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## Hydraulic Fracturing and Your Health: Water Contamination

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### What is Fracking?

High-volume horizontal hydraulic fracturing, commonly known as “fracking,”<sup>a</sup> is a method of extracting natural gas and oil extraction from deep underground bands of porous rock.

The fracking process forces a mixture of water, sand, and chemicals underground under high pressure, fracturing deep rock formations. Bubbles of fossil fuel trapped in the rock are freed to enter the well and make their way up to the surface. The rock is usually shale, which is why the captured substance is called “shale oil” or “shale gas.”

Industry sources estimate that an estimated 35,000 wells in the U.S. are now using the hydraulic fracturing method.<sup>1</sup> These wells are located across the U.S., with significant concentrations in the Marcellus Shale (PA, NY, OH, MD, WV, VA, NJ, KT, TN), the Bakken Shale (ND, MT), the Haynesville Shale (AR, LA, TX), the Eagle Ford Shale (Southern TX), and in Colorado, Wyoming, New Mexico, Kansas, and the Gulf of Mexico.<sup>2</sup>

### Water: Massive Consumption, Massive Contamination

Fracking operations consume and contaminate enormous quantities of water. In order to fracture a *single* well site, natural gas companies typically

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<sup>a</sup> We use the term “fracking” to refer to both the process of fracturing the rock formations, and the associated operations that extract, process and transport the natural gas or oil. This encompasses land clearing, well drilling, construction of the well



use over 4 million gallons of water. This amount of water is equivalent to what 11,000 American families use in a day.<sup>3</sup> Such intensive water use has become an issue in states such as California, which is experiencing a historic drought, and places hydraulic fracturing in competition with other consumers of water including households, agriculture, industry, and recreation. Nearly half of all fracking operations occur in areas with high or extremely high water stress.

Hydraulic fracturing combines water with an array of chemicals, some of which are carcinogenic, endocrine-disruptive, or otherwise toxic. The result is the contamination of huge quantities of water, with potential immediate and long-term threats to health. Only a fraction of this water (an estimated 20 to 40 percent) is brought back up to the surface, where it is classified as wastewater.<sup>4</sup> It is estimated that oil and gas operations in the U.S. produce more than two billion gallons of fracking wastewater a day.<sup>5</sup>

casing, flaring, wastewater extraction and storage, processing, compression, disposal of wastes, and transportation. While the process presents risks to health at many steps, we focus here on impacts on water.

## Selected Chemicals of Concern in Hydraulic Fracturing Fluid

|                 |  |
|-----------------|--|
| Benzene         | Known carcinogen. May cause anemia; can lessen white blood cell count, weakening the immune system. <sup>6</sup> Prolonged exposure may result in blood disorders like leukemia, reproductive and developmental disorders, and other cancers. <sup>7</sup> |
| Toluene         | Long-term exposure may affect the nervous system, cause irritation of the skin, eyes, respiratory tract, and birth defects. <sup>8</sup>   |
| Ethylbenzene    | Long-term exposure may result in blood disorders. <sup>9</sup>   |
| Xylenes         | Short-term exposure to high levels may cause irritation of the nose and throat, nausea, vomiting, gastric irritation, and neurological effects. Long-term exposure at high levels may affect the nervous system. <sup>10</sup>                             |
| Methanol        | Exposure can result in blurred vision, headache, dizziness, and nausea. <sup>11</sup>  |
| Napthalene      | May cause abdominal pain, nausea, vomiting, and fever. Chronic exposure can result in coma, confusion, convulsions, tachycardia, low blood pressure, and/or jaundice. <sup>12</sup>  |
| Formaldehyde    | A probable human carcinogen. Chronic exposure associated with lung and throat cancer. <sup>13</sup>  |
| Acrylamide      | A probable human carcinogen. Short-term exposure may cause damage to the nervous system. <sup>14</sup>   |
| Ethylene Glycol | At high exposures, may affect the central nervous system, heart and kidneys. <sup>15</sup>   |

Despite high-volume use of chemicals in fracking, only partial information is available on what these chemicals are or how they can affect health. Some companies engaged in hydraulic fracturing will not identify the chemicals they use, citing confidential business information (“trade secrets”). Others cannot identify the

chemicals because they receive them as a pre-mixed chemical cocktail. The Endocrine Disruption Exchange examined the toxicity of 353 chemicals used in fracking. Of those, they found that 25 percent can cause cancer and mutations; 37 percent affect the endocrine system; 40 to 50 percent affect the brain, kidneys, and nervous, immune, and cardiovascular systems; and more than 75 percent affect the skin, eyes or other sensory organs, and the respiratory and/or gastrointestinal system.<sup>16</sup>

