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League of Women Voters of Pennsylvania

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Delaware River Basin Commission
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Joint comments of the League of Women Voters of Delaware (LWVDE), New Jersey (LWVNJ), New York State (LWVNYS) and Pennsylvania (LWVPA) on Draft Regulations Addressing Hydraulic Fracturing

Submitted electronically at http://dockets.drbc.commentinput.com/?id=PGChb

The League of Women Voters of Delaware, New Jersey, New York, and Pennsylvania ("Leagues") jointly submit the following comments for consideration by the Delaware River Basin Commission ("Commission" or "DRBC"). These written comments supplement the oral testimony provided individually by our organizations at the public hearings convened earlier this year.

The League of Women Voters is a national non-partisan, public interest organization with state and local chapters in the four states comprising the Delaware River Basin ("DRB" or the "Basin"). The League takes positions on issues through study and consensus at the grassroots level.

The League supports policies that protect and conserve natural resources to ensure their future availability. The League further supports policies to ensure the safe treatment, transportation, storage and disposal of solid and hazardous wastes in order to protect public health, air, water and land resources. To this end, pollution should be controlled in order to protect and preserve public health and the physical, chemical and biological integrity of ecosystems.

The League further supports policies to protect the quantity and quality of current and potential drinking-water supplies and the integrity of ecosystems for maintaining species populations and diversity, including measures to protect lakes, estuaries, wetlands and in-stream flows. To support these outcomes, it is essential to protect drinking water watersheds and aquifer outcrop areas to allow for recharge of groundwater; prevent the depletion or pollution of water supplies; reduce non-point source pollution; and rigorously enforce stringent controls on point-source discharges.

Based upon these positions, our Leagues urge the Commission to implement the proposed ban on drilling in full and to also ban all activities related to hydraulic fracturing in the Basin including the importation of waste from the oil and gas industry and the exportation of water for use in hydraulic fracturing activities elsewhere.

Prohibition of hydraulic fracturing in the Delaware River Basin

The Leagues strongly support the Commission's determination that "controlling pollution by prohibiting high volume hydraulic fracturing ("HVHF" or "fracking") in the Basin is required to effectuate the Comprehensive Plan, avoid injury to the waters of the Basin as contemplated by the Comprehensive Plan and protect the public health and preserve the waters of the Basin for uses in accordance with the Comprehensive Plan." From the time the Commission first contemplated the regulation of unconventional gas development in the Basin, our Leagues have advocated that DRBC must consider all of the scientific data on the risks associated with fracking and then enact regulations that protect drinking water quality and quantity, human health, ecosystem integrity, and community safety. Today, sufficient empirical evidence exists to enact a ban on all fracking-related activity in the Basin and thereby avoid unnecessary harm to public health, critical natural resources and the environment. Among the body of evidence, we note the following.

In 2015, the New York Department of Environmental Conservation ("NY DEC") undertook an exhaustive examination of the potential impacts of HVHF as well as potential mitigation measures that might be used to address those risks (published as its Final Supplemental Generic Environmental Impact Study or SGEIS).[1] This review encompassed information on the same topics for which the Commission now requests public comment. On the basis of its assessment, NY DEC concluded that there was significant uncertainty regarding the effectiveness of mitigation measures, and that any future fracking scenario carried "significant adverse public health and environmental impacts." The policy determination to ban fracking in New York flowed directly from these findings. Since the publication of the Final SGEIS, the body of evidence of adverse impacts associated with HVHF has only grown.

The Environmental Protection Agency's ("EPA") 2016 study examining the effects of HVHF on drinking water, which included findings from Pennsylvania and elsewhere, highlighted the possibility of adverse impacts from a number of drilling-related activities, especially water withdrawals, spills, sub-surface injection of fracking fluids, and the discharge of inadequately treated wastewater.[2] The Pennsylvania Department of Environmental Protection has amassed a record of complaints and documented water contamination events related to HVHF which corroborate these risks and its impact to drinking water

[1] *Final Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program;* New York State Department of Environmental Conservation, 2015. https://www.dec.ny.gov/docs/materials_minerals_pdf/findingstatehvhf62015.pdf

[2] *Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States;* US Environmental Protection Agency, 2016. https://www.epa.gov/hfstudy

supplies.[3] This record demonstrates that current industry practices are not sufficient to safeguard drinking water supplies.

Allowing HVHF in the Basin would also lead to the fragmentation and loss of the forests that directly contribute to the exceptional water quality in the Special Protection Waters of the Delaware River. Data compiled by the US Geological Survey (USGS) in 35 Pennsylvania counties where unconventional gas drilling activity occurs, documented decrease in percent forest cover, increased forest fragmentation and decreased forest patch size, loss of interior forest and increases in forest edge.[4] These types of changes in forest cover, attributable to both the well pads and associated infrastructure including roads and pipelines, increase runoff and sedimentation;[5] impacts which would be inconsistent with the management of the Basin's Special Protection Waters under the DRBC Comprehensive Plan.

