Fracking **Fracking**
Gas Drilling's Environmental Threat

Scientific Study Links Flammable Drinking Water to Fracking

(Abrahm Lustgarten/ProPublica)

by Abrahm Lustgarten
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For the first time, a scientific study has linked natural gas drilling and hydraulic fracturing with a pattern of drinking water contamination so severe that some faucets can be lit on fire.

The peer-reviewed study [1], published today in the Proceedings of the National Academy of Sciences, stands to shape the contentious debate [2] over whether drilling is safe and begins to fill an information gap that has made it difficult for lawmakers and the public to understand the risks [3].

The research was conducted by four scientists at Duke University. They found that levels of flammable methane gas in drinking water wells increased to dangerous levels when those water supplies were close to natural gas wells. They also found that the type of gas detected at high levels in the water was the same type of gas that energy companies were extracting from thousands of feet underground, strongly implying that the gas may be seeping underground through natural or manmade faults and fractures, or coming from cracks in the well structure itself.

“Our results show evidence for methane contamination of shallow drinking water systems in at least three areas of the region and suggest important environmental risks accompanying shale gas exploration worldwide,” the article states.

The group tested 68 drinking water wells in the Marcellus and Utica shale drilling areas in northeastern Pennsylvania and southern New York State. Sixty of those wells were tested for dissolved gas. While most of the wells had some methane, the water samples taken closest to the gas wells had on average 17 times the levels detected in wells further from active drilling. The group defined an active drilling area as within one kilometer, or about six tenths of a mile, from a gas well.

The average concentration of the methane detected in the water wells near drilling sites fell squarely within a range that the U.S. Department of Interior says is dangerous and requires urgent “hazard mitigation” action, according to the study.

The researchers did not find evidence that the chemicals used in hydraulic fracturing had contaminated any of the wells they tested, allaying for the time being some of the greatest fears among environmentalists and drilling opponents.

But they were alarmed by what they described as a clear correlation between drilling activity and the seepage of gas contaminants underground, a danger in itself and evidence that pathways do exist for contaminants to migrate deep within the earth.

“We certainly didn’t expect to see such a strong relationship between the concentration of methane in water and the nearest gas wells. That was a real surprise,” said Robert Jackson, a biology professor at Duke and one of the report’s authors.

Methane contamination of drinking water wells has been a common complaint among people living in gas drilling areas across the country. A 2009 investigation by ProPublica [4] revealed that methane contamination from drilling was widespread, including in Colorado [5], Ohio and Pennsylvania [6]. In several cases [7], homes blew up after gas seeped into their basements or water supplies. In Pennsylvania a 2004 accident killed three people, including a baby.

In Dimock, Pa. [4], where part of the Duke study was performed, some residents’ water wells exploded, or their water could be lit on fire. In at least a dozen cases in Colorado, ProPublica’s investigation found, methane had infiltrated drinking water supplies that residents said were clean until hydraulic fracturing was performed nearby.

The drilling industry and some state regulators described some of these cases as “anecdotal” and said they were either unconnected to drilling activity or were an isolated problem. But the consistency of the Duke findings raises questions about how unusual and widespread such cases of methane contamination may be.

“It suggests that at least in the region we looked, this is a more general problem than people expected,” Jackson told ProPublica.

For those who live in the midst of this problem, the report serves as long-awaited vindication. “We weren’t just blowing smoke. What we were talking about was the truth,” said Ron Carter, a Dimock resident whose water went bad when drilling began there in 2008 [8] and was later tested as part of the study. “Now I’m happy that at least something helps prove out our theory.”

Methane is not regulated in drinking water, and while research is limited, it is not currently believed to be harmful to drink. But the methane is dangerous because as it collects in enclosed spaces it can asphyxiate people nearby, or lead to an explosion.

To determine where the methane in the wells they tested came from, the researchers ran it through a molecular fingerprinting process called an isotopic analysis. Water samples furthest from gas drilling showed traces of biogenic methane—a type of methane that can naturally appear in water from biological decay. But samples taken closer to drilling had high concentrations of thermogenic methane, which comes from the same hydrocarbon layers where gas drilling is targeted. That—plus the proximity to the gas wells—told the researchers that the contamination was linked to the drilling processes.

In addition to the methane, other types of gases were also detected, providing further evidence that the gas originated with the hydrocarbon deposits miles beneath the earth and that it was unique to the active gas drilling areas. Ethane, another component of natural gas, and other hydrocarbons were detected in 81 percent of water wells near active gas drilling but in only 9 percent of water wells further away. Propane and butane were also detected in some drilling area wells.

