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To: Hanlon, Edward
Subject: PUBLIC COMMENT: Environmental Perspective Hydraulic Fracturing

Mr. Edward Hanlon
Designated Federal Officer SAB Hydraulic Fracturing Research Advisory Panel – Effect on Water Quality
PUBLIC COMMENT: Environmental Perspective Hydraulic Fracturing

I am submitting the attached White Paper "Environmental Perspective Hydraulic Fracturing" as a contribution to the USEPA SAB Research Advisory Panel's Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources. This white paper can be distributed to SAB and can be considered as public commentary.

This white paper, "Environmental Perspective Hydraulic Fracturing", shows the following:

- The private sector is beginning to implement recycling of flow-back water to (1) save time [fast-track state regulatory permits] and (2) reduce operating costs [avoid deep well disposal]

- Avoiding deep well disposal of flow-back waters reduces potential for localized earthquakes
- Control of Methane Emissions does not pose a significant cost to future wells and/or piping systems

I thank you for time and courtesy since I our initial correspondence in March 29, 2013. I hope my contribution assists the efforts of the EPA and SAB
Richard W. Goodwin 4/4/14

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ENVIRONMENTAL PERSPECTIVE HYDRAULIC FRACTURING

The application of horizontal drilling and Hydraulic Fracturing to extract shale gas and liquid hydrocarbons is directly responsible for development of these unconventional energy and chemical resources. Such development has greatly improved the USA economic future – creating energy independence, providing low cost energy and chemical feedstock for new USA industrial plants, creating potential for installation and exports of Liquified Natural Gas [LFG] facilities and promoting skilled labor jobs for such new projects. Hydraulic Fracturing, has created concerns with the public, media, elected officials and regulatory community. Such concerns include: environmental [disposal of wastewater and Methane emissions] and causal effect of potential earthquakes.

- **HYDRAULIC FRACTURING – ENVIRONMENTAL CONCERN**

Hydraulic fracturing or fracking involves the use of large quantities of water, three to eight million gallons per well, mixed with additives, to break down the rocks and free up the gas. Some 10 to as much as 40 percent of this fluid returns to the surface as "flowback water" as the gas flows into a wellhead. In hydraulic fracturing—or fracking, as it is sometimes called—millions of tons of water are injected at high pressure down wells to crack open shale deposits buried deep underground and extract natural gas trapped within the rock. Some of the water flows back up through the well, along with natural brines and the natural gas.

Once a well is in production and connected to a pipeline, it generates what's known as produced water. Flowback and produced water contain fluid that was injected from surface reservoirs--and 'formation water' that was in the shale before drilling." These flowback fluids carry high concentrations of salts, and of metals, radionuclides and methane. Such chemicals may affect surface and groundwater quality if released to the environment without adequate treatment.

- REGULATORY ACTIVITIES

The USEPA has established a Scientific Advisory Board to Review Methodology and Technology mitigating effect of fracking on water quality. Also ASTM, API etc. have established standard setting committees for drilling, fracking, production water options. During the next two years the efforts of experienced participants should change the way that fracking operations are implemented, managed and regulated. The SAB's work will continue until 2015 – both existing and grass-roots drilling projects will be monitored.

The USEPA continues to issue public notices to communicate progress.

As the regulatory community establishes standards for frac water recycling and the private sector commercially offers cost-effective technology, the drillers will be able to implements reuse while expediting their projects and saving money.

The private sector is employing Frac Water Recycling to save money and to save time – in TX new permits with Frac Water Recycling are fast-tracked.

Please consider how TX and WY regulate fracking, Both states apply more stringent regulations, they emphasize recycle of production frac waters. TX will fast-track drillers permits when water recycling will be implemented. TX and WY are drought prone. My particular interest lies in financial justification by operators to opt for reuse treatment of frac and product water. For instance, in drought prone areas raw water costs may justify additional expense of reuse treatment.

