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Institute for Energy and Environmental Research for Northeastern Pennsylvania (IEER) - Wilkes University commentary on Osborn et al. (2011) article: *Methane contamination of drinking water accompanying gas well drilling and hydraulic fracturing*, published in Proceedings of the National Academy of Sciences (vol. 108, pages 8172-8176)

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8 June 2011

About this document

This commentary was prepared by scientists and other technical professionals at IEER with expertise in environmental science and analysis, geology, surface and groundwater chemistry, and engineering. We sought to provide an independent analysis and explanation of the study to improve public understanding. Our target audience includes all stakeholders associated with Marcellus shale development, including industry, residents, and government – especially in Northeastern Pennsylvania. Thus, we minimized technical language inasmuch as possible.

This document includes a summary, a set of IEER comments with listings of perceived strengths and limitations, and a bottom-line assessment of significance.

Summary of article

This article summarized an analysis of water quality samples taken from drinking water wells in northeastern Pennsylvania and south-central New York State. Samples taken from wells located within 1 kilometer (0.62 miles) of shale drilling sites tended to have higher concentrations of dissolved methane (the primary component of natural gas) than samples taken from wells located more than 1 kilometer from drilling sites. Detailed analyses of the methane indicated that it originated from deep earth deposits (thermogenic), rather than from near-surface sources (biogenic). The authors listed three possible ways that deep methane can rise to shallow drinking water supplies, and suggested that leaky gas well casings were most likely. Such methane may pose an explosion risk within enclosed spaces. In contrast, concentrations of chemicals associated with hydraulic fracturing flowback water (salt, boron, radioactive radium) did not differ according to distance from drilling sites. Thus, the findings do not show evidence that flowback from hydrofracking contaminates drinking water, at least in the timeframe of the study.

IEER comments

This study addresses the contamination of drinking water due to hydraulic fracturing for shale gas in the northeastern United States – a topic widely discussed by residents of the region for the past two years. Since hydraulic fracturing is relatively new to the region, few peer-reviewed studies have examined its environmental impacts, especially to water quality.

Overall, the authors presented their findings with well-selected figures and tables, and wrote their narrative in a thoughtful, balanced tone expected of a scientific article. Though we question the use of the phrase "hydraulic fracturing" in the title, the authors did not make any claims unsubstantiated by their data, and carefully worded their conclusions to reflect areas of uncertainty in their data. Significantly, the journal in which they published, *Proceedings of the National Academy of Science*, is highly respected.

As is true with most scientific research articles, this study had both strengths and limitations. Stakeholders should recognize both when interpreting the significance of this work. We outline both below.

Strengths

The authors sampled from a regionally representative number (68) of private drinking water wells. Some samples were located in proximity to Marcellus drilling sites, and others were beyond the expected drilling footprint. Some of the samples were collected from south-central New York State, where drilling is prohibited.

The authors provided convincing evidence that many water wells located within 1 km (0.62 mi) of a drilling site contained elevated levels of methane that would warrant action, as established by the federal government (see Figure 3 in their paper). In contrast wells located more than 1 km from drilling sites had methane levels far below the Action Level.

The authors analyzed the methane using a widely accepted molecular fingerprinting technique called stable isotopic analysis to determine whether it was from thermogenic (deep earth) or biogenic (near-surface) sources. Their results indicated that methane near drilling sites was thermogenic, which means that it did not originate within wetlands or other near-surface processes (see especially Figure 4).

The authors also showed that drinking water samples taken from wells near Marcellus drilling sites did not have elevated concentrations of chemicals associated with flowback from Marcellus drilling operations (Table 2).

Limitations

As is true for most scientific studies, this effort had some limitations worth noting.

First, this relatively small and rapid study examined and compared water quality from sites varying in distance from drilling operations. A descriptive, correlative study such as this is a common and acceptable way to assess the impacts of human activities on the environment. However, a more robust approach would be to examine water quality in the same wells before drilling and after drilling. Given that this is a descriptive study, the authors can only claim an *association* between methane concentrations and drilling; it does not imply cause and effect.