The preponderance of scientific evidence also indicates that human health is harmed by unconventional natural gas development. A 2016 review of 685 scientific papers determined that 84% of public health studies found public health hazards, elevated risks or adverse health outcomes. The same study also found that 69% of water quality studies contained findings indicating potential or actual water contamination.[6]

In light of the body of evidence of adverse impacts to human health, water quality, and the environment, and the NY DEC's determination that these risks cannot be adequately mitigated, we conclude that the Commission should ban fracking throughout the Delaware River Basin. What constitutes a risk which cannot be mitigated in New York will be similarly problematic elsewhere in the Basin and deserving of equally protective measures. We thus fully support the Commission in banning HVHF throughout the Basin.

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[3] *Water Supply Determination Letters;* Pennsylvania Department of Environmental Protection. http://files.dep.state.pa.us/OilGas/BOGM/BOGMPortalFiles/OilGasReports/Determination_Letters/Regional_Determination_Letters.pdf

[4] *Forest Cover changes due to hydrocarbon extraction disturbance in central Pennsylvania*, Journal of Maps, Roig-Silva et al. https://pubs.er.usgs.gov/publication/70170250; also *Landscape Consequences of Natural Gas Extraction in Bradford and Washington Counties, Pennsylvania, 2004-2010*, USGS, Slonecker, E.T. et al. https://pubs.usgs.gov/of/2012/1154/of2012-1154.pdf; *Landscape Consequences of Natural Gas Extraction in Greene and Tioga Counties, Pennsylvania, 2004-2010*, USGS, Slonecker, E.T. et al. https://pubs.er.usgs.gov/publication/ofr20121220

[5] *Shale Gas Development Impacts on Surface Water Quality in Pennsylvania*; Proceedings of the National Academy of Sciences, March 2013, Olmstead et al. http://www.pnas.org/content/110/13/4962

[6] *Toward an Understanding of the Environmental and Public Health Impacts of Unconventional Natural Gas Development: A Categorical Assessment of the Peer-Reviewed Scientific Literature, 2009-2015*; PLoS ONE 11(4): e0154164, April 2016, Hays, J. and Shonkoff, SBC. http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0154164

Exportation of water in the Delaware River Basin for hydraulic fracturing activities outside the Basin

The abundant water supplies in the Delaware River Basin are what allow it to provide high-quality drinking water to over 15 million citizens, 5% of the country's population, including Philadelphia and New York City. This accessible, clean water needs to be valued and managed to ensure its protection over the long term. Yet, all too often we see water taken for granted, especially in regions such as ours where supplies have been generous compared to other regions. The northeastern U.S. has not been subjected to the kind of intense drought seen in the west and southwest, yet climate change is causing more frequent drought conditions and is reducing winter snowpack and meltwater here as well. Everything possible needs to be done to protect existing water supplies from evolving natural threats compounded by man-made threats. This includes sea-level rise, more violent storms, ill-handled drought policies and inadequately-maintained water infrastructure. Man-made threats include adverse impacts to water quantity and contamination of clean drinking water by under-regulated and under-enforced practices of the chemical and fossil fuel industries.

In regions where the oil and gas industry performs hydraulic fracturing, including just outside the Basin, water supplies are being depleted and contaminated. In Pennsylvania, regulators are not effectively protecting water supplies from the oil and gas industry's hydraulic fracturing operations. Proposing to allow water exports from the Basin for fracking goes against all wisdom and common sense. By proposing to ban drilling, DRBC acknowledges fracking's unacceptable harms and risks to the watershed and water supplies. It would be illogical to enable water exports that would facilitate the negative impacts elsewhere.

However, DRBC does open its doors in this regard to the industry, even as it states in its supplementary information[7] that "withdrawals from surface and ground water in the amounts required for HVHF may adversely affect aquatic ecosystems, river channel, and riparian resources downstream, including wetlands, and may diminish the quantity of water stored in an aquifer or a stream's capacity to assimilate pollutants;" and further "because HVHF operations may significantly increase the volume of water withdrawn in a localized area, they may ultimately upset the balance between the demand on water resources and the availability of those resources for uses protected by the Commission's comprehensive plan, particularly during periods of low precipitation or drought." Proposed New 18 CFR Part 440, Section 440.4 states that it is the policy of the Commission to "discourage" the exportation of water from the Basin. However, it proposes to regulate, with Commission approval in the form of a docket, the "transfer of surface water, groundwater, treated wastewater or mine drainage water, at any rate or volume, for utilization in hydraulic fracturing of hydrocarbon bearing rock formations outside the Basin."[8] The docket is subject to the evaluation described by section 2.30.4 of the Water Code. This

[7] *18 CFR Parts 401 and 440, Supplementary Information*; Delaware River Basin Commission, p. 6. http://www.state.nj.us/drbc/library/documents/HydraulicFracturing/RulemakingNotice113017.pdf

[8] *Proposed New 18 CFR Part 440 - Hydraulic Fracturing in Shale and Other Formations, Subchapter B – Special Regulations, 440.4*; Delaware River Basin Commission, p. 4. http://www.state.nj.us/drbc/library/documents/HydraulicFracturing/18CFR440_HydraulicFracturing_draft-for-comment_113017.pdf

section is exactly the same for fracking water exports as they are for other water exports. The only change is that now DRBC requires review for any amount of withdrawal, as opposed to the existing 100,000 gallons-per-day minimum.