According to Paul Schlosberg, co-founder and chief financial officer of Water Rescue Services, Texas drilling companies are now seeing recycling as an economic solution to water issues. Such systems have helped drillers not only to cut down on their freshwater use but also to reduce the amount of wastewater they dispose of.

The private sector also offers commercially available reuse systems. GE Power and Water cleans the process water, eliminating trucking/on-site storage and deep well disposal – according to Bill Heins [GM – thermal products]. Heins has stated “since the cleaned water from the process can be reused it also will reduce the amount of fresh water needed per well, thereby further reducing costs and ecological impact.” Reducing the brine concentration reduces operating costs.

- **ECONOMIC ADVANTAGE OF RECYCLING FRAC WATER**

Gas production through fracking generated about 35% as much wastewater per unit of gas recovered as wells where conventional drilling was employed. On average, the amount of wastewater produced by fracked wells exceeded about 10 times that generated by conventional wells but the former also delivered about 30 times more gas..

A typical fracked well can use more than 4 million gallons of water during its lifetime to force natural gas out of the ground. The water is often mixed with chemicals, making it impossible to reuse immediately for fracking. Options for this wastewater include: transport off-site to centralized treatment facitlity or deep well disposal, on-site treatment followed by recycling.

The costs for hauling away wastewater for deep-well injection range between $3 and $7 per barrel ($0.35 to $0.85 per cubic metre). For a newly fracked well, the cost could reach $100,000 for transporting over 14,000 barrels (1,670 m3) of flowback – water levels produced from each basin, and indeed, each wellhead can vary. Plus, an

additional potential 3400 barrels (405 cubic meters) each day of transported produced wastewater, at $20,000 per day.

APACHE CORP ALSO INCORPORATES RECYCLING FRAC WATER

Apache Corporation estimates that treating flowback water costs about $0.29 per barrel. By contrast, disposing of water with a third party costs Apache $2.50. According to Lucian Wray, production manager for Apache's South Permian region, the entire amount of the water used at wells in the area gets recycled, including produced water and flowback water. The company does not dispose of any of the water used in the process of oil and gas extraction, Wray added.

Most of the oil and gas exploration companies are still heavily dependent on freshwater for their drilling operations, but Apache Corporation has found a way to reduce its reliance on freshwater. Freshwater is the main ingredient used in fracking. Apache has become the first company to eliminate its dependence on freshwater at an Irion County oilfield in Texas in the Permian Basin. 'Produced water' is a byproduct of drilling, whereas 'flowback water' is the fluid that comes out of a well during fracking. Apache is recycling both types of water, which are usually trucked away for disposal, for reuse, allowing it to do away with freshwater. At the Irion County oilfield, Apache uses brackish water from the Santa Rosa aquifer and recycles waste water from wells and fracking sites.

Apache started experimenting with a freshwater alternative about a year ago and has so far managed to drill 50 fresh waterless wells, and it aims to drill a total of 70 by the end of this year. Success of this technology could produce huge rewards for the water-starved Texas oil fields, which are still suffering from the effects of a severe drought in 2011. Apart from reducing dependence on local freshwater supplies, Apache is also benefiting immensely from the reduced costs at fracking wells. A well typically uses 5 million gallons of water for fracking. So, this could result in a potential savings of around $350,000 per fracking well. This initiative has saved Apache an estimated $17.5 million already and could result in a total savings of $24.5 million by the end of this year. Apache has identified 3,293 drilling locations in the Wolfcamp Shale and the Cline Shale in the Permian basin. Using this new technique in all these locations could translate into a total cost savings upwards of $1.15 billion for Apache in the long term.

As Apache Corporation demonstrates its proprietary technology and improves is operating margins their competitors will realize the economic benefit of recycling frac water rather than transporting it to centralized treatment or resorting to deep well disposal – a practice related to increased earthquake frequency in frac regions. For example, Halliburton's H2OForward recycling service on some of its wells in New Mexico has led to cost savings between $70,000 and $100,000 per well, while no reduction in output has been noticed.

