Environmental Assessment of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources by the Environmental Protection Agency

Technical Review Memorandum by
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This review of the Environmental Protection Agency's Environment Assessment of Hydraulic Fracturing ("the EA") focuses on the radioactivity aspects of wastewater and primarily on Chapter 8. For the United States as a whole, the large majority (98%) of wastewater is disposed in deep wells, but there are a limited number of deep wells in the East.

In Pennsylvania, in particular, there are only nine deep wells available for disposal. This raises an important question. What is being done with the tremendous volume of wastewater that is being produced in Pennsylvania and is not being recycled; is the radioactive material in this wastewater being safely disposed? Clearly some out-of-State deep wells, in Ohio, for example, are being used; the full extent is not laid out by the EA.

More precisely, about 4 to 5 million gallons of water are used per unconventional well (Vengosh, et al, 2014). About 10% to 25% of injected volume is returned as flowback or produced water. Operators reuse a substantial amount - 70% to 90% - of Marcellus Shale wastewater in Pennsylvania. So, much is being recycled, but this leaves a large volume of wastewater that must be managed.

Our focus in this review of the Environmental Assessment (EA) is with the radioactivity in wastewater. This matter is treated lightly in the EA. Deep well disposal and reuse are methods of preventing Marcellus Shale radioactivity from reaching surface waters. But deep well disposal is limited in Pennsylvania.

As the EA has pointed out, the disposal percentages in Pennsylvania have changed over time. According to the EA, in the years 2009-2010, for 216 million gallons of waste

water, 10% was reused, 23% was sent to publicly owned treatment works (POTW), 52% was sent to centralized waste treatment facilities (CWT) and 2% to other (?). In the year 2013, for 1.3 billion gallons of waste water, 65% was reused, 0% to POTW following a request by Pennsylvania Department of Environmental Protection (PADEP), 20% was sent to CWT, and 0.5% other. This decline in volume to POTW was due to stricter Total Dissolved Solids (TDS) discharge limits at POTW's and voluntary compliance by oil and gas operators to a request from PA DEP to cease sending wastewater to treatment plants (Rahm et al, 2013).

Thus, the percent to POTWs went to 0% and the percent reused was dramatically increased, but the total amount to CWT's, from a radiological perspective, was not so positive, as we discuss below. Twenty percent of 1.3 billion gallons of wastewater in 2013 was still 260 million gallons of wastewater, a large volume of contaminated fluid.

It is acknowledged that Marcellus Shale contains naturally occurring radioactive material (NORM) at concentrations much higher than at background at the earth's surface. The radium-226 in the shale itself on average can be 30 times more radioactive; the interstitial liquids within the shale, the brine, can be up to 25,000 picoCuries per liter (pCi/L), compared to the drinking water standard[1], 5 pCi/L. In Pennsylvania, Raduim-226 concentrations in unfiltered samples were elevated, ranging from 40.5 to 26,600 pCi/L. Radium-228 concentrations were also elevated, ranging from 26.0 to 1900 pCi/L (PADEP 2014).

In production pipes in wells, feeder lines, and condensate tanks, radium, which is generally in solution in underground formation, may plate out on pipes, that is, form a scale when brought to the surface. The gamma emissions from these pipes are a hazard to workers and the general public. This gamma hazard is not seriously discussed or in any way addressed in the EA and is an important issue; it has been the subject of numerous lawsuits in Louisiana, Texas and Mississippi.

At pipe-cleaning facilities, radium scale has gotten into the air, been inhaled by workers, and has caused cancers to workers. When inhaled or ingested, radium concentrates in the bone and can cause leukemia and other cancers. The EA does not discuss or acknowledge the health effects of radiation. Just a fraction of the radium from Marcellus shale forms a scale; the remainder is in solution and is a problem for CWT's.

The EA discusses several "residuals" from CWT's that provide a hint at the decontamination methods being employed at these facilities. While we cannot know for certain what methods are being used, we are fairly confident that radium will not be removed and will not be safely secluded from the environment under current practices.

[1] 40 CFR 141.66(b)

The most basic treatment at CWTs is to remove suspended solids. Radium in solution would not be removed by this treatment process. According to the EA, residuals can consist of sludges from precipitation, filtration, settling units and biological processes, and spent media from ion exchange and membrane processes.

According to studies by PA DEP, none of these "residuals" has a marked increased concentration of radium. That is, evaporation or filtration or biological techniques have not separated out radium. Radium must be somewhere else; it cannot disappear. Radium must still be contained in some medium and must be addressed to protect the public and the environment.

Two known methods for separating radium have been in use for over fifty years at uranium mills. One method is to convert radium from liquid form into a solid with barium sulfate. As a solid, radium can be filtered and the radium concentrate can be properly disposed at low-level radioactive waste facilities (llw). Such facilities operate in Utah and Texas. The presence of high concentrations of total dissolved solids (TDS) is a complicating factor. Another complicating factor is the cost.

It is not obvious in the EA that CWTs are converting radium to a solid form and filtering it out. We have not seen evidence that gas companies are transporting radium concentrates to llw facilities..

Another method of use at uranium mills, primarily in the southwest, is to dispose of the wastewater, called uranium mill tailings, in the pits from where the uranium ore arose, and to use evaporation techniques, to dry the tailings to a sand-like consistency. This is clearly not an ideal method and not a method that can be employed where people live. The populous Northeast is obviously not suitable.

At the present time, aside from reuse and deep well injection, wastewater from unconventional wells drilled in the Marcellus Shale is going to CWTs, and the fate of radium is unknown. When processed at a CWT, it ends up as "residuals" or something else. Neither the PADEP nor the EPA knows the full extent of the ultimate disposition of these hazardous materials.

EPA should conduct a Ra-226 audit to discover the ultimate fate of radium in this waste stream. This can be done by measuring and quantifying the amount of Ra-226 in curies that has been brought up from Marcellus Shale in flowback and produced water and determine its fate and transport into scale, into "residuals," into landfills and pits, and into the surface waters of the Commonwealth. The equation should balance if all radium is accounted for. If not, further investigation must be done to find the ultimate repository for all radioactive materials that are being brought from deep formations to the surface through hydraulic fracturing for shale gas.

References:

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