We appreciate that there is a delicate balancing act the DRBC has to perform in order to supply water for existing uses such as: drinking water, reservoirs, power plants, agriculture, tourism, and recreational activities, among others. In all of this, DRBC must ensure the sufficient recharge volume to guard ground water and aquifers against drought periods and to allow for reservoirs to be at safe levels. Water project operations and state water allocations typically are based on long-term hydrological trends. Scientists are predicting that significant deviations from past trends may result in difficult challenges for water managers and water users alike. The EPA website under a section titled "Climate Impacts in the Northeast" refers to these and other challenges. Drought, higher temperatures, and sea-level rise are challenges which will become more consequential with time. Increasing amounts of water may need to be diverted from reservoirs to the lower Basin to keep incoming saltwater from intruding up-river. These factors may cause reservoir levels to dip too low. If this happens, evaporation rate increases, among other factors, can degrade water quality. Water from the Upper Delaware River is used by 8+ million people in New York City and Westchester and does not get filtered, so it is essential that it be of the highest quality.

DRBC notes that "the acquisition of water for use in HVHF may result in modifications to groundwater levels, surface water levels, and stream flows."[9] Many of the conditions contained in the existing Water Code would fail to protect the species, habitats and stream quality where water withdrawals for fracking may occur. One example is the use of the Q7-10 pass-by flow (the flow which occurs for a period of seven consecutive days one time in 10 years, considered "drought flow") which DRBC uses to limit the amount of water that could be withdrawn to ensure that streams could not be overdrawn. This parameter does not take into account seasonal fluctuations of flow; fluctuations to which aquatic life are accustomed. DRBC should not use Q7-10 pass-by in managing for the ecological health of aquatic species, but instead should develop flow management protocols grounded in more current ecological studies.

Large water withdrawals can diminish shallow groundwater and aquifers. If withdrawals deplete the groundwater that is necessary to recharge downstream flows, there may be discharges from aquifers to make up for the loss. Pumping can disrupt the flow of the groundwater that feeds existing wells or natural wetlands, seeps and springs. Withdrawals can deplete or disrupt water needed to support forest, wetlands, agriculture and other current uses in the Basin. Water volumes needed to dilute pollution can be taken away. In addition to the water depletion itself, the water export acquisition and delivery could involve thousands of truck trips-- and miles of roads and acres of parking lots needed by the trucks—as well as the building of pipelines and other infrastructure related to acquiring and distributing the water. All of this would have serious impacts on habitats, water quality, forests, streams and soils as well.

[9] *Supplementary Information, 18 CFR Parts 401 and 440*; Delaware River Basin Commission, p. 6. http://www.state.nj.us/drbc/library/documents/HydraulicFracturing/RulemakingNotice113017.pdf

DRBC commissioned a report by The Nature Conservancy to study seasonal impacts, ecological flows, and parameters which will be affected by water withdrawals.[10] This and related research conducted with the possibility of fracking water exports in mind, have demonstrated that flow alterations, such as the lowered flows that would be expected with fracking water withdrawals, adversely impact various fish guilds and that these adverse impacts are not limited to the seasonal low flow periods of the summer.[11] The Nature Conservancy report also identifies adverse impacts to macroinvertebrates, mussels, and other biota. Although these studies provide useful information for developing protective management principles, the Commission has not developed flow ecology-based management protocols. It did not enact any of the suggested protocols or change its existing application requirements for fracking water withdrawals. Importantly, the researchers stated that they did not have enough available information to study specifically how fracking water withdrawals would affect ecosystems. This is a fact borne out by biologists at University of Central Arkansas, who found that fracking dangerously depletes water levels in up to 51% of streams in Arkansas. The average well in the study used approximately 5 million gallons of freshwater from small streams over a two-to-five-day period when the hydraulic fracturing occurs. The researchers said that they "could not obtain detailed data on how much water was pumped from which stream and when" and that as a result "little is known about how much water can be withdrawn from these streams without impacts on fish and other aquatic species." [12]

DRBC's background information documents other reasons why water withdrawals for fracking are so much riskier than those for other uses. The section titled "Consumptive Use" quotes Susquehanna River Basin Commission (SRBC)'s statistics that 96% of water withdrawn for fracking is "consumptively used in the hydraulic fracturing process and that the balance of the water is consumptively used for other activities at the drilling pads, such as well drilling, preparation of drilling muds and grout, dust control, maintenance operations, and site reclamation." It states that in comparison, 90% of water withdrawn for existing domestic and commercial uses is returned to the Delaware River Basin's waters, either by infiltration into aquifers or by discharge to surface waters after wastewater treatment. Most of the fresh water which would be exported for fracking would be permanently removed from the hydrologic cycle.

