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The Shale Revolution and Water Quality

Daniel Raimi*

One of the first, and still one of the most prominent concerns over shale development has to do with the risks to water quality from hydraulic fracturing. To date, there are very few cases—perhaps as few as one or even zero—where underground fracturing activities have credibly been linked to damage of drinking water sources. However, a number of other aspects of oil and gas development have the potential to negatively affect drinking water sources, and there are hundreds of well-documented cases of such contamination.

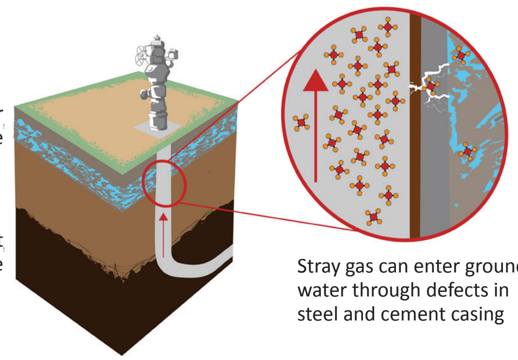
Fracking Chemicals

Early concerns over the risks of hydraulic fracturing centered on the potential for proprietary chemical formulas to infiltrate drinking water sources. However, shale development typically occurs at depths far below the water table (typically 3,000 to 10,000 feet), and the likelihood of fracturing chemicals to migrate upward into drinking water sources is extremely small. There is one case in Pavillion, Wyoming, where fracturing occurred at unusually shallow depths (roughly 1,200 feet), where researchers have gathered fairly compelling evidence of chemicals and hydrocarbons leeching into drinking water sources, possibly from underground fracturing activities and possibly from leaking wastewater storage ponds.

In another case from Bradford County, Pennsylvania, chemicals used in hydraulic fracturing have been detected in drinking water sources. Again, the pathway of contamination is not entirely clear, but a 2015 academic study hypothesized that improper gas well construction was the possible cause for the chemical 2-n-butoxyethanol migrating into a nearby drinking water source. In this case, the concentration of the chemical in question was not hazardous to human health.

Stray Gas

A more common risk to water sources from oil and gas development—regardless of whether hydraulic fracturing is involved—comes from methane migration, or "stray gas." Stray gas refers to methane entering groundwater due to improper well construction, typically due to faults in an oil or gas well's steel casing or the cement that surrounds it. If concentrations of methane are high enough, water sources can become flammable, as illustrated in widely-circulated scenes in film and television. Importantly, methane can occur



Stray gas can enter ground water through defects in steel and cement casing

RFF researchers in 2013 surveyed 215 experts across stakeholder groups on key risks. Top water-related priorities included on-site pit and pond storage, freshwater use, and wastewater management. For details, see *Pathways to Dialogue: What the Experts Say about the Environmental Risks of Shale Gas Development* (www.rff.org/research/publications/pathways-dialogue-what-experts-say-about-environmental-risks-shale-gas).

* This is one of a series issue briefs based on *The Fracking Debate: The Risks, Benefits, and Uncertainties of the Shale Revolution* (Columbia University Press, 2017) by Daniel Raimi. Raimi is a senior research associate at Resources for the Future.

naturally in groundwater, and in many cases, flammable water is a naturally occurring—rather than a human-caused—phenomenon.

Data on the prevalence of stray gas is limited. However, in 2010 in Pennsylvania, for every 100 new shale wells drilled, there were 0.8 new cases of stray gas. Over the next several years, the prevalence of these cases consistently declined such that by 2015, there were 785 new shale wells drilled with zero new cases of stray gas. A 2011 study from Texas and Ohio estimated that the rate of groundwater contamination from errors in casing and cementing was 0.02% and 0.06%, respectively. Despite these small percentage figures, the tens of thousands of wells drilled each year in the United States means that hundreds of water sources have likely been affected.

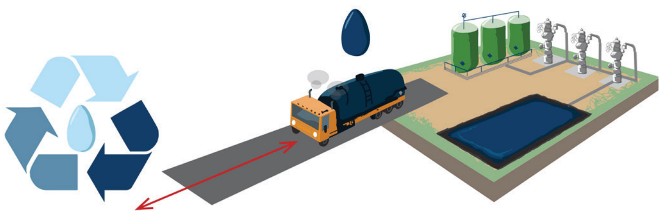
Spills and Wastewater

A more common risk comes from contaminants spilled at the surface, which may migrate downward into water sources. Spills of fracturing chemicals, oils, or wastewater may occur due to human error or equipment failure at well sites, from pipelines, or from traffic accidents involving industry trucks. Of roughly 400 cases of groundwater contamination caused by oil and gas production activities occurring over decades in Texas and Ohio, an analysis of state regulatory records identified leaks and spills of oil and wastewater as the most common causes of contamination.

In Pennsylvania, the state Department of Environmental Protection has, on numerous occasions, issued large fines to companies for contamination related to improper wastewater management. In addition, dozens of anecdotes and news reports document vehicle accidents involving industry trucks that have resulted in spills of wastewater, oil, and fracturing chemicals.

Managing Wastewater

While it is unrealistic to expect zero spills or leaks from oil and gas activities, a number of steps can be taken to reduce risks. For example, the use of tank batteries (rather than pits or ponds) for the storage of wastewater has the potential to reduce the risk of



spills and leaks into the surrounding environment. If pits or ponds are used, synthetic liners and other protections can reduce the risks of wastewater leaching into the soil and, further, migrating to water sources. In some regions, operators are increasingly recycling wastewater for use in subsequent fracturing operations. If these recycling operations reduce the distances traveled by trucks carrying wastewater (compared to the distance required to transport wastewater to disposal wells), it would reduce risks of accidents leading to spills.

The Role of Regulation

As oil and gas production has grown, state regulators—who take the lead on developing and enforcing rules for shale development—have at times struggled to keep up. For example, insufficient treatment of wastewater in Pennsylvania during the early days of Marcellus shale development led to the release of water contaminated with high levels of salts and other pollutants into local rivers. In California, regulators allowed the injection of oilfield wastewater into aquifers that could potentially be water sources in future years.

While these problems have since been addressed, they highlight the importance of high quality regulations and enforcement. To develop protective and cost-effective rules, state regulators and enforcement officers require high-quality training and access to the best available research. As oil and gas technologies continue to evolve, this will require an ongoing commitment by states to provide their regulators with the necessary tools to develop and implement smart rules.