The report noted that as much as a mile of rock separated the bottom of the shallow drinking water wells from the deep zones fractured for gas and identified several ways in which fluids or the gas contaminants could move underground: The substances could be displaced by the pressures underground; could travel through new fractures or connections to faults created by the hydraulic fracturing process; or could leak from the well casing itself somewhere closer to the surface.

The geology in Pennsylvania and New York, they said, is tectonically active with faults and other pathways through the rock. They noted that leaky well casings were the most likely cause of the contamination but couldn't rule out long-range underground migration, which they said "might be possible due to both the extensive fracture systems reported for these formations and the many older, uncased wells drilled and abandoned [9]."

The water was also analyzed for signs that dangerous fluids from inside the gas wells might have escaped into water supplies. The group tested for salts, radium and other chemicals that, if detected, would have signaled that the produced water or natural fluids in the well's target zone were making it to the aquifers. But those types of fluids were not found. The group did not test for fracking chemicals or hydrocarbons like benzene, relying instead on the saline or radioactive compounds like radium as indicators.

In an interview, Jackson said that gas was more likely to migrate underground than liquid chemicals. Based on his findings, he doesn't believe the toxic chemicals pumped into the ground during fracturing are likely to end up in water supplies the same way the methane did. "I'm not ready to use the word impossible," he said, "but unlikely."

In a white paper [10] the group issued along with the journal article, Jackson and the others acknowledged the uncertainty and called for more research. "Contamination is often stated to be impossible due to the distance between the well and the drinking water," they wrote. "Although this seems reasonable in most (and possibly all) cases, field and modeling studies should be undertaken to confirm this assumption. [2] ... Understanding any cases where this assumption is incorrect will be important—when, where, and why they occur—to limit problems with hydraulic fracturing operations."

A hydrogeologist closely affiliated with the drilling industry raised questions about the study. "It's possible, assuming their measurements are accurate, that all they have done is document the natural conditions of the aquifer," said John Conrad, president of Conrad Geosciences in Poughkeepsie, N.Y. Conrad spoke with ProPublica at the suggestion of Energy In Depth, a drilling industry advocacy group, but said that he did not work for EID.

He said that the thermogenic methane—which many scientists say comes from the same deep gas layers where drilling occurs—could be naturally occurring. He also said the researchers didn't test enough wells to support their conclusions, though he could not say how many wells would have been appropriate.

Conrad said the most likely cause for the contamination identified by the Duke researchers—that the gas was leaking out of faulty well casings—seemed implausible.

"For their assumptions to hold up there would have to be more than just the occasional bad cement job," he said. "They are implying that where you see hydraulic fracturing you should expect to see elevated methane. We are aware of faulty cement jobs. But we don't believe that it is common and we certainly don't believe that it is universal."

The Duke study precedes a national study by the Environmental Protection Agency into the dangers of hydraulic fracturing that is expected to be finished sometime next year. Last year the EPA found that [11] some chemicals known to be used in fracturing were among the contaminants detected in 11 residential drinking water wells in Pavillion, Wy.—where more than 200 natural gas wells have been drilled in recent years—but that investigation is continuing and the scientists haven't concluded that the contamination is linked with drilling or hydraulic fracturing.

The release of the Duke research could immediately shape the increasingly intense public debate over drilling and hydraulic fracturing, especially in some of the areas where the research was conducted. Pennsylvania, which holds drilling companies liable for drinking water contamination within 1,000 feet of a gas well, might consider the fact that the Duke researchers found the contamination extended to about 3,000 feet, Jackson said. New York State has a moratorium in place for hydraulic fracturing of horizontally drilled wells—which

cover more area and require more chemicals—through the end of June to allow for more consideration of the risks. “I would extend that at least temporarily,” Jackson said.

Congress, too, is taking note.

"This study provides eye-opening scientific evidence about methane contamination and the risks that irresponsible natural gas drilling poses for drinking water supplies,” said Congressman Maurice Hinchey, D-N.Y. “It provides yet another reason why more study of the environmental and health risks associated with hydraulic fracturing is needed."

Hinchey is one of several Democratic members of Congress who recently re-introduced the FRAC Act [12], which calls for public disclosure of the chemicals used underground. The bill, which is currently languishing in the House, would remove an exemption in federal law that prohibits the EPA from regulating hydraulic fracturing.

May 9: This story has been updated to include information from John Conrad that was received after publication.

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