic fracturing, and intends to release a preliminary report later this year and a final report in 2014.

Shale gas development also leads to contamination of drinking water wells, as indicated by a May 2011 study published by Duke University scientists in the *Proceedings of the National Academy of Sciences*. Methane concentrations were frequently elevated in drinking water wells within 1 km of shale gas operations, sometimes at levels great enough to pose a significant risk of explosion.

Local air pollution: The development of shale gas and other unconventional forms of natural gas (from coal-bed seams and tight-sand formations) results in significant local air pollution. One concern is the release of benzene and other aromatic hydrocarbons

to the atmosphere from routine operations. State officials in Texas have reported benzene concentrations in the air near gas operations that sometimes exceed acute toxicity standards. In Pennsylvania, reported benzene concentrations are so far lower, quite likely because the rate of gas development has been much lower. Nonetheless, reported atmospheric benzene levels near some drilling operations in Pennsylvania are high enough to pose risk of cancer from chronic exposure.

Ozone pollution is also of great concern. Ozone is created in the atmosphere when nitrogen pollution and organic compounds react under strong sunlight. Current ozone pollution in the US is estimated to cause 30,000 premature deaths each year, almost the same death rate as from automobile accidents. Unconventional natural gas development from hydraulic fracturing increases ozone pollution due to leakage of organic compounds to the air. The problem has been particularly acute in Wyoming, Utah, and Colorado in recent years, with ozone concentrations in the winter due to natural gas development being higher than observed in New York City.

Methane and global warming: Methane is released to the atmosphere during development, transport, storage, and use of natural gas. Methane is an incredibly powerful greenhouse gas, and as a result of methane emissions, both shale gas and conventional natural gas have larger greenhouse gas footprints than other fossil fuels such as oil and coal (when viewed over an integrated 20-year time frame after emission). Recent climate models point to the urgency in reducing methane emissions: without immediate global reductions in methane pollution, these models indicate that the Earth will warm to 1.5 degrees C above the long-term average within 15 years or so, and to 2 degrees C within 35 to 40 years. This is a dangerous level of warming, a level that greatly increases the likelihood of positive feedbacks in the climate system, leading to an acceleration of further warming. Reducing emissions of methane and other short-lived radiatively active materials such as black carbon is the best way to reduce this dangerous warming. Currently, almost 40% of all atmospheric methane released by human activity in the US comes from the natural gas industry. Most studies indicate that shale gas development releases 40% to 60% more methane than does conventional natural gas. To address the huge threat posed by global warming, I believe it is essential to move as quickly as possible away from natural gas towards renewable energy resources, and to not further develop shale gas unless major (and expensive) steps are taken to greatly reduce methane emissions.

Radon in natural gas supplies: Radon gas is a carcinogen, and exposure to radon is the largest source of public exposure to ionizing radiation in the US. Currently, radon in homes in the US results in an estimated 20,000 deaths per year. Natural gas contains radon, and using natural gas for home cooking is one route of home exposure. Shale gas from the Marcellus formation, and perhaps from other formations as well, has much greater levels of radon than does conventional natural gas. This is because the Marcellus shale is particularly rich in uranium and thorium, and radon is formed from the decay of these radioactive materials. Radon has a half life of 3.8 days, so with

sufficiently long storage, the radon decays away and poses less public health risk. However, the rapid movement of natural gas from the Marcellus shale to northeastern cities would seem to pose a major public health risk, one that certainly deserves much greater study and scrutiny.

The role of federal regulation: I believe federal agencies should have a central role in regulating oil and gas development, and particularly with the development of unconventional oil and gas by high-volume hydraulic fracturing. The issues involved are complex, the technologies are new and continually evolving, the scientific issues are difficult. From my experience with interacting with both federal and state regulatory agencies over the past 35 years, I believe most states lack the science capacity to adequately develop and enforce regulations for unconventional oil and gas.

Finally, I note that the pollution from unconventional oil and gas development moves across state lines in surface waters, in the air, and in gas pipelines (in the case of radon). This inter-state pollution clearly calls for federal oversight of environmental and public health regulation.

I thank the committee for the opportunity to testify today, and I would be pleased to answer any questions you may have.

Robert Howarth

Curriculum Vitae -- May 31, 2012

Robert Howarth is a biogeochemist and ecosystem biologist. He earned a BA in Biology from Amherst College in 1974 and a Ph.D. jointly from the Massachusetts Institute of Technology (MIT) and the Woods Hole Oceanographic Institution in 1979. In 1979, he was the Noyes Postdoctoral Fellow at the Ecosystems Center of the Marine Biological Laboratory in Woods Hole, and from 1980 to 1985 was a staff scientist at the Center. Howarth joined the faculty at Cornell University in 1985 and was appointed the *David R. Atkinson Professor of Ecology & Environmental Biology* in 1993. For the past 35 years he has run an active research program focusing on how human activity affects the environment, with emphases on global change and on coastal ocean water quality. Much of his research focuses on human alteration of the nitrogen cycle at scales from local to regional to global, including both sources of pollution and their consequences. He also works on greenhouse gas emissions (particularly methane and nitrous oxide) and the ecological consequences of oil and gas development. Following the Exxon Valdez oil spill, Howarth was the lead advisor to the Attorney General of the State of Alaska on the effects of the spill.