DRBC recognizes that in addition to its consumptive and polluting nature, the potential demand of freshwater from the gas industry could be tremendous.[13] It uses EPA and SRBC statistics in an attempt

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[10] *Ecosystem Flow Recommendations for the Delaware River Basin;* The Nature Conservancy, *2013.* http://www.nj.gov/drbc/library/documents/TNC_DRBFlowRpt_dec2013.pdf

[11] *Environmental Flow Analysis for the Marcellus Shale Region*, Cornell University et al., 2016. https://issuu.com/rosehessmiller/docs/aquatic_flows_applcc_final_report/2?ff=true&e=15745352/15125858

[12] *Water Stress from High Volume Hydraulic Fracturing Potentially Threatens Aquatic Biodiversity and Ecosystem Services in Arkansas, United States;* Environmental Science & Technology, Environ. Sci. Technol., Entrekein et al., 2018, 52 (4), pp 2349–2358 **DOI:** 10.1021/acs. https://pubs.acs.org/doi/abs/10.1021/acs.est.7b03304

[13] *Supplementary Information—Water Acquisition*; Delaware River Basin Commission, p. 6. http://www.state.nj.us/drbc/library/documents/HydraulicFracturing/RulemakingNotice113017.pdf

to quantity the potential demand, yet most of these numbers are from before 2013, and actual demand could be significantly higher given technological advances that now allow lateral pipes to be drilled up to four miles long. SRBC's and EPA's statistics regarding hydraulic fracturing in the Marcellus show a minimum of 4.1 million gallons of fracking fluid used per frack and that at least 84% of the fracking fluid is "fresh" water from surface water and groundwater surfaces; and the remaining 16% is recycled fracking wastewater. One well can be fractured multiple times. DRBC notes the fact that since 2013, the latest year for which it quotes statistics, well bores were beginning to be elongated, and the average amount of fracking water per frack event rose to between 5.1 to 6.5 million gallons. However, beyond what DRBC reports, water usage per well continues to rise. One report shows that in Ohio and West Virginia, there has been an 8-12% annual increase in well bore lateral lengths in the major shale basins since 2013. This has translated to an average amount of 9.7 million gallons of water used per fracked well. Up to 87 million gallons of water can be used by one super-lateral well. This also results in increasingly greater amounts of wastewater. [14]

At a potential 10 to 20 million gallons per well, a "water raid" on the Basin by the industry may occur and impede usages for domestic, recreational, and current industrial purposes. Even though DRBC proposes restrictions during certain periods such as drought and low-flow conditions, when a well is being fracked it needs water at hand and cannot wait for surface and ground water to replenish, so there would be an incentive for the oil and gas industry to ignore discouragement and restrictions. This industry drains water sources elsewhere in areas near the Basin, such as northeastern Pennsylvania and Susquehanna County where drilling is concentrated. This is why the industry would like to access water resources in the Basin. DRBC has not completed any cumulative impact studies related to water withdrawals for fracking activities, a step which is vital to making informed management decisions on proposed water withdrawals as its regulatory partners, such as the New York City Department of Environmental Protection, strongly advised back when DRBC initially proposed hydraulic fracturing regulations.[15] Given the unassessed threats, no regulations to permit the exportation of water for this use should be considered unless and until DRBC first studies and obtains an unequivocal, objectively acceptable result regarding the potential cumulative impacts of water exportation for fracking operations and establishes fully funded monitoring and enforcement mechanisms. In the absence of either flow ecology-driven management principles or a cumulative impact assessment, and without adequate resources for monitoring and enforcement, no water exports for fracking should be permitted.

As we wrote in a letter to the DRBC in 2017, an economic study estimated that the value of the Delaware River Basin exceeds $22 billion per year, with public drinking water supplies valued at $3.1 billion.[16] It also estimated a value of $425 million for potential Marcellus Shale gas extraction. The $425

[14] *The Freshwater and Liquid Waste Impact of Unconventional Oil and Gas in Ohio and West Virginia*; Ted Auch, October 2017. http://midatlanticwrc.org/event-info/agenda/the-freshwater-and-liquid-waste-impact-of-unconventional-oil-and-gas-in-ohio-and-west-virginia/

[15] *Oral testimony from DRBC Hearing on Draft Natural Gas Development Regulations;* NYC DEP Paul V. Rush, February 22, 2011, Liberty, NY. http://www.state.nj.us/drbc/library/documents/NGC/Agencies/NYCDEP022211.pdf

[16] *Economic Value of Nature and Ecosystems in the Delaware River Basin*; Journal of Contemporary Water Research & Education by Gerald J. Kauffman, August 2016. http://www.wra.udel.edu/wpcontent/uploads/2016/07/EconomicValueofNatureandEcosystemsintheDelawareRiverBasinGJKauffman2016.pdf

million was for all fracking activity, so the value of fracking water exports (and wastewater imports) would be a fraction of that. We reiterate here that unconventional gas drilling operations represent a short-term, boom-bust economy that brings long-term risks and potentially irreversible impacts to drinking water, and we assert that the risks of water exports (and wastewater imports) do not justify any potential benefit.

