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Feb. 28, 2011

Re: Additional Comments on Hydraulic Fracturing Study Plan Review Panel

Dear Mr. Hanlon:

I represent the Delaware Riverkeeper Network and the Delaware Riverkeeper, Maya van Rossum. We submitted a comment letter dated February 25, 2011, as well as eleven expert reports addressing various impacts to water resources implicated by the construction and installation of vertical wells intended for natural gas exploration and production in the Marcellus Shale contained within the Delaware River Basin.

Please accept these additional comments on the Environmental Protection Agency's Hydraulic Fracturing Study for consideration by the Plan Review Panel. In drafting these comments, we have relied heavily on input from Mr. Richard A. Raiders, a law student in our clinical program who has B.S. and M.S. degrees in petroleum engineering and more than twenty-two years of experience working in the field of environmental engineering and compliance.

The Environmental Protection Agency (EPA) Science Advisory Board (SAB) has proposed a draft work plan to study the effect of hydraulic fracturing of gas bearing formations on surface- and groundwater resources through various retrospective, prospective, and research studies. The proposed EPA work plan addresses many important issues. However, EPA must improve the proposed work plan to include and address critical issues related to natural gas development through hydraulic fracturing that have potentially significant deleterious effects on drinking water and the communities that rely on sources of safe drinking water. These effects may stem not only from the deliberate, intentional use of water in the hydraulic fracturing process, as the current study plan focuses on, but also the various impacts on drinking water from well construction and associated infrastructure development and non-intentional contamination through accidents or failure to adhere to appropriate environmental standards.

Radioactive Contamination from Wastewater and Other Drilling-Related Sources

According to the reporting by Ian Urbina in the New York Times dated February 27, 2011, titled Regulation Lax as Gas Wells' Tainted Water Hits Rivers, EPA already has studies or evidence in its possession that demonstrate that wastewater from hydraulic fracturing operations may be highly contaminated with NORM and is being sent to treatment plants that are not equipped to treat such waters to drinking water quality standards. The article also cites information obtained from industry sources concluding that the radioactivity in fracking waste cannot be fully diluted in rivers and other waterways. Moreover, as the article reported, these plants are not being required by the States or by the EPA to test for the presence of such radioactive materials.

See http://www.nytimes.com/2011/02/27/us/27gas.html

and documents cited therein.

The potential for contamination of drinking water with radioactive substances via hydraulic fracturing wastewater is obviously extremely significant. As such, the EPA must expand the focus of the study's section on the treatment and disposal of fracking wastewater to analyze this issue in detail. It is incumbent on the EPA to include, as part of this study, testing of wastewater before and after treatment at water treatment facilities for contamination by radioactive materials.

Radioactive materials present in wastewater also pose the risk of contamination to drinking water sources via accidental spills, leakage from in-ground pits, and injection into underground disposal wells. EPA should ensure that all stages of its analysis take into account the risks that NORM-contaminated wastewater and other materials produced during the natural gas development and extraction processes pose to drinking water quality.

Well Data

EPA appropriately proposed to study production well failures, suspected contamination, and coalbed methane issues. However, well construction and fracture design may affect the impact of the fracturing process on nearby water quality. If an oilfield service company overstimulates a well, either accidentally or by design, the fractures created during the hydraulic fracturing project could propagate beyond the target formation. If the service company fractures the cap formation, and possibly other formations preventing fracturing or production fluids from entering potable water supplies, these oilfield activities could cause indirect long-term water supply problems.

Likewise, EPA should collect any available recompletion data for any shale gas wells. Second attempts to fracture a well rely on the original fractures to provide avenues for produced gas to be captured by a production well. Because the formation is already fractured, the service company performing the fracture may have less control over

where a refracture may spread. Recompletion procedures could also weaken wellbore cement, potentially causing unwanted fluids to travel through the well annular space and possibly into potable water formations. EPA should understand, using actual well data or simulation models, how contemporary refracture and/or recompletion practices may breach either cap rock formations or the wellbore.

