STAC Workshop Summary:
Exploring the Environmental Effects of Shale Gas Development

Water Resource Issues Associated with Shale Gas Development in the Chesapeake Bay Watershed

MAY 2013

Exploitable Marcellus Shale gas resources underlie 43 percent of the Chesapeake Bay watershed, including 85 percent of the Susquehanna River Basin. Currently, the Chesapeake Bay Program's Total Maximum Daily Load (TMDL) does not account for the potential pollution loads that could occur due to shale gas activities in the watershed, and the Chesapeake Bay Watershed Model (CBWM) does not include a land use class for well pad/pipeline infrastructure. The Chesapeake Bay watershed states are largely in charge of regulating hydrofracturing industries within their borders, and all of the states are treating the land disturbances and potential hydrological and water quality impacts differently.

What Research and/or Monitoring is Needed to Prepare for the Environmental Effects of Shale Gas Development?

Current monitoring systems were not designed for Marcellus extraction activities, and although the Susquehanna River Basin Commission (SRBC) has maintained real-time water quality collections for shale gas contaminants since 2010, private well water data are not included, making it difficult to analyze localized environmental effects. Further, the lag time between when the input of a possible contaminant is first made to the environment, and when it is actually observable in streams makes detection more difficult. Loadings from extraction activities are especially important because they affect local water quality conditions, which might alter a jurisdiction's ability to meet TMDLs, requiring implementation of new or additional Best Management Practices (BMPs). Hence, additional site-associated monitoring is required. (Re: groundwater, there is no evidence of contamination from fracking chemicals and processes on a national scale).

Who is Monitoring Water Quality and Fracking Operations?

Although under consideration, the EPA does not require reporting of additives in water used for fracking, and monitoring water quality effects from shale gas development is divided in Pennsylvania. Water quality is regulated by the Pennsylvania Department of Environmental Protection (PA DEP) whereas the SRBC focuses only on water quantity issues within the Susquehanna watershed, and "does not regulate the treatment or disposal of wastewater, drilling fluids, flowback, or production fluids" (J. Richenderfer, SRBC). The SRBC regulates the shale gas industry with the first gallon used, i.e., all water uses by the industry are regulated whether from groundwater withdrawals (nominal), surface withdrawals (80%), or from public water systems (20%).

How Much Water is Needed for Fracking and Where Does it Come From?

Water use is high. "Between three to seven million gallons of water are used when fracking a well. Approximately 8-10% of the injected volume returns to the surface as flowback water. While the volume of flowback decreases over time, the total dissolved solids (TDS) of that water increases" (D. Yoxtheimer, PSU).

To frack one well in Pennsylvania, the following was required: "3.81 million gallons of water, 4.57 million pounds of sand, 1,333 gallons of hydrochloric acid, 1,695 gallons of a friction reducer, 2,211 gallons of an antimicrobial agent, and 386 gallons of a scale inhibitor (which includes ethylene glycol, a component of antifreeze)" (Penn State University Extension, College of Agricultural Science). The shale gas industry points out that these chemicals make up about 0.5 percent of the total fracking fluid injected into a well, but the precise mixture of chemicals has been listed as proprietary information by some companies.

About 80% of this water used is drawn from surface water located around the drill sites, but water is also trucked to other locations. Most of this water is recycled according to the industry, but the PA DEP reported in 2011 that only about 38% of fracking wastewater was being recycled (A.R. Ingraeffa, Cornell University).

By 2012, new data analysis showed that up to 90% of flowback water was reused, with approximately 10% deposited in disposal wells (Yoxtheimer et al.). Currently, shale gas extraction operations in the watershed require about 12 million gallons of water per day, and that is expected to rise to 30 million gallons per day at full well build-out during peak demand.

What Can We Learn from Arkansas' Experience with Shale Gas Development?

Researchers at the University of Central Arkansas (UCA) conducted studies of well development density and distance to surface waters, showing correlation between the location and number of well pads and changes in variables such as turbidity, suspended sediments, metabolism, and macroinvertebrate community metrics in nearby waterways. In areas with greater well density, turbidity increased, though results varied by storm event. This demonstrates that storm intensity, duration, and antecedent conditions may influence runoff quality and volume.

These studies also found a seasonal correlation between stream chlorophyll-a production in areas with high well density, as well as an increase in macroinvertebrates more suited for high nutrient and sediment loads (S. Entrekin, UCA). More research is needed as there are no long term data and still many confounding variables such as intense animal operations, cropland locations, etc.