Accepting waste into the Basin from hydraulic fracturing activities outside the Basin

DRBC proposes regulations for "produced water" (which we will refer to as "wastewater") from hydraulic fracturing in 18 CFR Part 440; Subchapter B – Special Regulations, 440.5. The Commission states that it "discourages" the importation of fracking wastewater into the Basin. However, it goes on to leave the door open to the oil and gas industry. It summarizes related wastewater policies, and sets out requirements for approval in order to grant permits for treated fracking wastewater.[17] Our comments below respond to the inadequacy of the stated requirements due to the unique properties of fracking waste, and why this waste needs to be completely prohibited from the Basin.

Chemicals in Fracking Wastewater

Water used for hydraulic fracturing operations contains a complex mixture of chemicals that play specific roles, including: reducing friction between fluid and pipes, changing the viscosity of the fluid at different points in the process, killing bacteria and other organisms, preventing corrosion of pipes, reducing surface tension in the liquid and dissolving other chemicals and helping them mix with water.[18] More than 1,084 different chemicals have been identified as having been used in fracking water at some time.[19] However, this list cannot be considered exhaustive because manufacturers of many commercial fracking fluids claim that their formulas are confidential.

Commercial fracking fluids often contain moderate to high levels of the BTEX group of chemicals (benzene, toluene, ethylbenzene and xylene).[20] Benzene is a known carcinogen[21] and ethylbenzene is predicted to be a human carcinogen on the basis of its carcinogenic effects in rats and mice. It is particularly noteworthy that a recent study has found that signs of endocrine disruption have been

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[17] *Hydraulic Fracturing in Shale and Other Formations, Proposed New 18 CFR Part 440, Subchapter B – Special Regulations, 440.5*, Delaware River Basin Commission, 2018, pp. 4-8. http://www.state.nj.us/drbc/library/documents/HydraulicFracturing/18CFR440_HydraulicFracturing_draft-for-comment_113017.pdf

[18] *Frac Focus – What Chemicals Are Used*; Frac Focus Chemical Disclosure Registry. https://fracfocus.org/chemical-use/what-chemicals-are-used

[19] *Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States;* US Environmental Protection Agency, 2016, p. ES-42. https://www.epa.gov/hfstudy

[20] *Fracking's Toxic Loophole*; Environmental Integrity Project, October 22, 2014. http://environmentalintegrity.org/wp-content/uploads/FRACKINGS-TOXIC-LOOPHOLE.pdf

[21] *MSDS (Materials Safety Data Sheet) for benzene*. Science Lab. http://www.sciencelab.com/msds.php?msdsId=9927339

observed in people chronically exposed to levels of BTEX chemicals orders of magnitude lower than currently listed EPA standards.[22] Use of these chemicals should raise a red flag, but they are listed only as petroleum distillates at the FracFocus.org site.

Other chemicals listed on the site include methanol[23] (possibly mutagenic/teratogenic, causes blindness); ethylene glycol[24] (toxic on ingestion) and 2-butoxyethanol[25] (toxic through ingestion, inhalation and skin contact; damage to kidney, liver, central nervous system). There is also evidence that polyacrylamides used in the process break down during use[26] to acrylamide[27] (known carcinogen, nerve and organ damage). Biocides are likely to have moderate or higher levels of human toxicity, but the toxicological effects of many have not been studied. Glutaraldehyde, listed as a biocide, is highly toxic and damages male and female reproductive systems.[28]

Water returned from or produced in fracking operations will contain a significant number of contaminants that are dissolved or washed up from the shale layers thousands of feet below the surface of the earth. The EPA study[29] identified 599 such materials including metals such as aluminum, barium, cadmium, chromium, copper, lead, magnesium, manganese, mercury and strontium and the metalloid, arsenic. Radionuclides such as radium, uranium and thorium are present and may be in water-soluble or insoluble forms. The produced water is likely to have high concentrations of sodium chloride, bromides, bicarbonates and sulfates.