Howarth is the Founding Editor of the journal *Biogeochemistry* and was Editor-in-Chief of the journal from 1983 to 2004. He chaired the National Academy of Sciences Committee on Causes and Consequences of Coastal Marine Eutrophication from 1998-2000, and has served on 10 other panels and committees of the National Academy, including one on oil pollution and one on trace gases and global change. Howarth co-chaired the International SCOPE Nitrogen Project from 1992 to 2002 (International Council of Science), directed the North American Nitrogen Center of the International Nitrogen Initiative from 2003-2006, and has been chair of the International SCOPE Biofuels Project on environmental effects of biofuels since 2007. He is a consultant to the United Nations Environment Program on sustainable resource use. From 2007 to 2009, Howarth served as president of the Coastal & Estuarine Research Federation. From 2008 to 2010, he was on the board of directors of the Council of Scientific Society Presidents, an umbrella organization representing almost 1.5 million professional scientists in over 100 different disciplines; Howarth co-chaired the Committee on Energy & Environment for this organization from 2008 through 2011. He also represents the State of New York on the Technical and Science Advisory Committee of the Chesapeake Bay Program, and directs the USDA-funded Agriculture, Energy & Environment Program at Cornell University. Howarth is a member of the Board of Directors of Physicians, Scientists, and Engineers for Healthy Energy.

In 2011, Howarth published the first comprehensive analysis of the greenhouse gas footprint of shale gas in the peer-reviewed journal *Climatic Change Letters* and an invited commentary on shale gas in *Nature*. For this, he was named by *Time* magazine as "one of the people who matter" for 2011. In the first few months of 2012, Howarth published a follow-up paper on this research in *Climatic Change* and was the lead author of a background paper for the National Climate Assessment on the role of methane from the natural gas industry on global change.

Howarth has published over 200 scientific papers, reports, and book chapters. An expanded CV with complete list of publications is available at http://www.eeb.cornell.edu/howarth/

Committee on Oversight and Government Reform
Witness Disclosure Requirement – "Truth in Testimony"
Required by House Rule XI, Clause 2(g)(5)

Name: Robert Howarth, Ph.D.

1. Please list any federal grants or contracts (including subgrants or subcontracts) you have received since October 1, 2009. Include the source and amount of each grant or contract.

See following page.

2. Please list any entity you are testifying on behalf of and briefly describe your relationship with these entities.

None.

3. Please list any federal grants or contracts (including subgrants or subcontracts) received since October 1, 2009, by the entity(ies) you listed above. Include the source and amount of each grant or contract.

None.

I certify that the above information is true and correct.
Signature: Date:

Robert W. Howarth May 29, 2012

Howarth, Robert: Federal grants and contracts since October 1, 2009
(all awards made to Cornell University)

National Science Foundation
"Nonlinear Feedbacks in Coupled Element Cycles During Eutrophication of Shallow Coastal Ecosystems"
$1,699,977; 8/15/04 to 7/31/10

National Oceanic & Atmospheric Administration (Subcontract from Univ. of Michigan)
"CHRP 2005: Watershed-Estuary-Species Nutrient Susceptibility"
$948,000; 8/1/05 to 7/31/12

US Department of Agriculture (Hatch)
"Atmospheric Deposition of NH3 Gas: Relation to Water Quality in the Susquehanna River Basin and to Inputs to Agricultural Systems"
$60,000; 10/1/07 to 9/30/10

US Department of Agriculture
"Agricultural Ecology Program: Understanding Sources and Sinks of Nutrients and Sediment in the Upper Susquehanna River Basin"
$256,499; 8/15/08 through 8/14/10

US Department of Interior (though the NY State Water Resources Institute)
"Silica Dynamics and Nutrient Retention Modeling in the Hudson River Watershed"
$20,000; 3/1/09 to 2/28/10

US Department of Agriculture
"Environmental Research Special Grant: Understanding Sources and Sinks of Nutrients and Sediment in the Upper Susquehanna River Basin"
$240,530; 9/1/09 to 8/31/11

US Department of Agriculture
"Environmental Research Special Grant: Agriculture, energy, and Environment Program at Cornell University"
$240,112; 9/1/10 to 8/31/12

US Department of Agriculture (Hatch)
"Watersheds and Nitrogen Pollution: The NANI tool and Trend Analysis"
$100,000; 10/1/10 to 9/30/12