How Will Pipeline and Drill Pad Infrastructure Affect Sediment Loads and the Surrounding Environment?

In the Susquehanna River Basin alone, 27,600 new wells are expected to be drilled by 2030, each accommodating 4 to 10 wells, with 10,000 to 25,000 miles of gas pipelines installed. This creates a total spatial footprint of 45,000 to 115,000 acres, with "edge effects" influencing a total of up to 520,000 acres of forested lands (Nels Johnson, The Nature Conservancy), "…allowing invasive species to infiltrate, and detrimentally impacting wildlife habitat."

Epilogue

There has been considerable additional information presented at workshops and meetings since the STAC workshop in 2012, with continuing investigations in PA and other natural gas-rich areas of the eastern states. Additionally, the Center for Sustainable Shale Development was formed as a coalition between the industry and several environmental organizations to develop guidelines for gas extraction, publication of chemical compositions of fracking solutions, and operating procedures to reduce potential environmental impacts (http://www.sustainableshale.org). Most recently, the EPA has announced requirements for future natural gas extraction, with some early resistance from both the industry and environmental organizations (Proposed Rule - http://www.gpo.gov/fdsys/pkg/FR-2013-04-12/pdf/2013-07873.pdf; Fact sheet - http://www.epa.gov/airquality/oilandgas/pdfs/20130328fs.pdf). As demand for inexpensive energy sources expands, natural gas extraction and possible environmental impacts will become even more important, with risk assessments likely as more land is disturbed for pad and pipeline construction, well drilling, and transportation of construction materials and fracking fluids.

Recommendations from April 11-12 STAC workshop entitled, "Exploring the Environmental Effects of Shale Gas Development in the Chesapeake Bay Watershed"

Recommendations to the Chesapeake Bay Program and its partners:

- Evaluate existing monitoring data to begin to assess the impact that Marcellus Shale drilling, production, and transport activities may have on sediment loading to the Bay.

- Implement monitoring of nitrogen deposition which may be very high locally near gas rigs, compressor stations, and processing plants.

- Add infrastructure associated with Marcellus Shale gas drilling, production, and transport into Chesapeake Bay land cover/land use maps.

- Investigate if any existing CBWM land uses may be appropriate for simulating the land uses associated with these Marcellus Shale gas play activities by undertaking simulations with a range of parameter values.

- Investigate if the sediment loss from dirt and gravel roads used for gas development and production are effectively simulated in the CBWM.

- Provide a framework to centralize the data for well pads, pipelines, road ways, and rapid land use/cover changes.

- Investigate any scale-effects (cumulative effects) associated with using the CBWM to effectively simulate the sediment loading from Marcellus Shale drilling, production, and transport activities.

- Investigate how the Marcellus Shale gas play may affect land use/land cover future projections, and in turn, how those adjusted projections affect nutrient and sediment loads to the Bay.

- Implement real-time monitoring at headwaters where Shale gas development is taking place or proposed.

Recommendations to Industry, Scientific, and Policy-Making Communities

- Federal agencies should take the initiative to monitor and conduct research on Shale gas development, recognizing that funding and coordinating such activities will be a challenge.

- A more local focus for monitoring and research should be taken because the Partnership cannot wait for the lag time to observe a larger Bay-wide impact.

- More research should be done on metals and other pollutants that are not included in the TMDL.

- Data on pad and pipeline locations and installation and operation periods need to be centralized.

- The industry should implement set back distances for pads from water bodies, maintain riparian buffers, and implement all mandatory and voluntary BMPs in order to lessen the cumulative impact to the Chesapeake Bay.

- Does Pennsylvania (PA) regulation for oil and gas activity include BMPs? If not, the PA Department of Environmental Protection (DEP) should encourage that BMPs are used or are amended and developed as necessary.

- States should change the permitting process to be project-based rather than individual site-based and to require that permits provide potential build-out scenarios to provide better potential cumulative effects information.

- Industry personnel and state regulators signing permits must be required to have BMP implementation/certification training.

All information provided and cited in this factsheet can be found in: STAC (Chesapeake Bay Program Scientific and Technical Committee). 2013. Exploring the environmental effects of Shale gas development in the Chesapeake Bay Watershed. STAC Publ. #13-01, Edgewater, MD. 30 pp. http://www.chesapeake.org/pubs/297_Gottschalk2013.pdf