Testing recovered water

Accurately testing for chemicals of concern in the wastewater will be difficult: First, there are many materials considered by most authorities to be toxic or potentially toxic. The NY DEC, for instance, lists 154 substances as contaminants of concern.[30] Second, 80-90 percent of the chemicals found in the

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[22] *Clarifying carcinogenicity of ethylbenzene*;, Regul Toxicol Pharmacol, 2010 Nov; 58(2): 167-172, James Huff, Po Chan and Ronald Melnick, Published online 2010 Aug 17. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2989615/

[23] *MSDS for methanol* http://www.sciencelab.com/msds.php?msdsId=9927227

[24] *MSDS for ethylene glycol* http://www.sciencelab.com/msds.php?msdsId=9927167

[25] *MSDS for 2-butoxyethanol* http://www.sciencelab.com/msds.php?msdsId=9923187

[26] *Chemical Degradation of Polyacrylamide during Hydraulic Fracturing*; Environ. Sci. Technol 52,1 327-336, Xiong, Roman-White, Miller, et al. https://pubs.acs.org/doi/abs/10.1021/acs.est.7b00792

[27] *MSDS for acrylamide* http://www.sciencelab.com/msds.php?msdsId=9927422

[28] *MSDS for glutaraldehyde* http://www.sciencelab.com/msds.php?msdsId=9924162

[29] *Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States;* US Environmental Protection Agency, 2016, p. ES-42. https://www.epa.gov/hfstudy

[30] *Revised Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas, and Solution Mining Regulatory Program, Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop*

wastewater have not been adequately characterized as to their toxicity to humans or to aquatic species, but there are valid reasons to suspect that a significant number may be toxic and/or carcinogenic. Finally, designing a sampling protocol that will accurately reflect the amounts of both soluble and insoluble contaminants will be extremely difficult.

If the wastes were clear, uniform solutions, obtaining representative samples would not be a problem. But fracking wastes are generally turbid mixtures with sand and soil mixed with various other minerals and dissolved salts. Sampling only the liquid solution will generally give a very inaccurate picture, with many metallic elements under-represented.

The metals brought up with the fracking fluids will be present in a great variety of metallic complexes and salts of varying solubilities. The ratio of soluble/insoluble compounds for any given metal will depend on a number of factors including temperature, pH, other minerals present and even how long the brine has been stored under the existing conditions.

Metals may form complex salts involving several different elements that can take months to form. In the presence of sulfur compounds,[31] bacterial actions can, over time, result in the formation of new salts and mixed metal complexes that display very different solubilities.

If tests are performed on untreated wastes to determine what methods should be used to remove toxic components, both the solid and liquid phases would need to be tested for all compounds of concern. If the wastes have already been treated with typical physico-chemical treatment that causes solids and many metallic species to precipitate, the testing of the liquids will be simpler. But tests would still need to be done on the precipitated material to determine if the levels of dangerous substances, such as radionuclides, will present dangers under long-term storage. (See section on Disposal of Solids.)

It should be clear that characterizing the liquid wastes as to toxic components is a complex issue. It would be dangerous to assume that the composition of different batches of wastes will be similar. Under these circumstances, it seems unlikely that the funding listed in the draft regulations ($5,000 for characterizing the need for treatment) would be nearly sufficient to cover costs.[32]

Removal of Heavy Metals and Radioactive Materials

One of the simplest ways to remove contaminants from water is to add agents, such as lime, that cause many metals to precipitate as solids. The vast number of constituents, inorganic and organic, in fracking wastes and the high level of toxicity of some of the materials render this treatment inadequate for

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the Marcellus Shale and other Low-Permeability Gas Reservoirs; New York State Department of Environmental Conservation, September 2011, Table 5.9 p. 5-102. http://www.dec.ny.gov/data/dmn/rdsgeisfull0911.pdf

[31] *The ecology and biotechnology of sulphate-reducing bacteria*; Nature Reviews Microbiology, volume 6, p. 441–454, May 2008, Muyzer, G and Stams, A. https://www.nature.com/articles/nrmicro1892

[32] *Administrative Manual and Special Regulations Regarding Natural Gas Development Activities; Additional Clarifying Amendments, A Proposed Rule by the DRBC*; Federal Register 01/12/2018, Table 1 to § 401.43, "Application Fees." https://www.federalregister.gov/documents/2018/01/12/2018-00344/administrative-manual-and-special-regulations-regarding-natural-gas-development-activitie

complete treatment of such wastes. While the concentrations of the most toxic metals may be reduced enough that normal industrial wastes might be treated and released into large volumes of water, the huge volume of fracking waste that would be treated means that the cumulative amounts of these toxins entering the river would be unacceptably high.

The most difficult purification problem arises from radionuclides including uranium, radium and thorium that are present in Marcellus shale. The presence of large amounts of barium in fracking wastes greatly increases the solubility of radium.[33] High levels of sodium chloride,[34] present in both the fracking solutions and the underground water from ancient seas, also increases the solubility of (BaRa)SO4 and uranium oxide.

Precipitation techniques are not sufficiently effective in removing these contaminants.[35] Although advanced techniques such as reverse osmosis, ion exchange and others exist,[36] they are not economically feasible for treating large quantities of fracking wastewater. We must not allow these contaminants into the Delaware River under any circumstances.

Studies carried out under the direction of Duke University's Professor Avner Vengosh [37] have shown that two radium isotopes and their decay products have been found in unacceptably high sediment levels in streams in which wastewater from conventional gas drilling was discharged after treatment in a central waste processing facility. Radium and other radionuclides tend to accumulate in sediment, where bacterial action will convert them into organic forms that can enter the food chain. Eventually they will bio-accumulate in the large birds such as herons and sport fish such as striped bass and tuna. Once present in the Delaware Estuary and Bay, high levels of radionuclides will likely persist for many millennia, poisoning this vital resource and rendering marine fish from it unsafe for countless generations to come.