EPA should also collect any historic or contemporary cement bond log information, especially for surface casing intended to protect potable water supplies. EPA should inquire if cement bond log data is available for shale gas wells, especially wells known or suspected to have failed and wells in the vicinity of known or anticipated potable water supply problems. In addition, EPA should collect data concerning the use (or lack of use) of centralizers in surface casing. If operators are not collecting cement bond log data from current wells, EPA should request that operators begin to log shale gas wells right after the operator sets the surface casing. Centralizer use and application data would allow EPA to evaluate the relationship between casing position, cement integrity, and well failure in the fate of potable groundwater supplies. Such data would allow EPA to understand if and how casing, cement, or centralizing problems affect sources of drinking water either at the surface or below ground.

Water Acquisition

The proposed water acquisition research studies would provide valuable knowledge for decision-makers in upcoming hydraulic fracturing related regulations. EPA's focus on drinking water supply, including cumulative impacts concerning multiple fracturing projects on a single waterway, appropriately captures one of the critical issues in this area. However, EPA should include goals to evaluate not only drinking water quality impacts, but also impacts on the various ecosystems in the affected watersheds. Seemingly insignificant changes in water quality can have a dramatic impact on several sensitive plant and animal species. Specifically, withdrawal of millions of gallons of water per well could cause increases in suspended solids, salinity, color, or temperature that could impact downstream ecosystems.

EPA's water acquisition studies should evaluate the impact of water withdrawals on downstream water quality. A trace constituent in a waterway that may not pose significant risk at current river flows could become a health hazard for downstream users at slightly higher concentrations.

The quality of streams and their ecosystems is directly related to the quality of surface water, affecting drinking water supplies drawn from the waterway. Therefore, EPA should also analyze the impact of water withdrawals from a surface water body on habitat for species dependent on the existing natural flow regime of the stream. As evidenced in the "Rules and Regulations for the Protection from Contamination, Degradation, and Pollution of the New York City Water Supply and its Sources" adopted by New York City for the protection of its source waters in the Delaware River watershed that flows to the City's reservoirs, one of three main causes of degradation and contamination to the City's source waters is "Urban, suburban, rural, mining,

silvicultural and agricultural land use practices that result in nonpoint source runoff of pollution and/or in adverse changes in the natural rate at which water flows into and through a delineated drainage basin". (Final Regulations, page 2)

Therefore, water flows must be analyzed as part of EPA's study. Changes in volume of flow as well as the natural variation and seasonal changes to a stream's regime directly impacts aquatic life - biota, fish, insects, etc. - as well as wildlife and flora and fauna populations that have adapted to natural stream conditions. Additionally, stream morphology is impacted by changes in flow, impacting stream life, downstream volume and rate of flow, and water quality. Withdrawals can also impact groundwater and aquifer recharge and base flow quality conditions of hydrologically connected surface waters and water-dependent features such as wetlands and verbal pools. Streamside shallow groundwater conditions can also be impacted. These hydrologically based and flow regime changes need to be evaluated and considered in water acquisition studies by EPA.

Impacts of Well Construction

As detailed in our letter of February 25, 2011, the impacts of vertical well construction as well as associated infrastructure cannot be discounted as a significant cause of drinking water quality degradation, particularly given the scale on which intensive gas development will alter the natural landscape, causing erosion, sedimentation, and stormwater issues on a large scale.

Best Management Practices for erosion and sedimentation control for pad development should also be reviewed by the EPA, since sediment pollution can severely affect benthic macroinvertebrates living in the stream and eliminate the habitat they need to survive by consolidating riffle habitats. Macroinvertebrates help filter out nutrients and other pollutants that directly affect the drinking water quality downstream. As richness and diversity of EPT (Ephemeroptera-Plecoptera-trichoptera species) are lost within the benthic community, so are the benefits they provide to drinking water downstream. As Dr. David Velinsky of the Academy of Natural Sciences has pointed out, this could create the need for more treatment procedures for drinking water downstream.

In the Delaware River Watershed, drilling is proposed for the most diverse headwater streams that remain in our Watershed and therefore, is a great potential threat to the diversity that sustains our clean drinking water downstream where benthic life may already be less diverse due to historic development and impacts from stormwater and other land use changes.

The EPA should consider and track waivers and exemptions records and the frequency of these exemptions with the state permitting process for Oil & Gas. For example, state regulations may be put in place to include floodplain protections or setbacks from wetlands, but in reality, waivers may be applied for by the industry that would put these industrial activities in sensitive and unstable habitats that could affect drinking water.