- **RECYCLING OF FRAC WATER AVOIDS DEEP WELL DISPOSAL AND RELATED LOCALIZED EARTHQUAKE EFFECT**

Recycling frac waters would not only save operators money and secure 'fast track' permits, but reuse would avoid deep well injection – removing a high potential contributing factor to localized earthquakes.

I refer to "Induced Seismicity Potential in Energy Technologies" National Research Council 2012. Per 'Executive Summary':

> "the process of hydraulic fracturing a well as presently implemented for shale gas recovery does not pose a high risk for inducing felt seismic events
> Injection for disposal of waste water derived from energy technologies into the subsurface does pose some risk for induced seismicity, but very few evetns have been documented over the past several decades relative to the large number of disposal wells in operation"

My work, economically justifying recycle of treated frac or production waters would eliminate use of disposal wells.

- **METHANE EMISSIONS FROM FRACKING – NOT EXCESSIVE**

A recent University of Texas study reflected a partnership between the Environmental Defense Fund, participating companies, an independent Scientific Advisory Panel and the study team: The National Academy of Science study's sponsors were Environmental Defense Fund (EDF), Anadarko Petroleum Corporation, BG Group plc, Chevron, Encana Oil & Gas (USA) Inc., Pioneer Natural Resources Company, SWEPI LP (Shell), Southwestern Energy, Talisman Energy USA, and XTO Energy, an ExxonMobil subsidiary.

This work reports direct measurements of methane emissions at 190 onshore natural gas sites in the United States. The measurements indicate that well completion emissions are lower than previously estimated; the data also show emissions from pneumatic controllers and equipment leaks are higher than Environmental Protection Agency (EPA) national emission projections. Estimates of total emissions are similar to the most recent EPA national inventory of methane emissions from natural gas production. These measurements will help inform policymakers, researchers, and industry, providing information about some of the sources of methane emissions from the production of natural gas, and will better inform and advance national and international scientific and policy discussions with respect to natural gas development and use.

Both studies were performed with adequate scientific integrity and without influence of special interests. Differing conclusions suggest that additional peer review scientific investigations are required.

- METHANE LEAKS CAN BE CONTROLLED VIA SOUND ENGINEERING MANAGEMENT

Methane leaks from oil and natural gas production can be cut by 40 percent for less than 1 cent per thousand cubic feet of gas, according to a study backed by an environmental group.

By plugging leaks in compressors and pipes, producers can cut emissions of methane, a potent heat-trapping gas, according to a report [March 2014] by the Environmental Defense Fund and ICF International Inc., a consultancy specializing in energy and the environment. The $2.2 billion cost would be offset over time by the sale of captured gas, the study estimates.

Methane, the main component of natural gas, is 21 times more potent at trapping heat in the atmosphere than carbon dioxide, leading environmental groups to call for stricter controls to help curb climate change. Producers say they are addressing the issue and that over-regulation could slow the energy boom that has lowered prices for consumers.

At approximately $10MM per well, the industry can afford to spread $2.2B over the costs of new and existing wells. The industry is expected to invest trillions of $US over the next several years in unconventional oil and gas development.

In addition, a recent MIT report addressed CH4 leaks. According to interview with co-author Francis O'Sullivan, director of research and analytics at the MIT Energy Initiative, "most pieces of equipment don't leak at all, while a few are "super-emitters" that release large amounts of methane".

Based on the above infrastructure should be inspected for adequacy wherever these 'super-emitters' occur and corrected. As MIT interview stated "more rigorous sampling and monitoring campaigns, and new technology for remote sensing that would allow us to identify these leaks on a more cost-effective basis".

SUMMARY CONCLUSIONS

Private sector application, of recycling of production frac waters, not only reduce operating costs, by eliminating deep injection disposal well, but reduce deep wells' contribution to localized earthquakes. Applying sound engineering to reduce Methane emissions would not significantly affect costs of future wells and/or piping systems.

By applying sound engineering and peer-review scientific investigations hydraulic fracturing technology can be improved to address substantive issues. Coupling economic incentive and sound public policy will avoid deleterious past practices while achieving enhanced practices.

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