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[33] *Barium sulphate method for radium-226 analysis by alpha spectrometry*; Internal Report 501, June, Supervising Scientist, Darwin. Medley P, Bollhöfer A, Iles M, Ryan B & Martin P. 2005. Unpublished paper. https://www.environment.gov.au/system/files/resources/f86ad030-3a76-4e72-bc75-a43274ec0b11/files/ir501.pdf

[34] *Solubility of uranium oxide and radium sulfate in brines*; Nebelung, C. http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/36/055/36055503.pdf

[35] *Unconventional Oil and Gas Extraction Effluent Guidelines*; Federal Register, US Environmental Protection Agency. https://www.epa.gov/eg/unconventional-oil-and-gas-extraction-effluent-guidelines

[36] *New trends in removing heavy metals from industrial wastewater*; Arabian Journal of Chemistry, Volume 4, Issue 4, October 2011, pages 361-377, M.A.Barakat. https://www.sciencedirect.com/science/article/pii/S1878535210001334

[37] *Sources of Radium Accumulation in Stream Sediments Near Disposal Sites in Pennsylvania: Implications for Disposal of Conventional Oil and Gas Wastewater*; Nancy Lauer, Nathaniel Warner, Avner Vengosh, Environmental Science and Technology, DATE Jan. 4, 2018, DOI: 10.1021/acs.est.b04952 https://nicholas.duke.edu/about/news/radioactivity-oil-and-gas-wastewater-persists-pennsylvania-stream-sediments

Removal of Bromides, Bromates and Trihalomethanes
Fracking wastewater usually contains high concentrations of bromine salts. During treatment of drinking water by municipalities or purveyors, treatments such as ozonation and chlorination oxidize them to bromates. In the presence of organic compounds they can react to form highly toxic trihalomethanes.

Although trihalomethanes can be removed by adsorption on activated carbon; and bromates and bromides can be removed by selective oxidation to release free bromine gas, these operations would be expensive for large volumes of water. Failing to remove them would have deleterious effects on the Delaware Estuary and Bay. Thus, it is unacceptable to allow their disposal in any ground or surface waters.

Removal of Organic compounds
Although solvents such as the BTEX family and other organic compounds may be removed by absorption on active chemical surfaces such as activated carbon, this will be an expensive approach. The used substrate would need to be recovered by heating and the organic vapors condensed and collected. The mixtures could be reused. If not, they should be incinerated with care taken to avoid dioxin formation. Overall, great care should be taken to keep any BTEX chemicals from contaminating water or air because of their ability to function as endocrine disruptors at extremely low concentrations.[38]

Disposal of treated liquids
As is clear from the above discussion, currently available approaches do not provide cost-effective methods to remove all of the many toxic materials from fracking wastes. However, even if that were possible, disposing of the treated water would still present serious problems because the TDS (total amount of dissolved solids) is so high. In high concentrations even "benign" materials such as sodium chloride can be toxic for aquatic organisms living in fresh water. This can present a particular problem in Zone 5, which begins at the Delaware/Pennsylvania border. The regulations indicate that liquids with TDS levels of 1000mg/l could be disposed of in the Delaware River in northern Delaware and Southern New Jersey. But tests have shown that even TDS levels less than 500mg/l (the maximum level allowed further north) have clear negative effects on fish spawn of some species.[39] For instance, 350 mg/l TDS reduced spawning of striped bass (Morone saxatilis) in the San Francisco Bay-Delta region, and concentrations below 200 mg/l promoted even healthier spawning conditions for fish.[40] This region of the Delaware River is vital for spawning the endangered Delaware River species of Atlantic sturgeon.

[38] *New Look at BTEX: Are Ambient Levels a Problem?;* Environ. Sci. Technol., 2015, *49* (9), p. 5261–5276, Bolden, A.L. et al. https://pubs.acs.org/doi/abs/10.1021/es505316f

[39] *Development of a dynamic water quality simulation model for the Truckee River*; Earth Metrics Inc., Environmental Protection Agency Technology Series, 1987, Hogan, C.M. and Papineau, M., Washington D.C.