Chemical Mixing

EPA appropriately proposes to study the hazards of various materials used, or potentially used, in hydraulic fracturing projects. EPA should expand this study to evaluate the full life cycle of water used at a well: drilling fluids, completion and fracturing fluids, and produced waters. Water used in each step of the process typically contains different added and naturally occurring water pollutants. EPA should attempt to understand the nature of how each fluid changes composition in use. This study would allow EPA to develop or optimize test methods to detect trace concentrations of potentially toxic or other pollutants in these streams. Current SW-846 analytical data may not provide the requisite sensitivity to detect materials known or suspected to be in fracturing or produced water. Matrix interferences from the clays typically found in drilling mud may complicate evaluate of toxic materials in drilling muds.

EPA should consider both acute and chronic risks in each class of aqueous streams generated during well drilling and production. Some of the materials identified in various water studies, including n-hexane, tetracholoroethylene, and naturally occurring radioactive materials (NORM) can exhibit toxic effects at very dilute concentrations. EPA should perform comprehensive analytical evaluations in several samples of produced and generated fluids, using the most sensitive analytical methods available, to determine what trace constituents may cause human health or other pollution harms.

EPA should then take this data and evaluate treatability of all constituents known or suspected to be contained in these fluids. Where current data exists, EPA could rely on such data. However, in some cases trade secret or other trace compounds could cause substantial potable water supply risks should they reach drinking water or surface water supplies.

In this proposed study area, EPA is missing a major opportunity to evaluate the actual need to use many very toxic materials in fracturing water. Some constituents are not expressly needed in this service. Operators, if requested, should be able to identify a variety of less toxic alternatives to the current additives practices.

EPA appropriately proposes to study spills that potentially impact drinking water quality. EPA should also collect data on well construction issues that negatively affect drinking water supplies. EPA should also identify and track best management practices (BMPs) used by drillers and fracturing contractors to determine if truly best practices are routinely being followed. Following existing state law may or may not adequately protect water supplies.

EPA should further evaluate flowback and produced water chemistry to determine if the dissolved materials in such water significantly change based on when the water is produced. Similarly, EPA should consider how to discern what constituents in produced water occur from surface activities, and which constituents naturally occur in-situ. EPA should also integrate information from wellbore and fracturing failure into this study. The

fate and transport of produced water, especially relating to wellbore or formation failure, will provide EPA with critical insight concerning future regulation of this industry.

As stated in our letter of February 25, 2011, EPA's study must also take into account chemicals that are neither naturally occurring nor used in the drilling or fracturing processes but that are created via interactions with these two classes of substances. We point to the example of 4 Nitroquinoline 1-oxide (4NQO), a powerful carcinogen that has been identified in wastewater produced by natural gas drilling. This chemical compound is not a drilling or hydraulic fracturing additive and it is also not found naturally in the geologic formations that produce flowback water during the stimulation process. Apparently, it is formed through interaction of the chemicals that are present in these fluids. This is one example, but there are potentially more such compounds that should be identified and addressed through EPA' study.

Injection

The proposed work plan will identify critical issues associated with fluid injection during fracturing operations. The proposed well failure analysis for known well failures will assist EPA in future rulemaking efforts. However, EPA should also study a control group of wells not believed to have failed to establish both if these wells exhibit adequate structural integrity and to provide as a control basis for the failed well study. The differences between a failed cement job and a successful well job can be subtle, which may only be determined by conducting cement bond logs on failed and control wells. For example, if the surface casing is offset in the wellbore by an inch or less, the cement fastening the surface casing into the wellbore may not adequately isolate potable water supply from fracturing fluids used during well completion. EPA should use statistical control methods to inform this analysis.

EPA should also review other pathways that may cause groundwater contamination. For instance, if a service company overpressures a formation during the fracturing process, the fracture may propagate beyond the design fracture location. EPA should study overfracturing and determine if overfracturing may affect overburden formations, up to and including potable water bearing formations. EPA should also review any relationship between high fracturing pressure and cement stability. EPA should review the cement strength used for surface casing cementing and final production casing cement projects, to determine if the junction between the surface casing and the production casing may be a cause of potential well failure. If fracture injection pressures exceed the maximum compression pressure that the cement may withstand, the cement, properly placed into a well, could still fail.