## Naturally Occurring Toxics Coming to Surface with Fracking Water

|                          |  |
|--------------------------|--|
| Arsenic                  | Can cause stomach pain, partial paralysis, blindness, and cancer of the bladder, lungs, skin, kidney, nasal passages, liver, and prostate. <sup>17</sup>   |
| Strontium                | Linked to bone cancer, cancer of the soft tissue near the bone, and leukemia. <sup>18</sup>  |
| Iron and Magnesium       | Low levels of exposure may cause diarrhea, nausea and abdominal cramping. High levels of exposure may cause nausea, vomiting, depression, muscle weakness, difficulty breathing, extreme hypotension, irregular heartbeat, and cardiac arrest. <sup>19</sup> |
| Methane, Ethane, Propane | May cause rapid breathing, rapid heart rate, clumsiness, emotional upset and fatigue. At greater exposure, may cause vomiting, collapse, convulsions, coma and death. <sup>20</sup>  |
| Radon and Radium         | Radioactive elements for which long-term exposure via ingestion or inhalation increases the risk of developing lymphoma, leukemia and aplastic anemia; can increase risk of cancer in all tissues and organs. <sup>21, 22</sup>                              |

According to a 2011 Congressional report, of the 750 known fracking substances accounted for in the study, 29 of the most commonly used are dangerous enough to be regulated under the various environmental protection laws that

fracking has been exempted from, including the Safe Drinking Water Act and the Clean Air Act.<sup>23</sup>

Fracking wastewater combines withdrawn fracking fluids with naturally occurring brines – waters that contain salts and other substances brought to the surface from deep underground.<sup>24</sup> Natural brines are highly saline and may contain toxic levels of elements like barium, arsenic and radioactive radium.<sup>25</sup> This wastewater is categorized by the EPA as “special wastes” and as such is exempted from federal hazardous waste regulations under the Resource Conservation and Recovery Act (RCRA).

## **Pathways to Exposure**

### **➤ Contamination of Underground Aquifers**

Toxic fracking chemicals and wastes can come into contact with humans at numerous points in the fracking process, creating risks for health. One risk is the contamination of aquifers, which are huge natural reserves of underground water. Hydraulic fracturing pipes often pass through shallow aquifers. If well casings crack, fracking chemicals can contaminate the aquifer, which may be the sole water source supplying local wells. As a result, nearby residents may be subject to exposures as they drink water, cook, bathe, etc. (More than 15 million American households regularly depend on well water.)<sup>26</sup> In one study conducted in northeastern Pennsylvania, methane was detected in 82% of drinking water samples, with homes less than one kilometer from natural gas wells exhibiting average concentrations six times higher than those located far away. Ethane and propane were also found, again with higher concentrations close to fracking wells.<sup>27</sup>

### **➤ Surface Contamination**

When fracking wastes are returned to the surface, they can pose exposure threats to workers, local residents, and animals, as well as possibly

contaminating local surface waters and shallow groundwater. Exposure can arise from spills, leaks, unintentional and intentional releases. A few states still allow untreated wastewater to be sprayed on roads for dust control, or directly onto the land.

Holding ponds, where fracking wastewaters sit until disposal, are another potential source of exposure. These open-air pits may be located near households and agricultural sites, placing children, pets and farm animals at particular risk. Animals that drink water contaminated with fracking fluids may bring unidentified chemicals into the human food chain through the sale of their meat and milk.



### **➤ Wastewater Treatment and Disposal**

Fracking wastewater is generally so severely contaminated that conventional water treatment facilities cannot purify it.<sup>28</sup> Some wastewater is sent to desalination facilities, but these too may be inadequate to the task. A study of one such facility in western Pennsylvania, where treated water is discharged to local streams, found increased stream levels of chloride and bromide, as well as radium levels 200 times greater than background levels, exceeding radioactive waste disposal threshold regulations and posing potential risks of radium bioaccumulation.<sup>29</sup>



Due to the expense of proper disposal of fracking fluids, many drilling companies use misters to spray wastewater into the air so as to speed evaporation,<sup>30</sup> thus reducing the volume of waste fluids. This has the effect of transferring toxic substances from the water to the air, where they may cause harm to health via inhalation.