[40] *California, Final Report to the State of California, San Francisco Bay-Delta Water Quality Control Program*; Kaiser Engineers, State of California, Sacramento, CA (1969) as quoted in a private Communication from the Delaware Riverkeeper (Feb. 2018)

Disposals of solids

The goal of treating wastes is to make them innocuous enough to dispose of in ordinary municipal landfills, I.e. there must be only limited emissions of toxic gases or nuclear radiation and limited amounts of toxic solids that have any significant solubility. If these conditions are not met, disposal in ordinary landfills (which generally have only plastic liners underground and no protection above ground) is problematic. Toxic gases and emission of particles from nuclear decay will threaten the health of workers in the area and could be dangerous for others if closed landfills are developed. Landfills anywhere in the Delaware River Basin will be subject to leaching from rainfall and the leachate can drain into tributaries of the Delaware River or into underground aquifers that either lead to the river or to waters that are used for drinking water. The situation is exacerbated when, as is frequently the case, the landfills are located near the tidal zone of the Delaware River. Sea-level rise and storm surges can result in non-soluble materials washing into the River. Most treatments of hazardous wastes rely on adding chemicals that will react with toxic materials such as heavy metals to form nearly insoluble compounds. In some cases, the degree of insolubility achieved by typical treatments, such as addition of lime, is not adequate when the landfills are subject to the level of rainfall common in the Delaware River Basin. A number of circumstances can result in toxins leaching into surrounding areas and waterways. For instance:

- The metal salts are not completely insoluble. Rainwater can wash away dissolved salts, allowing more to be gradually dissolved.
- Decomposition of organic material can lead to formation of acids that can lower the pH, rendering some metal salts more soluble.
- In the presence of anaerobic bacteria and sulfur-containing compounds, metals can undergo oxidation/reduction reactions that result in the formation of more soluble salts.
- Metals can form mixed-metal salts that will have different solubilities than the corresponding single metal salts.
- Radioactive decay of unstable isotopes can lead to new radionuclide salts of higher or lower solubilities.

Thus solid wastes from treated fracking wastewater cannot be considered as permanently inert and insoluble. Leaching or dispersion in flood water will always be a concern.

Disposal of drill cuttings

One issue that is not covered by these proposed regulations is the deposition of drill cuttings in municipal waste facilities. It is our understanding that drill cuttings from gas drilling operations in Pennsylvania are routinely deposited in facilities in the Delaware River Basin. These depositions present even more serious problems than those of treated fracking wastes because cuttings taken from lateral drilling lines in deep oil shale will contain higher concentrations of radionuclides per volume of waste material because the radioactive materials have not been diluted with sand and precipitants.

The current practice has been to allow drill cuttings to be deposited with enough loads of standard wastes that the net radiation would not be expected to exceed acceptable levels. What has happened in fact is that radiation levels have frequently been found to be higher than expected, or allowed. This could be due to a) inadequate monitoring allowing too many radioactive loads: b) poor measurements of radioactivity in the individual batches; and c) radioactive decay of the original radionuclides leading to

less stable elements that decay even more quickly. This is a particular problem if radon gas from radium decay is trapped in the waste solids.[41]

Storage of these dangerous materials in municipal waste facilities presents dangers associated with leaching which can be expected to accumulate and become more dangerous in future decades. The DRBC must take responsibility for preventing a serious problem by properly characterizing the waste as hazardous and prohibiting this unsafe disposal practice.

Conclusion

As citizens, we have a basic right to clean drinking water and a healthy environment in which to live. Fifteen to seventeen million people drink water from the Delaware River watershed. Accordingly, it is deeply disturbing that the Commission would go forward with drafting regulations based on an assumption that it could control and monitor activities when the basic information it needs to protect the environment and the public has not been assembled and evaluated, the studies have not all been done; particularly in the context of federal regulations which absolve the oil and gas industry from having to disclose all the chemicals they use for hydraulic fracturing operations and from adhering to the regulations set forth in the Clean Air Act, Clean Water Act, Drinking Water Act, and the Superfund Act. Additionally, this industry currently has no technology allowing them to feasibly remove all the radioactive materials and other dangerous elements from the massive volumes of wastewater which flow back, thus guaranteeing pollution no matter what.

You cannot monitor and regulate what you don't know.

State environmental protection agencies are currently struggling with funding cutbacks that curtail the availability of staff to carry out their full responsibilities. Further, the proposed DRBC regulations do not make clear how the DRBC would monitor compliance and issue and enforce violations to ensure that the water quantity, water quality and public health are protected and preserved. Since the proposed regulations have not made this clear and the DRBC has no enforcement police, who would be the responsible party to guarantee that regulations are being met?

As stated above, we also ask the Commission to consider after having determined that HVHF operations carry too much risk to be permitted within the Delaware River Basin, how it can justify permitting water exports and wastewater imports to facilitate HVHF operations elsewhere.

Based upon the aforementioned League positions and the science referred to in these comments, our Leagues urge the Delaware River Basin Commission to implement the proposed ban on drilling in full in the Basin and to also ban all activities related to hydraulic fracturing in the Basin, including the importation of drilling waste from the oil and gas industry and the exportation of water from the Basin for use in hydraulic fracturing elsewhere.

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[41] *Understanding the radioactive ingrowth and decay of naturally occurring radioactive materials in the environment: an analysis of produced fluids from the Marcellus Shale;* Environ Health Perspect 123:689–696**,** Nelson AW et al. 2015. https://ehp.niehs.nih.gov/wp-content/uploads/123/7/ehp.1408855.alt.pdf

Thank you for your consideration.

Sincerely,

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