EPA should also review the presence or absence of coal seams or other soft formations that may occur near potable water formations and/or near the bottom of the surface casing. Soft formations like coal seams may be more difficult to seal during cementing operations than typical sandstones, limestones, and shales. EPA should also review other potential causes of formation breach, such as abandoned or plugged wells or other wells within one to two miles of locations where potable water supplies may have

been compromised. By conducting a comprehensive review of causes of potential drinking water contamination, EPA can advance the understanding of how shale gas drilling relates to groundwater contamination.

In reviewing mechanical integrity, EPA should review all downhole equipment, including casing materials of construction, any plugs used during drilling and casing installation, and any other downhole equipment. EPA should also review how various permitting authorities authorizing drilling determine the lowest potable water bearing formation to validate that current surface casing practices are designed to protect all potable groundwater resources.

EPA appropriately identifies degradation products of fracturing fluid components as a study goal. EPA also appropriately proposes to study the water contaminants carried out of the fractured formation during fracturing. EPA also proposes to begin the study of trace water contaminants in fracture water. However, EPA should review the ability of the current wastewater analytical methods to detect trace amounts of potentially toxic fracturing additives and in-situ contributors to fracturing water contamination. Method development takes significant planning and design time, and EPA should identify method development needs as soon as possible. The sooner EPA evaluates the toxicity of naturally occurring and fracturing additive water contaminants, the more valuable EPA's work will become.

Flowback

EPA appropriately proposes to review spill and pit leakage contributions to water contamination issues associated with hydraulic fracturing. EPA should review all available hydraulic fracturing models, well logs, and seismic data to determine where conduits between well fluids and groundwater resources may exist.

EPA should also evaluate water quality data from direct discharges and from indirect dischargers who route flowback to wastewater treatment facilities. The existence of treatment facilities may not indicate adequate wastewater treatment. Treatability is a critical element of mitigating pollution from flowback waters, especially in areas where operators rely on wastewater treatment plants not necessarily designed to manage these industrial wastewater streams. To better understand this issue, EPA should collect and analyze information concerning how flowback waters may be treated, and how much of the many pollutants are actually removed by wastewater treatment plants currently used to treat flowback water.

EPA has also conducted research that shows that aquatic invertebrates such as mayflies, for example, appear very susceptible to increased total dissolved solids. If gas drilling flowback water reaches streams through accidents and spills, large die offs of benthic macroinvertebrates could occur (US EPA Region 3 Freshwater Biology Team). Even in the absence of other stressors (pH, organic enrichment, habitat quality, metals) TDS/conductivity significantly explains impairment of aquatic life use. As stated above, the impairment of healthy ecosystems with flourishing aquatic invertebrate communities

may degrade drinking water quality and create the need for additional water treatment to bring waters back up to drinking quality standards.

Wastewater Treatment and Disposal

EPA proposes to use a chloride balance to evaluate salinity in produced and flowback waters. EPA should further study related salts, such as bromides, sulfates, fluorides, and other salts that may exhibit effluent toxicity upon discharge. EPA should also propose a study of less toxic alternative materials that operators may use to accomplish well completion goals while minimizing environmental risks. Less toxic drilling fluids, completion fluids, and fracturing fluids are likely available for use in drilling and hydraulic fracturing. EPA should take this opportunity to study the need for toxic additives such as perchloroethylene, n-hexane, and benzene in fracturing fluid systems. Further study will likely identify less toxic suitable additives. By delaying requiring less toxic alternatives in drilling and well completion, EPA unduly risks contaminating groundwater supplies with materials not needed to conduct drilling operations.

EPA also should study the fate of drilling cuttings on water quality. Drilling cuttings may be contaminated with a wide variety of added or naturally occurring wastewater contaminants that may leach out from Subtitle D landfills and onsite burial disposal facilities. EPA should study contamination levels in drilling cuttings and disposed drilling fluids, and evaluate what steps may be needed to isolate potential contaminants from groundwater and surface water supplies.

Finally, as stated at the beginning of this letter, it is critically important that the EPA's study conduct a detailed analysis of all waters produced by drilling and hydraulic fracturing for contamination with NORM and a detailed analysis of the fate of such contaminated waters and their impacts on sources of drinking water.

Thank you for the further opportunity to comment on EPA's draft study.

Very truly yours,

Jane P. Davenport

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