In the U.S., over 95 percent of fracking wastewater is pumped into injection wells.<sup>31</sup> Most are old oil wells where the wastewater is used to flush out additional oil. An estimated 30,000 injection wells, however, serve as permanent storage sites for fracking fluids.<sup>32</sup>

In some cases, the injection of large amounts of fracking fluids has been associated with earthquakes, including in Ohio<sup>33</sup> and Oklahoma,<sup>34</sup> which in November 2011 experienced a destructive 5.7 magnitude quake. Deep injection of wastewater is not permitted in Europe except for stimulation of gas and oil wells.

## PSR's Conclusion: Ban Fracking

Based on the dangerous toxicity of chemicals used in hydraulic fracturing, as well as the powerful impacts that methane has on the climate – it is a potent greenhouse gas, 86 times more powerful than carbon dioxide during its first 20 years in the atmosphere – and fracking's many other environmental health impacts, **Physicians for Social Responsibility calls for a ban on fracking and a rapid transition to cleaner, healthier, carbon-free sources of energy.** As we make that transition, the oil and gas industry must make significant changes in their operations, including: These changes would include (although would not be limited to) the following:

- Full and timely public disclosure of the chemicals and chemical mixtures they use, amounts of waste generated, and procedures used for waste disposal;
- Appropriate strategies to manage safely the threats to health and the environment. The costs of such health-protective measures should be assumed by industry and should not be paid by the general public; and
- Independent testing of water supplies and bodies of water during and after fracking, and full and timely public disclosure of findings.

**PSR**®

**Physicians for Social Responsibility**

1111 14<sup>th</sup> St, NW, Suite 700  
Washington, DC 20005

Tel: (202) 667-4260  
[www.psr.org](http://www.psr.org)

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<sup>1</sup> EnergyfromShale, “What is Fracking,” <<http://www.energyfromshale.org/hydraulic-fracturing/what-is-fracking>>.

<sup>2</sup> U.S. Department of Energy, U.S. Energy Information Administration, Form EIA-895A, “Annual Quantity and Value of Natural Gas Production Report,” EIA estimates based on data from the Bureau of Safety and Environmental Enforcement, and predecessor agencies; state agencies. <[http://www.eia.gov/dnav/ng/ng\\_prod\\_wells\\_sl\\_a.htm](http://www.eia.gov/dnav/ng/ng_prod_wells_sl_a.htm)>.

<sup>3</sup> Cusick, M., & Colaneri, K., “How Much Water Does It Take to Frack a Well?,” *StateImpact Pennsylvania*. 2013. <<http://stateimpact.npr.org/pennsylvania/2013/03/12/how-much-water-it-takes-to-frack-a-well/>>.

<sup>4</sup> The Institute for Energy & Environmental Research for Northeastern Pennsylvania, Marcellus Shale Information Clearinghouse, What is flowback, and how does it differ from produced water? <<http://energy.wilkes.edu/pages/205.asp>>.

<sup>5</sup> Jackson, R.B., et al., “The Environmental Costs and Benefits of Fracking,” *Annual Review of Environment and Resources*. 39.1 (2014).

<sup>6</sup> National Institute for Occupational Safety and Health (NIOSH), “Emergency Preparedness and Response: Facts about Benzene,” *Centers for Disease Control and Prevention*. 14 Feb 2013. <<http://www.bt.cdc.gov/agent/benzene/basics/facts.asp>>.

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<sup>10</sup> “Outdoor Air – Industry, Business, and Home: Oil and Natural Gas Production – Additional Information.” *United States Environmental Protection Agency*. 19 Mar 2014. <[http://www.epa.gov/oaqps001/community/details/oil-gas\\_addl\\_info.html](http://www.epa.gov/oaqps001/community/details/oil-gas_addl_info.html)>.

<sup>11</sup> U.S. Environmental Protection Agency, Technology Transfer Network - Air Toxics Web Site, Facts about Methanol. <<http://epa.gov/ttnatw01/hlthef/methanol.html>>.

<sup>12</sup> MedlinePlus, A service of the U.S. National Library of Medicine, From the National Institutes of Health, Naphthalene poisoning. <<http://www.nlm.nih.gov/medlineplus/ency/article/002477.htm>>.

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<sup>14</sup> U. S. Environmental Protection Agency, “Acrylamide: Hazard Summary,” *EPA*. Jan. 2000. <<http://www.epa.gov/ttnatw01/hlthef/acrylami.html>>.

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