Second, the authors did not explain how they selected their sampling sites. Information provided by a request to the authors suggested that they analyzed available data from a subset of drilling sites – which included those known to have methane contamination due to poor casing and

cementing practices. While that dataset may have been the only one available to the authors, a more comprehensive dataset might have yielded different results.

Third, while many drinking water wells near drilling sites did have high methane concentrations, many wells did not (see Figure 3). The authors did not discuss that variability. Understanding the cause of that variability would likely provide important insights that might relate to geology or construction techniques.

Fourth, water quality often varies over time. It appears that the researchers only obtained one sample at each site. Conducting repeated sampling would give a more complete understanding of any dynamic behavior of methane in water wells.

Fifth, the authors' claim that the region is tectonically active is debatable. The risk of methane leakage from old fractures may not be as high as the authors assert on page 3.

The bottom line

Despite the identified limitations, we believe that this study is significant because it is one of the first peer-reviewed analyses of water quality associated with Marcellus shale drilling. It strongly suggests that drilling can lead to elevated methane contamination to at least some nearby drinking water supplies. While methane is not inherently toxic, it may pose a safety hazard if concentrations are too high.

Conversely, the fact that the authors did not find other contaminants associated with drilling near Marcellus operations suggests that flowback does not cause widespread contamination of drinking water – as is widely feared. However, because methane is more mobile than other dissolved substances, those other substances may appear in the future.

As the authors point out, more studies of drinking water quality are needed. Future studies should encompass a larger area, and work to better identify pathways for migration of deep methane to drinking-water aquifers. To facilitate such studies, natural gas companies and regulatory agencies should release data from their own drinking water assessments to the scientific community. Moreover, regulatory agencies, gas companies, and the scientific community should collaborate to conduct pre-and-post drilling water testing. Such testing will provide more direct evidence as to whether Marcellus gas extraction indeed impacts water quality.

This study has lessons for both the gas industry and citizens concerned about gas development. For the industry, this study strongly suggests that gas development may cause methane contamination of drinking water wells near drilling sites. Industry should ensure that they consistently adopt practices to minimize damage to local water supplies.

Conversely, citizens concerned about drilling impacts should recognize the limitations of this study, and the fact that this study did not find any evidence of impacts to drinking water caused by hydrofracking itself. Thus, it does not at all represent "definitive proof" that hydrofracking will inevitably lead to groundwater contamination, as some are claiming.

Finally, we agree with the authors that "greater stewardship, knowledge, and—possibly—

regulation are needed to ensure the sustainable future of shale-gas extraction." That statement is a prudent policy implication of their findings.

Acknowledgments

We thank the following colleagues for valuable comments on the Osborn et al. article, and on developmental versions of this commentary: Thomas Barnard, Ph.D., Ned Fetcher, Ph.D., Joseph E. (Tim) Gilmour, Ph.D., Sid Halsor, Ph.D., David Hines, Donald Mencer, Ph.D., Bryce Payne, Ph.D., Anne Pelak, Brian Redmond, Ph.D., Erich Schramm, Ronald Supkowski, Ph.D., Reynold Verret, Ph.D.

About the IEER

Housed at Wilkes University in Wilkes-Barre, PA, the Institute for Energy and Environmental Research for Northeastern Pennsylvania is a collaborative of Wilkes, King's College, and the Institute for Public Policy and Economic Development. The IEER conducts research and provides community education on issues associated with energy development in northeastern Pennsylvania. The IEER is funded by a contract with the Department of Energy to support that mission with respect to Marcellus shale gas development. More information about IEER can be found at http://www.IEER-NEP.org.

None of the IEER scientists and staff involved with developing this article participated in this study or any reviews leading to its publication.

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